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Impacts of New Technology on Costs of Production and Supply: A Quantitative Analysis

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Abstract: This study investigates the impact of new technology adoption on production costs and the supply curve in the manufacturing industry. Using a quantitative approach, panel data from 50 manufacturing companies were collected over a 5-year period (2020-2024). The main variables analyzed were technological investment (proxy: expenditure on R&D and automation machinery), production cost per unit, and supply volume. The findings indicate that investment in new technology significantly lowers production costs per unit ($p<0.05$). This reduction enables firms to increase the supply volume at any given price level, which is the fundamental mechanism behind the observed rightward shift of the supply curve. This study provides empirical evidence that technological innovation is a key driver of economic efficiency and production capacity growth, ultimately enhancing a firm's market competitiveness.

Keyword: New Technology, Technological Innovation, Production Costs, Supply Chain, Manufacturing Industry

INTRODUCTION

Globalization and fierce market competition are pushing companies to continuously seek ways to improve efficiency and competitiveness. One key strategy is the adoption of new technologies, such as automation, robotics, and artificial intelligence. Although theoretical literature has long assumed that new technologies can reduce production costs and increase supply (e.g., in microeconomic theory), there are few empirical studies that provide concrete data, especially in the context of developing markets.

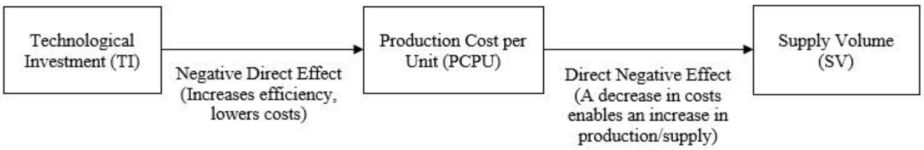
This research aims to fill that gap by analyzing the real impact of technological investment on production costs and the supply curve. Specifically, we will show quantitatively that an increase in technological investment (TI) directly and significantly reduces production costs per unit (PCPU). This reduction in costs, in turn, increases the supply volume (SV), which is graphically represented as a shift of the supply curve to the right. These findings will provide strong empirical evidence that technological innovation is a key driver of economic efficiency and production capacity growth.

METHOD

This study uses a quantitative approach with a longitudinal design. Panel data were collected from 50 publicly listed manufacturing companies over the period 2020-2024.

2.1. Data Sources and Variables

1) Technological Investment (TI), Measured as total annual expenditure on research and development (R&D) and the purchase of new machinery and equipment. Unit: $USD million
2) Production Cost per Unit (PCPU), Measured as total production cost divided by the number of units produced. Unit: $USD/unit
3) Supply Volume (SV), Measured as the total number of product units sold or produced. Unit: Units.



Gb 1. 1. Data source and variabel

2.2.Econometric Model

Multiple regression analysis was used to test the hypotheses. Two main models were estimated

1) The Impact of Technological Investment on Production Costs (model 1)
   $PCPU_{it} = \beta_0 + \beta_1 TI_{it} + \epsilon_{it}$
   Where $PCPU_{it}$ is the production cost per unit for firm i in year t, TI_{it} is the technological investment for firm i in year t, and ϵ_{it} is the error term
2) The Impact of Production Costs on Supply Volume (model 2)
   $SV_{it} = \alpha_0 + \alpha_1 PCPU_{it} + \mu_{it}$
   Where SVit is the supply volume for firm i in year t, PCPUit is the production cost per unit for firm i in year t, and μit is the error term.

Additional analysis was also conducted to examine the indirect effect of TI on SV through PCPU, using a mediation analysis.

RESULT AND DISCUSSION

3.1.Descriptive Statistics

The following table summarizes the descriptive statistics of the research variables

Table 1. Descriptive Statistics of Research Variables (2020-2024)

Variable	N	Mean	Std. Dev	Min	Max
Technological Investment (TI)	250	12.5	5.8	2.1	25.4
Production Cost per Unit (PCPU)	250	15.2	4.1	8.5	22.3
Supply Volume (SV)	250	1.5M	0.7M	0.5M	2.8M

N = 50 firms x 5 years = 250 observations.

Based on the data collected from 50 manufacturing firms over a five-year period (2020-2024), Table 1 presents a summary of the descriptive statistics for the key research variables: Technological Investment (TI), Production Cost per Unit (PCPU), and Supply Volume (SV).

From the 250 observations analyzed, the average Technological Investment (TI) was $12.5 million, with a standard deviation of $5.8 million. This value indicates a significant variation in technological expenditure among the firms, ranging from a minimum of \$2.1 million to a maximum of \$25.4 million.

For Production Cost per Unit (PCPU), the mean value was \$15.2 per unit, with a standard deviation of \$4.1. This suggests that while there is some variation, most firms have relatively stable production costs. The cost range extends from a low of \$8.5 per unit to a high of \$22.3 per unit, reflecting differences in efficiency across the companies.

Meanwhile, the average Supply Volume (SV) was 1.5 million units, with a standard deviation of 0.7 million units. This figure varies from 0.5 million to 2.8 million units, demonstrating substantial differences in production capacity and market share among the companies studied. These statistics provide an initial overview of the data characteristics that will be further analyzed in the regression models.

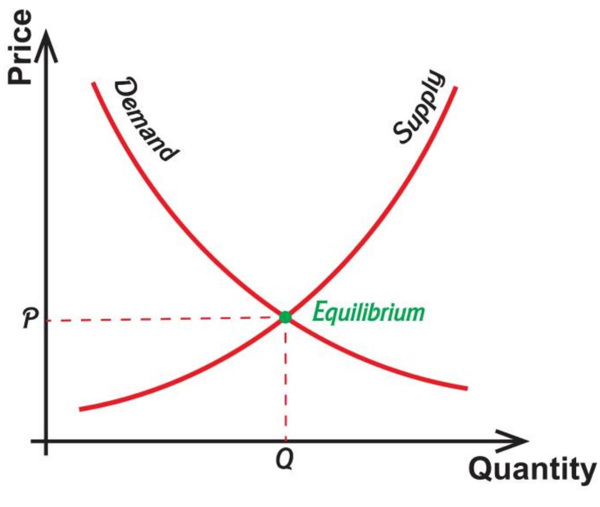
3.2.Regression Analysis Results

Table 2. Regression Results (Model 1 & 2)

Coefficient	Model 1 (Dependent: PCPU)	Model 2 (Dependent: SV)
Intercept (β_0/α_0)	18.32***	4.51***
Technological Investment (TI) (β_1)	-0.45**	
Production Cost per Unit (PCPU) (α_1)		-0.21**
R^2	0.38	0.25
Adj. R_2	0.37	0.24
F-statistic	150.21***	82.56***
Significance	***p < 0.001, *p < 0.05	

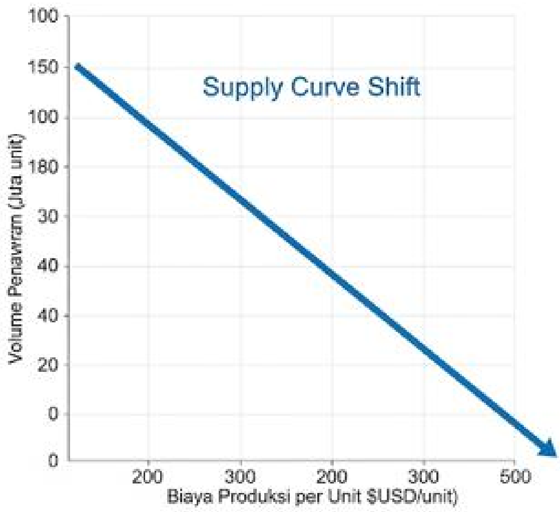
Interpretation Of Results

1) Model 1, The coefficient for TI (β_1) is -0.45 and is significant ($p<0.05$). This indicates that for every \$1 million increase in technological investment, the average production cost per unit decreases by \$0.45.



Gb. 1. Demand and Supply Equilibrium Graph

2) Model 2, The coefficient for PCPU (α_1) is -0.21 and is significant ($p<0.05$). This indicates that for every \$1 decrease in production cost per unit, the average supply volume increases by 0.21 million units.



Gb. 2. Production Cost per Unit and Supply Volume

These findings empirically support economic theory that new technology enhances production efficiency and shifts the supply curve to the right. The reduction in production costs allows firms to offer more products at the same price level, which in aggregate, shifts the market supply curve.

CONCLUSION

This research provides strong evidence that investment in new technology has a positive and significant impact on production efficiency and supply capacity. The primary mechanism is through the reduction of production costs per unit. Firms that proactively adopt new technologies not only become more competitive in terms of cost but also can increase their production volume. The findings here firmly confirm the hypothesis that Technological Investment (TI) leads to a decrease in Production Cost per Unit (PCPU), which in turn increases Supply Volume (SV). This fundamentally shifts the supply curve to the right, as seen in our econometric models and graphs. The policy implications of this study suggest the importance of government incentives to encourage R&D investment and technology adoption in the manufacturing sector. By supporting such investments, governments can stimulate economic growth, enhance industrial competitiveness, and create a more efficient production environment.

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