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RESEARCH ARTICLE

COMPARATIVE ADVANTAGE BETWEEN TRANSPORT MODES BY DISTANCE IN VIETNAM

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ABSTRACT

This study aims to determine the comparative advantage between modes of transport by distance in Vietnam. From theoretical background and research modeling, the study analyzed data for a 21-year period from 1995 to 2015. The results of the study show that transport distance is an important factor in choosing the mode of transportation in Vietnam. As to passenger transport, road transport is still the most common mode, followed by air transport, while water and rail transport are becoming less common. To be more specific, air transport is tending to grow and express the advantage by distance. The remaining modes do not express the advantage by distance. Unlike passenger transport, in cargo transport, water transport is used most often, followed by road and rail transport. In that, only water transport expresses the advantage of distance and air transport only accounts for a negligible proportion.

INTRODUCTION

Choice of transport mode is an important decision of the transport service user. Vietnam has four main modes of transport such as road, rail, water and air transport. Transport modes in the economy both compete with each other and support each other in the market segments where each mode of transport has its own advantages. The advantages of transport modes are derived from natural factors such as the distance and the factors of transport modes such as capacity, cost, speed, comfort... Distance will give different advantage to the modes of transport in different market segments. Therefore finding the specific comparative advantage of transport modes by distance is a significant task for the Vietnamese transportation sector. To achieve this objective, the study will summarize the theoretical foundations and related studies, design the research model, collect and analyze data to estimate the parameters in the models. Estimated parameters will show trends in the proportion of use in transport modes by distance.

Theoretical basis and research design

Theoretical basis

Transportation alway plays the key role in the development of the national economy. It meets the needs of travel and plays the function as the circulatory system in the economy, ensuring the links between industries, sectors of the socio-economic system. There are currently four main modes of transport: road transport, water transport, rail transport and air transport. Road transport is highly flexible, but its small tonnage, high cost and limited speed so that it is often best suited to short haulage. Besides, water transport has great transport capacity and low cost, but its speed is slow, so it is generally suitable for cargo transportation, especially sea transport. While rail transport has the advantage of high capacity and relatively low cost, but it only works on fixed routes, so it is low flexible. Finally, air transport, with fast speed and good service quality, but with low tonnage and very high transport costs as well as low flexibility due to its dependence on the airport system. There fore it suitable with long-distance passenger transport and market segments had high-paying. Above all, each mode of transport has its own advantages, so it is suitable for different market segments (Nguyen Hai Quang *et al*, 2014). The advantage of a mode of transport compared to other modes of transport expresses the tendency to use that mode of transport in modes of transport. As to a theoretical perspective, Jean-Paul Rodrigue *et al*. supposed distance remains one of the basic determinants of modal usage for passenger transportation. However, for a similar distance, costs, speed and comfort can be significant factors behind the choice of a mode of transport. The same opinion about distance, Jean-Paul Rodrigue *et al*. (2017) in The Geography of Transport System showed that the choice transport modes depend on distance and transport costs. From the perspective of specific markets, James Harrigan (2010) conducted empirical research in the United States on the

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choice of shipping mode through factors such as trade, distance, transport costs, and found that the probability of air shipment is strongly related to distance. Or Hee Deok Cho (2013) developed a model of the relationship between the choice of transport mode on long-distance in the United States and the explanatory variables, including distance of transport. Also related to the distance variable, Daniel Albalate *et al* (2015) studied the European transport market and pointed out that the choice of high-speed rail and air transport between two regions depends on population, GDP, distance between regions as well as cost and speed of transport means. Shenggang Xu *et al*. (2014) studied in China and found that due to the different of technologies and economic characteristics, high-speed railway, air traffic and highway traffic had comparative advantages by distance and their segment market. Based on a theoretical basis and a summary of some related studies, it can be seen that there are many factors that affect the comparative advantage between modes of transport. One of them is the distance and it is considered as independence variable in this study. The advantage of the modes of transport by distance in this study is the tendency of use a mode of transport in all modes of transport when the transport distance changes.

Overview of the transportation system in Vietnam

Vietnam is located in Southeast Asia, in the north by China, in the west by Laos and Cambodia, in the east and south-east by the East Sea. Vietnam's terrain is long and narrow, having S shaped. Population and urban center network are distributed in 3 North, Middle and South with 3 big centers: Hanoi, Da Nang and Ho Chi Minh City. At present, Vietnam has a transportation system with all basic modes of transportation such as road, rail, waterway (inland waterway and sea) and air transport. According to the Ministry of Transport of Vietnam (2013), the total length of Vietnam's roads is over 258,200 km and covers all localities, including 104 national highways and 5 expressways with the length of 18,744 km. The railway network has a total length of 3,143 km, of which 2,531 km of main lines, mainly arranged along the north-south axis, 612 km of branch roads and stations. The waterway system consists of about 2,360 rivers and canals with a total length of 41,900 km and more than 3,200 km of coastline, an average river density of 0.127 km/km^2. The seaport system currently has 37 seaports, with 166 ports, 350 wharfs and a total length of about 45,000 m of wharf, with capacities ranging from 350 to 370 million tonnes per year. Regarding the air traffic system, Vietnam has 21 airports in service of civil activities, including 7 international airports, the key is three international airport Tan Son Nhat, Noi Bai and Da Nang having the ability to acquire B747 aircraft. According to the General Statistics Office of Vietnam (2017), in 2015 the transport sector of Vietnam carried 3,303.9 million arrivals and 1,141.14 million tons of cargo, of which 3,099.2 million arrivals and 874.03 million tons of cargo were carried by road transport; 162.4 million arrivals and 260.24 million tons of cargo were carried by water transport; 31.1 million arrivals and 0.20 million tons of cargo were carried by air transport; 11.2 million arrivals and 6.67 million tons of cargo were carried by rail transport. In that order, total number of passenger and cargo traffic were 154,348 million passengers-km and 229,873 million tons-km; 104,991 million passengers-km and 51,418 million tons-km by road transport; 3,048 million passengers-km and 173,863 million tons-km by water transport; 42,068 million passengers-km and 556 million tons-km by air transport; 4.241 million passengers-km and 4.036 million tons-km by rail transport.

Design research model

From the theoretical base and some related empirical research, this study identifies the advantage between modes of transport by distance of transport which is calculated by its proportion in total modes of transport (Vietnam's transport sector). Impact variable is the average transport distance of all transport modes. These proportion are studied for both passenger transport (Formula 1) and cargo transport (Formula 2).

Model1: $\mathbf{P_{pj}} = \quad_{pj} + \sim_{pj}\overline{\mathbf{D}}_{\mathbf{p}}$ (1)

Where:

P_{pj}: The proportion (%) of transport mode j in total number of passenger transported in Vietnam.

D_p: The average distance of passenger transported by all transport modes in Vietnam

β_{pj}, α_{pj}: Parameters to estimate in the model

Model 2: $\mathbf{P_{cj}} = \quad_{cj} + \sim_{cj}\overline{\mathbf{D}}_{\mathbf{c}}$ (2)

Where:

P_{cj}: The proportion (%) of transport mode j in total number of cargo transported in Vietnam.

D_c: The average distance of cargo transported by all transport modes in Vietnam

β_{cj}, α_{cj}: Parameters to estimate in the model

With: j = 1 for air transport; j = 2 for road transport; j = 3 for rail transport and j = 4 for water transport.

MATERIALS AND METHODS

Method of measuring the value of variables

Measuring the proportion of each transport mode in total transport modes

There are two methods of calculating the proportion of transport mode based on the number carried and number of traffic. This study uses the number of traffic because it considers both number and distance transported. It means that the proportion of each transport mode in all transport modes is calculated by the number of traffic. It is calculated by the number carried multiply with the distance (Ministry of Transport of Vietnam, 2016). To be more detailed, as to cargo transport, it is determined by the tons-km by the mode of transport j and the total ton-km by all modes of transport. As to passenger transport, it is determined by the ratio of passengers-km by mode of transport j and the total passengers-km by all modes of transport (Formula 3).

$$P_{pj} = \frac{PPK_j}{PPK} \quad Or \quad P_{cj} = \frac{PTK_j}{PTK} \tag{3}$$

Where:

PPK_i and PPK: Performance of passenger-km by mode of transport j and passenger-km by all modes of transport in that order.

PTK_i and PTK: Performance of tons-km by mode of transport j and tons-km by all modes of transport in that order.

Measuring the average of transport distance

The formula for the average distance transported is calculated from the formula calculating for the number of passenger or cargo traffic (number of passenger or cargo transported multiplied by the distance). The formula for the average distance transported by passenger is presented in Equation (4) and cargo is presented in Equation (5).

$$PPK = D_p \times Pax \rightarrow D_p = \frac{PPK}{Pax} \quad (4)$$

$$PTK = D_c \times Ton \rightarrow D_p = \frac{PTK}{Ton} \quad (5)$$

Where: Pax and Ton are respectively the number of passengers and tons of cargo transported by all modes of transport.

Source data

Passenger, passenger-kilometer, tons of cargo, tons-km transported by air, road, rail and water transport as well as all modes of transport are collected from statistical report of Vietnam (General Statistics Office of Vietnam, 2016). These data are collected over a 21 year period from 1995 to 2015. Then it is calculated into the value of variables by formular (3), (4) and (5). During the period surveyed, the average proportion of passenger-km by road transport was largest (73.23%), followed by air transport (29.26%), then by rail transport (9.86%) and finally by water transport (8.35%). As to the average distance transported, air transport was the longest (1561.97 km), followed by rail transport (403.58 km), then by road transport (37.69 km) and finally by water transport (22.70 km) (Table 1). As to cargo transport, during the period surveyed, the average proportion of tons-km by water transport was largest (79.97%), followed by road transport (16.93%), then by rail transport (2.86%) and finally air transport accounted for only very small proportion (0.23%). As regards

Table 1. Descriptive statistics of passenger transport data

Variable	Code	N	Unit	Minimum	Maximum	Mean	Std. Deviation
Proportion of air passenger transport	P_{p1}	21	%	13.2497	29.2555	18.8394	4.3822
Proportion of road passenger transport	P_{p2}	21	%	64.0219	73.2328	68.7516	2.2816
Proportion of rail passenger transport	P_{p3}	21	%	3.2230	9.8555	6.9342	2.3598
Proportion of water passenger transport	P_{p4}	21	%	2.1471	8.3470	5.4748	2.3257
Average passenger transport distance	D_p	21	Km	41.2400	46.7200	43.2167	1.2883
Distance of passenger transport by air	D_{p1}	21	Km	1352.70	1732.00	1561.97	102.7001
Distance of passenger transport by road	D_{p2}	21	Km	32.45	37.69	34.42	1.6015
Distance of passenger transport by rail	D_{p3}	21	Km	242.42	403.58	342.33	49.3417
Distance of passenger transport by water	D_{p4}	21	Km	17.31	22.70	20.10	1.5728

Source: Processing from the data of General Statistics Office of Vietnam

Table 2. Descriptive statistics of cargo transport data

Variable	Code	N	Unit	Minimum	Maximum	Mean	Std. Deviation
Proportion of air cargo transport	P_{c1}	21	%	.1590	.2886	.23060	.03389
Proportion of road cargo transport	P_{c2}	21	%	13.6911	22.3682	16.9337	2.5809
Proportion of rail cargo transport	P_{c3}	21	%	1.7432	5.6634	2.8632	.9739
Proportion of water cargo transport	P_{c4}	21	%	75.6343	82.8018	79.9726	2.1779
Average cargo transport distance	D_c	21	Km	201.44	278.22	237.09	20.7977
Distance of cargo transport by air	D_{c1}	21	Km	1471.40	2511.20	2076.70	259.3555
Distance of cargo transport by road	D_{c2}	21	Km	54.09	61.63	57.92	2.8467
Distance of cargo transport by rail	D_{c3}	21	Km	275.03	605.31	420.54	115.2895
Distance of cargo transport by water	D_{c4}	21	Km	153.22	261.40	210.82	31.8790

Source: Processing from the data of General Statistics Office of Vietnam

Table 3. Estimated results of passenger transport model

	Air transport		Road transport		Rail transport		Water transport	
	β_{p1}	α_{p1}	β_{p2}	α_{p2}	β_{p3}	α_{p3}	β_{p4}	α_{p4}
Coefficient	-93.9220	2.6092	103.6237	-0.8069	48.0491	-0.9514	42.2490	-0.8509
t-Statistic	-4.3392	5.2117	6.6271	-2.2311	3.0948	-2.6493	2.6755	-2.3297
Prob.	0.0004	0.0000	0.0000	0.0379	0.0060	0.0158	0.0150	0.0310
R^2	0.588407		0.207606		0.269761		0.222195	
Adjusted R^2	0.566744		0.165901		0.231327		0.181258	
F-statistic	27.16210		4.977968		7.018867		5.427729	
Prob.(F-statistic)	0.000050		0.037918		0.015824		0.030999	

Source: Estimated results

Table 4. Result test the null hypothesis in the passenger transport model

	Hypothesis β_{p1}=0		Hypothesis β_{p2}=0		Hypothesis β_{p3}=0		Hypothesis β_{p4}=0	
	Value	Prob.	Value	Prob.	Value	Prob.	Value	Prob.
F-statistic	18.8283	0.0004	43.9185	0.0000	9.5779	0.0060	7.15819	0.0150
Chi-square	18.8283	0.0000	43.9185	0.0000	9.5779	0.0020	7.15819	0.0075
	Hypothesisα_{p1}=0		Hypothesis α_{p2}=0		Hypothesis α_{p3}=0		Hypothesis α_{p4}=0	
	Value	Prob.	Value	Prob.	Value	Prob.	Value	Prob.
F-statistic	27.1621	0.0000	4.9780	0.0379	7.0189	0.0158	5.42779	0.0310
Chi-square	27.1621	0.0000	4.9780	0.0257	7.0189	0.0081	5.42779	0.0198

Source: Wald-Test results

the average distance transported, air transport was also the longest (2076.70 km), followed by rail transport also (420.54 km), then by water transport (210.82 km) and finally by road transport (57.92 km) (Table 2).

Method of estimating the parameters of the model

The parameters of the formula in Equation (1) and (2) are estimated by the Ordinary Least Square (OLS) method of Eview software. Parameters are accepted when statistic values $|$t-Statistic$|$ ≥ 2 or Prob. ≤ 0.05. The model is accepted when the statistical value of F-statistic ≥ 2 or Prob.(F-statistic) ≤ 0.05. The null hypothesis will be rejected when F-statistic ≥ 2 or Prob. ≤ 0.05.

RESULTS AND DISCUSSION

Comparative advantage of modes in passenger transport

The results of regression analysis of passenger transport models show that the statistical value of the free parameters (β_{pj}) and the parameter of the average transport distance (α_{pj}) to the trend (proportion) of the modes of transport give for $|$t-Statistic$|$ > 2 or Prob. <0.05, so the estimated parameters are accepted. Except for the model of passenger transport by air, the remainingmodels for R^2 adjustment are not very high. This means that there may be other factors influencing, but the F-statistic values of the models > 2 (Prob. <0.05). Therefore, the regression model for passenger transport is suitable and can be applied into practice (Table 3).

proportion of using passenger transport modes in Vietnam in formula (6) and the trend of changing passenger transport structure by the distance in Figure 1 below.

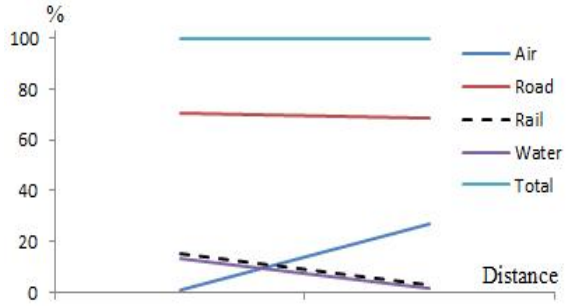

Figure 1. Trends of changing the proportion of passenger transport by distance

Proportion of air passenger transport = - 93.9220 + 2.6092*Average passenger transport distance (6)
Proportion of road passenger transport = 103.6237 – 0.8069*Average passenger transport distance
Proportion of rail passenger transport = 48.0491 – 0.9514*Average passenger transport distance
Proportion of water passenger transport = 42.2490 – 0.8509*Average passenger transport distance

Comparative advantage of modes in cargo transport

As well as the model of passenger transport, the results of regression analysis of cargo transport models show that the statistical value of the free parameters (β_{cj}) and the parameter of the average transport distance (α_{cj}) to the trend (proportion)

Table 5. Estimated results of cargo transport model

	Air transport		Road transport		Rail transport		Water transport	
	β_{c1}	α_{c1}	β_{c2}	α_{c2}	β_{c3}	α_{c3}	β_{c4}	α_{c4}
Coefficient	0.4155	-0.0008	37.1078	-0.0851	5.1151	-0.0054	59.3311	0.0871
t-Statistic	5.3191	-2.3755	7.5249	-4.1060	7.8400	-3.5730	18.6756	6.5211
Prob.	0.0000	0.0282	0.0000	0.0006	0.0000	0.0020	0.0000	0.0000
R^2	0.228995		0.470147		0.401879		0.691178	
Adjusted R^2	0.188416		0.442260		0.370399		0.674924	
F-statistic	5.643156		16.85901		12.76613		42.52413	
Prob.(F-statistic)	0.028202		0.000601		0.002029		0.000003	

Source: Estimated results

Table 6. Result test the null hypothesis in the cargo transport model

	Hypothesis β_{c1}=0		Hypothesis β_{c2}=0		Hypothesis β_{c3}=0		Hypothesis β_{c4}=0	
	Value	Prob.	Value	Prob.	Value	Prob.	Value	Prob.
F-statistic	28.2928	0.0000	56.6244	0.0000	61.4654	0.0000	348.7772	0.0000
Chi-square	28.2928	0.0000	56.6244	0.0000	61.4654	0.0000	348.7772	0.0000
	Hypothesisα_{c1}=0		Hypothesis α_{c2}=0		Hypothesis α_{c3}=0		Hypothesis α_{c4}=0	
	Value	Prob.	Value	Prob.	Value	Prob.	Value	Prob.
F-statistic	5.6432	0.0282	16.8590	0.0006	12.7661	0.0020	42.5241	0.0000
Chi-square	5.6432	0.0175	16.8590	0.0000	12.7661	0.0004	42.5241	0.0000

Source: Wald-Test results

Wald-Test with the null hypothesis that the values of the parameters β_{pj} orα_{pj}= 0 give the result that F-statistic values of all variables have Pro. < 0.05 and Chi-square < 0.05 (Table 4). Therefore, the null hypotheses are rejected and the average distance transported by modes of transport has an impact on the trend of using modes of passenger transport in Vietnam.

The results of parameter estimation and test of hypotheses in Table 3 and Table 4 give the regression model about the of the modes of transport also give for $|$t-Statistic$|$ > 2 or Prob. <0.05, so the estimated parameters are accepted. Except for the model of passenger transport by water, the remaining models for R^2 adjustment are not very high. This also means that there may be other factors influencing, but the F-statistic values of the models > 2 (Prob. <0.05). Therefore, the regression model for cargo transport is suitable and can be applied into practice (Table 5).

Wald-Test with the null hypothesis that the values of the parameters β_{cj} orα_{cj}= 0 give the result that F-statistic values of all variables also have Pro. < 0.05 and Chi-square < 0.05 (Table 6). Therefore, the null hypotheses are rejected and the average distance transported by modes of transport has an impact on the trend of using modes of cargo transport in Vietnam.

The results of parameter estimation and test of hypotheses in Table 5 and Table 6 give the regression model about the proportion of using cargo transport modes in Vietnam in formula (7) and the trend of changing cargo transport structure by the distance in Figure 2 below.

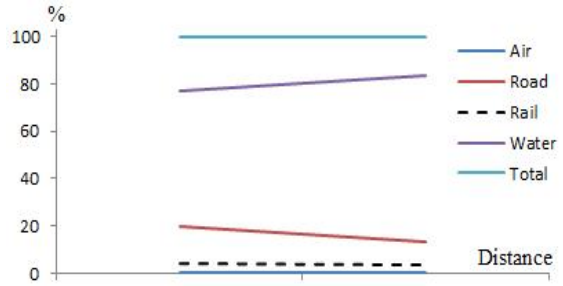

Figure 2. Trends of changing the proportion of cargo transport by distance

Proportion of air cargo transport= 0.4155– 0.0008*Average cargo transport distance (7)
Proportion of road cargo transport = 37.1078 – 0.0851*Average cargo transport distance
Proportion of rail cargo transport = 5.1151 – 0.0054*Average cargo transport distance
Proportion of water cargo transport = 59.3311+ 0.0871*Average cargo transport distance

Conclusions and policy implications

The results of this study show that the distance of transport is an important factor in choosing the mode of transport in Vietnam. For passenger transport, the average distance of air transport is longest, followed by rail transport, then road transport and the distance of water transport is shortest. Road transport is still the most common mode, followed by air transport, while water and rail transport are becoming less common.In passenger transport, air transport tends to grow and show advantage by distance but other modes do not express this advantage.It means that in case of other factors do not change, when the distance transported increases, passengers will tend to use air transport more than other modes of transport. To be more detailed, when the average distance of passenger transport rises by 1%, the proportion of using air transport in all modes of transport increases by 2.6092%. In contrast, the proportion of using rail transport, water transport and road transport decrease by respectively 0.9514%, 0.8509% and 0.8069%. Compared to passenger transport, there is only change between road transport and water transport in the order of average transport distance. As to the popularity, water transport shows the advantage of cost and weight as well as volume so it is used the most. Next is the road transport and rail transport also accounts for a small proportion. Despite of having advantage by distance and speed, but air transport has high cost so the utilization rate is negligible. In all modes of transport, only water transport shows the advantage by distance. It means that in case of other factors do not change, when the distance transported increases, people will tend to use water cargo transport more than other modes of transport.To be more specific, when the average distance of cargo transport rises by 1%, the proportion of water transport in all modes of transport increases by 0.0871%. In contrast, the proportion of using road transport decreases 0.0851% and rail transport decreases lightly at 0.0054%. While the proportion of using air transport almost does not change. These findings are an important basis for transport policy makers in Vietnam to recognize the advantages of each mode of transport for proper development policies. Beside, it also helps transport companies make the right decisions to select market segments that each mode of transport have its advantages over other modes of transport.

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