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The Calculus of Quick Commerce: Demand, Pricing, Elasticity and Profit Optimization in India

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ABSTRACT

The fast-paced evolution of digital retail requires the enhanced application of quantitative analysis of decisions related to pricing, demand forecasting, inventory control and fulfillment. In this paper, there is a mathematical treatment of the modern business model of quick commerce and how the tools of calculus and business mathematics can be employed in order to analyze the decisions related to it. For this purpose, a linear inverse demand function is constructed that sets the connection between price and quantity. Using this connection, a quadratic function of revenue is developed and then marginal revenue is found out via differentiation. Further, a nonlinear cost function that reflects the fixed operating cost, variable costs and increasing marginal cost is constructed. Using the profit function, its first derivative is found in order to find out the stationary level of output and the second derivative helps in defining the characteristics of this point. Moreover, price elasticity is computed in order to measure the degree of sensitivity of demand to the price change. The numerical values are fictional and are used for the purpose of demonstrating the process of mathematical analysis. The study is contextualized within the context of digital commerce within India, which entails the emergence of quick commerce and an open digital commerce infrastructure like ONDC. Calculus will serve as a tool for developing an interpretable and coherent relationship between mathematical theory and the practical aspects of commerce.

***Keywords**: Calculus, Business Mathematics, Quick Commerce, Demand, Pricing, Elasticity, Marginal Revenue, Marginal Cost, Profit Optimization, Digital Commerce.*

Introduction

Commercial activities have gradually shifted from decision-making processes that relied mostly on arithmetical calculations to data-driven decision-making process.

Online merchants are always faced with decision-making problems relating to price, demand of customers, discount rates, frequency of orders, stock levels, shipping capabilities and operational costs.

All the variables mentioned above are related to each other in some way or another, and mathematics helps to describe the relationship among all those variables in a formal way.

Calculus becomes useful especially where change is involved.

Derivative is the measure of the rate at which one variable changes with respect to another, and it is therefore the basis of marginalism.

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Marginal revenue, marginal cost, marginal profit, marginal product and elasticity are some of the applications of this idea in business and economics.

Second derivatives also help to establish whether a stationary point is maximum or minimum given some assumptions.

Quick commerce offers a good modern example to prove this point.

It relies on a business model that integrates digital ordering with local inventory and fulfilment plus delivery.

This creates an interesting mathematical business case since an increase in sales could potentially result in higher income and higher procurement, fulfilment, inventory, and delivery expenses.

The current paper attempts to provide an illustrative business case and not to replicate the confidential business economics of any specific company.

Contemporary Business Context

Quick commerce has emerged as an essential element of India's digital-retail industry.

Quick commerce usually refers to an operating model based on local fulfillment centers, digital orders, products in stock, and fast last-mile deliveries.

Publicly reported information for 2026 reveals growing competition between the companies and further investments in quick-commerce activities.

An especially noteworthy example includes the shift towards the inventory-based operations strategy.

As publicly reported in August 2026, there were plans regarding Swiggy Instamart moving into the inventory-based operations strategy.

Such strategy could influence procurement, pricing, ownership, inventory management, working capital, and supply chain decision making.

All of these factors create a real-life scenario for exploring demand, cost, and profit through calculus.

However, this paper does not try to quantify the real-life performance of Instamart or any other firm.

This business scenario is employed for the sake of introducing a mathematical case where all the numerical coefficients are exemplary.

Statement of the Research Problem

The problem of research discussed in this article is the translation of modern business issue into the mathematical model.

A digital store should consider possible changes in price concerning the demand, the way how quantity and price determine the company’s income, changes in the cost due to the increase in the quantity produced and the way how to choose the point of operation from the economic standpoint.

The problem is in linking of the business issue with such mathematical instruments that could be comprehensible enough, however, they would allow demonstrating the marginality and optimization.

In this regard, the article suggests a series of demand, income, cost and profit functions and uses differentiation at every step.

Objectives of the Study

- To illustrate how calculus is applied to a current commercial issue.
- To generate a linear equation of demand for an illustrative quick-commerce industry.
- To develop the revenue and marginal revenue equations.
- To generate a nonlinear cost equation for an illustrative inventory-driven operational setting.
- To obtain the profit equation and find a potential maximized profit output by using calculus.
- To use the second derivative test on the profit equation.
- To calculate the point elasticity of price at the operating point.
- To analyze the impact of different cost assumptions on the mathematical solution.
- To describe how the model can be modified based on real business data.

Conceptual Foundation

Mathematical underpinnings of the study include four concepts, which are closely related.

A demand function defines the relationship between price and quantity demanded.

Revenue function takes both price and quantity into account, while cost function shows the amount of resources necessary to produce at a certain quantity.

Profit is defined as the difference between revenue and cost.

Derivative of a function determines its marginal effects.

In other words, if R(Q) is a revenue function and C(Q) is a cost function, then dR/dQ is marginal revenue and dC/dQ is marginal cost.

First-order condition for interior profit maximum is expressed by the equation MR=MC.

Second derivative determines curvature of the profit function.

Elasticity measures responsiveness in relative terms.

For example, price elasticity of demand usually has a negative sign because it refers to downward sloping demand relationship.

Methodology

This study applies a descriptive, analytical, and mathematical modeling method.

Public domain information is employed to describe the current business environment.

The mathematical element involves a fictional scenario aimed to show an application of calculus in a practical business situation.

The analytic process involves the following steps:

- Define the price, quantity, revenue, cost and profit variables.
- Define a linear inverse demand function.
- Derive the revenue function based on price multiplied by quantity.
- Differentiate the revenue function to derive the marginal revenue.
- Derive a non-linear cost function as an example.
- Differentiate the cost function to derive the marginal cost.
- Derive the profit function as the difference between the revenue and cost functions.
- Solve the first order condition for the stationary level of output.
- Check the stationary point with the second derivative.
- Evaluate the price elasticity at the chosen point.
- Conduct sensitivity analysis by altering the coefficient of the variable cost.
- Point out how the illustrative model can be estimated using the real data.

One of the methodological features is that the numerical coefficients are not empirical estimations.

Instead, they are chosen merely in order to make the mathematical equations.

Variables and Notation

Symbol	Meaning	Interpretation
Q	Quantity of units/orders	Units in the analysis period
P	Price	₹ per unit/order
R(Q)	Revenue function	Total revenue
C(Q)	Cost function	Total operating cost
π(Q)	Profit function	Revenue minus cost
MR	Marginal revenue	Change in revenue from an additional unit
MC	Marginal cost	Change in cost from an additional unit
E	Price elasticity	Responsiveness of quantity to price

Development of the Linear Demand Model

Here is the illustrative example of an inverse demand function:

$P = 240 – 0.002Q$

This function indicates that the price in the model falls when the quantity rises.

Transforming the function into the form of quantity demand, we get:

$Q = 120000 – 500P$

The derivative $dQ/dP = -500$ shows the slope of the demand function.

The negative sign in the derivative corresponds to the conventional assumption that the higher the price, the smaller the quantity demanded.

In empirical research, the slope and the intercept of the function should be estimated.

Revenue as a Quadratic Function

Revenue can be stated as follows:

$R(Q) = P \times Q$

Plugging in the inverse demand function:

$R(Q) = (240 - 0.002Q) \times Q$

$R(Q) = 240Q - 0.002Q^2$

The revenue function is a quadratic one even though the demand function is linear.

This is a crucial business mathematics principle where the multiplication of a variable price by variable quantity results in a nonlinear revenue function.

Marginal Revenue

Derive the marginal revenue function with respect to Q:

$MR = dR/dQ = 240 - 0.004Q$

The marginal revenue falls with increase in Q in the illustrative example.

This outcome arises from the fall in price that is necessitated in order to sell extra units in accordance with the assumed demand relation.

Illustrative Cost Function for an Inventory-Based Business

Let the cost function be:

$C(Q) = 1{,}800{,}000 + 70Q + 0.0008Q^2$

The fixed part is made up of costs that are constant regardless of the number of units produced during the period.

The linear part shows variable operating costs.

The positive quadratic part means that the marginal cost will increase with increased activities, which is one way of capturing effects of increased capacity or fulfillment complexity on cost.

The marginal cost can be derived as follows:

$MC = dC/dQ = 70 + 0.0016Q$

Profit Function

Profit is revenue less cost:

$\pi(Q) = R(Q) - C(Q)$

$\pi(Q) = (240Q - 0.002Q^2) - (1{,}800{,}000 + 70Q + 0.0008Q^2)$

$$\mathbf{\pi(Q) = -1{,}800{,}000 + 170Q - 0.0028Q^2}$$

Profit Optimization

Differentiate the profit function:

$\pi'(Q) = 170 - 0.0056Q$

Set the first derivative equal to zero:

$170 - 0.0056Q = 0$

Q* = 30,357.14 units

The second derivative is:

$\pi''(Q) = -0.0056$

Since the second order derivative is negative, the profit curve is concave under the given set of assumptions.

The critical point will thus be a maximum for the sample profit function.

The price is found using the inverse demand function equation:

$P^* = 240 - 0.002(30{,}357.14) \approx$ Rs 179.29

This is just a mathematical result based on the hypothetical model.

It should not be considered the real price of the quick commerce firm.

Verification Based on the MR = MC Condition

The same operating point can also be verified based on the standard marginal principle.

Marginal revenue is equated to the marginal cost:

$240 - 0.004Q = 70 + 0.0016Q$

$170 = 0.0056Q$

$Q = 30{,}357.14$ units.

Price Elasticity of Demand

For $Q = 120000 - 500P$, the point price elasticity is:

$E = (dQ / dP)(P/Q)$

At $Q \approx 30{,}357.14$ and $P \approx$ ₹179.29, with $dQ/dP = -500$:

$E \approx -2.95$

The absolute value of elasticity is approximately 2.95 at the considered point.

So, in terms of the suggested demand equation, quantity is rather sensitive to the change in price.

This finding can not be extrapolated to the real quick-commerce industry without empirical calculation.

Sensitivity Analysis

To analyze the effect of the variable cost, keep all the other assumptions but substitute ₹70 with different coefficients.

In the general cost function $C(Q)=1{,}800{,}000 + vQ + 0.0008Q^2$, the first-order condition will depend on v.

Variable Cost v (₹)	Illustrative Optimum Q	Illustrative Price
60	32,142.86	₹175.71
70	30,357.14	₹179.29
80	28,571.43	₹182.86

The scenario analysis shows that the modelled optimum is sensitive to cost assumptions. This is one reason actual business modelling should estimate cost parameters from reliable operational data rather than relying on assumed values.

Business Interpretation of the Model

- The link between pricing and demand means that a price change will influence the number of units predicted to sell according to the model.
- Since revenue depends on price and quantity, it follows that an increase in price does not necessarily mean increased revenue.
- The marginal revenue and marginal cost concepts reveal what happens in terms of incremental implications of increased volume.
- Inventory-driven approach implies that procurement, inventory carrying, wastage and working capital become important for cost estimation.

- If order volume is high, then constraints in supply and logistics may bring about increasing marginal costs, providing an incentive for nonlinearity in the cost function.
- Elasticity allows describing how responsive customers are to price changes; nevertheless, elasticity is to be estimated empirically.
- The solution obtained via optimisation is dependent on the model assumptions and hence decision-support rather than forecasting in nature.

Relevance of ONDC and Open Digital Commerce

On the other hand, ONDC or Open Network for Digital Commerce offers another example of a current context for business mathematics.

While traditional business mathematics models the digital commerce on the basis of one platform, the open network context can include multiple parties like buyer and seller applications, logistics services providers, and technology service providers.

Using mathematical terms, the very same approach can be used to analyze the interrelationship between price, order quantity, delivery cost, frequency of customers, order amount, and expenses.

For instance, in a practical application, one can assess the correlation between price or delivery charges and order amount and then use that demand function to obtain the revenue and marginal functions.

The essential difference is that between mathematical models and empirical claims.

The formulas presented in this paper are only examples, real-life analysis will need corresponding data collected.

Managerial and Academic Significance

The case has relevance to the fields of business analysis and teaching.

In the field of business analysis, it illustrates the process of using a series of basic functions to transform a pricing challenge into an optimization problem.

From the perspective of academic teaching, the case provides a comprehensive instance where students learn to relate linear functions, quadratic functions, derivatives, marginal theory, elasticity, and optimization.

The case is especially appropriate for subjects such as Business Mathematics, Statistics, Economics, and Commerce, because the calculations are directly related to digital business activities.

It further helps in understanding the relevance of making a distinction between a conceptual model and actual observation evidence.

Limitations of the Study

- The demand function includes only price and quantity, thus ignoring numerous determinants of demand in reality.
- The coefficients of the functions are made up and do not constitute any estimations of a specific firm's operation.
- The actual cost structure of quick commerce businesses can contain other elements such as procurement, warehousing, delivery, marketing and other.
- The consumer behavior can differ depending on products' category, geography, season, income, promotions and competition.
- The existence of the mathematical optimum does not automatically mean that the assumed price or quantity is attainable in the real world.
- Current developments in publicly known businesses can vary over time and, therefore, should be verified by reliable primary or secondary sources before the publication.

Scope for Future Research

In various ways, the model above can be expanded to an empirical test.

Researchers may compute the demand function from transaction-level data, surveys of consumers or appropriate anonymised panel data.

Comparison may be made between the results obtained by using logarithmic, exponential or other non-linear functional form and that of linear function.

Delivery distance, delivery time, stock-outs, waste, discount strength, cost of advertising and market segments can be included.

Seasonal variations in demand can be estimated through time series analysis and the optimization model could be extended to take inventory and capacity constraints into account.

Research of comparative nature might explore the same phenomenon in conventional e-commerce, quick commerce, D2C firms and open digital-commerce networks.

These expansions will change the model above from being purely mathematical to one based on evidence.

Conclusion

In this paper, the use of calculus to analyse a modern day business problem using a series of interconnected mathematical functions is demonstrated.

A linear inverse-demand equation was used to describe the relationship between price and quantity.

The quadratic revenue function was calculated from the inverse-demand equation, and the differentiation gave us the marginal revenue.

A nonlinear cost function was defined to account for increasing costs as the activity level increased.

Differentiation of the profit function gave us a stationary point, which was proved to be a local maximum using the second derivative.

Calculation of the price elasticity gave an extra dimension as it measured the responsiveness of the demand to change in price at the point where the model applies.

Finally, sensitivity analysis proved that when there is a change in the variable cost assumed, it changes the mathematical operating point.

The key value of the paper is its methodology.

Specifically, it demonstrates how various concepts traditionally studied independently – linear functions, quadratic functions, derivatives, marginal analysis, elasticity and optimization – can be used together in order to analyze a real-life business case.

Meanwhile, the paper draws a clear line between the business news publicly available and numerical assumptions made up for this example.

In empirical studies, the logical continuation will not be taking the illustrative coefficients as reality, but estimating them based on proper data and statistically testing the model.

This mixture of mathematical logic and empirical research may help to apply the tools of Business Mathematics and Calculus in modern Commerce.

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Appendix A: Mathematical Calculation Summary

Component	Result
Inverse demand	$P = 240 - 0.002Q$
Quantity form	$Q = 120000 - 500P$
Revenue	$R(Q) = 240Q - 0.002Q^2$
Marginal revenue	$MR = 240 - 0.004Q$
Cost	$C(Q) = 1{,}800{,}000 + 70Q + 0.0008Q^2$
Marginal cost	$MC = 70 + 0.0016Q$
Profit	$\pi(Q) = -1{,}800{,}000 + 170Q - 0.0028Q^2$
First derivative	$\pi'(Q) = 170 - 0.0056Q$
Optimal output in the model	$Q^* = 30{,}357.14$
Second derivative	$\pi''(Q) = -0.0056$
Price at Q*	$P^* \approx$ ₹179.29
Elasticity at Q*	$E \approx -2.95$

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