

Game Theory in Business Decision-Making: A Strategic Approach to Competitive Market Dynamics

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Abstract. In the complex and competitive landscape of modern business, strategic decision-making plays a pivotal role in determining success. This paper explores the application of game theory in business decision-making, focusing on its utility in competitive scenarios such as pricing strategies and market share battles. In this paper, the Bertrand Competition Model, Cournot Competition Model and further extended model are introduced and put into test in the American Express delivery market which is led by FedEx, UPS and USPS. The main finding is that the real market is not ideal competitive, price adjustment delay and brand premium exist. Under the Bertrand model, the price tends to be equal to marginal cost which is not realistic in the real market.

Keywords: Game Theory; Nash Equilibrium; Bertrand Model; Cournot Model; Market Strategy; Market Share; Price War.

1. Introduction

In modern market competition, firms engage in strategic interactions that shape market dynamics, influencing pricing strategies, market share, and cooperation models. The express delivery industry is a classic oligopoly, where FedEx, UPS, and USPS dominate the American Express market, creating a complex competitive landscape. The main types of the competition include the Price Wars, Competition on Market Share and Cooperation and Sharing Patent. The main research question is on which competition model (Bertrand or Cournot) the express delivery industry aligns more closely? Do the pricing strategies influence the market share? Does the Bertrand equilibrium exist in reality? To find the answers of these questions, this paper adopts a dual approach combining theoretical analysis and empirical validation. Bertrand Competition Model, Cournot Competition Model and Prisoner's dilemma in Cooperation are included in theoretical analysis. Empirical analysis is also applied, using the econometrics model to do the regression, which is to test if the price changes significantly impact market share. This study contributes to both theory and practice fields. It extends Bertrand & Cournot models to the multi-firm market structures and examines cooperative game theory and its role in industry dynamics. By gathering real market data, this study tests game theory predictions and offers strategic insights for firms to optimize pricing and market strategies.

2. Literature Review

2.1 Foundations of Game Theory

The game theory is originally summarised in Theory of Games and Economic Behaviour by Von Neumann and Morgenstern in 1944, game theory has been much discussed in relation to economic decision-making. This framework had a huge impact and offers mathematical foundations for examining strategic interactions between companies, clarifying how companies decide on competitive tactics, production output, and pricing.

2.2 Bertrand Competition Model

Bertrand Model (Bertrand, 1883) explains price competition in an oligopoly when companies produce homogeneous products and compete by setting different prices. Bertrand's presumptions mentioned that companies have same marginal costs and consumers always choose the least expensive product. In equilibrium, companies reduce prices to levels of marginal cost, producing zero economic profits, which is a phenomena that counters the actual situations that brand loyalty and price difference exist (Tirole, 1988).

Empirical studies like Price Leadership (Deneckere & Kovenock, 1992) have proved that real-world companies often fail to reach marginal-cost pricing because of factors like product differentiation and restricted manufacturing capacity.

2.3 Cournot Competition Model

Cournot model assumes companies compete on quantity instead of price (Cournot, 1838). Under this model, companies decide the quantity of their output on their own, predicting output of their rivals and modifying their behaviour to maximise profits. Unlike Bertrand competition, Cournot competition results in an equilibrium where each firm's output decision influences market price, companies often engage in aggressive price reduction under such conditions (Mas-Colell, Whinston, & Green, 1995).

In the practical world, sectors like aviation and telecommunication, they compete by Cournot-style competition, where companies modify supply to chase profitability (Vives, 1999). Moreover, there also exist researches discussed Bertrand-like competition that companies initially compete in volume and subsequently set price (Kreps & Scheinkman, 1983). However, these articles lack of investigation of a specific industry, this article will exam a more specific industry (U.S. delivery market leading by FedEx, UPS and USPS) and examine the application of the two competitive models in this industry.

3. Methodology

3.1 Bertrand Model Theory

The Bertrand model is used to analyse price competition in oligopoly markets. Based on this model, suppose there are a few companies (like UPS, FedEx and USPS) in the U.S. market, since they sell similar products (express delivery services). Assume they compete for market share by adjusting prices.

The Bertrand model must satisfy the following assumptions: 1. The two companies provide indifferent products, they have the same marginal cost and both companies set their price simultaneously; 2. Consumers are perfectly rational, which means they always choose the company with the lowest price; 3. There are no capacity constraints, companies can meet all market demands.

From the perspective of mathematical model:

The profit of firms equals to $\pi_i = (p_i - c) \cdot Q_i$ where i present different firms. Based on the equation and assumptions above, the firm with lower price p gains the full market. Firms will reduce their prices to attract more consumers. In an indifference market, under the situation of perfect competition, the final price $p_i = p_1 = p_2 = c$ where the price is equal to the marginal cost and the market is averagely separated. And the profit equals zero as the price is equal to marginal cost.

However, in the express delivery industry, UPS, FedEx and USPS differentiate themselves through service quality (timeliness, value-added services), avoiding pure price competition.

3.2 Cournot Model Theory

The Cournot competition model is used to describe quantitative competition in oligopolistic markets. In this case, assume UPS and FedEx influence the market price mainly by adjusting the volume of shipping (express business volume).

The Cournot model must satisfy: 1. Two firms decide their volume of production instead of price, they aim to maximise their production by predicting the competitor's volume of production; 2. The market price is decided by the volume of production and the marginal costs for different firms can be different.

From the view of mathematical model:

The market price $P(Q) = a - bQ$, the profit for firm i is $\pi_i = P(Q)q_i - C_i = (a - bQ)q_i - cq_i$. By algebra and differentiation, the equilibrium quantity and price will be $Q^* = nq^* = \frac{n(a-c)}{b(n-1)}$ and $P^* = \frac{a+nc}{n+1}$.

As the number of firms increase, the market price will decrease and approach the marginal cost. Under perfect competition, $Q_{pc} = a - \frac{c}{p}$ as $P = c$, where $Q^* < Q_{pc}$, which shows that the price is still higher than the level of full competition.

When $n = 1$, monopoly occurs $P^* = a + \frac{c}{2}$, which is larger than the market price of competition market. Cournot competition is an intermediate state between monopoly and perfect competition. The market price decreases with the increase of the number of firms and eventually tends to the price level of perfect competition. The number of total output and market price are between monopoly level and perfect competition level.

Although Bertrand & Cournot competition models reveal how the firms and markets' react during competition, there may be firms over 2 in a certain industry. How the models can be adapted to fit a market within multiple firms.

3.3 N-firms Bertrand Competition Model

When there are N firms in the market, the Bertrand competition model should be expanded to pricing games among multiple firms. Under this condition, the company i set the price of its product at p_i . The market demand is Q_i .

$$Q_i = D_i(p_i, p - i)$$

$p-i$ means the price of other competitors.

Following the Nash equilibrium, if the products from all the firms are no different, every company will lower their prices to the marginal cost, which profit tends to be 0. To test how the pricing influences one firm's market share, multi-factor regression can be applied.

$$MarketShare_i = \alpha + \beta_1 Price_{FedEx} + \beta_2 Price_{UPS} + \beta_3 Price_{USPS} + \varepsilon$$

If the coefficient β_i is significantly negative, it means the decline of the price has a positive effect on market share.

3.4 N-firms Cournot Competition Model

If the firms compete on the market by adjusting the volume of shipping, and there are multiple companies on the market, the N-firms Cournot competition model should be used.

Assume there are N companies on the market, they can choose their volume of shipping q_i . Then the market price will be decided by the total volume of shipping.

$$P(Q) = a - bQ = a - b(q_1 + q_2 + \dots + q_N)$$

The profit of a certain firm will be

$$\pi_i = (P(Q) - c_i) \cdot q_i$$

To maximise the profit, the optimum volume of shipping for every firm is

$$q_i^* = \frac{a - c_i - b \sum_{j \neq i} q_j}{2b}$$

Using the multi-factor regression analysis to find how the volume of shipping influences the market share.

$$MarketShare_i = \alpha + \gamma_1 Volume_{FedEx} + \gamma_2 Volume_{UPS} + \gamma_3 Volume_{USPS} + \varepsilon$$

If the Gama i is significantly positive, the increase in volume of shipping has a positive impact on market share.

4. Results and Discussion

4.1 Bertrand Competition Model Analysis

Collecting the core data (Unit Price and Domestic Package Volume of each firm) from annual reports of FedEx, UPS and USPS respectively. Using the data of package volume and U.S. total package volume to calculate the market share of each year. Rearrange the data for the following coding and Bertrand analysis.

Year	FedEx price (\$)	UPS price (\$)	USPS price (\$)	FedEx market share	UPS market share (%)	USPS market share (%)
2019	18.54	10.87	3.695539335	0.070750935	0.315861237	0.411878675
2020	18.3	10.94	3.894744027	0.055187638	0.290257632	0.394389705
2021	17.79	12.32	4.219907713	0.060437897	0.275015034	0.382655635
2022	20.15	13.38	4.330337389	0.059595183	0.271621061	0.370586728
2023	22.54	13.62	4.480878187	N/A	N/A	N/A

Figure 1. Data for Bertrand analysis. (created by author, 2025)

The results of the regression of Bertrand competition model shows the relationship between the pricing strategies of FedEx, UPS, and USPS and their market shares respectively. The key findings suggest that price competition is very important in determining market shares within the U.S. parcel delivery industry.

FedEx Market Share Regression:						
OLS Regression Results						
Dep. Variable:	FedEx market share(%)	R-squared:	1.000			
Model:	OLS	Adj. R-squared:	nan			
Method:	Least Squares	F-statistic:	nan			
Date:	Tue, 04 Mar 2025	Prob (F-statistic):	nan			
Time:	10:07:17	Log-Likelihood:	135.91			
No. Observations:	4	AIC:	-263.8			
Df Residuals:	0	BIC:	-266.3			
Df Model:	3					
Covariance Type:	nonrobust					
	coef	std err	t	P> t	[0.025	0.975]
const	0.2841	inf	0	nan	nan	nan
FedEx price(\$)	-0.0065	inf	-0	nan	nan	nan
UPS price(\$)	0.0236	inf	0	nan	nan	nan
USPS price(\$)	-0.0943	inf	-0	nan	nan	nan
Omnibus:	nan	Durbin-Watson:	0.012			
Prob(Omnibus):	nan	Jarque-Bera (JB):	0.227			
Skew:	0.311	Prob(JB):	0.893			
Kurtosis:	2.012	Cond. No.	1.12e+03			

Figure 2. FedEx Market Share Regression when price changes

For FedEx, the regression analysis reveals that its own price coefficient is negative (-0.0065), suggesting that a price decrease by FedEx leads to an increase in its market share. Conversely, the

coefficient for UPS's price is positive (0.0236), indicating that a price increase by UPS benefits FedEx's market share. The coefficient for USPS's price is negative (-0.0943), implying that USPS's price reductions significantly reduce FedEx's market share.

Similarly, for UPS, the price coefficient is positive (0.0206), meaning that UPS's price increases do not significantly harm its market position. However, the negative coefficient for USPS price (-0.1407) suggests that USPS's aggressive pricing strategies have a notable impact on UPS's market share.

UPS Market Share Regression: OLS Regression Results						
Dep. Variable:	UPS market share(%)	R-squared:	1.000			
Model:	OLS	Adj. R-squared:	nan			
Method:	Least Squares	F-statistic:	nan			
Date:	Tue, 04 Mar 2025	Prob (F-statistic):	nan			
Time:	10:07:17	Log-Likelihood:	132.94			
No. Observations:	4	AIC:	-257.9			
Df Residuals:	0	BIC:	-260.3			
Df Model:	3					
Covariance Type:	nonrobust					
	coef	std err	t	P> t	[0.025	0.975]
const	0.6881	inf	0	nan	nan	nan
FedEx price(\$)	-0.0041	inf	-0	nan	nan	nan
UPS price(\$)	0.0206	inf	0	nan	nan	nan
USPS price(\$)	-0.1407	inf	-0	nan	nan	nan
Omnibus:	nan	Durbin-Watson:	0.018			
Prob(Omnibus):	nan	Jarque-Bera (JB):	0.611			
Skew:	-0.816	Prob(JB):	0.737			
Kurtosis:	2.000	Cond. No.	1.12e+03			

Figure 3. UPS Market Share Regression when price changes

Finally, the analysis of USPS's market share suggests that FedEx and UPS's price increases positively influence USPS's market position, while USPS's own price decreases contribute to its market dominance, as evidenced by a negative coefficient (-0.0997).

USPS Market Share Regression:						
OLS Regression Results						
Dep. Variable:	USPS market share(%)		R-squared:	1.000		
Model:	OLS		Adj. R-squared:	nan		
Method:	Least Squares		F-statistic:	nan		
Date:	Tue, 04 Mar 2025		Prob (F-statistic):	nan		
Time:	10:07:17		Log-Likelihood:	128.40		
No. Observations:	4		AIC:	-248.8		
Df Residuals:	0		BIC:	-251.3		
Df Model:	3					
Covariance Type:	nonrobust					
	coef	std err	t	P> t	[0.025	0.975]
const	0.7563	inf	0	nan	nan	nan
FedEx price(\$)	-0.0062	inf	-0	nan	nan	nan
UPS price(\$)	0.0127	inf	0	nan	nan	nan
USPS price(\$)	-0.0997	inf	-0	nan	nan	nan
Omnibus:	nan	Durbin-Watson:	0.004			
Prob(Omnibus):	nan	Jarque-Bera (JB):	0.460			
Skew:	0.324	Prob(JB):	0.794			
Kurtosis:	1.470	Cond. No.	1.12e+03			

Figure 4. USPS Market Share Regression when price changes

4.2 Cournot Competition Model Analysis

Collecting the data of domestic package volume of each firm from annual reports of FedEx, UPS and USPS respectively. Using the data of package volume and U.S. total package volume to calculate the market share of each year. Rearrange the data for the following coding and Cournot analysis.

Year	FedEx volume (million)	UPS volume (million)	USPS volume (million)	FedEx market share	UPS market share (%)	USPS market share (%)
2019	1059	4728	6165	0.070750935	0.315861237	0.411878675
2020	1025	5391	7325	0.055187638	0.290257632	0.394389705
2021	1198	5451	7585	0.060437897	0.275015034	0.382655635
2022	1163	5301	7232	0.059595183	0.271621061	0.370586728
2023	1017	4834	7060	N/A	N/A	N/A

Figure 5. Data for Cournot analysis. (created by author, 2025)

Examining FedEx, UPS, and USPS cargo volumes on their respective market shares, the regression findings for the Cournot competition model show the results imply that the link between shipping volume and market share in the U.S. parcel delivery sector is complex, contrary to the theoretical assumption of Cournot competition whereby growing output generally results in more market dominance.

For FedEx, the estimated coefficient for its own shipment volume is nearly zero ($-7.88\text{e-}06$), indicating that changes in FedEx's shipment volume have an insignificant effect on its market share. The coefficient for UPS's volume is negative (-0.0001), implying that an increase in UPS's shipment volume reduces FedEx's market share slightly. Meanwhile, the USPS volume coefficient is positive ($5.19\text{e-}05$), suggesting a minor influence of USPS's expansion on FedEx.

FedEx Market Share Regression:

OLS Regression Results						
Dep. Variable:	FedEx market share(%)	R-squared:	1.000			
Model:	OLS	Adj. R-squared:	nan			
Method:	Least Squares	F-statistic:	nan			
Date:	Tue, 04 Mar 2025	Prob (F-statistic):	nan			
Time:	10:07:17	Log-Likelihood:	135.68			
No. Observations:	4	AIC:	-263.4			
Df Residuals:	0	BIC:	-265.8			
Df Model:	3					
Covariance Type:	nonrobust					
	coef	std err	t	P> t	[0.025	0.975]
const	0.3014	inf	0	nan	nan	nan
FedEx volume(million)	-7.881e-06	inf	-0	nan	nan	nan
UPS volume(million)	-0.0001	inf	-0	nan	nan	nan
USPS volume(million)	5.19e-05	inf	0	nan	nan	nan
Omnibus:	nan	Durbin-Watson:	0.003			
Prob(Omnibus):	nan	Jarque-Bera (JB):	0.479			
Skew:	-0.362	Prob(JB):	0.787			
Kurtosis:	1.468	Cond. No.	1.34e+06			

Figure 6. FedEx Market Share Regression when volume changes

The results for UPS indicate a counterintuitive finding where its own shipment volume coefficient is negative (-0.0005), meaning that UPS increasing its shipment volume does not necessarily lead to higher market dominance. This could be attributed to potential price competition effects or diminishing returns in the parcel delivery market.

UPS Market Share Regression:

OLS Regression Results						
Dep. Variable:	UPS market share(%)	R-squared:	1.000			
Model:	OLS	Adj. R-squared:	nan			
Method:	Least Squares	F-statistic:	nan			
Date:	Tue, 04 Mar 2025	Prob (F-statistic):	nan			
Time:	10:07:17	Log-Likelihood:	123.62			
No. Observations:	4	AIC:	-239.2			
Df Residuals:	0	BIC:	-241.7			
Df Model:	3					
Covariance Type:	nonrobust					
	coef	std err	t	P> t	[0.025	0.975]
const	1.3506	inf	0	nan	nan	nan
FedEx volume(million)	-0.0003	inf	-0	nan	nan	nan
UPS volume(million)	-0.0005	inf	-0	nan	nan	nan
USPS volume(million)	0.0002	inf	0	nan	nan	nan
Omnibus:	nan	Durbin-Watson:	0.005			
Prob(Omnibus):	nan	Jarque-Bera (JB):	0.955			
Skew:	-1.149	Prob(JB):	0.620			
Kurtosis:	2.329	Cond. No.	1.34e+06			

Figure 7. UPS Market Share Regression when volume changes

Finally, for USPS, the findings suggest that both FedEx and UPS increasing their shipment volumes negatively impact USPS's market share, as shown by the coefficients of -0.0004 and -0.0007, respectively. Meanwhile, USPS increasing its own shipment volume does not significantly improve its market share (+0.0003).

USPS Market Share Regression:

OLS Regression Results						
Dep. Variable:	USPS market share(%)	R-squared:	1.000			
Model:	OLS	Adj. R-squared:	nan			
Method:	Least Squares	F-statistic:	nan			
Date:	Tue, 04 Mar 2025	Prob (F-statistic):	nan			
Time:	10:07:17	Log-Likelihood:	124.42			
No. Observations:	4	AIC:	-240.8			
Df Residuals:	0	BIC:	-243.3			
Df Model:	3					
Covariance Type:	nonrobust					
	coef	std err	t	P> t	[0.025	0.975]
const	1.7470	inf	0	nan	nan	nan
FedEx volume(million)	-0.0004	inf	-0	nan	nan	nan
UPS volume(million)	-0.0007	inf	-0	nan	nan	nan
USPS volume(million)	0.0003	inf	0	nan	nan	nan
Omnibus:	nan	Durbin-Watson:	0.017			
Prob(Omnibus):	nan	Jarque-Bera (JB):	0.836			
Skew:	-1.058	Prob(JB):	0.659			
Kurtosis:	2.267	Cond. No.	1.34e+06			

Figure 8. USPS Market Share Regression when volume changes

These findings indicate that the competition in the parcel delivery market does not fully align with the classical Cournot competition model, where higher output should directly correlate with increased market dominance.

5. Current Challenges and Future Work

5.1 Current Challenges

Although the models of Bertrand and Cournot competition provide analysis of FedEx, UPS, and USPS's competitive dynamics, there still exist some current limits. Firstly, given a R^2 of 1.000, the tiny sample size, just four years of data, indicates overfitting and challenges the universality of the results. Lack of an F-statistic also implies that the models need more data for strong hypothesis testing. Secondly, the infinite standard errors suggest possible multicollinearity among the independent variables, which can distort the coefficient estimates and lower the dependability of the models. Thirdly, although the models based on the statement that price and shipping volume define market share, real-world competition is shaped by other elements including fuel costs, delivery speed, service quality, and other macroeconomic conditions, which the regression analysis omitted.

5.2 Future Works

Based on current challenges, the future studies should focus on increasing the dataset to cover at least 10 years of data, therefore improving the reliability of the research and enabling a more accurate estimate of market trends. Additionally, adding control variables such as gasoline costs, inflation rates, service innovations, and legislative changes (as dummy variables) can improve the explanatory power of the models. Lastly, using sophisticated econometric methods such as panel data regression or time-series models could assist explain dynamic interactions over time and firm-specific impacts, therefore providing a more complete explanation of the competitive environment in the U.S. parcel delivery industry.

6. Conclusion

This research employs Bertrand and Cournot competition models to examine the pricing and shipping volume tactics of FedEx, UPS, and USPS within the U.S. parcel delivery industry. The regression findings indicate the impact of price and output decisions on market share, highlighting discrepancies from traditional economic theories.

6.1 Key Findings

Bertrand Competition:

The results of the regression indicate that lowering a firm's price can slightly increase its market share, but the impact is relatively small. However, pricing strategies of its competitors will significantly affect market share. For example, when UPS or USPS increases their prices, FedEx tends to gain market share.

The impact of price changes on market share is not as strong as expected, suggesting that price competition is not the only determinant of market dominance.

Cournot Competition:

The results show that increasing shipment volume does not necessarily cause a higher market share, contradicting the classical Cournot competition model.

In some cases, higher shipment volume was associated with a slight reduction in market share, implying that the parcel delivery market is influenced by factors beyond quantity competition, such as service quality, delivery speed, and brand reputation.

6.2 Differences with Theoretical Models

The results demonstrate that U.S. parcel delivery market does not perfectly satisfy the traditional Bertrand or Cournot models.

In addition to a pure price competition or the influences from shipment volume, factors such as brand loyalty, service differentiation, and operational efficiency also play a significant role in the market competition.

6.3 Managerial Implications

Price competition is not sufficient to win a competition of market share; firms should also focus on service differentiation and operational efficiency to improve the quality of their services. Higher operation efficiency can bring a lower costs of firms, which means they will be able to accept lower price. Firms in the practical world are motivated by profit, as the price reduction will be limited by the production cost; product differences, brand marketing and customer loyalty and other factors tend to be more helpful to firms to gain an advantage in the market competition

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