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Derivative application in economic problems

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Derivative application in economic problems

R Marsitin* and N R Sesanti

Universitas Kanjuruhan Malang, Malang, Indonesia

*mars_retno@unikama.ac.id

Abstract. The objective of this research is to describe derivative applications in economic problems. This study uses quantitative descriptive approach. The study is conducted at the home industry of snack in Surabaya. The data collection in this research uses observation and documentation. The data analysis uses tabulation methods and derivative applications. The results of the study show that home industry of snack gains profit because the results of the second derivative are negative. The conclusion of the study that derivative applications in economic problems include four stages, the first stage is determining the variables, the second stage is determining the mathematical model, the third stage is completing the mathematical model and the fourth step is using the second derivative smaller than zero.

1. Introduction

Derivative is one of the materials in calculus and calculus is one of branches in mathematics. Calculus discusses various materials with theoretical studies and the application is very wide, including physics, chemistry, biology, and economics. Derivative is differentiation process of a function, thus to determine the derivative of a function is through deferring the function. The result obtained from differentiating functions is called derivative [1].

Derivative calculation is related to the calculation of the function changing problem and very instrumental in economic problems. In derivative in its application for economics there are three important functions, namely function, cost, income function and maximum profit function. Derivative application in economic problems is done firstly through determining a mathematical model of economic problems, then completing the mathematical model and finally by interpreting the results obtained in solving the problem [2-3].

In this regard, derivative applications can be applied as an analysis in resolving problems in companies or home industries. There are various factors of economic problems in a company or home industry, including the factor of the number of employees, cost time, economic conditions and so on. These factors are variables that are inconsistent so that the derivative concept is very instrumental in resolving these problems and the company or home industry gains maximum profit. In connection with previous research on the application of derivatives in economic problems, the results of [4] research on analysis need to know about accounting for derivatives stated that prepare financial statements had to learn accommodate to the new requirements, analysis also must understand this standard in order to interpret derivative results appropriately. The results of [5] research on effect of derivative accounting rules on corporate risk-management behavior stated that derivative user as an effective hedger if its risk exposures decreased after the initiation of the derivatives program, and as an ineffective hedger/speculator otherwise. The calculation of the right selling price with maximum profit depends on the correct cost of production and the correct production costs. Selling prices that are not right have an

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impact on the minimum profit and even suffer losses. The above exposure and phenomena are very interesting to discuss regarding the application of derivatives in economic problems, with the aim of analyzing derivative applications for maximum profits and interpreting derivative results in the home industry.

2. Research method

This study aims to describe derivative applications in economic problems. With regard to the purpose of the study, this study uses a quantitative descriptive approach. The data obtained in the study are analyzed and then interpreted. The research is conducted at the chips home industry in Surabaya. The data collection in this research uses observation and documentation. The data analysis with stages: (a) Data preparation, by preparing data completeness; (b) Data tabulation, by determining variables and mathematical models; (c) Derivative application, by analyzing the data obtained and mathematical models that have been determined using the maximum profit derivative application. The stage of derivative application with maximum benefits include; (a) Determining the cost function, demand function and revenue function; (b) Determining the profit function; (c) Determining the first derivative; (5) Determining the second derivative with terms that the results obtained in the second derivative are smaller than zero. In the second derivative, the term is if the result of second derivative is negative then the maximum profit is obtained and if the result of second derivative is positive then the maximum loss is obtained.

3. Results and discussion

The results of the study obtained data covering: production costs, production results and prices of production. Data obtained from the "H & R" chips home industry in Surabaya with the following table 1:

Table 1. Fixed cost of "H& R" chips home industry Surabaya.

Cost	Total Cost (Rupiah)	
Promotion	Rp	400,000
Equipment maintenance	Rp	6,169,000
Employee salary per year	Rp	5,400,000
Tax per year	Rp	14,500,000
Electricity, water and telephone costs per year	Rp	2,500,000

In table 1, the data obtained are about description of the costs and the amount of costs and those data are used to obtain the profit function.

Table 2. Production cost of "H& R" chips home industry Surabaya.

Product	Total cost		Average	
Balado Potato Chips	Rp	12,199,300	Rp	933.02
Original Potato Chips	Rp	12,103,750	Rp	849.09
Seaweed Potato Chips	Rp	9,350,450	Rp	1,241.76
Balado Cassava Chips	Rp	9,775,650	Rp	1,347.44
Original Cassava Chips	Rp	10,055,400	Rp	711.89
Seaweed Cassava Chips	Rp	8,750,000	Rp	1,122.51
Balado Banana Chips	Rp	10,021,100	Rp	711.98
Original Banana Chips	Rp	9,073,750	Rp	979.36
Jackfruit Chips	Rp	7,350,250	Rp	1,555.61
Apple Chips	Rp	11,025,550	Rp	1,338.54
Mushroom Chips	Rp	11,195,250	Rp	1,212.92

In table 2, the data obtained are total costs and average costs to get the cost function in each production. The description of 2016 production results in the following table 3:

Table 3. Production result and production cost per unit "H& R" chips home industry Surabaya (Year 2018).

Product	Amount of Production	Price per unit
Balado Potato Chips	13075	Rp 8,250
Original Potato Chips	14255	Rp 7,250
Seaweed Potato Chips	7530	Rp 7,750
Balado Cassava Chips	7255	Rp 6,750
Original Cassava Chips	14125	Rp 8,250
Seaweed Cassava Chips	7795	Rp 7,250
Balado Banana Chips	14075	Rp 6,250
Original Banana Chips	9265	Rp 8,750
Jackfruit Chips	4725	Rp 7,250
Apple Chips	8237	Rp 7,250
Mushroom Chips	9230	Rp 8,750

In table 3, the data obtained are the unit price of production in 2016 to obtain the demand function of each production. The description of production results in 2017 in table 4:

Table 4. Production result and production cost per unit "H& R" chips home industry Surabaya (Year 2017).

Product	Amount of Production	Price per unit
Balado Potato Chips	12525	Rp 8,500
Original Potato Chips	14000	Rp 7,500
Seaweed Potato Chips	7100	Rp 8,000
Balado Cassava Chips	6025	Rp 7,000
Original Cassava Chips	13700	Rp 8,500
Seaweed Cassava Chips	7000	Rp 7,500
Balado Banana Chips	13500	Rp 6,500
Original Banana Chips	8725	Rp 9,000
Jackfruit Chips	4000	Rp 7,500
Apple Chips	7525	Rp 7,500
Mushroom Chips	8700	Rp 9,000

In table 4 the data obtained are the production unit price in 2017 to obtain the demand function of each production as described in table 5 below:

Table 5. Cost Function and demand function of production "H& R" chips home industry Surabaya.

Product	Cost function of each production (C)	Demand function of each production (P)
Balado Potato Chips	$C = 29.049.700 + 933\ Q$	$P = -0{,}45\ Q + 14.193$
Original Potato Chips	$C = 29.049.700 + 849\ Q$	$P = -0{,}98\ Q + 21.225$
Seaweed Potato Chips	$C = 29.049.700 + 1.242\ Q$	$P = -0{,}58\ Q + 12.128$
Balado Cassava Chips	$C = 29.049.700 + 1.347\ Q$	$P = -0{,}21\ Q + 8.225$
Original Cassava Chips	$C = 29.049.700 + 712\ Q$	$P = -0{,}59\ Q + 16.750$
Seaweed Cassava Chips	$C = 29.049.700 + 1.123\ Q$	$P = -0{,}31\ Q + 98.103$
Balado Banana Chips	$C = 29.049.700 + 712\ Q$	$P = -0{,}43\ Q + 12.369$
Original Banana Chips	$C = 29.049.700 + 979\ Q$	$P = -0{,}46\ Q + 13.039$
Jackfruit Chips	$C = 29.049.700 + 1.556\ Q$	$P = -0{,}34\ Q + 8.879$
Apple Chips	$C = 29.049.700 + 1.339\ Q$	$P = -0{,}35\ Q + 10.135$
Mushroom Chips	$C = 29.049.700 + 1.213\ Q$	$P = -0.47\ Q + 13.103$

In table 5, the data obtained are cost functions and demand functions of each, those data are used to obtain the profit function. If the number of items produced is multiplied by demand price, then it produces revenue function. If the revenue function is subtracted by the cost function, then it produces the profit function that is explained in table 6:

Table 6. Revenue Function and Profit Function "H& R" chips home industry Surabaya.

Product	Revenue Function of each production (R)	Profit Function with Extreme Point (π')
Balado Potato Chips	$R = -0{,}45\ Q^2 + 14.193\ Q$	$\pi' = -0{,}45\ Q^2 + 13.260\ Q$
Original Potato Chips	$R = -0{,}98\ Q^2 + 21.225\ Q$	$\pi' = -0{,}98\ Q^2 + 20.376\ Q$
Seaweed Potato Chips	$R = -0{,}58\ Q^2 + 12.128\ Q$	$\pi' = -0{,}58\ Q^2 + 10.886\ Q$
Balado Cassava Chips	$R = -0{,}21\ Q^2 + 8.225\ Q$	$\pi' = -0{,}21\ Q^2 + 6.878\ Q$
Original Cassava Chips	$R = -0{,}59\ Q^2 + 16.750\ Q$	$\pi' = -0{,}59\ Q^2 + 16.038\ Q$
Seaweed Cassava Chips	$R = -0{,}31\ Q^2 + 98.103\ Q$	$\pi' = -0{,}31\ Q^2 + 8.578\ Q$
Balado Banana Chips	$R = -0{,}43\ Q^2 + 12.369\ Q$	$\pi' = -0{,}43\ Q^2 + 11.657\ Q$
Original Banana Chips	$R = -0{,}46\ Q^2 + 13.039\ Q$	$\pi' = -0{,}46\ Q^2 + 12.060\ Q$
Jackfruit Chips	$R = -0{,}34\ Q^2 + 8.879\ Q$	$\pi' = -0{,}34\ Q^2 + 7.323\ Q$
Apple Chips	$R = -0{,}35\ Q^2 + 10.135\ Q$	$\pi' = -0{,}35\ Q^2 + 8.796\ Q$
Mushroom Chips	$R = -0.47\ Q^2 + 13.103\ Q$	$\pi' = -0.47\ Q^2 + 11.890\ Q$

In table 6, the data obtained are the revenue function and the profit function in each production. The profit function (π) is then analyzed using the second derivative concept to obtain the maximum profit described in table 7:

Table 7. Maximum profit function and maximum demand "H& R" chips home industry Surabaya.

Product	Profit Function of each Production (π'')	Maximum Production
Balado Potato Chips	$\pi'' = -0{,}90\ Q + 13.260$	$Q = 14.733$
Original Potato Chips	$\pi'' = -1{,}96\ Q + 20.376$	$Q = 10.396$
Seaweed Potato Chips	$\pi'' = -1{,}16\ Q + 10.886$	$Q = 9.384$
Balado Cassava Chips	$\pi'' = -0{,}42\ Q + 6.878$	$Q = 16.376$
Original Cassava Chips	$\pi'' = -1{,}18\ Q + 16.038$	$Q = 13.592$
Seaweed Cassava Chips	$\pi'' = -0{,}62\ Q + 8.578$	$Q = 13.835$
Balado Banana Chips	$\pi'' = -0{,}86\ Q + 11.657$	$Q = 13.555$
Original Banana Chips	$\pi'' = -0{,}92\ Q + 12.060$	$Q = 13.109$
Jackfruit Chips	$\pi'' = -0{,}68\ Q + 7.323$	$Q = 10.769$
Apple Chips	$\pi'' = -0{,}7\ Q + 8.796$	$Q = 13.994$
Mushroom Chips	$\pi'' = -0{,}94\ Q + 11.890$	$Q = 12.648$

In table 7, the function π for each type of chip is obtained by the first derivative π 'as the critical point, then the second derivative π'' as the maximum or minimum point. If the result of second derivative is negative ($\pi'' < 0$) then it is said that at that point the maximum point is reached. The results in table 7 of the maximum profit function ($\pi'' < 0$) and maximum demand (Q) of the Surabaya H & R chips home industry production show $\pi'' < 0$ means that the home industry gains the maximum profit at the level of production in one year. This is in relation with the opinion of [6] that the profit function with the second derivative is smaller than zero, so that maximum profit is obtained. Differentiation and integration, are basic in calculus and analysis [7]. The Mathematics of financial modeling and investment management clearly ties together financial theory and mathematical techniques [8]. Maximum profit in one year in the production of Surabaya's "H & R" chips home industry in details including: production of balado potato chips at 14,733, original potato chips production of 10,396, seaweed potato chips production of 9,384, balado cassava chips production of 16,376 , the production of original cassava chips amounted to 13,592, the production of seaweed chips by 13,835, the production of balado banana chips by 13,555, the production of original banana chips by 13,109, jackfruit chips production by 10,769, the production of apple chips by 13,994, the production of mushroom chips by 12,648. The production of the home industry gained maximum profit of 142,391 totally. The associated

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expected integrated profit is maximised by calculus derivative method. This is in relation with the opinion of [9,10] that production cost, holding cost, backlogging cost, lost sale cost, reworked cost and selling price are taken together to construct the integrated expected average profit function, which is maximized to obtain the optimal production rate, optimal lot size and value of optimum expected average profit by using the calculus method. [11-13] that the associated average profit function is maximised by calculus method.

4. Conclusion

From the description and discussion of the results can be concluded that: a) Completion with derivative applications in the economy, especially on the problem of maximum profit analysis with steps that include: data preparation by preparing data completeness, tabulation of data by determining variables and mathematical models and derivative applications, by analyzing the data obtained and predetermined mathematical models using the maximum profit derivative application; b) Completion with derivative applications on maximum benefits includes: determining the cost function, the demand function and the revenue function, the profit function, the first and second derivatives. The results obtained in the second derivative are smaller than zero. In the second derivative with the rule that if the result of second derivative is negative then the maximum profit is obtained and if the result of second derivative is positive then the maximum loss is obtained; c) "H & R" Chips Home Industry Surabaya's gains maximum profits for all production with $\pi'' < 0$.

References

[1] Nualart E 2007 Lectures on Malliavin calculus and its applications to finance *Lectures*
[2] Zhang H 2009 Effect of derivative accounting rules on corporate risk-management behavior *J. Account. Econ.*
[3] Zaloom C 2010 The Derivative World *Hedgehog Rev.*
[4] Kawaller I G 2004 What analysts need to know about accounting for derivatives *Financ. Anal. J.*
[5] Beatty A 1999 Assessing the use of derivatives as part of a risk-management strategy *J. Account. Econ.*
[6] Hunt P J and Kennedy J E 2004 *Financial Derivatives in Theory and Practice*
[7] Bashirov A E, Kurpinar E M and Özyapici A 2008 Multiplicative calculus and its applications *J. Math. Anal. Appl.*
[8] Focardi S M and Fabozzi F J 2004 *The Mathematics of: Financial Modeling and Investment Management*
[9] Roy M Das, Sana S S and Chaudhuri K 2014 An economic production lot size model for defective items with stochastic demand, backlogging and rework *IMA J. Manag. Math.*
[10] Kümmel R, Ayres R U and Lindenberger D 2010 Thermodynamic laws, economic methods and the productive power of energy *J. Non-Equilibrium Thermodyn.*
[11] Sana S S, Sarkar B K, Chaudhuri K and Purohit D 2009 The effect of stock, price and advertising on demand – an EOQ model *Int. J. Model. Identif. Control*
[12] Cain M B and Alvarado F L 2004 Implications of cost and bid format on electricity market studies: linear versus quadratic costs *2004 Large Eng. Syst. Conf. Power Eng. (IEEE Cat. No.04EX819)*
[13] Kümmel R and Lindenberger D 2014 How energy conversion drives economic growth far from the equilibrium of neoclassical economics *New J. Phys.*

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