Classification of the Type of Inland Freight Transport in Landlocked Countries

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Abstract: Since landlocked countries (LLCs) have no seaport in their territory, they are forced to access to seaports in neighbor transit countries (TCs) for the use of maritime transport. LLCs have several common disadvantages compared to coastal countries with overseas trade for their geographical conditions, however each LLC might own inherent problems. This study aims to clarify significant factors affecting inland transport time of overseas trade, and classify the type of problems of inland freight transport among LLCs using these factors. As the result of regression analysis, it is determined that significant factors of inland transport time are transport infrastructure of LLCs and TCs, country risk of LLCs and TCs, and distance to seaport. Using these factors, the type of problems of LLCs is classified by cluster analysis. Major findings are that importance of infrastructure condition in TCs to contribute inland transport time is higher than that in LLCs.

Keywords: landlocked countries, inland freight transport, transport time, cluster analysis

1. INTRODUCTION

There are 43 landlocked countries (LLCs) in the world. United Nations reported 31 of them are being called landlocked developing countries. One of the factors of their harsh economic conditions is considered to be difficulty in overseas trade. As LLCs have no their own seaport in their territory, they have to across at least one border for accessing to seaports in neighbor transit countries (TCs) for the use of maritime transport. In case that the quality of infrastructure and procedures on trade such as cargo inspection, LLC suffers from lengthy transport time and consequently, high transport cost.

Although LLCs have several disadvantages in terms of trade and economic development, some LLCs in Europe are classified into high income or upper middle income countries by World Bank (2013). This fact encourages LLCs to realize further economic development. LLCs basically suffer from high cost and long transport time for export and import in overseas trade, however trade environment are different among LLCs.

Several literatures related to LLCs' difficulties have found the impact of being landlocked on transport cost, trade volume and value, and economic growth rate. Radelet and Sachs (1998) and Stone (2001) revealed that LLC suffered from heavy burden of transport cost compared with coastal countries. Radelet and Sachs (1998) also proved that transport and insurance costs were twice as high as coastal countries and there was a negative relation between transport cost and economic growth. Regarding the economic growth of LLCs, MacKellar *et al*. (2000) revealed that LLCs had a 1.5% lower growth for the period between 1960 and 1992. Limao and Venables (2001) stated that being landlocked raises transport cost by approximately 50% for the middle-class landlocked countries compared to that of coastal countries. In addition to high transport cost, middle-class LLCs only have 30% of the trade volume compared to coastal countries (Limao and Venables, 2001). In case of Central Asian countries, landlockness reduced trade volume by more than 80% (Raballand, 2003). An improvement of the level of infrastructure from the median Central Asian countries to the top 25th percentile of other landlocked countries would raise exports (imports) by 6.5% (8.6%) (Grigoriou, 2007). An improvement in infrastructure quality to the level of the median coastal countries would raise exports (imports) by 14.5% (19.6%) (Grigoriou, 2007). By contrast, an improvement in transit-country infrastructure to the level of the best 25th percentile amongst other landlocked countries would raise the countries in Central Asian Countries' exports by 52% (Limao and Venables, 2001).

Most previous researches have used landlocked dummy in their regression or gravity model expressing LLCs' disadvantage. The landlocked dummy can show us how much LLCs have difficulties on average in transport, trade and economic activity, however, the differences among LLCs cannot be observed. Each LLC might have different characteristics among LLCs. In this context, this study aims to clarify significant factors affecting inland transport time of overseas trade, and classify the type of problems of inland freight transport among LLCs using these factors. This study uses inland transport time as the indicator to express difficulties in LLC's overseas trade because long inland transport time is one of the most serious problems for LLCs. Taking Uganda for example, inland transportation time from its capital, Kampala to Kenyan seaport, Mombasa (1,187 km) takes 18 days, whereas Kenya (from Nairobi) needs 4 days to complete the transport to Mombasa for 488km distance transport. On the other hand, Austria, one of European high income LLCs, spends only 2 days for access to German seaport of Hamburg despite the distance of 900km.

The remainder of this study is organized as follows. Section 2 conducts the regression analysis for determining the factors affecting inland transport time of LLCs to access a seaport located in TC. In section 3, cluster analysis is conducted in order to classify the type of problems of inland freight transport among LLCs using these factors determined by regression analysis in section 2. Subsequently, case study learned from site survey is addressed. Section 4 is the conclusion.

2. REGRESSION ANALYSIS

2.1 Variables

Factors contributed to inland transport time (*TT*) are analyzed using multiple regression model. Average inland transport time of export and import is used for dependent variable. Inland transport time is one of the most important indicators to observe severity of overseas trade activities of LLCs. The data is retrieved from "Doing Business database" released by World Bank, which covers time duration between departure of cargo at the warehouse in capital of each LLC and arrival at seaport in TCs. As for explanatory variables, transport infrastructure (road and railway), country risk, distance to seaport, and geographical conditions of LLCs and TCs are incorporated into regression models.

a) Transport Infrastructure

The quality of transport infrastructure such as road and railway is likely to affect transport time. The low quality of transport infrastructure links to force drivers low speed haulage. On the other hand, high-speed haulage is possible under the environment that transport infrastructure is well developed and keeps good conditions.

As LLCs are enforced to depend on TCs for their overseas trade through maritime transport, in the process of their access to seaport, transport infrastructure quality of not only LLCs (*LLCInfra*) but also TCs (*TCInfra*) might be important factors for inland transport time. The indicators of infrastructure quality are ratio of paved road, density of road (kilometers of road per $1km^2$) and density of rail (kilometers of railway per $1km^2$), which are obtained from CIA (2012). However, inclusion of all variables separately to the model would be accompanied with multicollinearity because of high correlation among the variables. Thus, we constructed composite variables of above three indicators (ratio of paved road, density of road and density of rail) by principal component analysis.

Some LLCs can select more than one TCs for accessing seaports. This study refers to Uprety (2005), which lists up TCs of each LLC on the basis of accessing to seaport, in order to extract TCs. However, since Uprety (2005) lacks the designation of TCs of some Central Asian LLCs (Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan), Grigoriou (2007) is also referred as a supplement. In case that LLC has more than one TCs for accessing to seaport, average value of *TCInfra* of extracted TCs is used.

The higher value of *TCInfra* and *LLCInfra* are interpreted as better infrastructure condition. Hence, the sign condition of transport infrastructure should be negative.

b) Country Risk

The level of bureaucracies of the country is considered to influence on efficiency for trade activities such as border-crossing procedures, increase in frequency of cargo inspection, increase in number of documentation submitted, etc. In this study, the database named "Euromoney Country Risk" released by Euromoney Institutional Investor PLC (2013) which shows the government stability, regulatory environment, non-payment of loans, dividends, trade-related finance, non-preparation of capital, corruption, perception and information access, transparency is used to express the level of bureaucracies. In this study, such variables are named as "country risk" of LLCs (*LLCCR*) and TCs (*TCCR*).

Here, smaller the scores of *LLCCR* and *TCCR*, more inefficient and unstable system of the countries are indicated. Hence, the sign condition of country risk should be negative.

c) Distance to Seaport

Distance between LLC and seaport is obviously one of the significant factors affecting inland transport time. The LLCs located geographically far away from the seaport are likely to be required longer transport time. In this study, the data for distance (*Dist*) is used between the capital of LLCs and seaport of TCs, which are quoted from UNCTAD (2006). In case more than two TCs are designated, average distance to seaports is used. In UNCTAD (2006), data for used seaport is only available for developing countries. Hence, as for those for landlocked developed countries, Uprety (2005) is used as supplemental data.

The longer travel distance obviously contributes on longer transport time. Hence, the sign condition of distance to seaport is positive.

d) Geographic Conditions

Most of LLCs suffer from their geographic conditions, such as quasi-deserts, deserts or mountainous areas (Raballand, 2003). European LLCs are on the Alpine Arc, while those in Africa lie in the Sahel region or on the continental ridge. Central Asian LLCs are located at the heart of the world's largest endorheic basin, which mostly semi-desert. There is a possibility that freight transport is in the difficult geographic conditions. Especially mountainous condition might influence on transport time, because the longer transport distance, lower speed of the haulage.

Hence, altitude of the capital in LLCs (*Altitude*) and percentage of forest area (*LLCforest*, *TCforest*), which is calculated by area of forest divided by total country's area, are used as variable expressing mountainous land form. Data of *Altitude* is retrieved from GPS Visualizer and that of *LLC forest* and *TC forest* are collected from FAO (2012).

The higher altitude and larger forest area are likely to be the cause of severe transport condition. Thus, the sign condition of transport infrastructure is positive.

2.2 Regression Models and Estimation Results

In the regression analysis, 37 LLCs are used as sample countries because six countries data (Andorra, Liechtenstein, Vatican City, San Marino, Serbia, Turkmenistan) are not available. Prior to developing regression model using variables explained in 2.1, correlation analysis is conducted to avoid multicollinearity among some variables. The result of correlation analysis is shown in Table 1.

Table 1. Result of correlation analysis

	Dist	*LLCInfra*	*TCInfra*	*LLCCR*	*TCCR*	*Altitude*	*LLCforest*	*TCforest*
Dist	1							
LLCInfra	-0.224	1						
TCInfra	-0.275	**0.926**	1					
LLCCR	-0.366	**0.796**	**0.770**	1				
TCCR	-0.536	**0.680**	**0.745**	**0.644**	1			
Altitude	-0.085	-0.402	-0.355	-0.191	-0.082	1		
LLCforest	-0.428	0.131	0.206	0.216	0.360	0.188	1	
TCforest	-0.205	-0.034	-0.063	0.216	-0.046	-0.257	0.321	1

From the Table 1, it is observed that the variables *LLCInfra*, *TCInfra*, *LLCCR*, *TCCR* are highly correlated among themselves (correlation coefficient is more than 0.6). Hence, these four variables are separately incorporated into each regression model as followings;

1. *TT* = *f* (*Dist*, *LLCInfra*, *Altitude*, *LLCforest*, *TCforest*)
2. *TT* = *f* (*Dist*, *TCInfra*, *Altitude*, *LLCforest*, *TCforest*)
3. *TT* = *f* (*Dist*, *LLCCR*, *Altitude*, *LLCforest*, *TCforest*)
4. *TT* = *f* (*Dist*, *TCCR*, *Altitude*, *LLCforest*, *TCforest*)
5. *TT* = *f* (*Dist*, *LLCInfra*)
6. *TT* = *f* (*Dist*, *TCInfra*)
7. *TT* = *f* (*Dist*, *LLCCR*)
8. *TT* = *f* (*Dist*, *TCCR*)

In this study, above eight regression models are developed in order to determinate factors affecting inland transport time. The results of parameter estimation are shown in Table 2 (Model 1 to 4) and 3 (Model 5 to 8). The model 5 to 8 are developed for the purpose of excluding the effect of *Altitude*, *LLCforest*, *and TCforest*, which are judged as statistically not significant values as shown in Table 2. As a result, goodness-of-fit of the model (adjusted R-squared) are improved in all models.

From the result (Model 5 to 8), distance to seaport (*Dist*), transport infrastructure quality of LLCs (*LLCInfra*) and TC (*TCInfra*), country risk of LLCs (*LLCCR*) and TCs (*TCCR*) are statistically confirmed to be significant factors influencing on inland transport time. The implication of this result is that inland transport time is affected not only hard aspects such as transport distance and quality of infrastructure but also soft aspects such as country's risk.

Regarding the distance to seaport, all models received as statistically significant value and sign condition (positive) is satisfied. However, absolute value of the coefficient (*Dist*) is relatively small. This implied that distance factor contributes on transport time; however, this might not be the decisive factor to determine transport time. On the other hand, the coefficient for *LLCInfra*, *TCInfra*, *LLCCR*, and *TCCR* are relatively large. Thus, we can understand that these factors are the decisive factors for transport time.

What should be emphasized in this result from the regression analysis is that the value of coefficient of *LLCInfra* (model 5) is smaller than that of *TCInfra* (model 6). This implies that the importance of infrastructure of TCs is higher than those in their own territories of LLCs. On the other hand, variables expressing geographical conditions such as altitude of capitals in LLCs (*Altitude*) and forest area (*LLCforest*, *TCforest*) were not significant variables as illustrated in model 1 to 4 in Table 2.

Table 2. Result of parameter estimation (Model 1 to 4)

	Model 1		Model 2		Model 3		Model 4	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Constant	4.062	0.773	5.031	0.971	14.100**	2.432	11.950	1.345
Dist	0.009***	4.889	0.008***	4.787	0.007***	4.620	0.008***	3.944
LLCInfra	-2.572	-1.559						
TCInfra			-3.299**	-1.994				
LLCCR					-0.733***	-3.390		
TCCR							-0.487	-1.472
Altitude	-0.001	-0.347	-0.001	-0.558	-0.001	-0.001	0.000	0.067
LLCforest	-0.037	-0.456	-0.017	-0.203	-0.023	-0.325	-0.028	-0.331
TCforest	0.006	0.049	-0.026	-0.197	-0.004	-0.039	0.002	0.012
Adjusted R2	0.512		0.534		0.616		0.508	
Observations	37		37		37		37	

*** Significant at 1% level, ** Significant at 5% level, Significant 10% level.

Table 3. Result of parameter estimation (Model 5 to 8)

	Model 5		Model 6		Model 7		Model 8	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Constant	2.085	0.921	2.458	1.100	12.054***	3.393	11.542*	1.873
Dist	0.009***	5.977	0.009***	5.827	0.008***	5.531	0.008***	4.570
LLCInfra	-2.341**	-1.730						
TCInfra			-2.902**	-2.163				
LLCCR					-0.712***	-3.617		
TCCR							-0.510*	-1.770
Adjusted R2	0.548		0.568		0.645		0.550	
Observations	37		37		37		37	

*** Significant at 1% level, ** Significant at 5% level, Significant 10% level.

3. CLASSIFICATION OF THE TYPE OF INLAND FREIGHT TRANSPORT

Based on five factors affecting inland transport time (*LLCInfra*, *TCInfra*, *LLCCR*, *TCCR*, and *Dist*) obtained by regression analysis in the previous section, the type of problems of inland freight transport among LLCs are classified by agglomerative cluster analysis (Ward method) (Everitt *et al*., 2011). Ward method uses an analysis of variance approach to evaluate the distances (linkage level) between clusters. In general, this method is efficient to obtain stable result (Everitt *et al*., 2011).

Using *LLCInfra*, *TCInfra*, *LLCCR*, *TCCR*, and *Dist* as decision variables, LLCs are clustered as a dendrogram as illustrated in Figure 1.

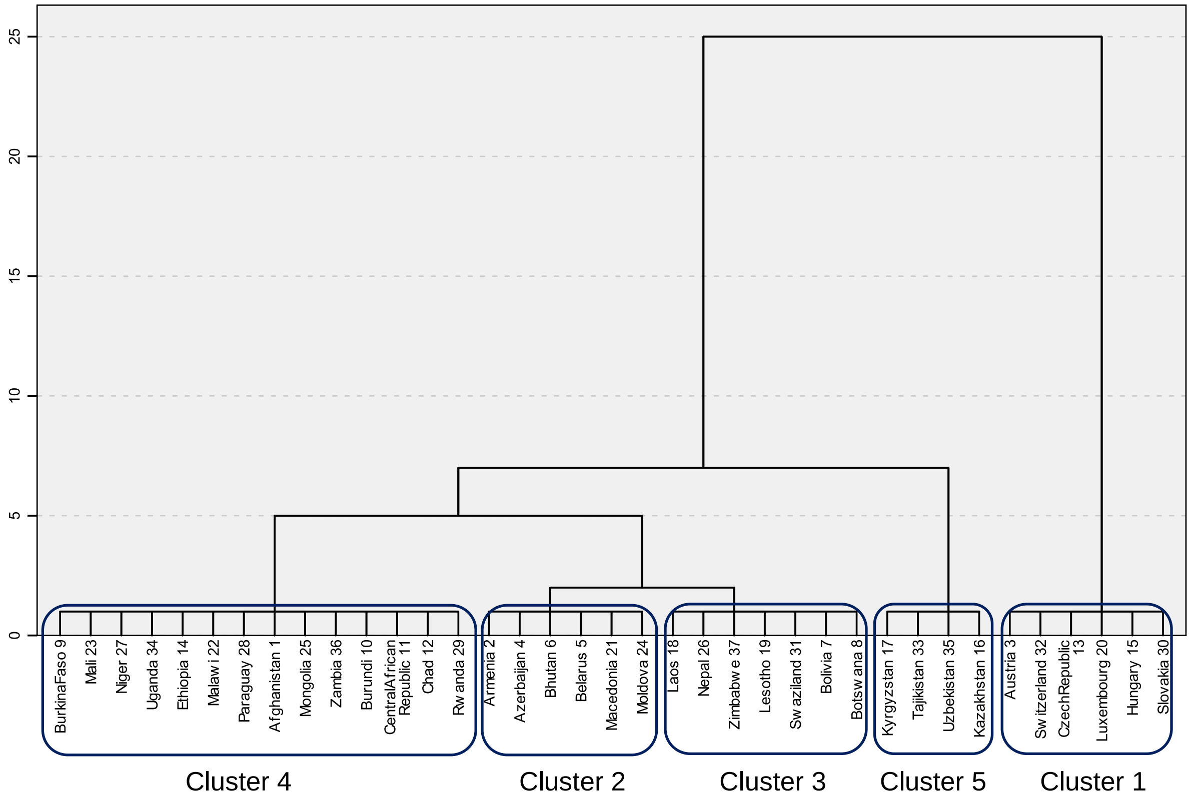


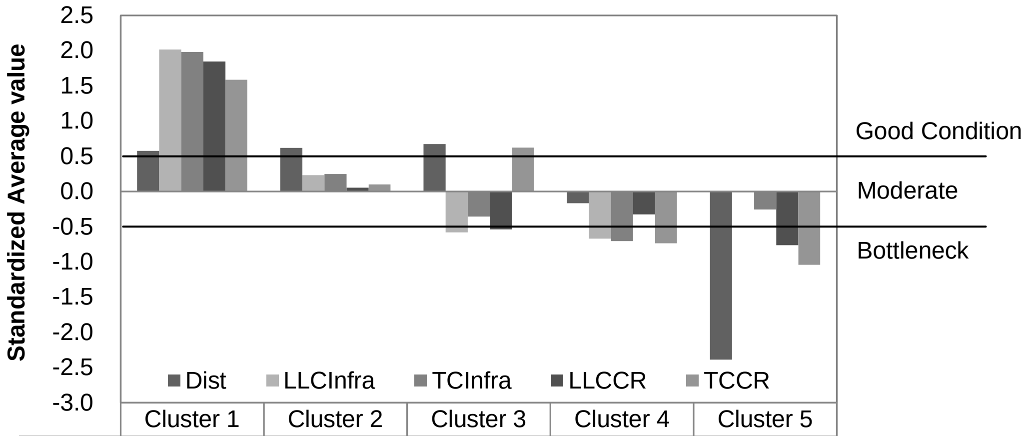
Figure 1. Result of cluster analysis

In figure 1, vertical axis indicates linkage level among LLCs. As closest linkage is chosen to define the clusters, five clusters are obtained as illustrated in Figure 1. From Figure 1, we can understand that Cluster 2 and 3 is the closest conditions each other. In these LLCs, each factor to affect inland transport time is defined as near the moderate condition. On the other hand, Cluster 1 is far different condition compared to other four clusters as linkage level to other four clusters is received as 25.0 while clusters 2 to 5 is grouped by linkage level at 7.0. Countries in Cluster 1 are listed up high income European countries while other four clusters are basically classified as developing countries.

For each cluster, five factors affecting inland transport time are classified into good condition, moderate, or bottleneck as shown in Table 4. Figure 2 visualize the standardized average value of five factors for each cluster. In this study, the value more than 0.5 is defined as good condition while that between -0.5 and 0.5 and less than -0.5 are defined as moderate and bottleneck in order to easily understand conditions of each factor for each cluster, respectively.

Table 4. Comparison of factors affecting transport time of each cluster

	LLCs	Good condition	Moderate	Bottleneck
Cluster 1	Austria, Switzerland, Czech Republic, Luxembourg, Hungary, Slovakia	*LLCInfra, TCInfra, LLCCR, TCCR, Dist*		
Cluster 2	Armenia, Azerbaijan, Belarus, Macedonia, Moldova, Bhutan	*Dist*	*LLCInfra, TCInfra, LLCCR, TCCR*	
Cluster 3	Zimbabwe, Lesotho, Swaziland, Botswana, Laos, Nepal, Bolivia	*TCCR, Dist*	*TCInfra,*	*LLCInfra, LLCCR*
Cluster 4	Burkina Faso, Mali, Niger, Uganda, Ethiopia, Malawi, Zambia, Burundi, Central African Republic, Chad, Rwanda, Paraguay, Afghanistan, Mongolia		*LLCCR, Dist*	*LLCInfra, TCInfra, TCCR*
Cluster 5	Kyrgyzstan, Tajikistan, Uzbekistan, Kazakhstan		*LLCInfra, TCInfra,*	*LLCCR,TCCR, Dist*



	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Dist	0.58	0.62	0.67	-0.17	-2.39
LLCInfra	2.02	0.23	-0.58	-0.67	-0.01
TCInfra	1.98	0.25	-0.36	-0.70	-0.26
LLCCR	1.85	0.05	-0.54	-0.33	-0.77
TCCR	1.59	0.10	0.62	-0.74	-1.04

Figure 2. Comparison of average value of each cluster

Following this definition, factors affecting inland transport time of Cluster 1 are in all good condition. It can be understood that distance to seaport is almost same condition as Cluster 2 and 3, however, other factors (infrastructure condition and country risk) are much better than those of Cluster 2 and 3. Countries in Cluster 2 are middle income European countries plus Bhutan, and in the second best condition among five clusters. Comparing to Cluster 1, although distance advantage of Cluster 2 is slightly better than Cluster 1, other factors (infrastructure condition and country risk) are much lower. Countries in Cluster 3 are come from Southern African and Asian countries plus Bolivia. Distance to seaport is almost in same condition with Cluster 1 and 2, however, conditions of LLCs in terms of both infrastructure and country risk of their countries are to be in bottlenecks. On the other hand, conditions in TCs are in more than moderate conditions. This result implies that countries in Cluster 3 need to improve transport condition in their territories.

Cluster 4 and 5 are in difficult condition among the clusters. Cluster 4 consists of

African and Asian countries, which infrastructure developments of both LLCs and TCs are the worst among the clusters. In Cluster 5, all countries are detected from Central Asian countries. They suffer from long distance to seaport of TCs, bad bureaucracies of both LLCs and TCs. Consequently, the quality of infrastructure in both LLCs and TCs in Cluster 5 are not in bad condition.

4. CONCLUSION

This study clarified the determinants of LLCs' inland transport time to seaport and classified the type of inland freight transport conditions for LLCs. The results show that LLCs have the different type of problems although they have several common disadvantages compared to coastal countries.

As a first step of the analysis, the important factors which influence on inland transport time of LLCs' access to seaport in TCs are clarified by multiple regression analysis. In any model, distance to seaport is a significant factor which has positive correlation with transport time; however, the absolute value of coefficient is relatively smaller than other significant variables, such as quality of infrastructure and country risk. Infrastructure condition and country risk of LLCs and TCs have impact on transport time.

On the basis of factors affecting inland transport time confirmed by regression analysis, the differences among LLCs is clarified by cluster analysis. LLCs of high income European countries (Cluster 1) are all in good condition. However, distance advantage is slightly lower than middle income European countries (Cluster 2) and Southern African and Asian countries (Cluster 3). High income European countries are far better conditions of infrastructure and efficiency of bureaucracies. Regarding countries in Cluster 3, conditions of LLCs in terms of both infrastructure and country risk are to be in bottlenecks. On the other hand, conditions in TCs are in more than moderate conditions. This result implies that countries in Cluster 3 need to improve transport condition in their territories. As for the countries in Central Asia (Cluster 5), they suffer from long distance to seaport, bad condition of TCs and have inefficient bureaucracies. Infrastructure condition in both LLCs and TCs are not in bad condition.

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