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ELASTICITY OF MARKET DEMAND BETWEEN MODES OF TRANSPORT IN VIETNAM BY PRICE AND INCOME

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This study aims to determine the demand elasticity of passenger and freight transport market between different modes of transport in Vietnam by income, by price and by the price of substitute mode of transport (cross price). Upon consideration of the theoretical basis and inheriting the results of previous studies, this study applies a non-linear model to estimate the elasticity coefficients of demand. The analysis of the data for a 16-year period from 2001 to 2016 in Vietnam shows that as a general rule, the average per capita income is a factor that positively influences the transport market demand of different modes of transport. Freight rates, as a general rule, have an opposite effect on passenger transportation by waterway, freight transportation by road, by waterway and by air. Demand is greatly affected by the cross price in the freight transportation by air. The outcome of the research serves as a basis to propose business implications for executive management to make appropriate policies for each mode of transport and to create harmonization of all modes of transport.

Keywords: Elasticity of Demand of Transport Market, Own Price, Cross Price, Income per Capita
JEL Classification: A10, A11

1. INTRODUCTION

Income, freight rates and prices of substitute transport mode are important factors

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affecting the market demand in general and the transport market demand in particular. Determining their elasticity to the market demand has a very important meaning for carriers' executives to have appropriate business policies as well as for national transport policy makers of countries to have a well-balanced competition and development policy between different modes of transport. In Vietnam, there are currently 4 major modes of transport: by roads, railways, waterways and airways. On the one hand, these modes of transport both compete and support each other to create a synchronous transportation system in Vietnam. On the other hand, each of these modes of transport has certain competitive advantages. There is an increased globalization process around the world in the world in general (Vo, 2009; Vo and Daly, 2005; Vo et al., 2017; Vo and Ellis, 2018) and in Vietnam in particular (Nguyen et al., 2018; Vo and Nguyen, 2018). The role of Vietnam has been increased significantly in the last decades even though the country still suffers problems associated with developing nations such as inequality, government problem, and bad debts in the banking system (Bui et al., 2018; Vo, 2018e, 2018f). Hence, further study investigating the case of Vietnam is important.

Road transport with its high mobility is relatively suitable for short-distance transport where reasonable road infrastructures are available. Waterway transport with its low cost, but slow transit time, will highly promote long-distance freight transport with high tonnage or large quantities. Meanwhile, airway transport with its advantage of being fast, safe and comfortable, but high cost, should be highly recommended for long-distance passenger transportation and for transportation of light and high value freight that needs express delivery. Although railway transport has low costs, it requires significant infrastructure investment and therefore it is not properly developed in Vietnam.

Per capita income in Vietnam increases by an average of 11.88% per year in the period of 2001-2016 based on the purchasing power parity, from $403 per person per year in 2011 to $2,171 per person per year in 2016 (World Bank, 2018). The rapid increase in income actually enables high growth for high-end modes of transport that gradually increases its dominant position in the transport market.

Various papers examine the context of Vietnam (Vo, 2019a, 2019b, 2019c, 2019d; Vo and Chu, 2019; Vo and Phan, 2016, 2017, 2019a, 2019b), however, there is very limited number of study analyzing the transportation economy. This paper examines the elasticity of demand of the transport market (passengers and freight) between different modes of transport in Vietnam according to their prices, the price of the substitute and income per capita. To accomplish this objective, this study will examine the theoretical methodology, design the research model, collect and analyze the data to estimate and verify the parameters of the model.

The remainder of the paper proceeds as follows. Section 2 discusses theoretical foundation and research design. Section 3 introduces the research method. Section 4 presents the results. Finally, section 5 concludes the paper.

2. LITERATURE REVIEW

2.1. Theoretical Foundation

Economic theory has shown that demand for goods and services depends on many factors, such as price of goods, services, income, number of buyers, the price of goods and services of the substitutes, etc. To measure their impacts on the market demand, the coefficient of elasticity of demand is used. The coefficient of elasticity of demand of a certain factor shows how much the demand for goods and services will change if such factor changes by 1%, providing that all other factors remain unchanged (Ivan, 2015).

Price elasticity of demand:

Price is an important factor affecting market demand. This importance is reflected in the relationship between demand and price in demand theory as demand is described as the amount of goods or services that buyers are willing and able to buy at different prices. The price elasticity of demand is measured by the change in demand when the price changes by 1% under the condition that all other factors remain unchanged (Formula 1).

$$Price\ elasticity\ of\ demand = \frac{\%\ Change\ in\ quantity\ demanded}{\%\ Change\ in\ price}. \quad (1)$$

Income elasticity of demand:

Similar to the price elasticity of demand, income elasticity of demand is measured to capture the sensitivity of consumer demand for goods or services according to changes in consumers' income. The income elasticity of demand is measured by the change in demand when income changes by 1% under the condition that all other factors remain unchanged (Formula 2).

$$Income\ elasticity\ of\ demand = \frac{\%\ Change\ in\ quantity\ demanded}{\%\ Change\ in\ income}. \quad (2)$$

Cross-price elasticity of demand:

In economics, the cross-price elasticity of demand is a concept that is measured by a change in the demand of a good or a service when the price of substitute goods or services changes 1% under the condition that all other factors remain unchanged (Formula 3).

$$Cross\ price\ elasticity\ of\ demand = \frac{\%\ Change\ in\ quantity\ demanded}{\%\ Change\ in\ cross\ price}. \quad (3)$$

According to the general rule, the relationship between demand and price is an inverse relationship whereas the relationship between demand and income as well as cross price is a direct relationship. In other words, under the condition that all other factors remain unchanged, when the price of goods or services increases, its demand tends to decrease and when income increases, consumers tend to buy more. When the price of substitute goods or services increases, consumers will focus on buying goods or services.

2.2. Research Overview

So far, a consider number of empirical studies relating to the elasticity of demand in the transport sector are published. In transport operations in general, Fouquet (2012) studies and points out that income and price elasticities of passenger transport demand in the United Kingdom are very large (3.1 and 1.5, respectively) in the mid-nineteenth century, and they have declined since then. In 2010, long run income and price elasticity of aggregate land transport demand are estimated to be 0.8 and 0.6.

In public transport, Bresson et al. (2004) estimates the long run elasticities of income for public transport in French urban areas at level to be 0.23. Paulley et al. (2006) studies effects of income on the demand for public transport in Great Britain with long run elasticity estimation fluctuating between 0.5 and 1. Holmgren (2007) points out that the short-term estimations made with available research for Europe present elasticity values of 0.62 for income. Cordera et al. (2015) researches demand for public transport by bus in Spain and points out that elasticity for income levels estimated in the static model is of 0.505 and of 0.861 in the long run dynamic model.

In airway transport, Hwang and Shiao (2011) analyze air cargo flows of international routes at Taiwan Taoyuan International Airport and show that the demand elasticities for air cargo transport by price from -0.26 to -0.21. Chi and Baek (2012) estimate the price and income elasticities of demand for air transportation in US airfreight industry for the long run and show that Income elasticity and price elasticity are at 9.35 and -5.6 respectively. Yao and Yang (2012) study air transport and regional economic growth in China and point out that the demand elasticities for air cargo transport by income are at 0.77 for the short run and 1.22 for the long run. Lo et al. (2015) estimates the price and income elasticities of air cargo demand at Hong Kong International Airport by sampling the period of 2001-2013 and show that the price elasticity for air cargo transport demand ranges from 0.74 to 0.29, suggesting that air cargo demand in Hong Kong reacts negatively to price (as expected) but does not appear to be very sensitive to price; the income elasticity ranges from 0.29 to 1.47 and appears sensitive to seasonality adjustment approaches.

Empirical research on demand elasticity of income, price and cross price is done not only for the transport market but also for different industries such as demand elasticities in tourism by many other authors (Song, Romilly and Lieu, 2000; Greenidge, 2001; Song and Witt, 2003; Li et al., 2006; Song, Kim and Shu Yang, 2010; Lee, 2011; Song,

Wong and Chon, 2013) or in the electricity industry (Zhu et al., 2018; Campbel, 2018) in mineral commodities (Fernandez, 2018).

The empirical studies on the elasticity of demand as mentioned above are solid examples for the role of income, price and cross-price demand in general and to transport demand in particular, which will enable this research to set up the research model and hypotheses. On the other hand, they also help this research inherit the implementation method.

2.3. Research Design

From the theoretical basis and several related studies, the elasticity of demand of the transport market in Vietnam by price, income and cross price is designed according to the model as in Formula (4) below:

$$D_{ij} = a_{ij}.I^{\propto_{ij}}.WP_{ij}^{\beta_{ij}}.CP_{ij}^{\gamma_{ij}}.e^{\varepsilon}, \quad (4)$$

or $log(D_{ij}) = log(a_{ij}) + \alpha_{ij}.log(I) + \beta_{ij}.log(WP_{ij}) + \gamma_{ij}.log(CP_{ij}) + \varepsilon,$

where D_{ij} is the demand of the transported i for mode of transport j; I is the income of user of transportation service; WP_{ij} is the price of the transported i for mode of transport j; CP_{ij} is the cross-price of the transported i for mode of transport j. In addition, a_{ij}, α_{ij}, β_{ij}, γ_{ij} are parameters to be estimated, and ε is the error term. Finally, i = 1 denotes the passenger transport, while i = 2 denotes the freight transport; and j = 1, j = 2, j = 3, j = 4 represent the railway transport, road transport, waterway transport, and airway transport, respectively.

3. RESEARCH METHOD

3.1. Variables and Data Source

Demand of Transport: The demand of each mode of transport is determined by the result that the mode has implemented. Transport results are measured by the volume transported (the number of passengers or tons of goods transported) and the volume transferred (the number of passengers or tons of goods circulated on transport routes. In this study, the volume transported is used to measure transport demand in the past. The use of volume transported ensures more generalization because it does not only reflect the volume transported but also reflects the transport distance. Data on the circulated volume of transport modes are taken from the report of the General Department of Statistics of Vietnam.

Income of User of Transport Service: This study uses Vietnam's per capita income represent the income of transport service users in Vietnam. Using per capita income will

be more meaningful than using GDP because it does not only reflect GDP but also reflects the annual average population size. The use of per capita income to represent income variables is also published (Song et al., 2000; Lim, 2004; Lee, 2011). The data on per capita income in this study is the average per capita based on purchasing power parity and is taken from data published by The World Bank (2018).

Price of Transport Service: In reality, price data are often difficult to collect for research purposes. Since the purpose is to estimate the elasticity of demand by income, price and cross price, this study uses the price index and takes the base year price of 100 to calculate the price for the following years. This method is applied in many studies (Song et al., 2000, 2003a; Li et al., 2006; Otero-Giráldez et al., 2015). Data on passenger transport price index and freight transport price index for each mode of transport are collected and processed from the statistical data and statistical reports of the General Department of Statistics of Vietnam (2018).

Price of the Substitute Mode: The price of the substitute mode of transport is calculated by the price index of the substitute mode of transport and takes the base year price of 100 to calculate the price for the following years in the same way as the price of transport service is calculated as above mentioned. The price index of the substitute mode of transport is calculated by the weighted average price of the substitute modes in the Formula (5) below:

$$CP_{ij} = \frac{\sum D_{ik} WP_{ik}}{\sum D_{ik}}, \tag{5}$$

where: CP_{ij} is the cross price of the transported i for mode of transport j; D_{ik} is the volume of the transported i for mode of transport k; WP_{ik} is the price of the transported i for mode of transport k; and $k \neq j$.

Table 1. Descriptive Statistics of Research Data for Passenger Transport

Variable		Unit	Minimum	Maximum	Mean	Std. Deviation
Passenger transported	By rail	Million passenger-km	3391.20	4659.50	4243.94	406.23
	By road	Million passenger-km	23394.90	114008.10	62462.00	29543.17
	By water	Million passenger-km	2692.50	3407.10	3040.02	199.01
	By air	Million passenger-km	6110.70	48236.60	20058.00	12641.68
Own price	By rail	USD per Unit	96.27	230.34	152.23	50.17
	By road	USD per Unit	97.31	239.40	157.12	52.86
	By water	USD per Unit	93.04	171.26	128.64	29.67
	By air	USD per Unit	98.06	378.95	216.29	113.83
Cross price	By rail	USD per Unit	97.09	260.86	166.24	62.53
	By road	USD per Unit	96.51	314.41	188.38	87.36
	By water	USD per Unit	97.30	263.43	167.36	63.40
	By air	USD per Unit	96.84	234.71	154.85	51.30
Income		USD per capita	403.00	2171.00	1202.44	627.36

Note: Price and cross price in 2001 are calculated as 100.

Table 2. Descriptive Statistics of Research Data for Cargo Transport

Variable		Unit	Minimum	Maximum	Mean	Std. Deviation
Cargo transported	By rail	Million tone-km	2054.40	4311.50	3483.5	710.23
	By road	Million tone-km	9184.90	56563.30	30703	15667.11
	By water	Million tone-km	51766.90	177678.00	126910	50049.46
	By air	Million tone-km	158.20	683.40	362.06	158.25
Own price	By rail	USD per Unit	93.73	182.78	133.42	33.54
	By road	USD per Unit	93.19	173.08	129.47	30.30
	By water	USD per Unit	97.14	239.25	156.89	52.94
	By air	USD per Unit	93.80	183.49	133.74	33.77
Cross price	By rail	USD per Unit	96.27	230.34	152.23	50.16
	By road	USD per Unit	97.31	239.40	157.12	52.86
	By water	USD per Unit	93.04	171.26	128.64	29.66
	By air	USD per Unit	98.06	378.95	216.29	113.83
Income		USD per capita	403.00	2171.00	1202.4	627.36

Note: Price and cross price in 2001 are calculated as 100.

Data are collected and processed for a period of 16 years from 2001 to 2016. Statistical data for passenger transport activities are presented in Table 1 and statistical data for freight transport activities are shown in Table 2 below.

3.2. Method to Estimate the Parameters of the Model

The parameters in the models are estimated by the least squares method using the Eviews software. Parameters are accepted when the statistical value Prob. ≤ 0.05. The adjusted R^2 value and the F-statistic value of ≤ 0.05 are indicators to evaluate the measure of fit of the model.

4. RESEARCH FINDINGS AND DISCUSSION

4.1. Elasticity of Demand of Passenger Transport

The estimation of demand elasticity model in the passenger transport market by income, price and cross price shows that at a significant level of 5% (Prob. ≤ 0.05), only for rail transport, all 3 variables: income, price and cross price are accepted. For road, waterway and road transport, only income variable is accepted. If the significance level is at 10% (Prob. ≤ 0.1), for road transport, the cross-price variable is also acceptable (Table 3).

Models for road, waterway and air transport are determined based on the principle of gradual eliminating variables that have no statistical significance (Prob. ≤ 0.05) to

choose the most suitable model. The result that includes price variable is statistically significant for waterway transport model. Adjusted R^2 value of the models is quite high and the Prob (F-statistic) value of the models is all less than 0.05, so it can be applied in practice (Table 4).

Table 3. Parameters of Passenger Transport Modes for All Three Variables

Transport Modes		Factor/variable				Measure of fit of the model	
		Constant	Income	Own price	Cross price	Adjusted R^2	Prob (F-statistic)
By rail	Coefficient	6.7096	0.5251	2.8160	-3.1735	0.5180	0.0079
	Prob.	0.0000	0.0034	0.0037	0.0019		
By road	Coefficient	6.2709	0.9134	-1.0553	0.7000	0.9914	0.0000
	Prob.	0.0000	0.0000	0.1019	0.0914		
By water	Coefficient	9.3704	0.2698	-0.6418	-0.0246	0.4197	0.0228
	Prob.	0.0000	0.0375	0.3954	0.9657		
By air	Coefficient	1.8988	0.9899	-0.1273	0.3242	0.9489	0.0000
	Prob.	0.4839	0.0026	0.8886	0.8291		

Table 4. Parameters of Passenger Transport Mode after Eliminating Variables

Transport Modes		Factor/variable				Measure of fit of the model	
		Constant	Income	Own price	Cross price	Adjusted R^2	Prob (F-statistic)
By rail	Coefficient	6.7096	0.5251	2.8160	-3.1735	0.5180	0.0079
	Prob.	0.0000	0.0034	0.0037	0.0019		
By road	Coefficient	4.9230	0.8647	-	-	0.9906	0.0000
	Prob.	0.0000	0.0000	-	-		
By water	Coefficient	8.2534	0.3316	-0.5022	-	0.4296	0.0103
	Prob.	0.0000	0.0030	0.0036	-		
By air	Coefficient	2.4135	1.0527			0.9558	0.0000
	Prob.	0.0000	0.0000				

4.2. Elasticity of Demand of Cargo Transport

Table 5. Parameters of Cargo Transport Modes for All Three Variables

Transport Modes		Factor/variable				Suitability of the model	
		Constant	Income	Own price	Cross price	Adjusted R^2	Prob (F-statistic)
By rail	Coefficient	9.0399	0.6400	-2.1758	1.0522	0.7217	0.0003
	Prob.	0.0013	0.0044	0.2842	0.4973		
By road	Coefficient	4.2723	1.2069	-0.4160	-0.0908	0.9948	0.0000
	Prob.	0.0002	0.0000	0.5322	0.8773		
By water	Coefficient	3.8821	1.5159	-3.2064	2.7512	0.9631	0.0000
	Prob.	0.0563	0.0000	0.0195	0.0686		
By air	Coefficient	7.2022	0.4086	-2.4914	1.5047	0.9665	0.0000
	Prob.	0.0055	0.0187	0.0118	0.0064		

Unlike passenger transport, the estimation of demand elasticity model in the cargo transport market by income, price and cross price shows that at a significant level of 5% (Prob. ≤ 0.05), only for air transport, all 3 variables: income, price and cross price are accepted. For road and waterway transport, two variables: income and price are accepted. Meanwhile, for railway transport, income is the only statistically significant variable. If the significant level is at 10% (Prob. ≤ 0.1), for waterway transport, all 3 variables: income, price and cross price are also accepted (Table 5).

Similar to passenger transport, the models for road, waterway and airway for cargo transport are determined based on the principle of gradual eliminating variables that have no statistical significance (Prob. ≤ 0.05) to choose the most suitable model. The results are not different from the original ones. Adjusted R^2 value of the models is quite high and the Prob (F-statistic) value of the models is also less than 0.05, so it can be applied in practice (Table 6).

Table 6. Parameters of Cargo Transport Mode after Eliminating Variables

Transport Modes		Factor/variable				Measure of fit of the model	
		Constant	Income	Own price	Cross price	Adjusted R^2	Prob (F-statistic)
By rail	Coefficient	5.9312	0.3173	-	-	0.6729	0.0001
	Prob.	0.0000	0.0001	-	-		
By road	Coefficient	4.3880	1.1938	-0.5150	-	0.9952	0.0000
	Prob.	0.0000	0.0000	0.0046	-		
By water	Coefficient	7.4586	1.2497	-0.8942	-	0.9546	0.0000
	Prob.	0.0000	0.0000	0.0139	-		
By air	Coefficient	7.2022	0.4086	-2.4914	1.5047	0.9665	0.0000
	Prob.	0.0055	0.0187	0.0118	0.0064		

4.3. Research Findings Discussion

The overall outcome of this study shows that Vietnam's per capita income has a positive impact on the demand for rail, road, waterway and air transport. This is in line with the general rule of demand. For passenger transport, the income elasticity of demand is relatively high for transport by air with the elasticity coefficient of 1.0527 while for cargo transport, the income elasticity of demand is considerably high for transport by water with the elasticity coefficient of 1.2497 followed by road with the elasticity coefficient of 1.1938. The income elasticity of demand of the remaining transport modes is less than 1. For passenger transport, the lowest elasticity coefficient is transport by water with the elasticity coefficient of 0.3316 followed by railway transport with the elasticity coefficient of 0.5251 and finally by road transport with the elasticity coefficient of 0.9134. For cargo transport, the lowest elasticity coefficient is by road with the elasticity coefficient of 0.3173 and then by air with the elasticity coefficient of 0.4086.

In addition, price is a variable that affects most modes of cargo transport, except for cargo transport by rail. For passenger transport, price is only statistically significant for

waterway and rail transport. Except for passenger transport by rail, price variable has an opposite effect according to the general rule. For example, demand is highly elastic by price for cargo transport by air with the elasticity coefficient at -2.4914. For the remaining modes of transport, demand is less elastic by price. The lowest elasticity coefficient is passenger transport by waterway with the elasticity coefficient at -0.5022, followed by cargo transport by road with the elasticity coefficient at -0.5150 and finally cargo transport by waterway with the elasticity coefficient at -0.8942.

Finally, the cross-price of transport modes is not statistically significant in Vietnam in the past period, except for cargo transport by air and passenger transport by rail. However, only the cross-price of cargo transport by air is impacted by the general rule with the elasticity coefficient of 1.5047. The impact of income and price on the demand of the transport market in this study is fundamentally consistent with recently published studies (Bresson et al., 2004; Paulley et al., 2006; Holmgren, 2007; Cordera et al., 2015; Hwang and Shiao, 2011; Yao and Yang, 2012), except for the impact of price and cross-price on the demand for railway passenger transport market. This phenomenon of unconventional impact is also presented in study of Lo et al. (2015). The impacts of price and cross-price on the market demand for passenger transport by rail are not in line with the general rule due to the weakness of Vietnam's railway industry in the past period. The railway network in Vietnam in recent years is not developed and the service quality is not improved. Meanwhile, the infrastructure, the network and the quality of alternative transport modes are growing strongly. This clearly shows that railway transport does not follow the general trend. The growth rate for passengers being transported between 2001-2016 period is: -0.07% by rail, 11.14% by road, 1.19% by waterway and 14.77% by air. The growth rate for total transport industry is 10.93% (General Statistics Office of Vietnam, 2018).

The main difference of this study from previous publications is that it engages in a comprehensive review of different modes of transport in Vietnam, whereas previous publications usually study one mode or some specific modes of transport in different countries.

5. CONCLUSION AND POLICY IMPLICATIONS

Income, price and cross price are basic elements affecting demand in demand theory. Their main role in explaining the demand theory in general and transport demand in particular is proved by many empirical studies in recent years in different countries. This study examines the above relationship in the transport market by rail, by road, by waterway and by air in Vietnam following a non-linear model. Research results show that per capita income is the factor that positively influences transport market demand in different modes of transport according to the general rule.

Demand is more elastic with income in passenger transport by air and in cargo transport by waterway as well as by road in Vietnam. Freight rates have an opposite

effect according to the general rule of transporting passengers by waterway, transporting cargo by road, by waterway and by air in Vietnam. While demand is more elastic with price in transporting cargo by air, it is less elastic with price for the remaining modes. For cross price, demand is only affected considerably by the transport of cargo by air.

The outcomes of this study will provide additional information on empirical studies of transport demand elasticity. At the same time, these results will lay out the foundation to help transport operators/carriers and transport management and administration agencies in Vietnam to have a better forecast on the transport market for different modes of transport based on its elasticity coefficient with income, price and cross price. The elasticity of market demand of different transported objects (passengers and cargo) will also serve as a basis for transport operators/carriers to select appropriate pricing policies to compete, maximize revenue and improve business efficiency.

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