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Application of Mathematics in Economics: Demand and Supply Functions

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Abstract

This article aims to review the application of mathematics in economics regarding the function of demand and supply and market stability. This study uses exploratory methods and data is collected through literature study techniques. The use of demand, supply and market balance problems can be in the form of mathematical concepts in a two-variable linear equation system and the solutions are formed through elimination, substitution, and graphic methods. The study findings explain that the correlation between demand and supply functions is formed from the mathematical concept of linear functions and equations of two variables.

Keywords: *Economy; Demand-Supply Function; Market Equilibrium; Mathematics.*

1. INTRODUCTION

In principle, economics and business are sciences that are semi-exact and require certain reasoning. For this reason, studying economics requires quantitative and qualitative analysis. In economics, quantitative analysis must use mathematical concepts as an instrument to simplify calculation problems. That way, to study economics you must also study the mathematical concepts of business. Economic mathematics is part of applied mathematics, where this is pure mathematics which is the basis of various economic sciences(Purbowati & Utomo, 2016).

Mathematics is concerned with something that can be expressed in the form of a number (quantity) or something that can be counted. There are many economic variables (concepts) that can be quantified, for example, total products demanded and desired, product prices, etc (Janna, 2022). ot only does it play a role in quantifying economic variables, but mathematics also reviews inter-correlation variable *economic*. Correlation available *economic* with other variables is often referred to as an economic model. Because, these variables can be quantified, so that this economic model can be said to be in the form of a symbol, shape, or mathematical model. In reality, the relationship between economic variables is very complex because to facilitate the realization between variables and the economy, variables are used that are in line with mathematical principles in economics. A variable is a symbol used to represent a value (Pratama at al., 2022).

Economic modeling can be in the form of mathematical and non-mathematical models. Economic models in the form of mathematical models are composed of simplified variables and the interrelationships between economic variables to create a series of mathematical equations(Kurnia, 2022). Economic models can be simplified into mathematical equations that create linear and nonlinear functions. Linear functions are functions that economists use to analyze and solve

economic problems. Most economic and business problems can be simplified or converted into linear models. In economics and business, one application of linear functions is the demand and supply function (Marlina & Ruhiyat, 2018).

One of the basic concepts of economics is the concept of demand and supply. The demand function is an equation that explains the relationship between the desired product quantity and the factors that influence it. In contrast, the supply function explains the relationship between the price of goods and the quantity of goods(Purnomo, 2019). Market equilibrium is a condition where price balance or quantity balance is achieved. This can be achieved if: 1) the price of the product (service) offered by the seller (producer) is equivalent to the price desired by the buyer (consumer); and 2) the total products (services) offered by sellers (producers) are balanced with the number of products desired by buyers (consumers) (Wirawan, 2019). Demand and supply are influenced by price, and vice versa, the price and quantity of products offered are influenced by the stability of demand and supply in the market. If the price is below the stable price, then there is an excess or excess *demand*, because demand can rise while supply falls. On the contrary, if the price is above the stable price, then there is excess supply (*excess supply*) because total supply increases while total demand decreases (Barus & Azahra, 2020).

Analyzing economics must be based on applied mathematics, therefore mathematics must be understood to analyze mathematical economicsAnalyzing economics must be based on applied mathematics, therefore mathematics must be understood to analyze mathematical economics(Gunawan, 2013). Demand analysis can be carried out through mathematics or graphics. The mathematical approach creates a demand function, while the graphical approach creates a demand curve. In supply analysis, only the relationship between product price and quantity of products traded is determined, while other factors, such as product price, production funds, company targets, and the technology used are perceived as not changing. Departing from this description, this article aims to review the application of mathematics in economics regarding the function of demand and supply and market stability.

Economic mathematics is a scientific discipline that reviews all matters relating to humans fulfilling their economic needs according to the principles contained in economic principles. Economic mathematics is part of applied mathematics, namely pure mathematics. The economic models in predictions/estimations are simplified into mathematical equations that create linear and nonlinear functions. Linear functions are functions that experts use to analyze and solve economic problems. It is not uncommon for economic problems to be simplified into a linear model. One application of linear functions in economics is the demand and supply function (Gunawan, 2013).

Demand is the total product demanded by the market at the level of price, income, and specific time. Offer is the total number of products offered by sellers to buyers within a certain time and price. The demand function explains the relationship between the total product that buyers want and the product price. As in economic theory in the law of demand, if the price rises, the quantity of the desired product decreases, while if the price falls, the total product desired also increases (Wirawan, 2019). The supply function explains the correlation between the total products offered by sellers and the product price. According to economic theory, the law of supply is that if the price rises, the total product offered will increase, while if the price falls, the total product offered will decrease. The demand and supply functions are influenced by high product prices, people's income, and product prices that meet buyers' wishes, there are other related products, and product prices are not expected to increase in the future (Marlina & Ruhiyat, 2018).

Market price stability/equilibrium can occur when the quantity supplied is equal to the quantity demanded, or the offering price is equal to the asking price. Thus, market balance is created because

of an agreement between sellers and buyers in the market. Price balance can be achieved when supply and demand meet. (Rahayu, et al., 2017) explains that price equilibrium is the price when both sellers and buyers do not want to change the quantity of products bought or sold. If the price is below the equilibrium price, this will happen excess *demand* (excess demand), and as a result, demand increases while supply decreases. Meanwhile, if the price is above the equilibrium price, this will happen to excess *supply* (excess supply), and as a result, an increase in the quantity of products offered has an impact on decreasing product demand (Arief &Riyanto, 2013).

2. METHOD

This article uses an exploratory descriptive method. Hermawan (2019) explains that the exploration description method aims to reveal information or describe the condition of an object as it is so that the real facts can be revealed. The data in this study was collected through library/literature study techniques (*library research*). A literature study is a method used to collect data or sources related to a theme being researched(Kaharuddin, 2017). The data in this study is data related to the demand and supply function, which was collected through books, scientific articles, and other literature that is relevant to the discussion of the study. In this article, exploratory analysis is used to see the correlation of mathematical concepts with demand and supply functions through equations of 2 variables and linear functions. To understand the function of demand and supply, a 2-variable linear equation approach is needed through stages including 1) using quantity data on demand, supply, and price in the form of a table; 2) assign variables; 3) describe the data in the form of graphs; 4) determine linear equations in 2 variables through various methods. Meanwhile, to find out the demand and supply functions using a linear function approach, you need to: 1) use demand, supply, and price-quantity data in the form of a table; 2) determine the set and Cartesian product; 3 describe the data graphically; and 4) determine a linear function using known data function values. Exploration is also used to explore mathematical ideas that may exist in the concepts of demand and supply (Arief &Riyanto, 2013).

3. RESULT AND DISCUSSION

Mathematical Relationship to Demand

The demand function explains the correlation between the total products demanded by buyers and other variables that can influence it over a certain period. Economists generally explain that there are main variables including: 1) product price, 2) buyer's income, 3) price of other related products, 4) desired product price in the future, 5) customer preferences, and 6) advertising. For this reason, the request function can be written systematically, as below:

$$Q_{dx,t} = f\left(P_{x,t}{}' P_{y,t}{}' Y_t{}' P^e{}_{x,t+1}{}' S_t{}' A_t\right)$$

Information:
$Q_{dx,t}$: Total products what customers want at a certain time t
$P_{x,t}$: Product prices at a certain time t
$P_{y,t}$: Product price a certain time
tY_t : Customer income at a certain time

$P^e_{x,t+1}$: Product prices what you want in the future, $t + 1$
S_t : Customer preferences in time t
A_t : Advertising spending at time t

If the demand function is converted into a linear equation, then it generally takes the form $Q_x = a - bP_x$ where Q_x is the total item *x* desired, P_x is the price of the item *x*, and a-b is the parameter.

For example:

When the price of red onions per kilo was IDR 40,000 the demand was around 800 kg, but when the price of shallots rose to IDR 80,000 and the demand decreased by 400 kg. Create a demand function for this problem!

Answer:

To find the demand function from the problem above, you can find it using the formula for the equation of a two-point line, namely:

$$\frac{y - y1}{y2 - y1} = \frac{x - x1}{x2 - x1}$$

Application:

$$\frac{P - P1}{P2 - P1} = \frac{Q - Q1}{Q2 - Q1}$$

$$\frac{P - 40.000}{40.000 - 40.000} = \frac{Q - x\ 800}{400 - 800}$$

P – 40.000 (-400) = 40.000 (Q -800)
-400P + 16.000.000 = 40.000Q – 32.000.000
-40.000Q = -32.000.000 – 16.000.000 + 400P
-30.000Q = -48.000.000 + 400P (:-40.000)
Q = 1.200 – 0,01

Looking at the form of the demand function, if you change it to the form P = f(Q), then:

0,01P = 1.200 – Q
P = 120.000 – 100Q

Thus we get the demand function Q_d = 0,01P atau P = 120.000 – 100Q.

Mathematical Relationship to Supply

The supply function explains the correlation between the quantity of goods requested by sellers to be marketed and other variables that influence it at a certain time. The main variables are 1) the price of an item; 2) the quality of existing technology; 3) prices of production factors used; 4) prices of goods related to production; and 5) the seller's expectations about the price of goods in the future. Thus the supply function can be written systematically as follows:

$$Q_{sx,t} = f\left(P_{x,t}'\ T_t'\ P_{F,t}'\ P_{R,t}'\ P^e_{x,t+1}\right)$$

Information:

$Q_{sx,t}$	: Total items requested by the seller at time t
$P_{x,t}$	: Price of goods at time t
T_t	: Technology that exists at a certain time t
$P_{F,t}$	: Price of production factors at a certain time t
$P_{R,t}$	: Prices of other related products at a certain time
$P^e_{x,t+1}$	: Customer preferences at a certain time t

If the supply function is converted into a linear equation, it generally takes the form $Q_x = a+bP_x$ where Q_x is the total item*x* desired, P_x is the price of the item*x,* and a and b are the parameters.

For example:

When the price of granulated sugar is IDR 14,000 per kg, a stall can only sell around 20 kg, but when the price is IDR 17,000 per kg, the stall can sell 50 kg of granulated sugar. Create a bidding function!

To find the supply function from the problem above, you can use the following linear equation formula:

$$\frac{P - P1}{P2 - P1} = \frac{Q - Q1}{Q2 - Q1}$$

$$\frac{P - 14.000}{17.000 - 14.000} = \frac{Q - 20}{50 - 20}$$

$$\frac{P - 14.000}{3.000} = \frac{Q - 20}{30}$$

(P – 14.000) (30) = (Q – 30) (3.000)

30P – 420.000 = 3.000Q - 90.000

-3.000Q = 420.000 – 90.000 – 30P

-3.000Q = 330.000 – 30P (: -3.000)

Q = 110 + 0,1P

-0,1P = -110 – Q

P = 1100 + 10Q

From this problem, the supply function Q_s = -110 + 0,1P ataupun P = 1100 + 10Q.

Market Equilibrium

Demand and supply result in market balance. Market stability occurs when price balance is created ($P_d = P_s$) or balance amount ($Q_d = Q_s$). Price stability occurs when the price given by sellers is in balance with the price desired by buyers in the market. Meanwhile, quantity balance is created when the total number of goods traded by the seller is in balance with the quantity of goods desired by the buyer.

Analysis:

It can be assumed that there is a data set related to demand and supply by looking at the correlation between variables Q and P. Through mathematical methods, an economic model can be obtained from the following data:

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Table 1. Demand and Supply Data

Product Price (Rp)	Request	Offer
100.000	500	100
200.000	400	200
300.000	300	300
400.000	200	400
500.000	100	500

Source: Secondary data processed, 2023.

Application:

Demand function analysis

$$\frac{P - P1}{P2 - P1} = \frac{Q - Q1}{Q2 - Q1}$$

$$\frac{P - 100.000}{500.000 - 100.000} = \frac{Q - 500}{100 - 500}$$

P – 100.000 (-400) = Q – 500 (400.000)
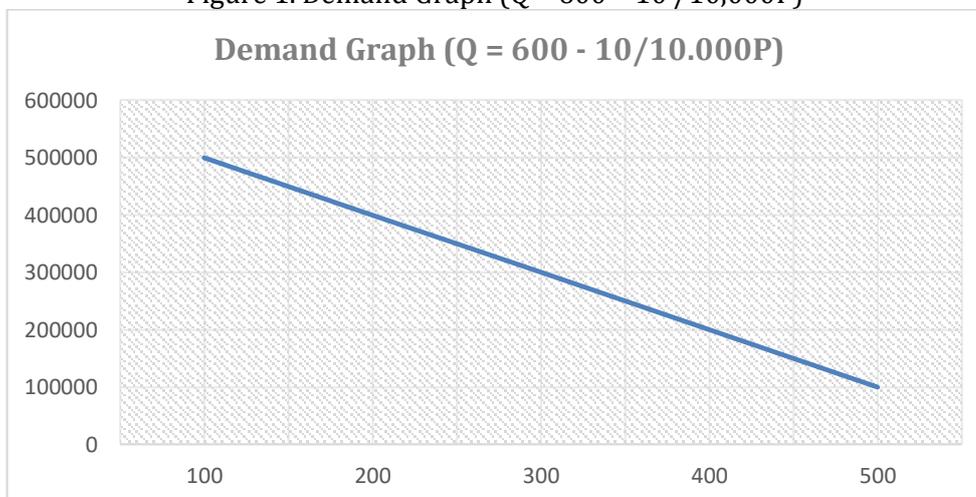
-400P + 4.000.000 = 400.000 – 20.000.000

400.000Q = -400P + 24.000.000

$$Q = \frac{-400P + 24.000.000}{400.000}$$

$$Q = 600 - \frac{10}{10.000}P$$

From the problem above, it can be seen that the demand function via a mathematical linear function is Q = 600 – 10/10,000P. When the product price is IDR 100,000, the desired product quantity is 500 units. As product prices rise, demand for goods decreases, and vice versa. This can be seen in the following graph:

Figure 1. Demand Graph (Q = 600 – 10 /10,000P)

Source: Secondary data processed, 2023.

Analysis of supply functions

$$\frac{P - P1}{P2 - P1} = \frac{Q - Q1}{Q2 - Q1}$$

$$\frac{P - 100.000}{500.000 - 100.000} = \frac{Q - 100}{500 - 100}$$

P – 100.000 (400) = Q – 100 (400.000)

400P + 4.000.000 = 400.000Q – 4.000.000

400.000Q = 400P + 8.000.000

$$Q = \frac{400P + 8.000.000}{400.000}$$

$$Q = 200 + \frac{10}{10.000}P$$

Looking closely at the problem above, it can be seen that the supply function of the mathematical linear function is Q = 200 + 10/10,000P. When the product price is IDR 100,000, the total product traded is 10 units. The higher the product price, the more the quantity of product offered will increase, and vice versa. This can be seen in the following graphic:

Figure 2. Supply Function (Q = Q = 200 + 10/10,000P)
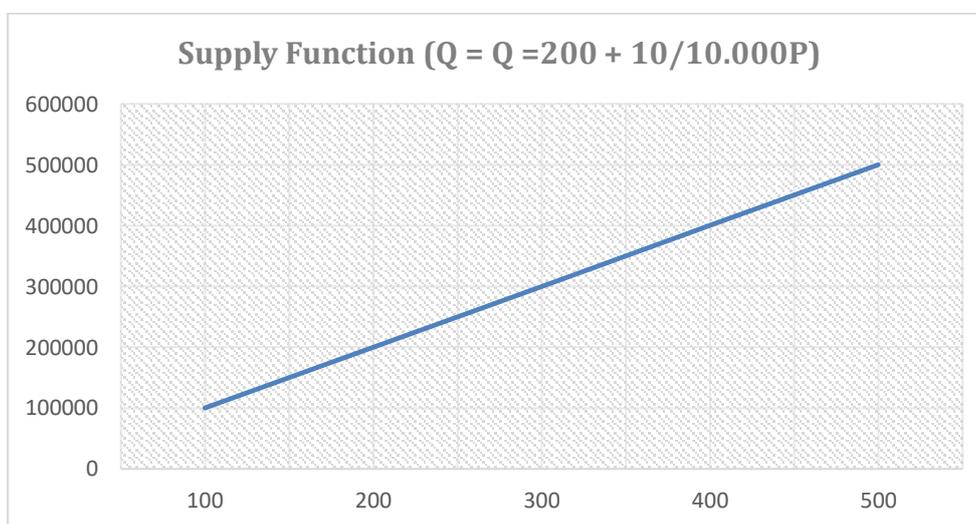
Source: Secondary data processed, 2023.

Market stability will be achieved if $P_d = P_s$ or $Q_d = Q_s$. Furthermore, algebraically, market stability is obtained through a linear equation between the demand and supply functions that are carried out at the same time. This can be depicted through a geometric cut of the demand and supply curves in the following graph:

Figure 3. Market Equilibrium
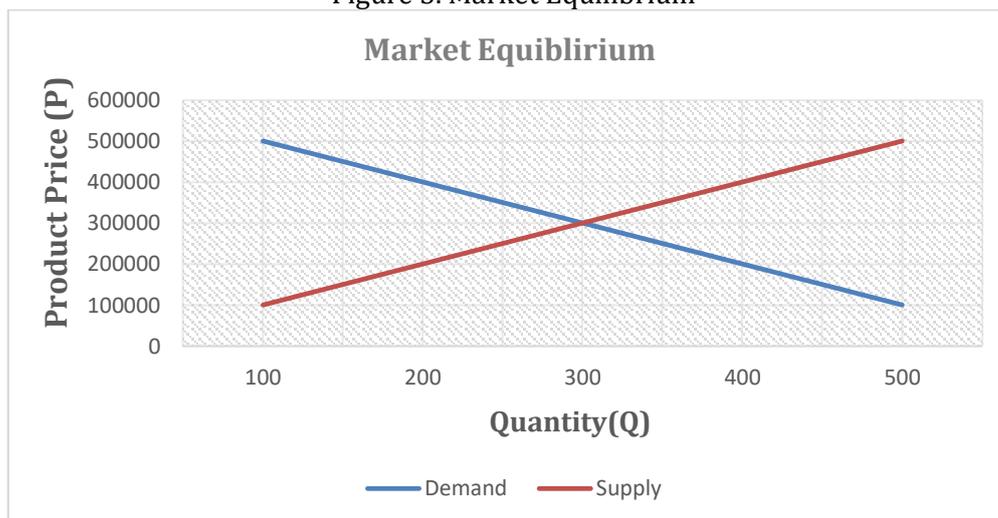
Source: Secondary data processed, 2023.

Examining the graph above, it is known that the demand function graph intersects with the supply function line which shows the balance point. This is shown at coordinates (300, 300,000), this is what is then called market balance. Where the equilibrium price is IDR 300,000, and the equilibrium quantity is 300 units.

Examining the results of the analysis above regarding the application of mathematics in economics regarding the function of demand and supply, we obtain an economic model that can be applied to solve problems relating to demand and supply. Thus, the demand function is to explain the correlation between price (P) and the quantity of product (Q) desired. As the law of demand states: "If the price rises, the quantity desired decreases, and if the price falls, the quantity of the product desired also rises." This can then be used as a reference if the demand function is related to the supply function, and vice versa, that these two functions can influence product prices on the market.

4. CONCLUSION

Based on the results of the analysis that has been carried out, it can be concluded that the correlation between demand and supply functions is formed from the mathematical concept of linear functions and the equation of two variables. The use of demand, supply, and market balance problems can be in the form of mathematical concepts in a two-variable linear equation system and the solutions are formed through elimination, substitution, and graphic methods.

The limitation of this study is that it only focuses on the demand and supply functions being analyzed, while there are still many branches of mathematics that can be applied in economics. Nevertheless, at least this article can provide an adequate overview of the application of mathematics in economics, especially regarding the demand and supply functions. However, the findings that researchers present may also be wrong, therefore this research can be used as an invitation to complement each other, to become a reference for further research, to produce a better scientific study.

REFERENCES

Arief & Riyanto, N.M. (2013). *Matematika Terapan Untuk Ekonomi*. Bandung: Pustaka Setia.

Barus, B. M., & Azahra, S.A. (2020). Analisis Penerapan Matematik dalam Ilmu Ekonomi terkait Fungsi Permintaan dan Penawaran. *Jurnalakuntansi bisnis dan publik*, *10*(2), 102-115.

Gunawan, I. (2013). Metode penelitian kualitatif. *Jakarta: Bumi Aksara*, *143*.

Hermawan, I. (2019). *Metodologi Penelitian Kualitatif, Kuantitatif, & Mix-Method*. Hidayatul Quran.

Janna, A. M. (2022). Fungsi Permintaan Dan Penawaran Matematika Bisnis. *Jurnal Dunia Ilmu*, *2*(1).

Kaharuddin, K. (2021). Kualitatif: Ciri serta Karakter sebagai Metodologi. *Equilibrium: Jurnal Pendidikan*, *1*(9), 1-9. https://doi.org/10.26618/equilibrium.v9i1.4489.

Kurnia, N. (2022). Aplikasi Persamaan Linear Dalam Matematika Bisnis:(Model Persamaan Linier/ Harga Keseimbangan Pasar/ Surplus Produsen/Konsumen pada Bahan Pokok Beras Tahun 2021). *Jurnal Dunia Ilmu*, *2*(1).

Marlina, E., & Ruhiat, D. (2018). Penerapan sub pokok fungsi dalam matematika ekonomi pada fungsi permintaan serta penawaran. *Jurnal Ilmiah Akuntansi FE UNIBBA*, *2*(3), 91-97.

Pratama, F. A., et al. (2022). Penerpan Persamaan Fungsi Non Linear pada Matematik Bisnis di Kehidupan sehari -hari. *Changethink Journa1*, *1*(03), 289-299.

Purbowati, R., & Utomo, L. P. (2016). Faktor-Faktor Yang Memengaruhi Penerimaan Opini dengan Paragraf Penjelas Goingconcern. *Eksis: Jurnal Riset Ekonomi dan Bisnis*, *11*(1). https://doi.org/10.26533/eksis.v11i1.31.

Purnama, N. I. (2017). Pengaruh Pajak serta Subsidi dalam Keseimbangan Pasar. *Jurnal Ekonomi Kawan*, *16*(1), 78085.

Purnomo, L.I., et al. (2019). *Matematika Ekonomi*. Banten: Unpam Press.

Rahayu, S.E., et al. (2017). *Pengantar Ekonomi Makro*. Medan: Pradana Publishing.

Wirawan, N. (2017). *Matematikan Ekonomi dan Bisnis*. Denpasar: Kararas Emas.