Determinants of nonferrous metals trade by gravity model approach--A case study of UK

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Abstract: This work is aimed to analyze the determinants of non-ferrous metals trade of UK using gravity model. The classic gravity model involves three main determinants which are the GDP of pair country and the distance in between them. Firstly, we test the applicability of the classic model on the UK nonferrous metal import and export. After confirms the applicability of the classic model, more additional explanatory variables are added for the further analysis. The results can be summarized in the following finds:1. The UK non-ferrous metal import is mainly associated with the UK GDP, GDP of other import and export countries, the distance and the percentage of the import trade of the total world and whether this country is a member of OECD. 2.The UK non-ferrous metal export is mainly associated with the UK GDP, the GDP, whether the trade partner is a member of EU and the percentage of total export trade of the whole world. 3.Other factors such as port development level, distance and population will have significant impact on the UK export of non-ferrous metal when the EU is excluded.

Key words: Gravity model, Classic gravity model, International trade,UK trade, Non-ferrous Metal.

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My gratitude also goes my families and friends who are always patient and supportive, offering me encouragement during my study. I'd like to express my sincere gratitude to the invaluable support I received in all forms.

Content

1. Introduction: The non-ferrous metal as an important minor dry bulk commodity, usually transported through typically shipping, plays a critical role in economic and social development. Important non-ferrous metals, such as aluminium, which has a wide range of uses in transportation, architecture and packaging for its excellent anti-corrosive and desirable lightweight properties; Brass, which has been widely applied in machinery and electricity. Other metals such as lead, nickel, tin, titanium, are also widely used in construction and manufacturing. Precious metals such as gold,sliver and platinum are also non-ferrous. Even though the non-ferrous metals is a minor dry bulk, it has important strategic value for the country, as it has close relationship between the energy industry and the information technology.

The following characteristics of non-ferrous metal industry makes it a key component in the economic development:Non-ferrous metal has great strategic value for the country. It is characterized by its wide range of variety and application. In particular, some non-ferrous metals with prominent physical and chemical properties have become indispensable materials for national defense industry, high-tech industry and strategic construction projects, which makes non-ferrous industry a highly-sensitive economic sector.

Non-ferrous metal is also characterized with strong global circulation capacity, as it has higher unit value comparing with general chemical products. They are typically containerised cargoes, the transportation costs only account for a small proportion in the cost of sales, therefore, they are not restricted by the distance between the countries.

Comparing with other bulk commodities such as crude oil and agriculture products, non-ferrous metals have lower storage costs. Most non-ferrous metals have strong antioxidant capacity, which can be easily stored for a long time. Therefore, it can be used as a hedging instrument against inflation and a tactical component in investment. Since the outbreak of economic crisis in 2008, with the expectations of rising inflation, many countries have increased their non-ferrous metal reserves.

The non-ferrous metal trade is closely linked with the international trade performance of the country and the world economy cycle. Figure 1 and 2 illustrated the top 10 exporters and importers of non-ferrous metals in 2018, UK ranked 9th and 6th respectively, with export values reached 13,734 million dollars and 12,062 million dollars. Therefore, research on UK international nonferrous metals trade is meaningful and necessary to guarantee the healthy and sustainable development of global nonferrous metal market.

According to the UK National Statistics, in 2019, the non-ferrous metal ranked the 11th of the total export commodities, with a 2.6 % of the total UK goods export. As for imports, the precious metal and the non-ferrous metal ranked 9th and 14th respectively, which each takes up 3.1% and 2.4% in the total goods imports. We choose the main trading metals--copper, aluminum, lead, tin, nickel and zinc to estimate the main exporters and importers of nonferrous metals of UK. Figure 3 and 4 show the top 15 UK non-ferrous metal importers and exporters in2019. Except for China and US, most the main exporters and importers are located in the Europe continent. Germany is the top trade partner of UK.

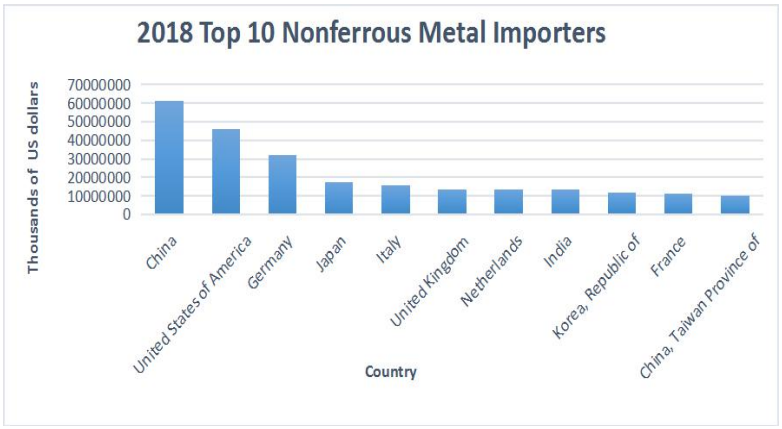

Figure 1. 2018 Top10 Ton-ferrous Metal Importers

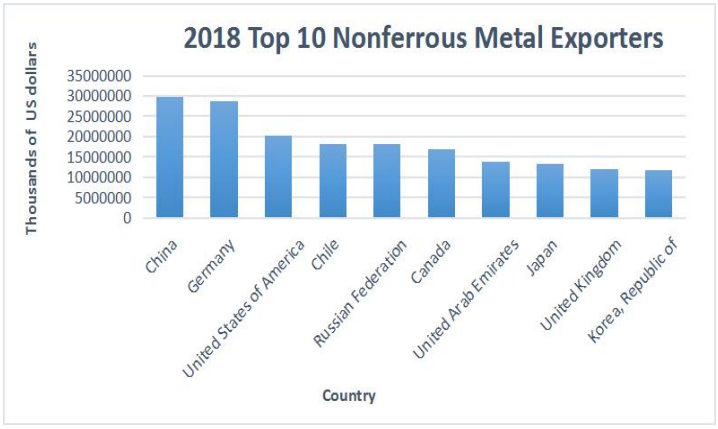

Figure 2. 2018 Top10 Non-ferrous Metal Exporters

EXPORTS				IMPORTS			
Commodity	Value 2018	Value 2019	% of Total	Commodity	Value 2018	Value 2019	% of Total
	£ million	£ million	UK Goods		£ million	£ million	UK Goods
			Exports 2019				Imports 2019
Cars	33 052	31 672	8.5	Cars	32 859	33 785	6.7
Mechanical power generators (intermediate)	24 213	28 179	7.6	Medicinal & pharmaceutical products	24 543	23 701	4.7
Medicinal & pharmaceutical products	24 269	23 286	6.2	Refined oil	22 981	21 588	4.3
Crude oil	23 838	20 898	5.6	Mechanical power generators (intermediate)	20 542	20 828	4.1
Precious metals	1 655	14 510	3.9	Clothing	19 873	20 677	4.1
Aircraft	14 902	14 398	3.9	Telecoms & sound equipment (capital)	19 239	19 627	3.9
Refined oil	13 324	12 580	3.4	Crude oil	19 904	19 385	3.9
Scientific instruments (capital)	9 433	10 077	2.7	Miscellaneous electrical goods (intermediate	16 001	15 893	3.2
Works of art	5 583	9 765	2.6	Precious metals	4 244	15 703	3.1
Organic chemicals	9 099	9 703	2.6	Other manufactures (consumer)	13 218	13 546	2.7
Non-ferrous metals	9 262	9 517	2.6	Road vehicles other than cars (intermediate)	14 103	13 508	2.7
Miscellaneous electrical goods (intermediate)	8 915	9 038	2.4	Office machinery (capital)	13 168	13 472	2.7
General industrial machinery (capital)	8 241	8 732	2.3	Miscellaneous metal manufactures	12 610	12 463	2.5
Other manufactures (consumer)	8 679	8 634	2.3	Non-ferrous metals	10 243	12 037	2.4
Beverages	7 839	8 147	2.2	Vegetables & fruit	11 053	11 451	2.3

Table 1. 2019 UK exports and imports Data source:https://www.ons.gov.uk/

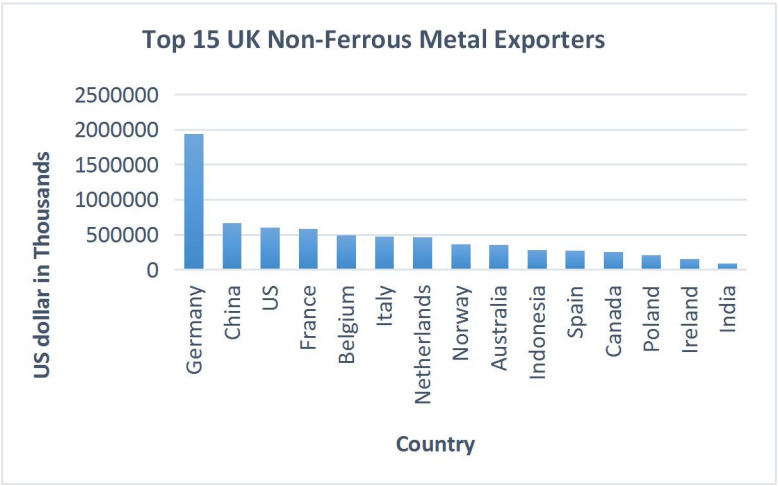

Figure 3. 2019 UK top15 non-ferrous metal exports partners

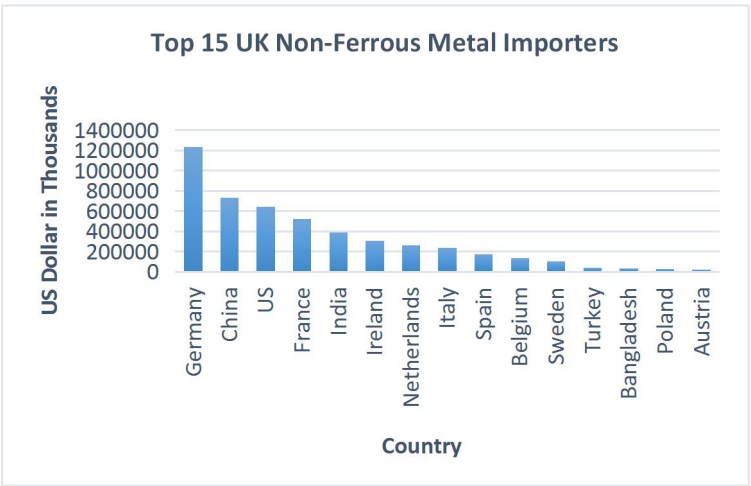

Figure 4. 2019 UK top15 non-ferrous metal imports partners

Over the past few decades, UK has been the leader for international trade, it has great shares in both importing and exporting. Figure 5 shows that UK has huge volumes of both exporting and importing, the trading Trade in nonferrous metals is in parallel with the value of the global industry. However, with the net value of exporting and importing is growing, the percentage of total world is decreasing. This is mainly due to the development stage of UK and other emerging economies. Figure 6 and 7 illustrate the dynamic evolution of UK's exports and imports volume to the world and EU. In order to reveal the factors may have an influence on nonferrous metals trade worldwide and within EU, it is essential to undertake formal empirical analysis take account of all the factors and examine to what extent they may affect the trade flow.

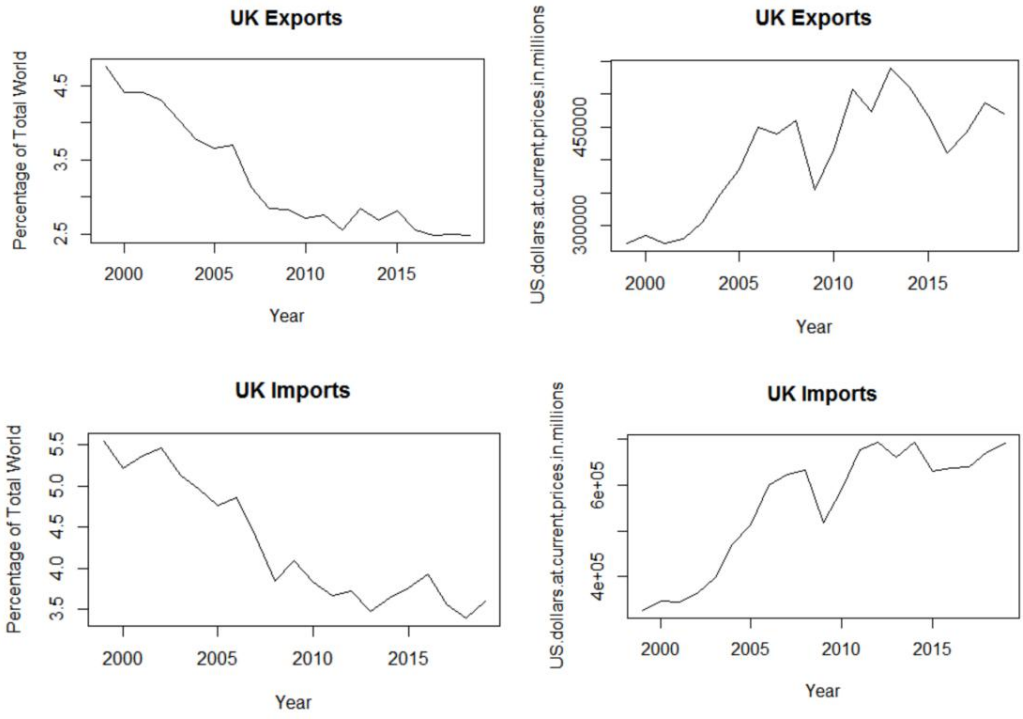

Figure 5. UK imports and exports value and percentage of world

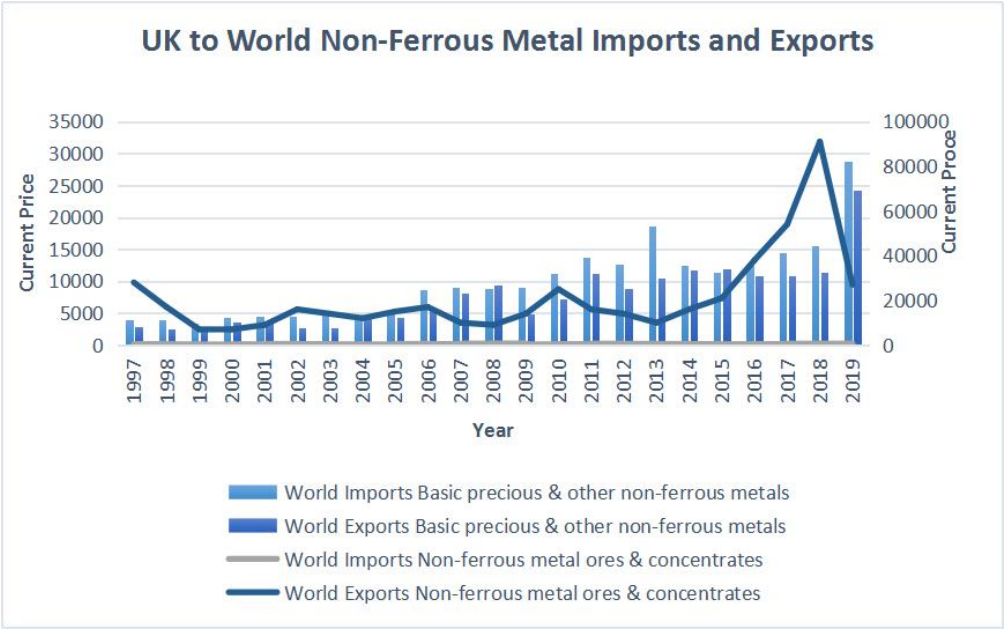

Figure 6. 2019 UK non-ferrous metals imports and exports value to the world

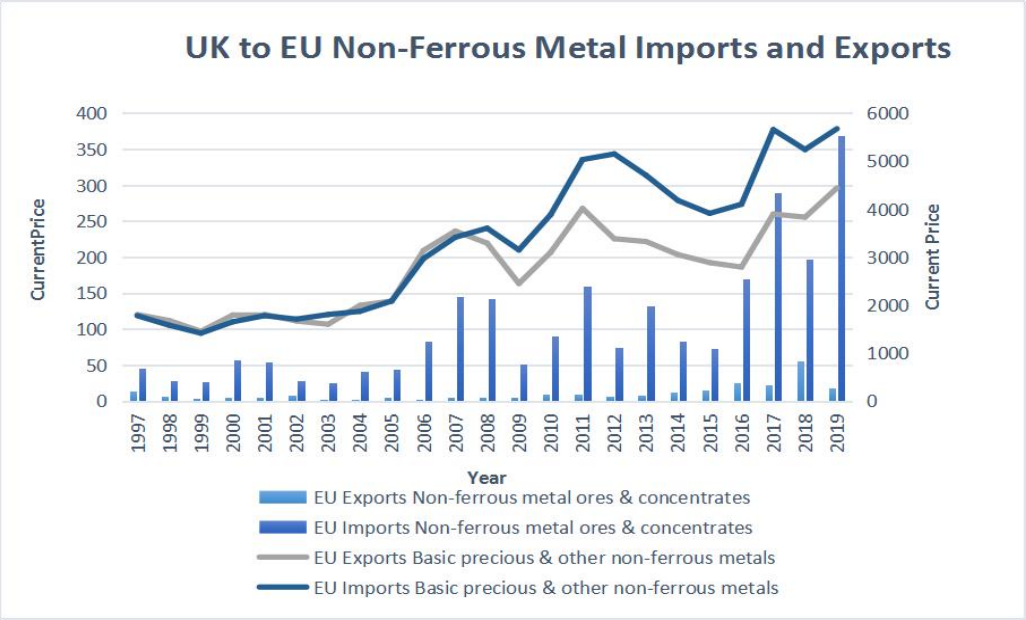

Figure 7. 2019 UK non-ferrous metals imports and exports value to EU

This article will examine the determinants of the nonferrous metal exports and imports in the UK and then give suggestions how to shape the policy to further cope with the current situations. Some of the determinants we choose to analyze the nonferrous trade,such as port development level, political risk, and so on will help to summarize problems that exists in the present development stage of the British nonferrous metal industry, port management and the international relation policy making. The results could serve as a foundation for the trading and port construction policy and contribute to the production and decision-making of companies and authorities.

Previous studies have used gravity model to analyze the determinants of international trade, Tinbergen(1962) first conceptualized this model. This model is often used in economic analysis as it can correctly modelling the bilateral trade flow(Cheng & Wall 2005; Drysdale & Xu 2004). However, researches use this model focused on the trade of metal industry is scant. Al-Rawahi and Rieber (1991) estimated the net embodied US imports of copper; Shao,Y (2015) investigated the potential energy savings of China's nonferrous metals industry; Zheng and Shao(2017) used gravity model considering several additional factors to analyze the nonferrous metal trade of China.

This paper contributes to related studies in the following aspects. First, there hasn't been any empirical study on UK's non-ferrous metals industry. This paper explores the unique patterns of UK international nonferrous metal trade flow. Secondly, this paper use the classic gravity model to analyze UK's nonferrous metal industry, except for the common factors, the political and social risks of trade partner caused by Brexit and COVID-19 pandemic, the port development levels are also included to test whether the conventional international trade theory can explain the nonferrous metals industry.

2. Literature Review

The gravity model has always been a popular method in analyzing the bilateral trade. According to Newton's Law of Universal Gravitation, any particles will attract other particle due to the force that positively proportional to the product of their masses, negatively proportional to the square of distance between them. When this law is applied to the bilateral trade flow, it implies the flow of goods is in proportional with the market size and inversely in proportional with the distance between two countries(Yotov,Y.2016).

Tinbergen (1962) applied the gravity model to study the bilateral trade flow. Anderson(1979) brought up with the theoretical economic foundation for the economic equation. The theoretical foundation is based on the assumptions of frictionless trade. Bergstand(1985) had came up with the finding that the trade volumes between two countries are proportions of the total world trade. Drysdale and Garnaut(1982) applied the relative size of a country's trade as a benchmark for what the country is expected to trade. Eaton and Kortum(2002) add the Recardian model into the work, they have derived gravity on the supply side with intermediate goods.Anderson J.E(2003) developed a method to deal with the omitted variables bias. The method they came up in this paper can consistently and efficiently estimates the gravity equation by correctly calculating the comparative statics of trade frictions. Nowadays, more and more scholars will use the gravity model to analyze the bilateral trade flow with specific focus on additional factors. For instance, Dinda.S(2013) used the gravity model to test the climate change and trade opportunity in climate smart goods in Asia.
If we collect the literature using the key words "gravity model" and "trade" in the Web of Science and select only the papers published in the economic related journals, and use the software to create the network of the co-reference. The most referenced works are shown in the centre of the graph.

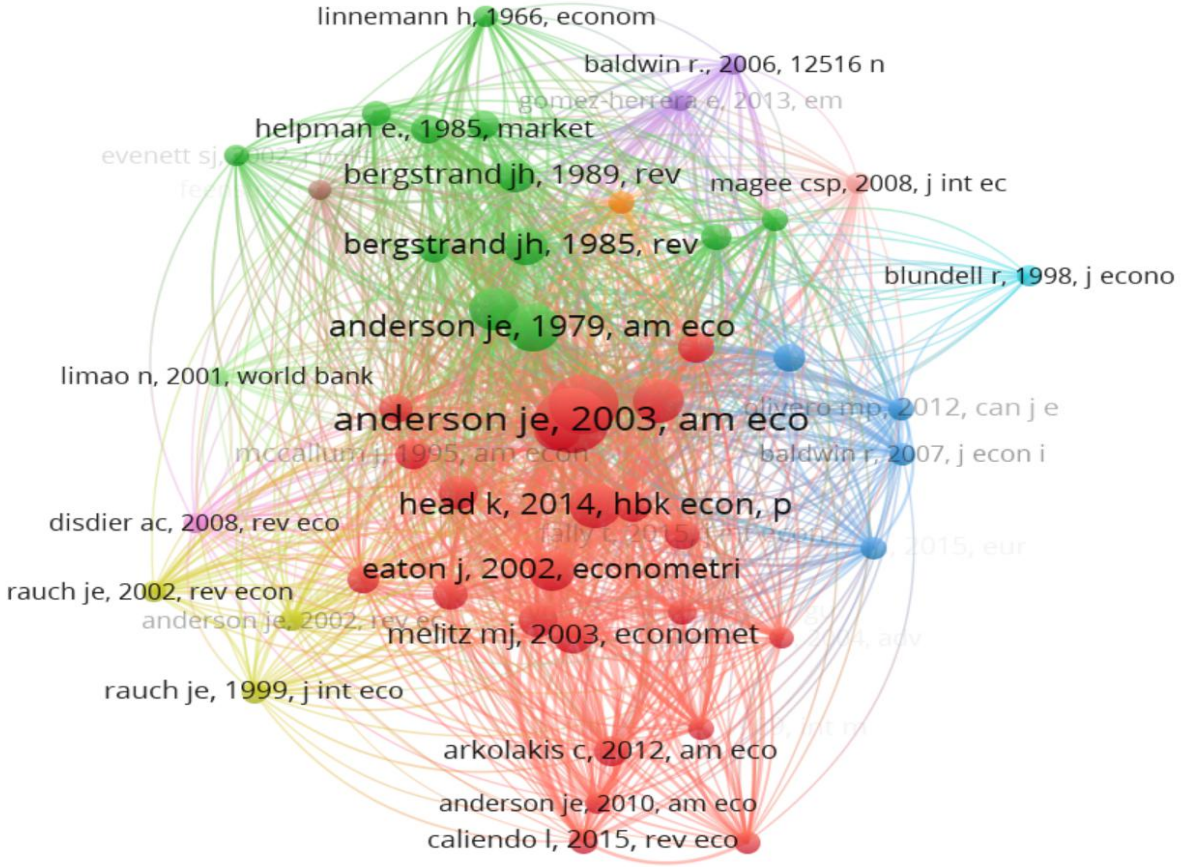

Figure.8 Co-reference Network Graph

If we create the networks of text data we will find out in the centre of the graph(shown in Fig 9), distance,trading partner, relationship are often mentioned as high-frequency words. The Europe and European Union are shown in the top of the graph, which suggests that many papers have analyzed the bilateral trade flow between European Union. Apart from that, in the green area of the graph, trade cost, reduction and tariff are often mentioned, which shows that the reduction of the trade costs and relevant words are often being analyzed.

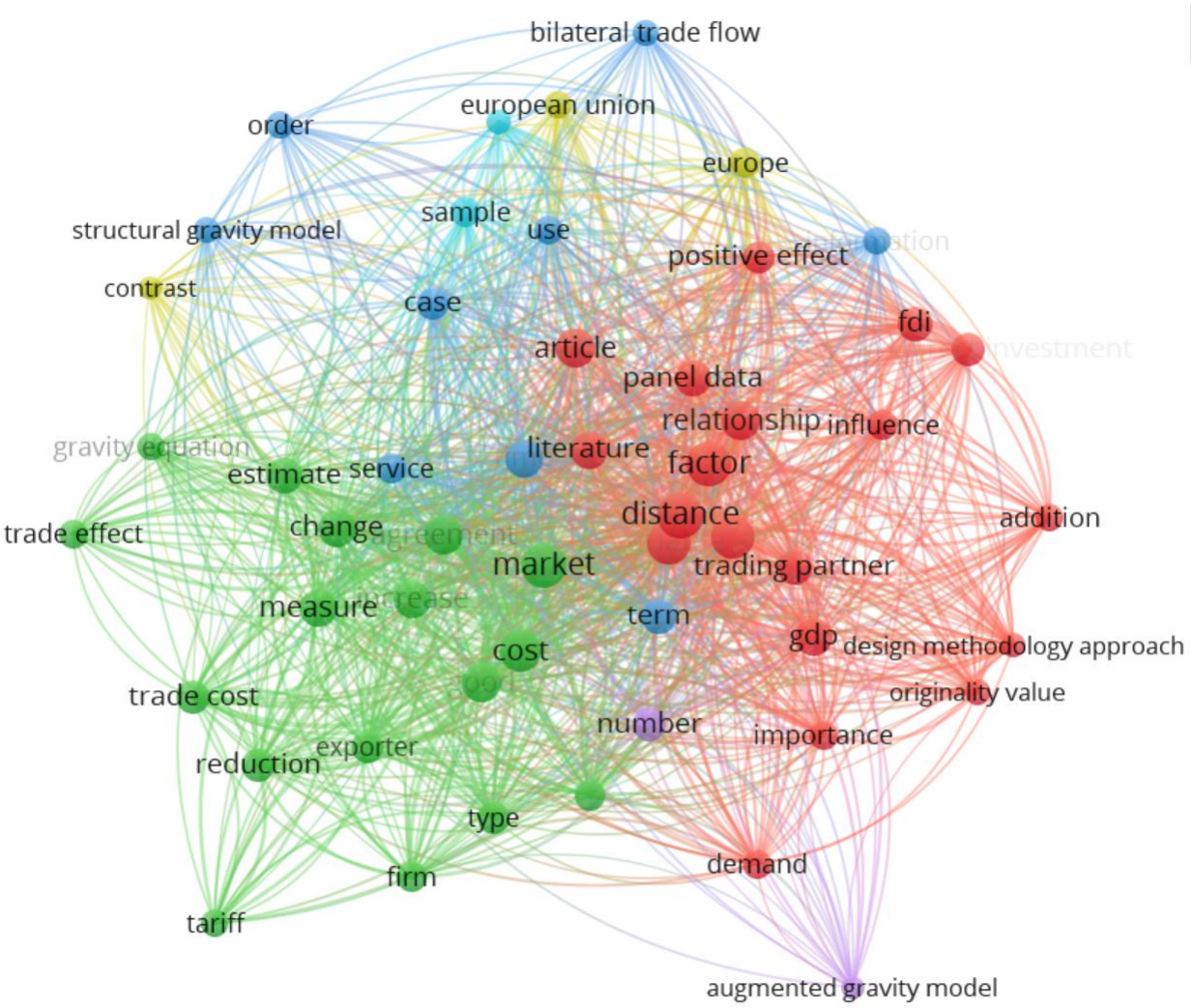

Figure.9 Text based Network Graph

3. Research Methodology

3.1 Classic Gravity model

Tinbergen (1962) pointed out empirically that international trade between two countries is determined by their relative masses and the distance between them. The gravity model has been used extensively in analyzing international trade flow since its inception. Over time the model has been used widely in explaining the determinants of trade flows, with key variables of economic size and distance.The basic form of gravity model is as follows:

$$Xij = \alpha(Yi)^{\beta_1}(Yj)^{\beta_2}(Dij)^{\beta_3}(Fij)^{\beta_4}\xi_{ij}$$

Xij denotes the movement of goods from country i to country j , α, β_1, β_2, β_3, β_4 are the parameters. $Yi(Yj)$ is the nominal gross domestic product in country (i, j) , which representing the market size of trading countries; Dij denotes the geographic distance from the economic center of country i to that of country j , representing the general trading cost; Fij is any other additional factors that affecting the trade between country i and country j . ξ_{ij} is a log-normally distributed error term with $E(\ln u_{ij}) = 0$

The conventional approach to estimating equation(1) is taking logs of both sides, and the log-log form of the equation shows as follow:

$$\ln(Xij) = \beta_0 + \beta_1 \ln(Yi) + \beta_3 \ln(Dij) + \beta_4 \ln(Fij) + \xi_{ij}$$

Where $\beta_0 = \ln\alpha, \varepsilon_{ij} = \ln\xi_{ij}, \varepsilon_{ij}$ is a random error term.

3.2 Determinants of UK international nonferrous metals trade

3.2.1 Basic factors in standard gravity models

Based on the theory of the standard gravity model, the distance between two economies and the GDP of each country need to be identified.

The common way of estimating the distance between countries is using the distance between the capital cities. However, in our case, most of the trading partners of UK are in the Europe, thus,when deciding the distance in between them, we will measure the distance between the ports. The top ten UK ports by tonnage, according to the UK Port Freight Statistics, are shown in figure 10 and 11 as follow. The tonnage of cargo type of each port can also be found in the report.

Grimsby&Immingham, London and Liverpool have relatively larger share of dry bulk cargo, these ports are the main ports we will be looking at.

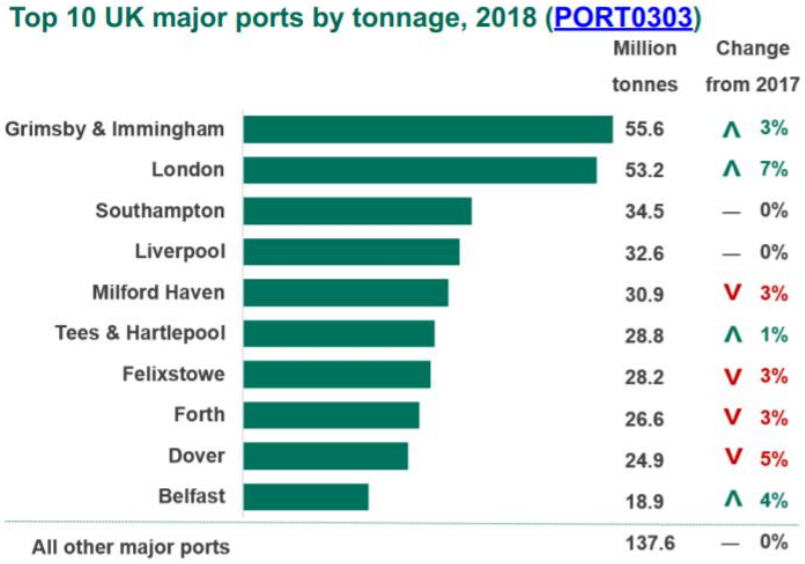

Figure 10. 2018 UK major ports by tonnage

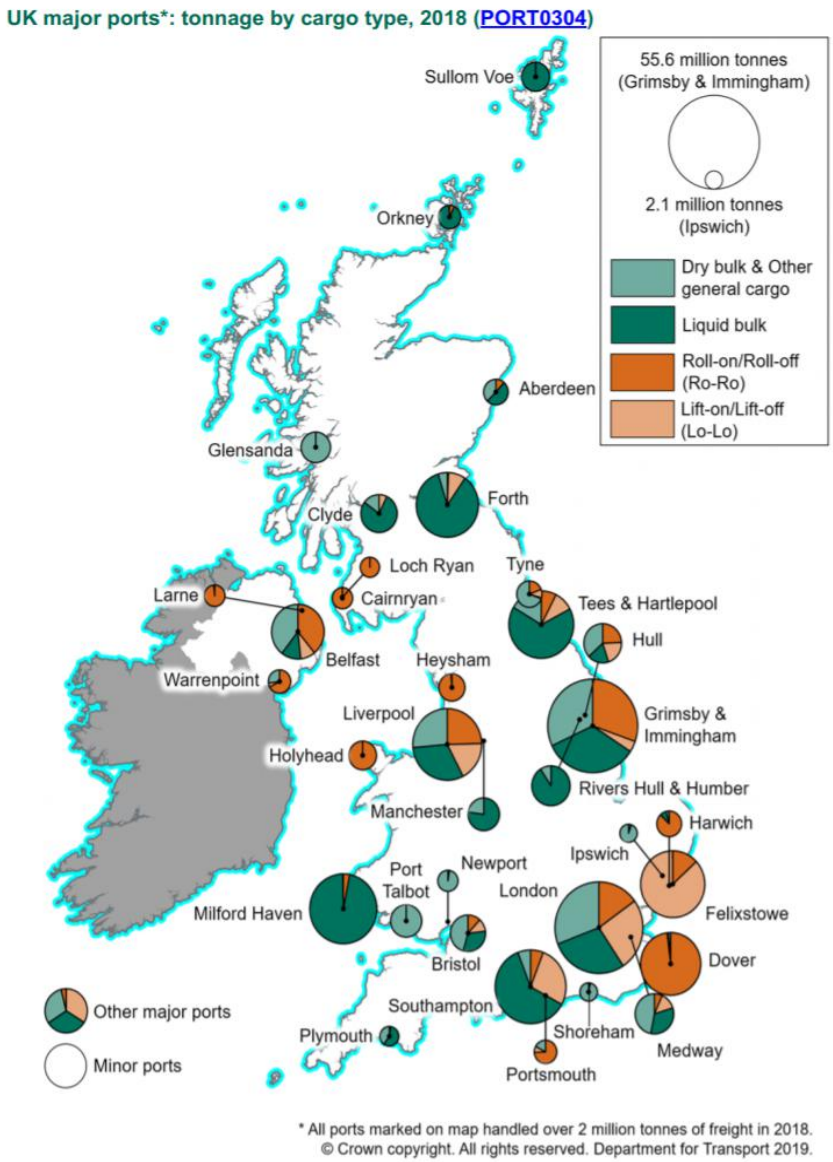

Figure 11. 2018 UK Ports Tonnage by Cargo

3.2.2 General determinants for UK international metal trade

Percentage of merchandise Trade: The percentage of export/import volume of the whole world.

Common Language: The culture similarity will affects the trade as well. Many studies have used culture similarity and common language as general determinants in their work(Zheng and Shao 2017, Dinda,S 2014,Grosso and Shepherd,2009). Common Language will be considered as a dummy variable.

Population: The population of the import/export countries, to some extent it will decide the market size.

Port development level: The port efficiency will have impact on the international shipping. Poor facilities in port will cause higher transportation costs(Wilson et al.2013)

EU Member: Most of the trading partners are located in the Europe, thus, whether a country belongs to the European Union is worth considered.

OECD Member: Whether this country is a member of OECD**.** OECD (Organization for Economic Cooperation and Development) is an intergovernmental organisation, the headquarter of which is located in Paris. The aim of this organisation is to provide a platform to identify good practice s and coordinate domestic policies and international policies. There are in total 37 members in the organization.

Percentage of Fleet: The percentage of merchant fleet by flag of registration is counted in this variable. The fleet of a country represents the maritime development level and the shipping industry.

3.3 Data and Model

The proxies for each determinant used in our empirical analysis are shown in Table 2.

The export and import volume as the dependent variables are collected from UNCAD STAT.In our empirical analysis, in total 18 countries (US,Canada,Germany,France,Italy,Netherlands,Norway,Finland,China,Australia,Japan,India,Poland, Sweden,Spain,Belgium,Greece,Turkey)are included and analyzed, these countries takes up above 50% of the non-ferrous metal trade volume, thus they are representative. . For the sample countries, the countries with no missing values during the time period 2000-2018 were chosen first. After ranking the import and export volumes in both export and import data sets,those countries appeared both in the import and export data sets with higher ranks are selected.

The distance between the countries is shown in the table 3.

Vaiables	Proxy	Unit	Expected Sign	Sources
Export/Import	Annual exports/imports of nonferrous metal of UK	Thousands of dollars		UNCAD STAT
Market Size	GDP	Millions of dollars	+	UNCAD STAT
Distance between UK	Geographic distance	Miles	-	http://www.distancefromto.net/
Merchandise Trade	Percentage of total trade value of the total world trade	%	+	UNCAD STAT
Common language	Whether English is official language		+	Wikipedia
Population of import/export countries	Population of two countries	Millions	+	UNCAD STAT
Port development level	Annual container port traffic	20 foot-TEU	+	World Bank
EU Member	Whether the country belongs to EU		+	Wikipedia
OECD Member	Whether the country belongs to OPEC		+	Wikipedia
Fleet	percentage of merchant fleet by flag of registration	%	+	UNCAD STAT

Table 2. The explanatory variable

Country	Port	Distance-mile
Australia	London-Canberra	10552.02
Belgium	London-Antwerp	196.17
Canada	Lodon-Vancouver	4710.87
China	London-Beijing	5056.77
Finland	London-Helsinki	1131.73
France	Dover-Calais	26.34
Germany	London-Hamburg	447.89
Greece	London-Athens	1486.53
India	London-New Dehli	4949.36
Italy	London-Venezia	643.97
Japan	London-Tokyo	5941.37
Netherlands	Lodon-Rotterdam	198.92
Norway	London-Oslo	716.99
Poland	Lodon-Gdansk	803.74
Spain	Lodon-Barcelona	707.09
Sweden	Lodon-Gothenburg	645.14
Turkey	London-Istanbul	1553.36
UnitedStatesofAmerica	London-NewYork	7278.7

Table 3. Distance Calculation

The panel regression models will be developed for UK nonferrous metal import and export. A fixed-effect panel model doesn't fit our data, time-constant variables such as distance is contained in our dataset. The sample size of the countries are also applicable to fixed-effect analysis. In the following analysis, random-effect(RE) model with Maximum Likelihood Estimation(MLE)will be carried out to estimate the the import and export model.
The following equations are developed for import and export models:

$$\ln \text{import}_t = c_{im} + \mu_1 \ln gdp + \mu_2 ukgdp + \mu_3 \ln distance + \mu_4 \ln per + \mu_5 \ln port + \mu_6 clang + \mu_7 eu + \mu_8 \text{oecd} + \varepsilon_{im}$$

$$\ln \text{export}_t = c_{ex} + \sigma_1 \ln gdp + \sigma_2 ukgdp + \sigma_3 \ln distance + \sigma_4 \ln per + \sigma_5 \ln port + \sigma_6 clang + \sigma_7 eu + \sigma_8 oecd + \sigma_9 pop + \varepsilon_{ex}$$

The lngdp represents the GDP of the sample countries during the time period2000-2018, the lndistance represents the natural logarithm of distance, the lnper represents the natural logarithm of percentage of the total merchandise trade volume of the world total trade,lnport represents the natural logarithm of percentage of the annual container port traffic,the eu represents whether the country belongs to European Union; clang represents whether the official language is English, OECD represents whether the country is a member of OECD.

4. Empirical Results Analysis

4.1 Non-ferrous metal Import Analysis

For the import model, we first use three basic variables to run a simple regression to test the applicability of the standard gravity model. The results are shown in table 4. The coefficient of distance and GDP is -0.2788 and 0.7736 respectively. The log of UK GDP, which the coefficient reached 0.236. The coefficients of three variables complies with our initial model,the GDP of other import countries is more sensitive comparing with other two values.The p value of log UK GDP is slightly larger than 0.1,which shows there is relatively larger chance that is variable is under the null hypothesis. However, 0.17 is still acceptable, the possible reason caused the larger p value is that the sample size is small. Overall, the gravity model doesn't work perfectly but it is acceptable for the UK non-ferrous metal import.

In the second column shows the results when adding more variables.The distance is insignificant in this results, also the relative smaller coefficient indicates that the distance between countries is less important in non-ferrous metal import of UK. The coefficient of log of GDP and UK GDP is 0.47 and 0.67 respectively, which shows that the UK GDP has more weight in the import of non-ferrous metal of UK. Other two variables---the OECD and the percentage of total merchandise trade are significant. The OECD as a dummy variable shows negative impact on the non-ferrous import of the UK, which is contradict to our initial expectation. The possible reason could be that in our samples China and India takes up large percentage of UK import while they are not members of OECD. The percentage of the trade shows positive related to the import. The import trade percentage of the world total trade reflects the openness of the country and also the market size, which is shown to be positively

related with the non-ferrous metal import.

The annual container port traffic and the percentage of merchant fleet by flag of registration are shown to be insignificant. Especially for the lnport, the coefficient shows negative coefficient.This finding suggests that the import of non-ferrous metal of UK is not related to other countries' port development level. The possible explanations could be that the non-ferrous metal as necessary resource but only takes a small percentage in the bulk cargo, the fleet and port development level doesn't have much impact on the import of the cargo as it only takes a small proportion of the bulk containerized cargo.The EU and common language variables have positive coefficients but not significant. Comparing with other insignificant variables, common language has relatively smaller p value, which indicates the import of non-ferrous metals is positively related with the similar culture. EU as another dummy variable shows insignificant, the possible explanation for this could be countries such as US, China, Canada has larger import volume and take up larger percentage in total import trade value, but not located in the Europe.

In the third column we get rid of the insignificant variables and simply adding the significant ones, the result shows that the only the basic three variables, the percentage of the total import and the OECD variables are significantly related with the import of non-ferrous metal.

Dependent variable:lnimport	RE_1	RE_2	RE_3
	Coef(p-value)	Coef(p-value)	Coef(p-value)
lnukgdp	0.2364175(0.17)	0.676645(0.002)	0.6715573(0.001)
lndis	-0.2788784(0.11)	-0.1573131(0.281)	-3092966(0.005)
lngdp	0.7736404(0.00)	0.4775039(0.00)	0.4720196(0.000)
lnport		-0.0230318(0.801)	
lnfleet		0.0148626(0.737)	
lnper		0.5479466(0.00)	0.4903617(0.001)
eu		0.3821821(0.381)	
clang		0.7216184(0.153)	0.214538(0.572)
oecd		-1.100666(0.035)	-0.8433394(0.091)
Log-likelihood	-226.30042	-211.58764	-218.33862
LR chi2	168.9	173.02	184.82

Table 4.Empirical Result of the UK non-ferrous metal analysis

***RE means Random Effect;Log-likelihood is the maximum value calculated by running MLE.**

Generally speaking, the gravity model works for the import of non-ferrous metals, but doesn't fit perfectly due to the smaller sample size. The UK GDP, GDP of other countries, the percentage of total import are significantly positive, the OECD is significantly negative. The import of non-ferrous metal has little to do with port development level and fleet. It is slightly negatively related with distance and positively related with the dummy variable EU.

The descriptive statistics of the import analysis variables are shown in table 5, correlation matrix of explanatory variables are shown in table 6.

Descriptive Statistics--Import					
Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
clang	342	0.2222222	0.4163489	0	1
eu	342	0.6111111	0.4882123	0	1
gdp	342	2342510	3694855	125706.6	2.07E+07
distance	342	2614.222	2962.857	26.34	10552.02
oecd	342	0.8888889	0.3147301	0	1
ukimport	342	352433.9	484627.3	3053.435	2626021
ukgdp	342	2530187	435192.8	1640352	3101058
import	342	3.317868	3.517123	0.2797833	18.92343
port	331	1.61E+07	3.26E+07	261419	2.26E+08
fleetper	342	1.143234	1.368561	0.0036642	6.308154
lnimport	342	11.94198	1.369654	8.024022	14.78098
lnukgdp	342	14.72682	0.191438	14.31042	14.94725
lndis	342	7.041858	1.494034	3.271089	9.264072
lngdp	342	13.89556	1.187938	11.74171	16.84474
lnport	331	15.69391	1.293131	12.47388	19.23529
lnfleet	342	-0.6494506	1.489576	-5.609132	1.841843
lnper	342	0.7293749	0.9909811	-1.27374	2.940401

Table 5. Descriptive Statistics of Import

Correlation Matrix--Import							
	lnimport	lnukgdp	lndis	lngdp	lnport	lnfleet	lnper
lnimport	1						
lnukgdp	0.196	1					
lndis	-0.12	0.0003	1				
lngdp	0.755	0.244	0.273	1			
lnport	0.597	0.154	0.268	0.8	1		
lnfleet	0.171	-0.0944	0.142	0.302	0.403	1	
lnper	0.8	0.0082	0.0439	0.879	0.811	0.229	1
eu	-0.0976	0	-0.794	-0.495	-0.456	-0.224	-0.331
clang	0.0881	0	0.334	0.196	0.18	-0.177	0.259
oecd	-0.226	0	-0.35	-0.234	-0.409	-0.324	-0.187
	eu	clang	oecd				
eu	1						
clang	-0.396	1					
oecd	0.443	0.189	1				

Table 6. The Correlation Matrix of import

4.2 Non-ferrous metal Export Analysis

Same as the import analysis, we first need to confirm the availability of the standard gravity model. The results are shown in first column of table 7. Al the variables show expected sign and thy all significant, which confirm the availability of application of standard gravity model. The coefficient of log of UK GDP and GDP is 0.84 and 0.59 respectively, indicating the UK GDP has more weight in affecting the export of non-ferrous metal. The coefficient of distance is -0.512, suggests that the export of non-ferrous metals is negatively related with distance.

In the second column of the table, we add more explanatory variables. The UKGDP,GDP, the percentage of import and the EU are significant. This results suggests that the export of non-ferrous metal is closely related with whether the country is member of the EU. UK used to play an important role in the European Union, EU is the largest trade partner with UK. According to statistics, in 2019,the exports volume of UK to the EU were £300 billion, account for 43% of all UK exports. The import reached £372 billion, account for 51% of all UK imports(commonslibrary.parliament.uk, 2020). The customs unions, free trade agreement and economic unions within EU have significantly improved the trades between memberships.
The coefficient of EU reached 1.565, which has greatest impact on the export of non ferrous metal. However, after Brexit in 2019, the trade agreements will need re-negotiation. In the second column we can see that the distance as a major variable is no longer significant, and the coefficient is a very small negative figure. The possible explanation could be that within the EU, the distance doesn't make any huge differences.The transportation costs won't variant within a certain range of distance. As for other important export countries, possibly the transportation costs can be covered by the profits of large volume of export.

Dependent variable:lnexport	RE_1 Coef(p-value)	RE_2 Coef(p-value)	RE_3 Coef(p-value)
lnukgdp	0.84701(0.000)	1.009602(0.000)	0.9551066(0.000)
lndis	-0.51282(0.000)	-0.0044888(0.972)	-0.2780335(0.019)
lngdp	0.58889(0.000)	0.4101575(0.001)	0.4222414(0.001)
lnpop		-0.1717664(0.296)	-0.4603422(0.006)
lnport		0.123421(0.194)	0.1749715(0.075)
lnfleet		-0.0134428(0.753)	-0.0146982(0.746)
lnper		0.364859(0.003)	0.3539252(0.006)
oecd		0.2999857(0.611)	0.0489724(0.947)
clang		0.0935763(0.784)	-0.3618051(0.358)
eu		1.56521(0.002)	
_cons	-4.740283(0.028)	-9.813193(0.006)	-3.670513(0.264)
Log likelihood	-235.55282	-212.76213	-216.27214
LR chi 2	193.05	215.53	208.51

Table 7.Results of UK non-ferrous metal export analysis

If we run again the regression without the variable EU,which the results are shown in the third

column, the distance became significant again with expected negative sign. The percentage of the export remains significantly positive, the population, port development level became significant. This result suggests that if EU is no longer considered as a significant variable, the distance is still significantly negative related with the export, which further confirms our explanation above.
The population is negatively related with the export of the non-ferrous metal. This is contradict with our expectation. The population doesn't necessarily related with the market size of the country. In the sample we choose, except for the EU countries, developed countries such as Canada, US, Australia, might have larger export market size than developing countries such as China, India with large population. The port development level is significant and positively related with the export of the non-ferrous metal, which suggests that in worldwide, the port development level is still closely related with the export of the non-ferrous.

In both analysis, the common language, fleet and OECD shows insignificant. The reasons for why common language is insignificant is that within the EU, there are multiple languages, whether speaking the same language doesn't affect the exportation of non-ferrous metal, the EU is still the biggest trade partner of UK.

The descriptive statistics of the export analysis variables are shown in table 8, correlation matrix of explanatory variables are shown in table 9.

Descriptive Statistics--export					
Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
code	342	9.5	5.195729	1	18
year	342	2009	5.485251	2000	2018
pop	342	193576.3	394590.6	4499	1427648
clang	342	0.2222222	0.4163489	0	1
eu	342	0.6111111	0.4882123	0	1
gdp	342	2342510	3694855	125706.6	2.07E+07
distance	342	2614.222	2962.857	26.34	10552.02
oecd	342	0.8888889	0.3147301	0	1
ukexport	342	403620.9	510062	7504	3132597
ukgdp	342	2530187	435192.8	1640352	3101058
per	342	3.175633	3.040846	0.1602186	13.73224
port	331	1.61E+07	3.26E+07	261419	2.26E+08
fleetper	342	1.143234	1.368561	0.0036642	6.308154
lnexport	342	12.30522	1.176036	8.923191	14.95737
lnukgdp	342	14.72682	0.191438	14.31042	14.94725
lndis	342	7.041858	1.494034	3.271089	9.264072
lngdp	342	13.89556	1.187938	11.74171	16.84474
lnpop	342	10.7379	1.595354	8.411611	14.17154
lnper	342	0.6677631	1.065479	-1.831216	2.619746
lnport	331	15.69391	1.293131	12.47388	19.23529
lnfleet	342	-0.6494506	1.489576	-5.609132	1.841843

Table 8. Descriptive Statistics of export

Correlation Matrix--Export							
	lnexport	lnpop	lnukgdp	lndis	lngdp	lnport	lnfleet
lnexport	1						
lnpop	-0.131	1					
lnukgdp	0.283	0.0166	1				
lndis	-0.492	0.401	0.0003	1			
lngdp	0.325	0.718	0.244	0.273	1		
lnport	0.198	0.71	0.154	0.268	0.8	1	
lnfleet	-0.045	0.336	-0.0944	0.142	0.302	0.403	1
lnper	0.477	0.541	-0.0033	-0.02	0.815	0.748	0.17
eu	0.477	-0.641	0	-0.794	-0.495	-0.456	-0.224
clang	-0.0151	-0.0511	0	0.334	0.196	0.18	-0.177
oecd	0.345	-0.738	0	-0.35	-0.234	-0.409	-0.324
	lnper	eu	clang	oecd			
lnper	1						
eu	-0.251	1					
clang	0.221	-0.396	1				
oecd	-0.167	0.443	0.189	1			

Table 7. Correlation Matrix of Export

Table 9. The correlation matrix of export

5. Conclusion

This work is the first work using the gravity model to investigate the import and export of the non-ferrous metal. The purpose of this work is to analyze to what extent the gravity model can explain the import and export of non-ferrous metal of UK, and how different variables effects the trade flow. We have used the panel data consisting 18 countries for the period of 2000-2018.

First of all, the regression of classic gravity model confirms its applicability. It might not fit perfect ly with the import of non-ferrous metal as the P value of UK GDP is slightly larger, however, it is still acceptable. The above analysis of the UK import and export of non-ferrous metal we can conclude that the percentage of the total trade of countries is a crucial determinant. For the import of non-ferrous metal,after adding additional variables, we can tell that the OECD as a dummy variable is significantly negative related with the import trade flow. Other variables seems not making a huge impact on the import of the non-ferrous metal of UK.

In terms of the export of the non-ferrous metal, the EU is an important variable in determining the export trade flow. Within the EU, distance is no longer a critical factor in the model. After exclude this variable, the population and port become significant. The population shows negatively related to the export trade flow, while the port development level is positively related to the export of non-ferrous metal of the UK.

The empirical results suggests several implications for the development of UK nonferrous industry. Firstly, the import of the non-ferrous metal is heavily related to the import trade percentage, other factors seem insignificant to the results. This implies that probably the import of the non-ferrous metal is largely dependent on the ore resources. In our sample data set, the countries have large percentage of the ore resources also ranked higher in the percentage of total import trade. Secondly, for the export analysis, the fact that the distance is not significant when EU is considered as a variable. This shows that the transportation costs of exporting within non-ferrous metal export doesn't variant a lot within Europe. The port development level became significant in the worldwide, whereas within the Europe, the port development level is less significant. The main reason could be that most countries we choose in the Europe are developed country and has relative developed port infrastructure and facilities. The importer located outside Europe will need to develop their port facilities to enlarge the volume of non-ferrous metal from the UK.

With the Brexit, unsettled trade agreements between UK and the EU might change the situation of non-ferrous metal trade. Due to the impact of the COVID-19 pandemic impact, the dry bulk sector is experiencing a tough stage. The average earning down 24% y-o-y in this year so far. However, for iron ore, China imports expand while other demands contracts. The demand for non-ferrous metal in many countries has been severely impacted. Taking India as an example, the ICRA reported that in2020, the consumption of non-ferrous metal will contract from 3-4 percent for copper and zinc and the aluminum is up to 8%(Financial Express,2020). For the UK, the export of non-ferrous metal will inevitably affected by the pandemic, the risk factors of import and border check of export will become more and more strict. The transportation costs of non-ferrous metal will increase as a result of restriction of transportation.

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