Clarifying the Relationship between the Seaborne Trade Flows of Landlocked Developing Countries and the Attributes of their Cross-border Corridors

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The thirty-two Landlocked Developing Countries (LLDCs) are listed by United Nations in the world. Their hardness to transport international cargos is most often blamed for their slow economic growth. International donors and various countries have conducted projects to improve various attributes of cross-border corridors. Despite their progress achieved on many fronts, it is still unclear that the influential attributes of corridors to increase its trade flow. Therefore, this study clarifies the attributes' change of cross-border corridors, which have influence on their seaborne trade cargo flow growth. Those flows are between most populated city of LLDC and the ports of their neighbor coastal countries. The empirical analysis with fixed effect model is carried out using annual panel data from 2011 to 2015, covering the cross-border corridors leading to 19 LLDCs. The attributes of each cross-border corridor are estimated based on publicly available statistical data. Those attributes are chosen through literature reviews. The result reveals that some attributes, such as Weighted mean applied tariff, Transit time, and Business costs of crime are statistically significant. Their estimated coefficients suggest that those improvements should be associated with increase the flow volume change. Regarding individual effects, which are constant each LLDC-specific characteristic, it cannot be said that the number of border crossing and the distance to seaports of neighbor countries have correlation with individual effects. The founded influential attributes of cross-border corridors, which should be facilitate on a priority basis, would be a useful information for development donors and their projects.

Key Words : *Landlocked developing country, Cross-border corridor, Seaborne trade cargo, panel data analysis, fixed-effect model*

1. INTRODUCTION

Landlockedness refers to the geographical situation of a country without direct access to the sea[1]. According to this definition, there are 44 landlocked countries in the world[2]. Of these, the United Nations lists 32 countries as landlocked developing countries (LLDCs) [2] as shown in **Table 1**.

Fig.1 shows the ratio of GDP per capita of LLDCs to that of world GDP per capita from 2005 to 2018. LLDCs' GDP per capita is increasing compared to that of world, but still less than 50% of it.

The hardness to transport from and to LLDCs is most often blamed for their slow economic growth. That is partly because their geographical situation—lack of direct access to the sea—makes their freight transports with long way hauling on land, and multiple clearances and trans-loading.

The special development needs of the LLDCs have been globally recognized. A ministerial intergovernmental conference held in Almaty in 2003 agreed to the Almaty Programme of Action (APoA) as a means to pursue the commitment to address the special needs of LLDCs[2]. In line with the APoA, the steps undertaken by international organizations to assist

Table 1 Landlocked developing countries[2]

Africa	Asia	Europe
Botswana	Afghanistan	North Macedonia
Burkina Faso	Bhutan	Moldova
Burundi	Kazakhstan	
Central African Republic	Kyrgyz Republic	**South america**
Chad	Lao PDR	Bolivia
Eswatini	Mongolia	Paraguay
Ethiopia	Nepal	
Lesotho	Tajikistan	**Caucasus**
Malawi	Turkmenistan	Armenia
Mali	Uzbekistan	Azerbaijan
Niger		
Rwanda	**Africa**	16 countries
South Sudan	**Asia**	10 countries
Uganda	**Europe**	2 countries
Zambia	**South america**	2 countries
Zimbabwe	**Caucasus**	2 countries

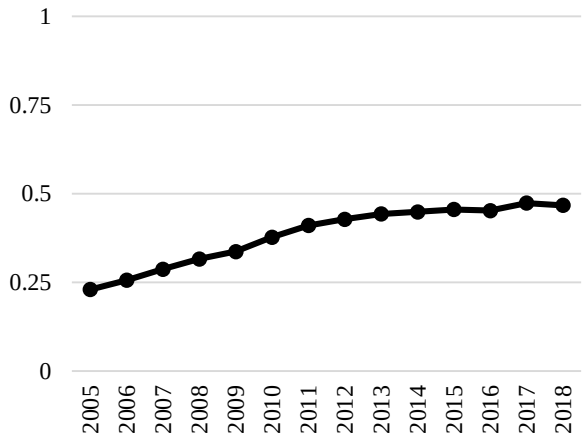

Fig.1 The ratio of GDP per capita of LLDCs to that of world GDP per capita[3)]

LLDCs mostly relate to trade and transport issues[2)].

In spite of the progress achieved on many fronts regarding LLDCs by those projects of international donor and various countries, skepticism remains as to the possibility of finding effective and comprehensive solutions to the transport challenges. Thus, this study clarifies the attributes of cross-border corridors, which have great influence on their seaborne trade flows through cross-border corridors. For this objective, following procedures are taken in this study. Firstly, relevant corridors' attributes are derived from a review of several previous studies and make indexes for each LLDCs. Then the relationships between the attributes of corridors and its freight flow volume are analyzed with the regression model. The founded influential attributes of cross border corridors, which should be facilitate on a priority basis, would be a useful information for development donors and their projects.

2. LITERATURE REVIEW

Several studies on evaluation of cross-border corridor have been conducted and vary in the size of corridor considered, the methodology of evaluation and the focus of the study.

Transakul et al. (2013)[4)] develop the trade facilitation hierarchy. It is used for evaluating factors, which influence on cross-border trade facilitation by multi-criteria decision making approach called Analytic Hierarchy Process. They assume that the most intermediary factors, which influence trade facilitation along the economic corridor directly, were broadly classified as time, cost and complication of overall trading processes. Those factors are affected by many sub factors, including transparency, technology, policy and infrastructure. They conduct the case study on the East-West Economic Corridor in the Greater Mekong Subregion with that evaluation and conclude the importance of operational transparency.

Regarding the sub factors of Transakul et al. (2013)[4)], some papers discuss more about influential factors for development of corridors based on literature reviews and interviews conducted by them. Those papers deal with issues and bottlenecks in economic and transport corridor and development of trade, logistics and transportation. Fraser and Notteboom (2014)[5)] carries out a study to assess attractiveness of seaport-based transport corridors in South Africa, defining three dimensions of corridor attractiveness, namely infrastructure and location, logistics activities and corridor management. To assess attractiveness of seaport-based transport corridors, they attempt to define attributes of attractiveness in the context of resources and capacities. Witte et al. (2012)[6)] conducts a study on bottlenecks along transportation networks in Europe and creates a conceptual framework that categorizes bottlenecks into governance, economic, spatial, and infrastructure. Though those categories are created mainly for transportation bottlenecks, the authors provided valuable perspective on attributes of corridors. Furthermore, based on the finding from the study, they also point out those bottlenecks are not merely an issue of capacity in transport infrastructure, but rather requiring consideration of different dimensions such as transportation, spatial planning, environmental issues, economic development and transnational governance. Rodemann and Templar (2014)[7)] conducts a study on intercontinental rail transport between Asia and Europe, through literature review and interview, identifying enablers and inhibitors of an intercontinental rail freight using the PESTLE framework and proposing strategies to minimize inhibitors. Enablers for rail transport highlighted in the study includes investment on transport infrastructure, transport capacity, transport reliability, high security, intergovernmental

agreement, geography, climate, CO2 emission and energy consumption.

Other papers compare the corridor with the alternative ones under their considerations, based on some indicators of corridors' attributes, which are similar to the most intermediary factors of Transakul et al. (2013)[4]. Moon et al. (2015)[8] make comparative analysis of six selected transport routes, which include sea and land routes, between the Republic of Korea and the Europe using the TOPSIS technique. It uses both quantitative and qualitative factors in analysis; quantitative factors included transport distance, time and cost, while qualitative factors covered reliability, flexibility, frequency, information service and safety. Regmi and Hanaoka (2012)[9] evaluates a much larger-scale cross-border land corridor connecting Incheon (Korea) to Yakatelnburg (West city of Russia) by time-cost-distance approach, and highlighted the importance of improvement of hard and soft infrastructure. Weigman and Janic (2019)[10] proposes the methodology for assessing performances of supply chains served by long-distance intercontinental intermodal rail/road- and sea-shipping freight transport corridor(s). The models of particular indicators are applied according to "what-if" scenario approach to assessing performances of the long-distance intercontinental inland and maritime freight transport corridors spreading between China and Europe in the scope of the "Silk Road Economic Belt" and "A New Maritime Silk Road" policy initiative. This methodology consists of the analytical models of indicators of the operational, economic, environmental and social performances of particular corridors and corresponding supply chains assumed to be dependent on the infrastructural and technical/technological capabilities.

Finally, Lim et al. (2017)[11] derives relevant factors to be considered in the development of transit trade corridors, in the context of policy-makers' perspective, from a review of previous studies that addressed closely related matters, including some papers mentioned above. This research has drawn eight underlying factors affecting the design of a transit trade corridor: development and policy implications; safety, security and political concerns; environmental protection; financing and investment; soft infrastructure; hard infrastructure; geography and landscape; and corridor performance.

From a comprehensive literature review, it is obvious that cross-border corridors have various attributes to be improved. Besides those improvements can be done by diverse and multidimensional aspects, covering political, economic, environmental, financial, and so on. But, there has been little research specifically focused on cross-border corridors of LLDCs, and less so on attributes to be considered in the development of them. In other words, there is no readily available literature that provides comprehensive collection of relevant corridors' attributes for this research to directly adopt and utilize. Therefore, under such constraints, this paper derived relevant corridors' attributes from a review of several previous studies that addressed closely related matters, in particular those dealing with issues and bottlenecks in cross-border corridor and development of trade, logistics and transportation.

3. METHDOLOGY

(1) Partner country and corridor selection

This study sets 19 LLDCs as research targets, which are shown in **Table 2**. The other 13 LLDCs are eliminated due to their lack of data source. Partner countries of each LLDC are defined as the countries that account for the top 80% of the LLDC's average trade volume from 2010 to 2015. Then based on the geographic location of partner country, the used sea ports and cross-border corridors are assumed as also shown in **Table 2**. All seaborne trade between the LLDC and its trading partner is assumed to be equally distributed to assumed ports. The 6-year average flow volumes of each cross-border corridor for each LLDC are calculated and its ratio among all corridors of each LLDC are estimated as the flow volume ratio. These ratios are shown in **Table 2** and used for independent variable setting.

(2) Panel data analysis with fixed model

To find the important attributes to facilitate cross-border corridor, panel data analysis with Fixed-effects model is applied. Fixed effects regression is a method that can provide unbiased estimates in this situation, if certain assumptions are valid. This study estimates an effect of causal variables change using an annual panel dataset. This dataset consists of each data's difference from the previous year for 19 LLDCs from 2011 to 2015. Fixed effects estimation builds on the error components linear model as follows,

$$\Delta Y_{it} = \boldsymbol{\beta}\Delta \boldsymbol{X_{it}} + \alpha_{\mathrm{i}} + \epsilon_{it} \quad (1)$$

$$\boldsymbol{\Delta X_{it}} = [\Delta X_{it1} \quad \Delta X_{it2} \quad \dots \quad \Delta X_{itK}] \quad (2)$$

where,

ΔY_{it} : Trade flow volume change of LLDC i from year t-1 to year t

$\boldsymbol{\Delta X_{it}}$: Attributes change of LLDC i from year t-1 to year t (1*K vector)

$\boldsymbol{\beta}$: Estimated parameter (K*1 vector)

α_{i} : Individual effect of LLDC i

ϵ_{it} : Idiosyncratic error

The α_{i} express LLDC-specific characteristics,

which do not change by year. This study deal several LLDCs located on different continent inclusively, thus this time-constant individual heterogeneity should be considered.

Table 2 Target LLDCs and their corridors' flow volume ratio

LLDC	Port country	Port city	Flow volume ratio
Botswana	South Africa	Durban	0.50
	Namibia	Walvis Bay	0.50
Burundi	Kenya	Mombasa	0.33
	Tanzania (Kobero)	Dar es salaam	0.33
	Tanzania (Nyarabanda)	Dar es salaam	0.33
Chad	Cameroon	Douala	0.50
	Nigeria	Lagos	0.50
Eswatini	Mozambique	Maputo	1.00
Lesotho	South Africa	Durban	1.00
Malawi	South Africa	Durban	0.25
	Mozambique	Beira	0.25
	Mozambique	Nacala	0.25
	Tanzania	Dar es salaam	0.25
Rwanda	Kenya	Mombasa	0.50
	Tanzania	Dar es salaam	0.50
Uganda	Kenya	Mombasa	0.50
	Tanzania	Dar es salaam	0.50
Zambia	South Africa (Harare)	Durban	0.20
	South Africa (Bulawayo)	Durban	0.20
	Mozambique (Chirundu)	Beira	0.20
	Mozambique (Bulawayo)	Beira	0.20
	Tanzania	Dar es salaam	0.20
Zimbabwe	South Africa	Durban	0.50
	Mozambique	Beira	0.50
Lao PDR	Thailand	Laem Chabang	0.50
	Vietnam	Da Nang	0.50
Mongolia	Russia	St. Petersburg	0.33
	Russia	Vladivostok	0.33
	China	Tianjin	0.33
Nepal	India	Kolkata	1.00
Armenia	Iran	Bandar Abbas	0.72
	Georgia	Poti	0.14
	Russia	St. Petersburg	0.14
Azerbaijan	Iran	Bandar Abbas	0.60
	Georgia	Poti	0.14
	Turkey	Istanbul	0.14
	Russia	St. Petersburg	0.11
North Macedonia	Greece	Thessaloniki	0.50
	Albania	Durrës	0.50
Moldova	Ukraine	Odesa	0.33
	Romania	Constanța	0.33
	Bulgaria	Varna	0.33
Bolivia	Chile	Arica	0.09
	Chile	Antofagasta	0.09
	Brazil	Santos	0.73
	Peru	Matarani	0.09
Paraguay	Argentina	Buenos Aires	0.50
	Brazil	Paranagua	0.50

( ): passed city of the corridor.
Not all of them are the cities of port country.

(3) Variable selection

To capture the flow volume [Metric ton] on cross-border corridor, the World Trade Service (WTS) data provided by IHS Global Insight[12] are used. This dataset is classified by mode such as Airborne, Seaborne and Overland/other. I assume that all seaborne trade freights from and to a LLDC are transported through the cross-border corridors between most populated city in a LLDC and sea ports in its neighbor coastal country. However, the trade volume of crude oil, natural gas, petroleum gases, gaseous hydrocarbons, and refined petroleum products are excluded, due to those are often transported through pipelines.

In this study, 16 independent variables classified into 6 groups are prepared as shown in **Table 3**. Those variables are once calculated by the cross-border corridor from the data source, x_{itk} and then are flow volume weighted for each LLDC, X_{itk} with the estimated flow volume ratios.

X_{it1} is the weighted mean applied tariff, that is the average of effectively applied rates weighted by the product import shares corresponding to each partner country. This study uses this index of LLDC as it is for indicate the level of domestic market access in LLDC. Data is derived from World Development Indicator (WDI)[3].

Independent variables X_{it2} to X_{it6} indicate the efficiency and transparency of administration and are belonging to second group of independent variables. Burden of customs procedure, X_{it2} measures business executives' perceptions of their country's efficiency of customs procedures. In this analysis, the original data of passed country are number of emigration and immigration weighted averaged and used as the indicator of its corridor. X_{it3} to X_{it5} are obtained from the World Bank Doing Business (DB) database[13]. It measures the number of documents, cost (excluding tariffs) and time, respectively, associated with exporting and importing a standardized cargo of goods by sea transport. For exporting goods, official procedures start from packing the goods into the container at the warehouse to their departure from the port of exit and includes processes at the inland border post.

Table 3 Independent variables

		Data contents of independent variables	Unit	Expected sign	Source
Domestic market access	x_{it1}	Weighted mean applied tariff	[%]	−	WDI
Efficiency and transparency of administration	x_{it2}	Burden of customs procedures	Categorical [1: worst - 7: best]	+	EOS
	x_{it3}	Number of document	[number]	−	DB
	x_{it4}	Cost	[USD per container deflated]	−	DB
	x_{it5}	Time	[days]	−	DB
	x_{it6}	Irregular payments and bribes	Categorical [1: worst - 7: best]	+	EOS
Availability and quality of transport infrastructure	x_{it7}	Quality of railroad infrastructure	Categorical [1: worst - 7: best]	+	EOS
	x_{it8}	Quality of port infrastructure	Categorical [1: worst - 7: best]	+	EOS
	x_{it9}	Quality of roads	Categorical [1: worst - 7: best]	+	EOS
Operating environment	x_{it10}	Business costs of crime and violence	Categorical [1: worst - 7: best]	+	EOS
	x_{it11}	Business costs of terrorism	Categorical [1: worst - 7: best]	+	EOS
Other	x_{it12}	Prevalence of trade barriers	Categorical [1: worst - 7: best]	+	EOS
Typical contents of Gravity model	x_{it13}	LLDC GDP	[current USD]	+	WDI
	x_{it14}	Partner countries GDP	[current USD]	+	WDI
	x_{it15}	LLDC population	[number]	+	WDI
	x_{it16}	Partner countries population	[number]	+	WDI

However, the time and cost for sea transport are excluded. All the necessary documents required from the trader to export the goods across the border are also recorded. X_{it6} is used to express the extend of undocumented extra payments or bribes connected with imports and exports; public utilities; annual tax payments; awarding of public contracts and licenses; obtaining favorable judicial decisions.

Third group is Availability and quality of transport infrastructure. X_{it7} to X_{it9} represent the business executives' perceptions of the quality of railroad, seaport, roads, individually. Each data source evaluates infrastructure level as whole country scale, thus the index of railroad and roads are converted to the distance weighted average. While that of seaport is the data of their port country as it is.

Forth group is operating environment especially focused on risk of accidents. X_{it10} expresses the business executives' perceptions of the cost for the incidence of crime and violence and X_{it11} expresses that for terrorism.

For the index of other prevalence of trade barriers such as health and product standards, technical and labeling requirements, X_{it12} is settled based on the business executives' perceptions. The data of first to forth group, excluding X_{it3} to X_{it5}, are calculated based on World Economic Forum's Executive Opinion Survey (EOS) [14].

Finally, typical contents of gravity model, which are GDP and population of both of LLDC and partner county, are also included this model for ensuring the model's reliability. Those data are derived from World Development Indicator[12].

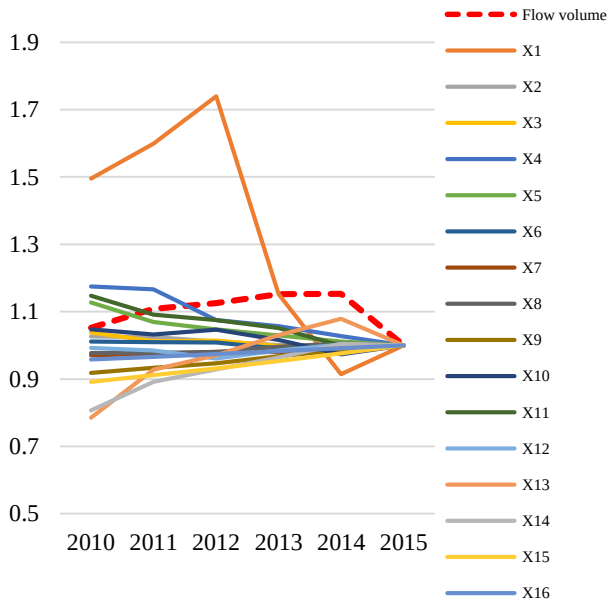

Fig. 2 The average change ratio of each variable (Base year: latest available year of each country)

Fig.2 shows the average change ratio based on each variable in 2015. However, Nepal has lacks of the X_{it7} in 2014 and 2015. Thus those rates are calculated by the data of latest available year basis. Seaborne trade flow volume is gradually increased by 2014. Several variables, such as X_{it7}, X_{it8}, X_{it9}, X_{it14}, X_{it15}, and X_{it16} are increased during this 6 year periods, while others are decreased, in terms of 19 LLDCs' average.

(4) Variance inflation factor

The variance inflation factor (VIF) is an indicator of the effect that the other independent variables have on the standard error of a regression coefficient[15]. This values also indicate a degree of multicollinearity among the independent variables. This factor score is calculated as equation 3.

$$VIF_k = \frac{1}{1-R_k^2} \tag{3}$$

Here, R_k^2 is the amount of a selected independent variable ΔX_{itk} that is explained by all of the other independent variables in the regression model. In this process, the selected independent variable is made a dependent variable predicted by all the other remaining independent variables. Large VIF values indicate a high degree of multicollinearity among the independent variables. A common cutoff threshold is a VIF value of 10[15].

VIFs of each independent variable is calculated as shown **Table 4**. It shows that VIFs of ΔX_{it4} and ΔX_{it5} have large VIF and almost same as the threshold 10 (the column A of **Table 4)**. Removing ΔX_{it5} reduces the VIF and all of them are less than 2 as shown in the column B. This implies that these parameters can have unreliable regression coefficients. Thus, the dataset excluding ΔX_{it5} is used in following analysis.

Table 4 Variance inflation factor

	A	B	
ΔX_{it1}	1.79	1.79	Weighted mean applied tariff
ΔX_{it2}	1.08	1.07	Burden of customs procedures
ΔX_{it3}	1.62	1.62	Number of document
ΔX_{it4}	**8.90**	1.05	Cost
ΔX_{it5}	**9.05**		Time
ΔX_{it6}	1.14	1.12	Irregular payments and bribes
ΔX_{it7}	1.17	1.16	Quality of railroad infrastructure
ΔX_{it8}	1.12	1.18	Quality of port infrastructure
ΔX_{it9}	1.18	1.56	Quality of roads
ΔX_{it10}	1.56	1.56	Business costs of crime and violence
ΔX_{it11}	1.15	1.14	Business costs of terrorism
ΔX_{it12}	1.14	1.13	Prevalence of trade barriers
ΔX_{it13}	1.14	1.13	LLDC GDP
ΔX_{it14}	1.69	1.67	Partner countries GDP
ΔX_{it15}	1.55	1.51	LLDC population
ΔX_{it16}	1.24	1.23	Partner countries population

4. RESULT AND DISCUSSION

(1) Regression analysis

Table 5 summarizes the estimation result of the model achieved through the above process of selecting explanatory variables. The result of the p-value of each individual effect suggest that the fixed effect model is significantly favored over the pooled model (**Table 7**). R^2 and Adjusted R^2 is 0.77 and 0.58, which show acceptable fitness of the model.

Table 5 Estimation results

	Estimate	P-value		
ΔX_{it1}	-5.48E+04	0.002	**	Weighted mean applied tariff
ΔX_{it5}	-5.14E+04	0.000	***	Time
ΔX_{it10}	5.39E+05	0.082	.	Business costs of crime &violence
ΔX_{it13}	8.80E-05	0.000	***	LLDC GDP
ΔX_{it2}	-6.87E+05	0.258		Burden of customs procedures
ΔX_{it3}	7.55E+04	0.638		Number of document
ΔX_{it6}	1.17E+05	0.775		Irregular payments & bribes
ΔX_{it7}	1.37E+05	0.802		Quality of railroad infrastructure
ΔX_{it8}	1.00E+06	0.105		Quality of port infrastructure
ΔX_{it9}	4.37E+05	0.499		Quality of roads
ΔX_{it11}	-7.19E+04	0.805		Business costs of terrorism
ΔX_{it12}	4.07E+05	0.294		Prevalence of trade barriers
ΔX_{it15}	-1.40E+00	0.264		LLDC population
ΔX_{it14}	-1.07E-07	0.039	*	Partner countries GDP
ΔX_{it16}	-2.96E-01	0.028	*	Partner countries population

R^2: 0.77, Adjusted R^2: 0.58,
Sample size: 75 (19 LLDCs, 2011-2015)

***: p-value < 0.001, **: p-value < 0.01,
*: p-value < 0.05, .: p-value < 0.1

Some estimated coefficients show significant effects with expected signs on the trade flow as shown in Table 3. ΔX_{it1}: Weighted mean applied tariff, ΔX_{it5}: Time, ΔX_{it10}: Business costs of crime and violence, and ΔX_{it13}: LLDC GDP are statistically significant at least the ten percent level. This result suggests that one unit of improvements of those attribute change (all else constant) increase the trade through cross-border corridors 54,800 MT, 51,400MT, 539,000MT, and $8.80*10^{-5}$MT, individually. Thus, the regional integration for reducing tariff and the measurements to reduce transit time and ensure the safety on cross-border corridors is effective for its seaborne trade growth.

Other independent variables, such as ΔX_{it2}: Burden of customs procedures, ΔX_{it3}: Number of document, ΔX_{it6}: Irregular payments and bribes, ΔX_{it7}: Quality of railroad infrastructure, ΔX_{it8}: Quality of port infrastructure, ΔX_{it9}: Quality of roads, ΔX_{it11}: Business costs of terrorism, ΔX_{it12}: Prevalence of trade barriers, and ΔX_{it15}: LLDC population, do not statistically significant even at the level of ten percent. This suggests that the changes of those variable does not enough to stimulate the flow volume change during the analysis period on the whole targeted LLDCs.

Finally, remaining independent variables, such as ΔX_{it14} and ΔX_{it15}: partner countries GDP and population, are statistically significant at the five percent level. However, those sighs are not what I expected. The possible cause of this result is the definition of trading partner country. In this study, trading partner country is defined as the country with an average trade volume of top 80 % from 2010 to 2015. **Table 6** shows the number of LLDCs whose change of assumed trade partner country share is increase or decrease. From this table, more than half of samples reduce their trade share between assumed trading partner countries. It means a large number of LLDCs increase the share of not assumed trade partner countries in this year and their trade partners are made more diverse. Thus, partner countries' GDP and population may be relatively decreased.

Table 6 The number of samples by their change of assumed trade partner country share

	Increase	Decrease	Total
2011	7	12	19
2012	10	9	19
2013	11	8	19
2014	8	11	19
2015	7	12	19
Total	**43**	**52**	95

(2) Individual effects

Estimated individual effects are shown in **Table 6**. It can be seen that most of the top countries belong to Africa. Those countries have some country specific characteristics to increase the difference from previous flow volume besides time varying attributes.

Table 7 Estimated individual effects

		p-value	
Zimbabwe	17.5	0.025	*
Malawi	11.3	0.019	*
Moldova	11.1	0.025	*
Paraguay	10.6	0.018	*
Uganda	10.5	0.016	*
Rwanda	9.75	0.022	*
Burundi	9.50	0.021	*
Azerbaijan	8.39	0.026	*
Botswana	8.38	0.026	*
Zambia	7.80	0.017	*
Lao PDR	7.73	0.015	*
Chad	7.43	0.032	*
Eswatini	6.42	0.048	*
Nepal	5.35	0.013	*
Bolivia	4.59	0.009	**
North Macedonia	4.19	0.031	*
Mongolia	3.46	0.022	*
Armenia	3.23	0.029	*
Lesotho	3.16	0.039	*

Bold: African country, **: p-value < 0.01, *: p-value < 0.05

There are two possible causes from my variables setting. They are the number of border crossing and

the distance to seaports of neighbor countries. It is because both of cross-border corridors and its flow volume ratio are assumed not change by year, thus those variables can be time-constant individual heterogeneity or individual effects of this model. **Fig.3** and **Fig.4** shows their scatter plots with individual effect, individually. Test for no correlation of both of them are conducted as shown in **Table 8**. It shows both of them do not have correlation at even ten percent level. Thus it cannot be said that the corridor length and number of border crossing have correlation with individual effect.

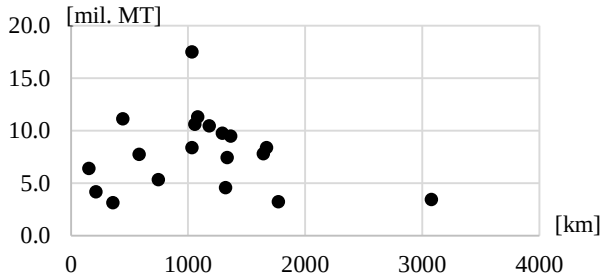

Fig.3 Individual effects and flow volume weighted average of corridor length

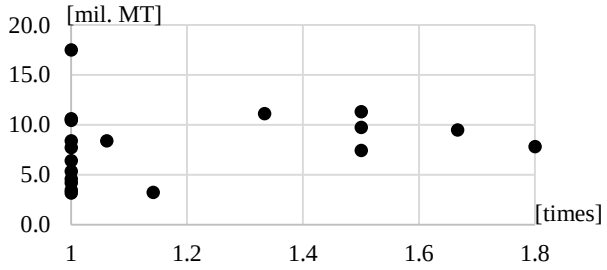

Fig.4 Individual effects and flow volume weighted average of number of border crossing

Table 8 Test for no correlation

Flow volume weighted average of	**p-value**
corridor length	0.62
number of border crossing	0.40

5. CONCLUSION

This study was conducted panel data analysis with fixed effect model to clarify the relationship between the seaborne trade volume change from landlocked developing countries and the change of cross-border corridors' attributes in all over the world. The dataset is constructed based on the indicators and indexes published by international organizations for the years 2010–2015. The model consists of each data's difference from that of previous year, including cross-border corridor specific attributes from literature reviews.

The result reveal that some attributes, such as Weighted mean applied tariff, Transit time, and Business costs of crime and violence are statistically significant. Their estimated coefficients suggest that a reduce of Weighted mean applied tariff and transit time and Business costs of crime and violence (all else constant) should be associated with increase the flow volume change. The other statistically significant independent variables are trade partner countries' GDP and population. However, those sigh does not show expected signs. The possible cause of this results is the ratio of trade volume of assumed partner countries out of real whole trade may be relatively decreased in many samples. Other independent variables are not statistically significant. This suggests that the changes of those variable does not enough to stimulate the flow volume during the analysis period.

Regarding individual effect, which is constant LLDC-specific characteristics, this study checked the coefficients with both of the number of border crossing and the distance to seaports of neighbor courtiers. Based on this analysis, it cannot be said that each of them have correlation with individual effects. The founded influential attributes of cross-border corridors, which should be facilitate on a priority basis, would be a useful information for development donors and their projects.

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