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MORALITY BEFORE KNOWLEDGE

Analysis of mushroom supply: Determinants and elasticity factors

Andrew Fahlevi[1], Endang Siti Rahayu[1], Ernoiz Antriyandarti[1]*
[1] *Agribusiness, Faculty of Agriculture, Universitas Sebelas Maret, Ir. Sutami Street No. 36 A, Kentingan, Surakarta, Central Java 57126, Indonesia.*
*Correspondence: ernoiz_a@staff.uns.ac.id

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ABSTRACT
Background: This study aims to determine the factors that influence the supply and elasticity of mushroom supply in Malang. **Method:** The primary method used in this research is descriptive and analytic. The research location was chosen purposively in Malang. The type of data used is secondary data in the form of time series for 39 months. The data analysis method used is multiple regression linear analysis with the partially adjusted Nerlove Model. **Findings:** The results showed the variable price of mushrooms, the area of the harvested mushroom, the price of chicken meat, the price of urea fertilizer, and interest rates individually affected the supply of mushrooms in Malang. The variable of mushroom production and the average rainfall had no significant effect. Variables that are elastic in the short term are the area of the harvested mushroom, and elastic in the long term are the area of the harvested mushroom and the price of chicken meat. **Conclusion:** The mushroom farmer needs production planning to anticipate increases in the price of substitution products. Mushroom farmers are advised to make storage for supply and expand the mushroom house with more substantial materials to increase supply. **Novelty/Originality of this study:** This analysis provides an in-depth understanding of supply dynamics, identifying key factors that influence supply elasticity in the short and long term. This study offers practical recommendations for mushroom farmers to optimize their production in the face of market fluctuations.

KEYWORDS: elasticity; mushrooms; nerlove model; supply response.

1. Introduction

Indonesia's economic growth has been pushed by economic activities in 17 sectors, such as agriculture, forestry, and fishery sector. Horticulture is one of the products from Sub-sector Agriculture. As one of the horticulture products, the mushroom has high nutrition at a low price, and some of them proved to be medicine and anticholesterol (Syariefa et al. 2010). Mushroom cultivation became interesting because it can be done on any scale and has a short period of production (Marshal and Nair, 2009). Raut (2009) explained that the mushroom industry is already going to a new era, and in many developed countries, such as Europe and America, it is being researched and developed. In Indonesia, mushroom cultivation has any type of farming scale, such as in house scale or even big scale.

Table 1 shows that mushroom has high productivity because mushroom can be harvested more than once in one planting period, so in a 1 hectare harvested area, they can produce about 77,94 tonne of mushroom. This number of production will have an impact on the supply of mushrooms in the market. Mankiw et al. (2012) explained that the quantity

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of supply of products and services is the number of products and services willing to be sold by the seller.

Table 1. Seasonal vegetables in the form of fresh vegetables in 2016-2017 in Indonesia

No	Vegetables	2016			2017		
		Harvested area (ha)	Production (ton)	Productivity (ton/ha)	Harvested area (ha)	Production (ton)	Productivity (ton/ha)
1	Mustard Greens	60,600	601,200	9.92	61,133	627,598	10.27
2	Kale	52,542	297,115	5.65	47,805	276,976	5.79
3	Spinach	43,458	160,248	3.69	40,608	148,295	3.65
4	Cauliflower	11,990	142,842	11.91	13,466	152,869	11.35
5	Mushroom	467	40,914	87.61	475	37,020	77.94

(BPS, 2017)

The subject of this research is mushrooms. Many research used mushrooms as a subject that researched the value chain and value-added from mushrooms. Next, Tahvaneinen et al. (2019) researched the market of wild mushrooms in Finlandia as Filandia Forest Product. For research that focuses on supply products, Alfianto (2019) already conducted, who researched supply and elasticity of shallot, but not much research about mushroom supply. See how important mushrooms as a financial product and production condition of mushrooms in Indonesia, make this research enjoyable to conduct to know factors that affect the supply of the mushroom commodity and elasticity of mushroom supply in Malang City.

2. Methods

The base methods used in this research are descriptive and analytic. This research was conducted in Malang City, the 3rd most significant mushroom production in East Java, about 874,6 tonne in 2017 (Indonesia Statistical Center of East Java, 2017). This condition proves that Malang is one of the mushroom production cities in Indonesia.

This study used time-series data from January 2016 to March 2018, obtained from the Departement of Agriculture, Departement of Trade and Cooperative, and Indonesia Statistic Center of Malang City. The mushroom has a short period of planting. Mushrooms can be harvested in week 4th after planting (Fosbener et al. 2018). This study applied multiple linear regression by using the supply model based on Nerlove theory. The model has been developed and adjusted from Ghatak and Ingersent (1984). The model transformed into a log-linear model to estimate or minimize a violation of the assumption of normality and classical regression assumptions (Gujarati, 2009) and to estimate the value of (partial) elasticity from each independent variable to the dependent variable. The model function of supply is defined in Equation (1).

$$ln\ ln\ Q_t = a_0 + a_1\ ln\ ln\ Q_{t-1} + a_2\ ln\ ln\ P_t + ln\ a_3 ln\ A_t + ln\ a_4 ln\ P_{chick} + a_5\ ln\ ln\ P_{ur} + a_6\ ln\ ln\ R_t + a_7\ ln\ ln\ I_t + e \quad \text{(Eq. 1)}$$

In this regression model, Q_t represents the supply of mushrooms in kilograms (kg), which is influenced by several independent variables. The model includes a constant term a0a_0a0 and a series of regression coefficients *a1 – a7* corresponding to the independent variables. The previous month's mushroom production, denoted as $Q_{t\text{-}1}$, is included to account for temporal effects. Additionally, the price of mushrooms P_t (in Rp/kg) impacts supply, along with the harvested area A_t (in square meters). The model also incorporates the price of chicken meat P_{chick} (in IDR/kg), the price of urea fertilizer P_{ur} (in IDR/kg), and the average rainfall R_t (in mm/month). Lastly, the interest rate I_t (in %) is considered to evaluate its effect on mushroom supply, making this model comprehensive for analyzing the various factors influencing mushroom production.

3. Results and Discussion

3.1 Results

Malang has an environment that matches the condition of the environment for mushroom cultivation. The area of Malang is 110,06 km^2 with a significant portion of his areal used for non-agricultural areas, about 8,197 m^2, and for about 1,744 m^2 is used for agricultural areal for paddy, included areal for mushroom cultivation, mushroom house (kumbung). Activity in the agriculture sector gives around 178 billion rupiah for the GRDP of Malang City in 2018 (Indonesia Statistic Center of Malang, 2019).

In statistic test, the value of R^2 is 0.976, which means, 97.6% variance of independent variable can explain dependent, and for other 2,4% is explained by other variables that not included in this research, such as the number of mushroom media (baglog), government regulations, price of pesticide, and the number of used fertilizer. The value of F is significant on α= 0.05 that the independent variable is affecting together with the dependent variable. 5 out of 7 variable is significant.

Table 2. Result of statistic test analysis supply of mushroom in Malang

Model	Unstandardized Coefficients	t	Sig.
	B		
(Constant)	-24.078	-2.168	0.038
lnQt-1	0.033^{ns}	0.664	0.512
lnPt	4.186	3.209	0.003
lnAt	1.049	22.961	0.000
lnPchick	1.868	1.947	0.061
lnPur	-3.842	-4.809	0.000
lnRt	0.015	0.472	0.640
lnIt	-1.444	-3.116	0.004
R^2	0.976		
F	182.254		
N	39		

Based on Table 2, the price of mushrooms, the area of harvested mushrooms, the price of chicken meat, the price of urea fertilizer, and the interest rate individually affect the supply of mushrooms. In contrast, the variables for mushroom production in the last month and average rainfall are not significant. Production of mushroom in last month (Qt-1) has value of significant 0.512 > α = 0.05 that means, this variable is not significant to dependent variable (Qt). Mushroom always has production every month, and even though it is not stable. Mushroom production, which has a short planting period, makes this cultivation fast to harvested with uncertain production every month. If the price of commodities is low, it will affect the supply to decrease and so the other way. The price of mushroom (Pt) has the value of significant 0.003 < α = 0.01 with a coefficient of 4.186, which means the price of mushroom individually and positively affects the dependent variable (Qt). Suppose the price increases for IDR 1,000,-, supply will be increased for 4.186 kg. When the price of mushrooms is high, the farmer has motivated to cultivate mushrooms again because the farmer's motivation for cultivating mushrooms is for additional income.

Level of significance from variable areal of harvested mushroom (At) = 0.000 < α = 0.01 and coefficient is 1.049, which means that the positively areal of harvested mushroom affect the dependent variable (Qt). For every increase in areal for 1.000 m2, the production of mushrooms will increase by 1.049 kg. In general, if someone is starting to cultivate mushrooms, will significantly increase the areal of harvested mushrooms in Malang.

Chicken meat is chosen as a proxy substitution for mushrooms. In Indonesia, substitution happens between mushroom and chicken meat because Indonesian people consume chicken meat more than cow meat or beef. The variable price of chicken meat (Pchick) is significant in 0.061 < α = 0.1 with the coefficient of 1.868, which means that the variable price of chicken meat individually affects the dependent variable (Qt) with a

positive effect. When the price of chicken meat increases for IDR 1,000,-, then the supply of mushrooms will increase by 1.868 kg.

The price of production inputs will affect the ability of farmers to produce. When the price rises, the cost becomes more expensive (Mankiw, 2003). The variable price of urea fertilizer (Pur) is significant at $0.000 < \alpha = 0.01$, with a coefficient of -3.842, indicating that the price of urea fertilizer individually affects the dependent variable (Qt) with a detrimental effect. For every IDR 1,000 increase in the price of urea fertilizer, the supply of mushrooms will decrease by 3.842 kg. Fertilizer components are necessary for the plant to accelerate the flowering process, ripen seeds and fruits, and protect the plant from diseases. If farmers use less urea fertilizer, production will also decrease.

The average of rainfall (Rt) has a significant level of $0.640 > \alpha = 0.05$ which means the average of rainfall is affecting the dependent variable (Qt). Rain is a natural factor that helps farmers as a source of watering the field. As for mushrooms, because the cultivation is in the mushroom house, in the end, rainfall does not affect the cultivation of mushrooms. Cultivating mushrooms in a room or mushroom house with purpose so the farmer can control the environment so prevent crop failure.

The reference of interest rate that used is the interest rate from Bank Indonesia (BI). The variable of interest rate (It) has significance in $0.004 < \alpha = 0.05$, and the coefficient is -1.444, which means as an individual, the interest rate will affect the dependent variable (Qt) negatively. Increasing in interest rate by 1% will decrease the supply of mushrooms by 1.444 kg. Boediono (1997) said that interest rate would determine the investment. Because the investment will influence productivity and then affect the quantity of output (supply), that shows interest rate is an opportunity cost for producing. It may conclude that interest rate affects the number of mushroom commodities indirectly.

Table 3. The elasticity of supply mushroom to affecting variable.

Variable	Short Elasticity	Long Elasticity
Price of mushroom (Pt)	0.058	0.172
Areal of harvested mushroom (At)	2.981	8.872
Price of chicken meat (Pchick)	0.398	1.184
Price of urea fertilizer (Pur)	-0.088	-0.261
Interest rate (It)	-0.00014	-0.00041

For the variable price of mushroom, the areal of harvested mushroom, price of chicken meat has positive relation. In contrast, the price of urea fertilizer and the interest rate have a negative relation to the dependent variable, the supply of mushroom commodities in Malang City. The price of mushrooms has an elasticity value of 0.058% in the short run and 0.172% in the long run so that the elasticity value is inelastic and has a positive effect. In the short term and the long term, when mushroom prices rise, the supply level will increase but less than 1%. When the price of mushrooms increases, it cannot be immediately followed by a rapid increase in production. The production continues to be done in stages so that the supply level increases but is not too big.

For the areal harvest mushroom, it has elastic and positive short-run and long-run elasticity. If there is an increase of 1% in harvested area, the supply will increase by 2.981%, and in the long term, it will increase by 8.872%. When mushroom farmers expand their mushroom houses or add shelves for production in that month, it will impact increasing mushroom production. Increased mushroom production will affect the level of supply of mushrooms in the market.

The variable price of chicken meat has different short-run and long-run elasticity values. The short term cross elasticity is inelastic, while in the long term is elastic. This finding is related to the relationship of mushrooms as a substitute for chicken meat. Indonesian people who usually consume chicken meat in their daily food consumption will look for a substitute when there is an increase in the price of chicken meat. Mushroom as a cheaper substitute with the same nutrition is a choice for the community. But when the increase occurs in the short term, mushroom farmers cannot increase production quickly

because it requires time and preparation. When the price of chicken meat rises in the long run, farmers can easily plan to keep pace with price increases by increasing the number of offers on the market.

The variable price of urea fertilizer has an inelastic and negative elasticity value. When prices increase by 1%, in the short run, the mushroom supply level will decrease by 0.088% and 0.261% in the long run. Urea fertilizer as an input factor in mushroom cultivation is used in making baglogs and watering when the temperature is too hot. The use of fertilizers will reduce if there is an increase in prices, which reduces the amount of production. The interest rate has an inelastic and negative elasticity. When there is an increase in interest rates by 1%, the supply level will decrease in the short-run by 0.00014 and by 0.00041 in the long-run—interest rates as one of the exogenous factors of mushroom supply that affect production indirectly. When interest rates increase, investment (the cost of capital) will go down. This condition will impact the production of inhibited mushrooms cultivation and reduce the supply on the market.

3.2 Discussion

3.2.1 Supply analysis of mushroom

Mushroom production of the previous month is one of the variables thought to affect the supply of mushrooms. Mushroom production is every month, but it is not stable. After multiple linear regression analysis, the variable of mushroom production in the previous month had no significant effect on the supply of mushrooms in Malang City. This result is different from the basic theory, which various things can cause. This theory applies to various commodities but does not apply to mushroom commodities. As stated by Purwadi et al. (2016) in their research, the production of a commodity in the previous month has no significant effect on the supply of these commodities. As with this research, many things can affect, starting from the mushroom harvest that is still not finished or mistakes in harvesting methods. Mushrooms can be harvested around 6-7 times every eight days for approximately 1-2 months, so the production from month to month is sometimes different because several baglogs had expired in the previous month. Sometimes there were differences in the ripe period for harvesting, so farmers decided to use up the remaining unfinished harvest area before starting new cultivation.

The price of mushrooms is one of the considerations for farmers in cultivating mushrooms. The lower the commodity's price, the lower the bidder is, and vice versa. Based on the results of linear regression analysis, the variable price of mushrooms month t individually has a positive effect on the supply of mushrooms in Malang City. A positive effect means that the price and supply have a directly proportional relationship. The supply level of mushroom farmers will be affected by rising and falling prices in that month. Due to this month, farmers will be motivated to replant when the price is high, with the harvest conditions running out. Although many mushroom farmers do not cultivate for their primary income, the motive of farmers cultivating mushrooms is for additional income. Rini (2010) stated that price is an essential factor and has a positive effect on the supply of a commodity.

Based on the results of linear regression analysis, the variable area of mushroom harvested at the month has a positive effect on the supply of mushroom commodities in Malang City. The effect of increasing the area will increase the number of offers. Increasing the planted area is expected to increase the harvested area and the amount of production, thereby increasing the supply of its products, as Setyowati and May (2009) stated that the harvested area of a commodity has a positive effect on the supply of that commodity. The increase in mushroom harvest area can be caused by increasing farmers who cultivate mushrooms or the development of existing mushroom farming. An increase from time to time shows the feasibility of a commodity to be developed and has good prospects. The harvested area influences the supply of mushrooms, but the amount of production is

different for each unit of measure of the harvested area. This is because, at certain times, there is an of the harvested area with low productivity.

Boiler chicken meat was chosen as a proxy for mushroom substitute goods. In Indonesia, substitution occurs between mushrooms and chicken meat because Indonesian people consume more chicken meat than beef in their daily food consumption life. Meat contains protein and nutrients that are good for human growth and development, likewise with mushrooms, which have the same protein and nutritional content as meat. This is consistent with what Miller et al. (2014) said that mushrooms could be a meat substitute with a better effect. Much of the research on mushrooms also addresses this. The linear regression analysis results also show that the variable price of chicken meat in the month individually positively affects the supply of mushrooms in Malang.

Urea fertilizer is one of the input factors in mushroom cultivation. The price of input goods will affect the ability of farmers to produce, when the price increases, the production costs will be more expensive (Mankiw, 2003). Based on linear regression analysis, the variable price of urea fertilizer at month individually has a negative effect on the supply of mushrooms in Malang City. Increased fertilizer prices will allow farmers to reduce the number of baglogs or media made to match expenses.

The average rainfall is one of the variables that are considered influencing the supply of mushrooms in Malang City. Lange in Salerni et al (2002) explains how fungal fertilization is affected by the level of rainfall. The average rainfall in Malang City is quite high at the beginning of the year. In 12 months there are always rainy days, although not much in the middle of the year, namely August to October, which is included in the low average rainfall. Even so, Malang City already has a suitable environmental condition for growing mushrooms. Based on the results of linear regression analysis, the average rainfall individually did not affect the supply of mushroom commodities in Malang. Rain is one of the supporting factors for farmers as a source of water to irrigate crops, one of which is farmer activities in the fields. Food crops, such as rice, require sufficient water to continue growing, in contrast to mushrooms. Cultivation of mushrooms only requires a little water. Besides that, mushroom cultivation is carried out in the kumbung, so that it is not affected by the weather outside the room. The decision of mushroom farmers to cultivate mushrooms does not change according to rainfall. As stated by Alfianto (2009), rainfall does not significantly affect the supply of a commodity.

The reference interest rate used is the interest rate issued by Bank Indonesia. The rise and fall of interest rates can affect the supply of mushroom commodities in Malang. Boediono (1997) states that the interest rate determines the amount of investment. Because the amount of investment will determine the amount of productivity, and the increase in productivity will affect the amount of output issued (supply). Based on the results of linear regression analysis, the variable of the interest rate month t individually has a negative effect on the supply of mushroom commodities in Malang. When the interest rate rises, it will decrease the supply level for mushroom commodities. When interest rates fall, people will invest. Because the cost of capital (investment) will be cheaper, people will invest in helping increase production. This finding is in accordance with Antriyandarti (2003) stated that interest rates have a negative effect on the supply of a commodity. It shows that the interest rate is an opportunity cost for producers. It indicates that the interest rate affects the supply of mushroom commodities, although indirectly.

3.2.2 Elasticity of mushroom

The variable price of the mushroom in the month is elastic and positive in the short and long term. If there is an increase in prices, it will increase the quantity of mushroom commodity supply by more than 1%. Tupamahu (2017) also said that the relationship between commodity prices and commodity supply is elastic and positive. The increase in the price of mushrooms impacts the quantity of mushroom supply because the price of mushrooms is one of the factors that determine the farmers' decisions in replanting.

The area of harvest in the month is elastic and positive in the short and long term. If there is an increase in mushroom harvest area in Malang City, there will be an increase in mushroom commodity supply greater than 1%. Farmers who already have experience in cultivating mushrooms will continue to develop their farming, and one way is to add baglogs, shelves, and even new kumbung. Hapsari (2011) explained that the elasticity relationship between commodity supply and harvested area, which is elastic and positive. Increasing the harvested area can increase the number of offers in the market. The increase can be caused by the presence of a new mushroom farmer, increasing the overall harvest area and the supply of mushroom commodities in Malang City. This impact will be immediately visible in both the short and long-term conditions, will increase the supply of mushrooms in the market.

The price of chicken meat in the month has elastic and positive elasticity in the short and long term. Similar to Mutasi (2011), the price elasticity of substituted goods on the supply of the commodities studied is elastic and positive. This is due to the effect of the substitution. Mushrooms are known for their high nutritional content and can be a meat substitute. The increase in the price of chicken meat will make people look for a substitute with the same nutritional content, namely mushrooms. Farmers did not immediately follow the change in meat prices during the month in a significant increase in production. However, in long-term conditions, farmers have a chance to plan and prepare the production. If there is an increase in the price of chicken meat, it will increase the supply of mushroom commodities in Malang City.

The price of urea fertilizer in the month has a negative elasticity value, which means that an increase in the price of urea fertilizer in the short and long term will cause the supply of mushroom commodities to decline. This variable has an elastic value of elasticity. These results are consistent with research from Suprapti et al. (2011). The price of the input product, urea fertilizer, has a negative elasticity value for the supply of these commodities because the amount of urea fertilizer used will influence the production. The price of urea will influence the amount of use. If the price goes up, farmers will buy less urea fertilizer and produce less, so the total output will decrease. As a result, the supply level of mushroom commodities declines.

The following variable is the interest rate variable in the month. The interest rate variable is elastic and negative in the short and long term so that if there is an increase in interest rates, the amount of supply will decrease. Research by Hermawan and Lukman (2010) also explains the negative relationship between interest rates and commodity supply. Changes in interest rates will affect supply indirectly. The interest rate is an exogenous factor affecting supply. The interest rate affects supply through the cost of capital (investment). If the interest rate rises, the allocation of capital (investment) cost will decrease, and vice versa. In the production of mushrooms, if the cost of capital (investment) falls, it will hamper production. The decreasing production will cause the mushroom commodity supply level in Malang also to decrease. Herispon (2010) stated that if the producer adds supply with additional costs, the supply will be elastic.

4. Conclusions

The factors affecting mushroom supply are mushroom prices, mushroom harvest area, and chicken meat prices have a positive effect, while urea fertilizer prices and interest rates affect negatively. The elasticity of the supply of mushroom commodities to mushroom prices, harvested area, and chicken meat prices are positive. In contrast, the variable price of urea fertilizer and interest rates are negative. In the short run, the elastic variable is the area of the harvested area, and in the long run, the elastic variable is the areal of harvested mushrooms and the price of chicken meat.

The conclusion recommends that farmers make a storage place to sell the products when there is abundant production gradually. The purpose is to increase the supply in a large market so that it impacts the decline in mushroom prices. Increasing in use of technology is also needed to expand the harvest area to maximize production. Arranged and

scheduled production is also essential so that in time of increase in chicken meat prices, can be anticipated quickly by farmers.

Author Contribution
All authors contributed significantly to the conception, design, research, analysis, interpretation of data, drafting, and revision of this article.

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Biographies of Authors

Andrew Fahlevi, Agribusiness, Faculty of Agriculture, Universitas Sebelas Maret, Ir. Sutami Street No. 36 A, Kentingan, Surakarta, Central Java 57126

- Email: andrewfahlevi@student.uns.ac.id
- ORCID: N/A
- Web of Science ResearcherID: N/A
- Scopus Author ID: N/A
- Homepage: N/A

Endang Siti Rahayu, Agribusiness, Faculty of Agriculture, Universitas Sebelas Maret, Ir. Sutami Street No. 36 A, Kentingan, Surakarta, Central Java 57126

- Email: endangsiti@staff.uns.ac.id
- ORCID: 0000-0002-4967-0780
- Web of Science ResearcherID: N/A
- Scopus Author ID: 57195307987
- Homepage: https://iris1103.uns.ac.id/profil-0004015708.asm

Ernoiz Antriyandarti, Agribusiness, Faculty of Agriculture, Universitas Sebelas Maret, Ir. Sutami Street No. 36 A, Kentingan, Surakarta, Central Java 57126

- Email: ernoiz_a@staff.uns.ac.id
- ORCID: 0000-0002-0948-4000
- Web of Science ResearcherID: N/A
- Scopus Author ID: 57201775415
- Homepage: https://iris1103.uns.ac.id/profil-0524108001.asm