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Double Diamond Analysis on the Determinants of Global Competitiveness of Manufacturing Industry – Focusing on High-Tech, ICT and Automotive Sectors

더블 다이아몬드 모델을 통한 제조산업 국제경쟁력의 결정요인 연구 – 하이테크, ICT, 자동차산업을 중심으로

2012年 **8**月

서울大學校 國際大學院

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Double Diamond Analysis on the Determinants of Global Competitiveness of Manufacturing Industry – Focusing on High-Tech, ICT and Automotive Sectors

Thesis by

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Graduate program in International Area Studies

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Double Diamond Analysis on the Determinants of Global Competitiveness of Manufacturing Industry – Focusing on High-Tech, ICT and Automotive Sectors

ABSTRACT

The manufacturing industry has been considered as the main engine of growth since the late 18th century. After the recent financial crisis, the importance of manufacturing industries has resurged. To find out the determinants of global competitiveness of manufacturing industry, many attempts have been made by the scholars and economists. However, not many studies have accounted for the impact of changing conditions in neighboring countries in addition to the more conventional home country's domestic conditions. This paper brings together the ideas of domestic competitiveness and global competitiveness of the manufacturing industry focusing on high-tech, ICT and automotive sectors. To find out the determinants, the modified double diamond model is used as a key tool to carry on the panel regression analysis.

According to the results, each industry's determinants of competitiveness appear to be different. In particular, the impact from neighboring countries turned out to be very distinct. The high-tech industry is affected by neighboring countries' GDP

while the ICT industry is affected by neighboring countries' industrial competitiveness, GDP and business start-up cost. The case of the automotive shows a strong correlation with neighboring countries' conditions due to being affected by neighboring countries' industrial competitiveness, GDP, GDP per capita, tertiary education and internet users.

The result implies that the determinants of competitiveness are different from industry to industry. Thus, strategies to enhance competitiveness should be respectively designed considering neighboring countries' conditions and carried out for each industry.

Compared to the previous studies, this study is worthy of investigation since it tries to identify what kind of impact neighboring countries have on the competitiveness of home country's industries. While this study limits the scope to arguably the three most important manufacturing industries – High Tech, ICT and Automotive, the same method could be applied to investigate determinants of competitiveness of other manufacturing industries. Moreover, this study's unique feature of accounting for the impact from other countries could be further developed to identify industrial characteristics of each region.

Keywords: double diamond model, global competitiveness, manufacturing industry, global production sharing, neighboring countries

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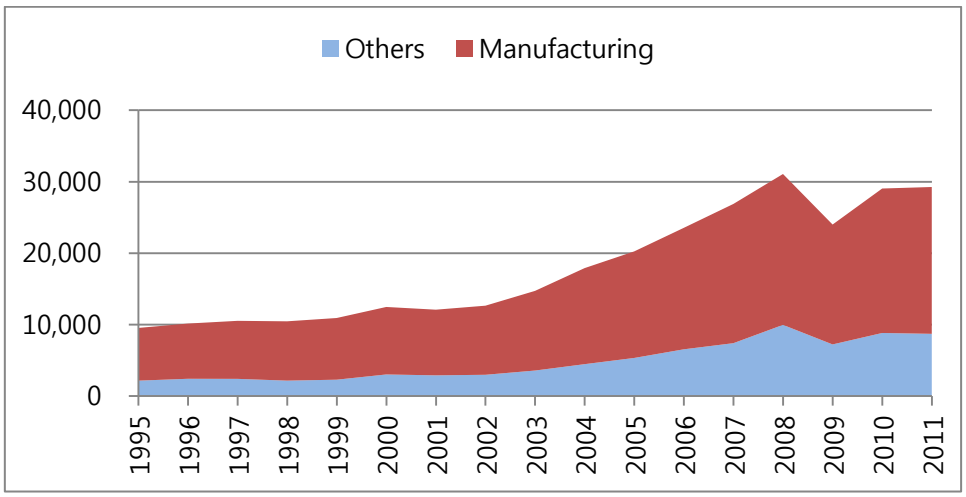
I. Introduction

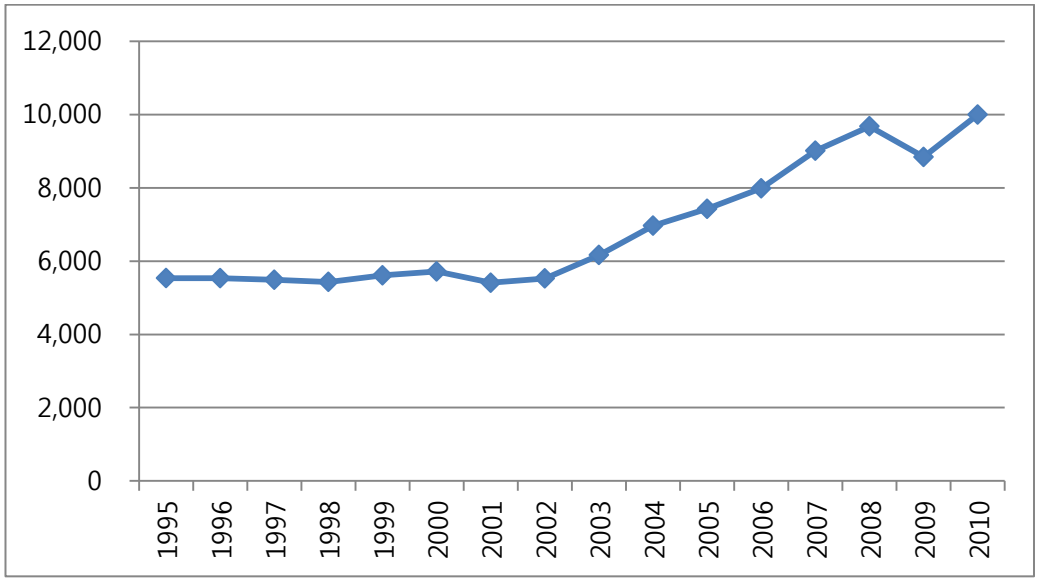
The manufacturing industry has been considered as the main engine of growth since the late 18th century. Manufacturing industry drives R&D and innovations and creates direct and indirect jobs. Some scholars such as Fagerberg and Verspagen, (1999, 2002, 2007); Timmer and de Vries(2007), Szirmai (2009) empirically tested the correlation between the manufacturing industry and the economic development. The importance of manufacturing industries has resurged after the recent financial crisis. The share of manufacturing goods in world export is dominant (see Figure 1) and the value added of manufacturing is increasing (see Figure 2).

<Figure 1> World Export Trade Value Composition (Unit: billion US$)



Source: UN Comtrade (SITC Rev.3, 1 Digit)

<Figure 2> Manufacturing, Value Added (Unit: billion US$)



Source: World Bank

With the globalization in the latter half of the twentieth century, the topics of industrial global competitiveness have become the main interest of public policy makers, business executives, and scholars in recent years. Especially, the export has been regarded as another motor of economic growth. Against this backdrop, this thesis aims to identify the determinants of manufacturing industry's global competitiveness which can be measured as Revealed Comparative Advantage (RCA).

This paper lies on the hypothesis that not only the domestic components but also neighboring countries' components are the key determinants of global competitiveness of a country's manufacturing industry. In so doing, the modified

forms of Double Diamond Model and both the domestic and global determinants will be empirically tested. This paper brings together the ideas of domestic competitiveness and global competitiveness of the manufacturing industry focusing on high-tech, ICT and automotive sectors. High-tech industries develop many products and processes with high R&D contents, and thus are regarded as industries that innovate (Fagerberg, 1995). ICT and automotive industries are spreading rapidly in developing countries and leading the Global Production Network (Lall et al. 2004).

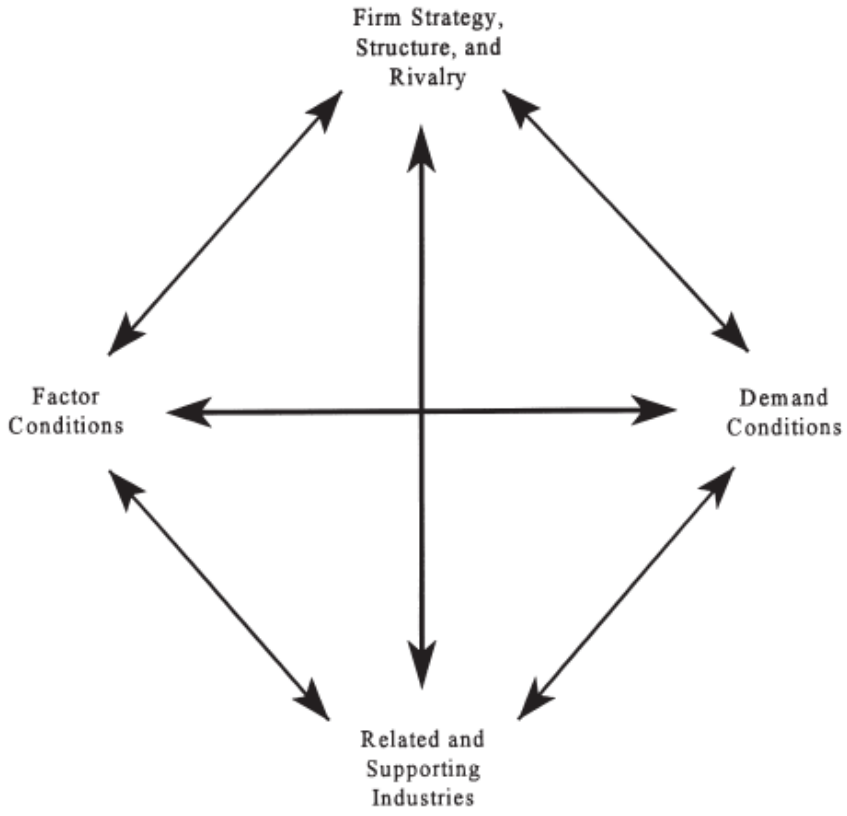
II. Literature Review

1. National Competitiveness theories

To analyze the determinants of global competitiveness of high-tech, ICT and automotive industries, this thesis adopts the Double Diamond Model as a key tool. Double Diamond Model is based on Porter's (1990) diamond model which analyzed the determinants of competitiveness of a nation or an industry through four components: factor conditions, demand conditions, firm strategy structure and rivalry, and related and supporting industries. (See Figure 3)

Porter's original diamond model explains the dynamism of national competitiveness and dimensions which the other traditional international trade theories do not consider. However, this single diamond model only considers domestic components thus failing to explain the effects of multinational activities.

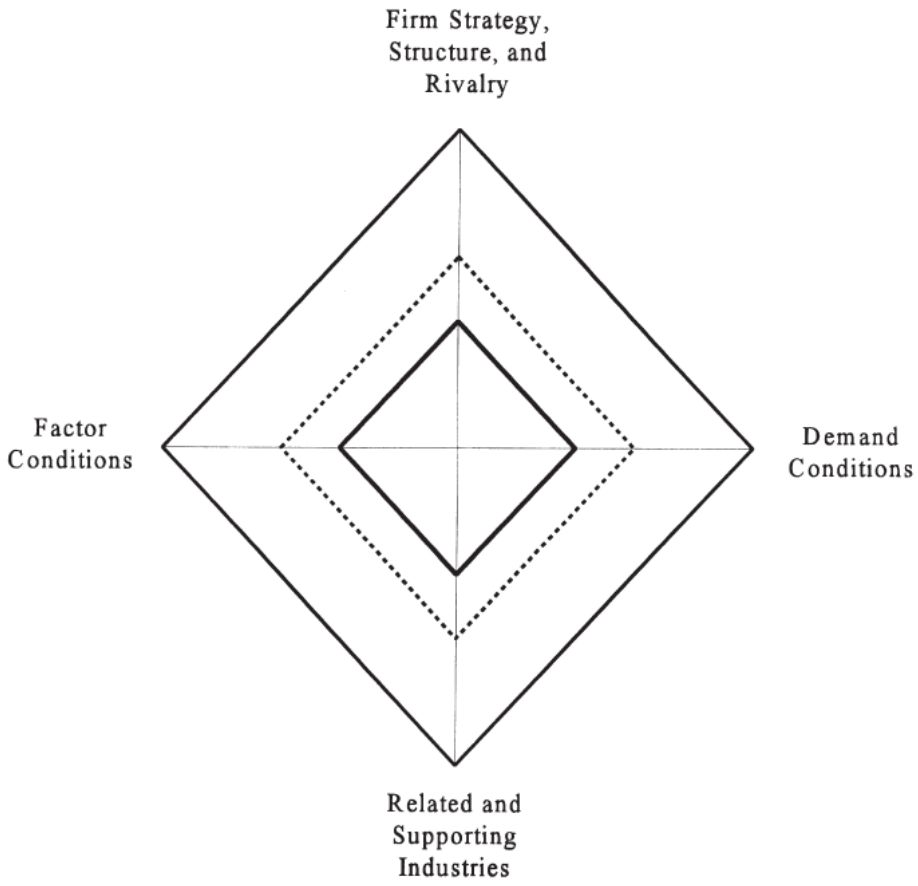
<Figure 3> The Home-based Single Diamond Model (Porter, 1990)



To integrate international dimensions, Rugman and D'Cruz (1993) modified the single diamond model and initiated the double diamond model. Based on double diamond model, Moon, Rugman and Verbeke (1995) developed the generalized double diamond including their international components. (See Figure 4) In this model, the single diamond model is extended into international dimension by the inclusion of multinational activities, inbound and outbound FDI.[1]

[1] Moon et al. (1998)

<Figure 4> The Generalized Double Diamond Model (Moon et al. 1998)



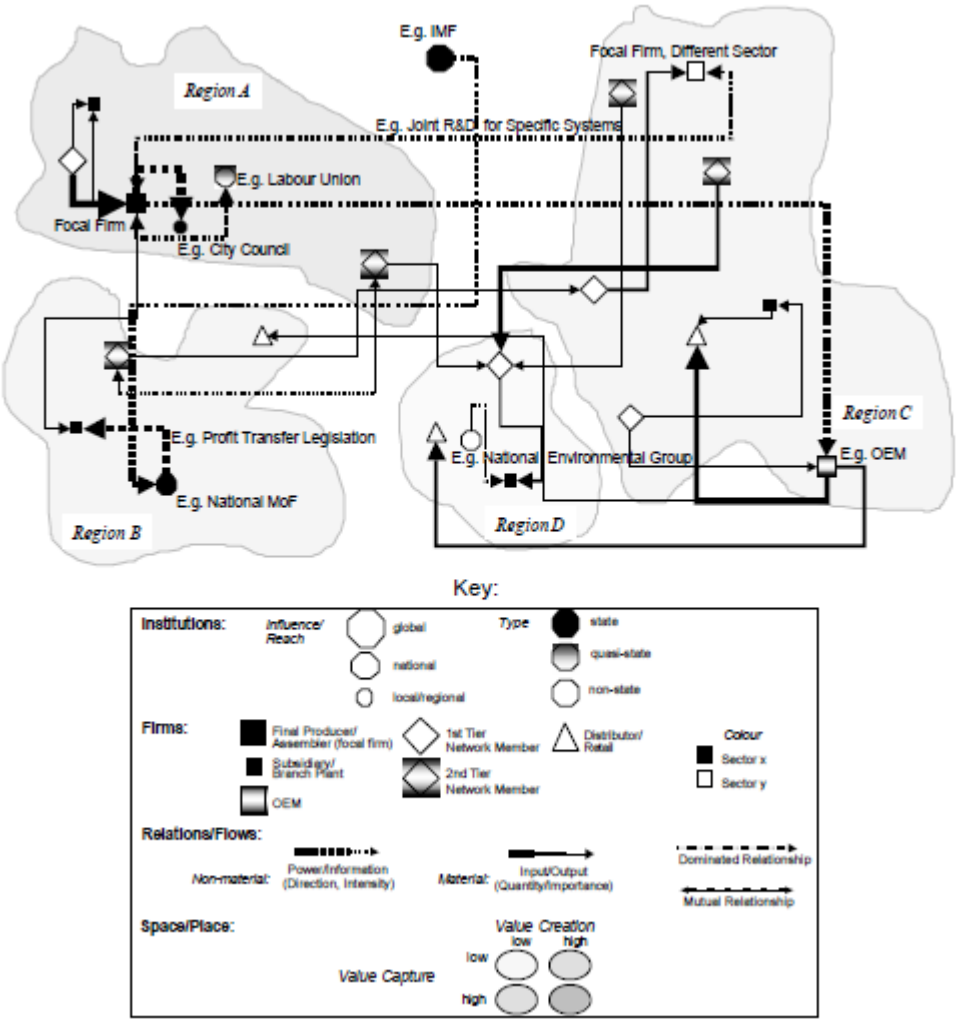
2. Theories on the Impact of Other Countries

Although the generalized double diamond model explains important determinants of competitiveness, it does not explain the impact from neighboring countries. This thesis lies on the hypothesis that not only a country's domestic

components but also its neighboring countries' domestic components would have impact as determinants on the country's industry.

Since the globalization accelerated the mobility of factors and trade, the firms and countries participate in the Global Production Sharing, which is formed through intra-industry trade. This concept was developed by Feenstra and Hanson(1996, 2001). Also the Global Production Network by Ernst and Kim (2002) shows the similar concept as a network which combines 'concentrated dispersion of the value chain across firm and national boundaries, with a parallel process of integration of hierarchical layers of network participants'.(See Figure 5)

<Figure 5> Mapping Global Production Networks: a stylized example (Handerson et al., 2002)



The gravity model also considers other countries' impact by factoring in bilateral distances between countries. Originated from the Newton's 'Law of Universal Gravitation', this model was first used by Tinbergen(1962) to predict the trade flow

between two countries and later theoretically justified by Linnemann (1966), Anderson (1979), and Deardorff (1998).[2]

$$F_{ij} = G\frac{M_i^{\alpha} M_j^{\beta}}{D_{ij}^{\theta}}$$

In this equation, Fij is the flow from i to j where M's are measure of economic mass and D is the distance between i and j. The equation with logarithm is as below:

$$\ln F_{ij} = R + \alpha \ln M_i + \beta \ln M_j - \theta \ln D_{ij} + \varepsilon_{ij}$$

For this study, I empirically test the Double Diamond Model using panel data analysis with modifications to integrate the neighboring countries' domestic components as a country's international components.

[2] Lewer and Van den Berg, (2008)

III. Methods

1. Explanation of the Variables

1.1 Dependent Variable

The dependent variable is revealed comparative advantage (RCA). RCA, first suggested by Balassa(1965), indicates whether a country has competitiveness for certain products and can be calculated as follows:

$$RCA_j = (X_{ij}/X_{tj}) / (W_{wj}/W_w)$$

The numerator represents the share of a good j in the exports of a country i, and the denominator indicates the contribution of the good j in global trade. The RCA ranges from 0 to infinity and above unity index is regarded as having revealed comparative advantage in exporting the good j. Trade data used in the calculation of indices is from United Nations Commodity Trade Statistics Database. The product codes for high-tech, ICT, automotive industries are as below.

<Table 1> High-tech Sector Code (SITC Rev.3)

511	554	752
512	562	759
513	571	761
514	572	762
515	573	763
516	574	764
522	575	776
523	579	792
524	581	871
525	582	872
531	583	873
532	591	874
533	592	881
541	593	882
542	597	883
551	598	884
553	751	885

Source: UNCTAD STAT Classification, SITC rev.3 products, manufactured goods by degree of manufacturing groupings (Manufactures with high skill and technology intensity)

<Table 2> ICT Sector Code (SITC Rev.3)

76381	7642	773
72655	7643	776
75	76482	7786
761	76483	8713
762	76491	873
763	7722	874
7641	7723	87469

Source: ICT definition by OECD (1998), Code conversion from SITI to SITC by Kegels et al. (2002)

<Table 3> Automotive Sector Code (SITC Rev.3)

7132	77835	78434
71382	784	78435
7139	7841	78436
74419	7842	78439
7783	7843	781
77831	78431	782
77833	78432	783
77834	78433	

Source: Based on parts and components codes classified by Belazquez (2010), completely built unit codes are added

1.2 Factor Condition

According to Porter (1990), the factor conditions for production are the inputs necessary to compete and can be categorized as human resources, physical resources, knowledge resources, capital resources and infrastructure. In this thesis, GDP per capita (current US$) and tertiary school enrollment (% gross) data from World Bank are used as factor determinants. GDP per capita here represents the level of wage and the tertiary school enrollment represents the level of education and the quality of labor in a country.

1.2.1. Domestic Factor Condition: GDPPCi, TERi

The country i's domestic factor conditions are demonstrated as GDPPCi and

TERi which represent GDP per capita in current USD and tertiary gross enrollment ratio of country i respectively.

1.2.2 International Factor Condition: NGDPPCi, NTERi

NGDPPCi stands neighboring countries' average GDP per capita of country i in current US dollar. It is calculated as below:

$$\mathrm{NGDPPCi} = \frac{\sum_{j=1}^{n} \frac{\mathrm{GDPPCj}}{\mathrm{Dij}}}{\mathrm{N}}$$

In this equation, GDPPCj is neighboring country j's GDP per capita and Dij is the distance[3] between country i and j.

NTERi is neighboring countries' average tertiary gross enrollment ratio of country i and is calculated as below:

$$\mathrm{NTERi} = \frac{\sum_{j=1}^{n} \frac{\mathrm{TERj}}{\mathrm{Dij}}}{\mathrm{N}}$$

TERj is neighboring country j's tertiary gross enrollment ratio and Dij is the distance between country i and j.

[3] Distance from country i to country j is distance from capital city to capital city. The data is from International Trade Data (http://www.macalester.edu/research/economics/PAGE/HAVEMAN/Trade.Resources/TradeData.html). However, the distances among countries sharing borders are unified as 4, which is the shortest distance data from capital city to capital city(Congo and Democratic Republic of the Congo)

1.3 Demand Condition

Demand condition here refers to 'home demand condition'. Porter (1990) explains that three broad attributes are significant in home demand. The three attributes are 'the composition (or nature of buyer needs), the size and pattern of growth of home demand, and the mechanisms by which the nation's domestic preferences are transmitted to foreign market'. For this thesis, GDP (current US$) data from World Bank is used for the determinants of demand condition which explains the market size of a country.

1.3.1. Domestic Demand Condition: GDPi

The country i's domestic demand condition is GDPi in current USD.

1.3.2 International Demand Condition: NGDPi

NGDPi stands neighboring countries' average GDP of country i in current US dollar. It is calculated as below:

$$\mathrm{NGDPi} = \frac{\sum_{j=1}^{n} \frac{\mathrm{GDPj}}{\mathrm{Dij}}}{\mathrm{N}}$$

GDPj is neighboring country j's GDP and Dij is the distance between country i and j.

1.4 Related and Supporting Industry Condition

The third determinant of national advantage in Diamond Model is related and supporting industries. The competitive related and supporting industries enable industries to access inputs efficiently, early, rapidly, and preferentially. (Porter, 1990). In this study, 'internet users per 100 people' data from World Bank is used as related and supporting industries variable to measure the level of worldwide network industry.

1.4.1. Domestic Related and Supporting Industry Condition: Ii

The country i's domestic related and supporting industry condition is Ii, which represents the internet users per 100 people in country i.

1.4.2 International Related and Supporting Industry Condition: NIi

NIi is neighboring countries' average level of domestic related and supporting industry condition of country i. The calculation is as below:

$$NIi = \frac{\sum_{j=1}^{n} \frac{Ij}{Dij}}{N}$$

Ij is neighboring country j's internet users per 100 people and Dij is the distance between country i and j.

1.5 Firm Strategy, Structure, and Rivalry Condition

The last determinant of Diamond Model is the ‘context in which firms are created, organized and managed as well as the nature of domestic rivalry’(Porter, 1990). The cost of business start-up procedures (% of GNI per capita) is used as the determinant of this condition(Source: World Bank). According to the definition of World Bank, the cost of business start-up procedures is the cost to register a business normalized in a percentage of gross national income (GNI) per capita.

1.5.1. Domestic Firm Strategy, Structure, and Rivalry Condition: BSTCi

The country i’s domestic firm strategy, structure, and rivalry condition is BSTCi, which represents the cost of business start-up procedures (% of GNI per capita) in country i.

1.5.2 International Firm Strategy, Structure, and Rivalry Condition: NBSTCi

NBSTCi is neighboring countries' average level of domestic firm strategy, structure, and rivalry condition of country i. The calculation is as below:

$$\mathrm{NBSTCi} = \frac{\sum_{j=1}^{n} \frac{\mathrm{BSTCj}}{\mathrm{Dij}}}{\mathrm{N}}$$

Ij is neighboring country j's cost of business start-up procedures (% of GNI per capita) and Dij is the distance between country i and j.

1.6 Other Variable

In this thesis, the impact of neighboring country's RCA will be included as variable based on the hypothesis that a country's competitiveness of an industry will be affected by the neighboring country's level of competitiveness in the same industry.

The neighboring countries' RCA will be represented as NRCAi and the equation for this variable is as below:

$$\mathrm{NRCAi} = \frac{\sum_{j=1}^{n} \frac{\mathrm{RCAj}}{\mathrm{Dij}}}{\mathrm{N}}$$

RCAj is neighboring country j's RCA and Dij is the distance between country i and j. RCA is calculated by author's own calculation with the data from UN Comtrade.

2. Modeling

In this thesis, I did panel data analysis with E-views7 to identify the determinants of global competitiveness of manufacturing industry. Based on the hypothesis, the following three equations are created to carry out the tests.

$$(1)\ RCA_i = \beta_0 + \beta_1 \cdot GDP_i + \beta_2 \cdot GDPPC_i + \beta_3 \cdot TER_i + \beta_4 \cdot I_i + \beta_5 \cdot BSTC_i + \varepsilon$$

The first equation tests only the domestic conditions as the determinants of revealed comparative advantage of country i.

$$(2)\ RCA_i = \beta_0 + \beta_1 \cdot GDP_i + \beta_2 \cdot GDPPC_i + \beta_3 \cdot TER_i + \beta_4 \cdot I_i + \beta_5 \cdot BSTC_i + \beta_6 \cdot NRCA_i + \varepsilon$$

The second equation tests the domestic conditions and the neighboring country's revealed comparative advantage as the determinants of RCA of country i.

$$
\begin{aligned}
(3)\ RCA_i = {} & \beta_0 + \beta_1 \cdot GDP_i \\
& + \beta_2 \cdot GDPPC_i \\
& + \beta_3 \cdot TER_i \\
& + \beta_4 \cdot I_i \\
& + \beta_5 \cdot BSTC_i \\
& + \beta_6 \cdot NGDP_i \\
& + \beta_7 \cdot NGDPPC_i \\
& + \beta_8 \cdot NTER_i \\
& + \beta_9 \cdot NI_i \\
& + \beta_{10} \cdot NBSTC_i + \varepsilon
\end{aligned}
$$

The third equation tests the domestic conditions and the neighboring countries' domestic conditions as the determinants of revealed comparative advantage of country i.

IV. Empirical Results

1. High-tech Industry

<Table 4> Empirical Results of High-tech Industry (1), Coefficient and t Value

HT	OLS			Period Fixed		
	1	2	3	1	2	3
GDP	0.000	0.000	0.000	0.000	0.000	0.000
	3.346***	3.364***	2.719***	3.566***	3.584***	2.864***
GDPPC	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	-1.541	-1.647	-1.824*	-2.127**	-2.246**	-2.260**
I100	0.011	0.011	0.011	0.013	0.013	0.012
	5.555***	5.624***	5.306***	6.150***	6.235***	5.750***
TER	-0.001	-0.001	0.001	-0.002	-0.002	0.000
	-0.455	-0.713	0.564	-1.229	-1.488	-0.169
BSTC	-0.001	-0.001	-0.001	0.000	-0.001	-0.001
	-3.712	-3.592	-2.748***	-2.127**	-3.945***	-2.977***
N_HT_RCA		9.888			10.537	
		1.258			1.342	
NGDP			0.000			0.000
			4.692***			4.544***
NGDPPC			0.000			-0.000
			0.794			-0.042
NI100			-0.656			-0.173
			-1.598			-0.384
NTER			-0.156			-0.263
			-0.963			-1.560
NBSTC			-0.049			-0.057
			-1.412			-1.617
C	0.370	0.353	0.379	0.383	0.365	0.391
	7.478	6.880	7.300	7.674	7.045	7.432
R-squared	0.313	0.315	0.349	0.325	0.327	0.359

Source: Result from E-views7. Period Included = 8(2003~2010), Cross-section Included =105, Total panel observation = 550

<Table 5> Empirical Results of High-tech Industry (2), Coefficient and t Value

HT	OLS			Period Fixed		
	1	2	3	1	2	3
Log(GDP)	0.080	0.081	0.082	0.079	0.080	0.080
	5.911***	5.863***	5.826***	5.827***	5.755***	5.679***
Log(GDPPC)	0.006	0.009	0.015	-0.003	-0.001	0.004
	0.211	0.286	0.465	-0.095	-0.028	0.114
I100	0.008	0.008	0.008	0.009	0.009	0.009
	5.112***	5.027***	4.562***	5.466***	5.374***	4.763***
TER	-0.002	-0.002	-0.002	-0.003	-0.003	-0.002
	-1.638	-1.597	-1.132	-1.930*	-1.892*	-1.299
BSTC	-0.001	-0.001	0.000	-0.001	-0.001	0.000
	-1.338	-1.298	-0.537	-1.698*	-1.660*	-0.900
N_HT_RCA		-4.226			-3.410	
		-0.525			-0.422	
Log(NGDP)			0.037			0.038
			1.608			1.645*
Log(NGDPPC)			-0.012			-0.014
			-0.388			-0.431
NI100			-0.301			-0.148
			-0.985			-0.467
NTER			-0.233			-0.297
			-1.462			-1.810
NBSTC			-0.064			-0.068
			-1.826			-1.924
C	-1.599	-1.651	-2.329	-1.503	-1.545	-2.212
	-4.471	-4.450	-4.521	-4.147	-4.106	-4.249
R-squared	0.341	0.341	0.364	0.347	0.348	0.369

Source: Result from E-views7. Period Included = 8(2003~2010), Cross-section Included =105, Total panel observation = 550

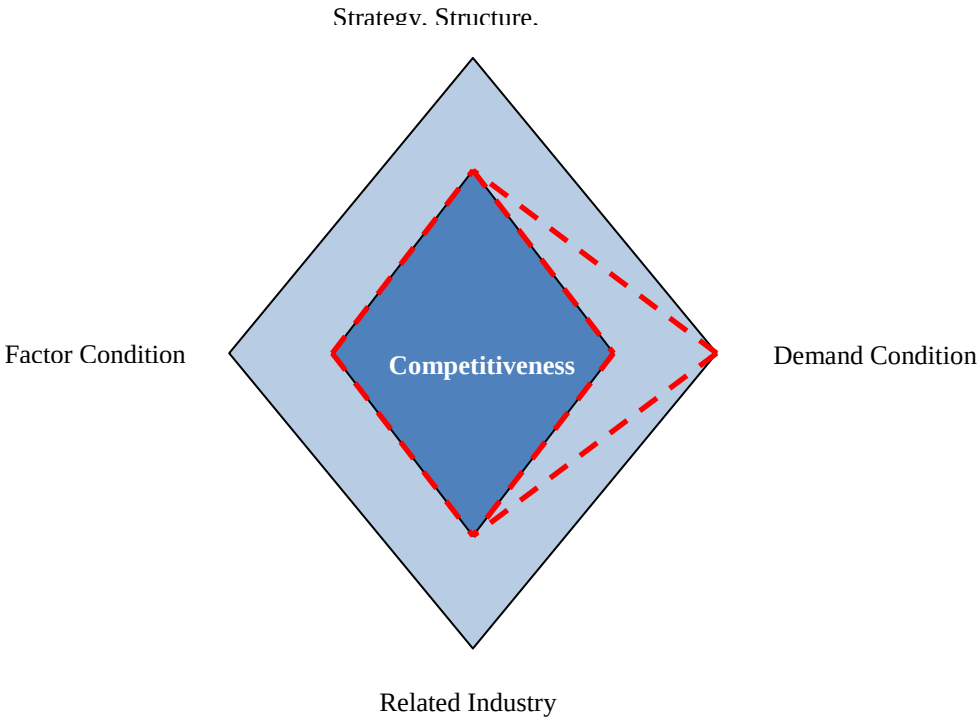
According to the empirical results, the competitiveness of high-tech industry is strongly influenced by domestic factors. Regarding 3rd model of period fixed test in Table 4, it is observed that domestic GDP and internet users per 100 people are

positively correlated while domestic GDP per capita and business start-up cost show a negative correlation. The only condition which was insignificant was domestic tertiary gross enrollment ratio. This result means that high-tech industry is affected by domestic factor, demand, related and supporting industry, firm strategy, structure, and rivalry conditions.

On the other hand, the international conditions of high-tech industry have mostly insignificant impact on the competitiveness of home country's high-tech industry. The competitiveness of neighboring countries' high-tech industry also appeared to be insignificant. Only the GDP of neighboring countries were significant. This can be interpreted that the bigger market size of neighboring countries has positive impact on home country's high tech industry.

Based on this result, we can draw the double diamond model of high-tech industry as <Figure 6>. In this figure, the smaller diamond shows the domestic conditions and bigger diamond represents the international conditions. The dotted lines indicate the determinants competitiveness of high-tech industry.

<Figure 6> Double Diamond Model of High-tech Industry



Source: Based on the result from E-views7

2. ICT Industry

<Table 6> Empirical Results of ICT Industry (1), Coefficient and t Value

ICT	OLS			Period Fixed		
	1	2	3	1	2	3
GDP	0.000	0.000	0.000	0.000	0.000	0.000
	3.285***	3.284***	3.130***	3.503***	3.505***	3.247***
GDPPC	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	-6.772***	-6.734***	-6.097***	-7.438***	-7.415***	-6.572***
I100	0.022	0.022	0.022	0.025	0.025	0.024
	7.485***	7.596***	7.564***	8.196***	8.335***	8.043***
TER	-0.004	-0.005	-0.004	-0.005	-0.006	-0.005
	-1.814*	-2.256**	-1.642***	-2.589***	-3.040***	-2.295**
BSTC	-0.002	-0.002	-0.001	-0.002	-0.002	-0.001
	-3.515***	-3.324***	-2.451**	-3.901***	-3.711***	-2.656***
N_ICT_RCA		20.575			21.638	
		2.023**			2.136**	
NGDP			0.000			0.000
			2.543**			2.403**
NGDPPC			0.000			-0.001
			0.156			-0.678
NI100			-1.534			-0.848
			-2.569***			-1.298
NTER			0.384			0.256
			1.630			1.046
NBSTC			-0.138			-0.148
			-2.729***			-2.923***
C	0.405	0.380	0.475	0.421	0.394	0.483
	5.703	5.288	6.310	5.879	5.446	6.340
R-squared	0.212	0.218	0.250	0.231	0.237	0.263

Source: Result from E-views7. Period Included = 8(2003~2010), Cross-section Included =104, Total panel observation = 544

<Table 7> Empirical Results of ICT Industry (2), Coefficient and t Value

ICT	OLS			Period Fixed		
	1	2	3	1	2	3
Log(GDP)	0.127	0.123	0.147	0.126	0.123	0.146
	6.217***	6.022***	7.018***	6.172***	5.969***	6.928***
Log(GDPPC)	-0.132	-0.132	-0.070	-0.147	-0.148	-0.079
	-2.948***	-2.959***	-1.441	-3.232 ***	-3.254***	-1.596
I100	0.011	0.011	0.010	0.012	0.012	0.011
	4.400***	4.536***	4.079***	4.741***	4.901***	4.126***
TER	-0.002	-0.003	-0.004	-0.003	-0.003	-0.004
	-0.969	-1.271	-1.651*	-1.182	-1.507	-1.689*
BSTC	-0.001	-0.001	-0.001	-0.002	-0.002	-0.001
	-2.472**	-2.403**	-0.977	-2.785***	-2.727***	-1.129
N_ICT_RCA		16.328			17.404	
		1.578			1.675*	
Log(NGDP)			-0.014			-0.013
			-0.405			-0.377
Log(NGDPPC)			-0.018			-0.019
			-0.384			-0.405
NI100			-1.402			-1.318
			-3.117***			-2.818***
NTER			0.474			0.448
			2.026**			1.848*
NBSTC			-0.141			-0.144
			-2.747***			-2.773***
C	-1.697	-1.632	-2.214	-1.564	-1.491	-2.134
	-3.169	-3.042	-2.917	-2.884	-2.746	-2.774
R-squared	0.196	0.200	0.246	0.203	0.207	0.249

Source: Result from E-views7. Period Included = 8(2003~2010), Cross-section Included =104, Total panel observation = 544

According to the results, it appears that the competitiveness of ICT industry is significantly affected by all domestic conditions. The domestic market size represented as GDP and internet users per 100 people have strong positive correlation with the ICT industry's competitiveness. However, the wage level

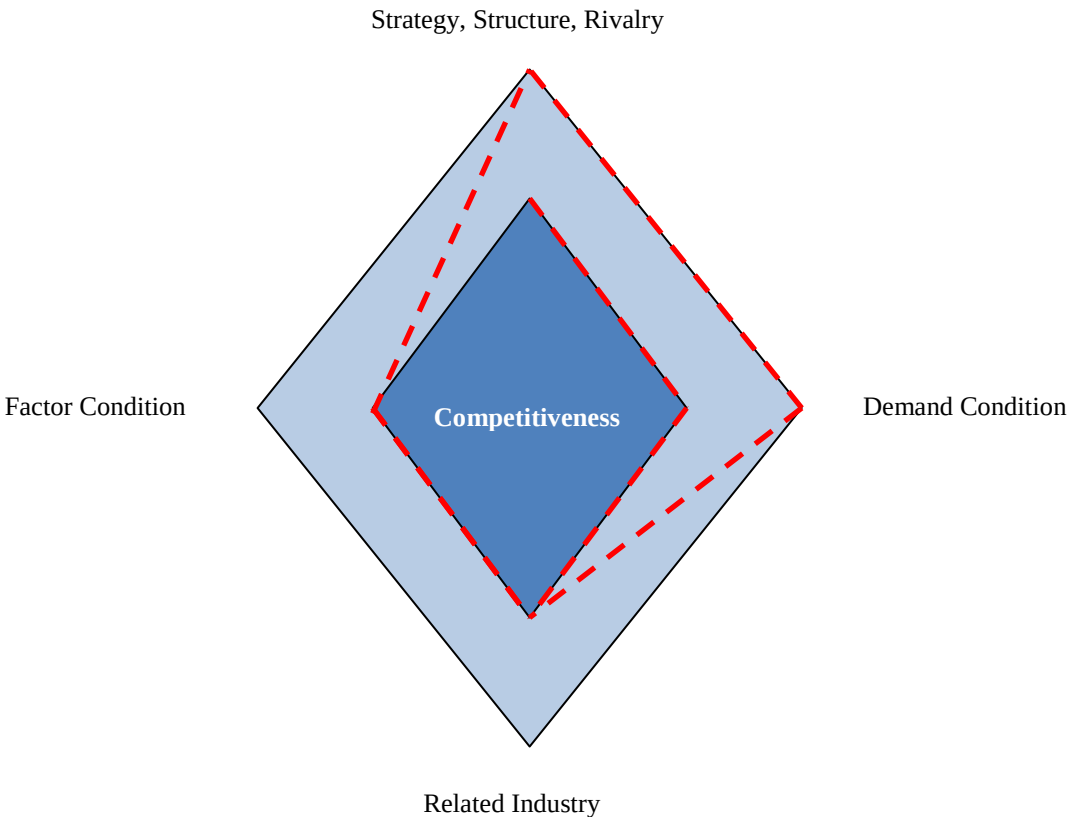
(GDP per capita), workers' education level (tertiary gross enrollment ratio) and business start-up cost have strongly negative correlation. This implies that what matters for ICT industry is low wage and low business entrance barrier. Since the technologies of ICT industry is changing very rapidly, it is important to have low entrance barrier for its competitiveness.

Also the neighboring countries' industrial competitiveness is appeared to be significant in ICT industry. The more competitive the neighboring countries get, the higher the home country's competitiveness would be.

Regarding international conditions, it is observed that only GDP and business start cost of neighboring countries have significant impact. It means that the market size which is demand condition and low entrance barrier in nearby countries act as important factors in home country's ICT industry.

This result can be described as <Figure 7> in double diamond model. In this figure, one should note that all domestic conditions and international demand, firm strategy, structure, and rivalry conditions are the determinants of ICT industry's RCA.

<Figure 7> Double Diamond Model of ICT Industry



Source: Based on the result from E-views7

3. Automotive Industry

<Table 8> Empirical Results of Automotive Industry (1), Coefficient and t Value

Auto	OLS			Period Fixed		
	1	2	3	1	2	3
GDP	0.000 4.380***	0.000 4.176***	0.000 4.914***	0.000 4.519***	0.000 4.326***	0.000 4.870***
GDPPC	-0.000 -3.852	-0.000 -4.268	-0.000 -5.160	-0.000 -3.764	-0.000 -4.210***	-0.000 -4.824***
I100	0.011 4.409 ***	0.012 4.801***	0.012 5.324***	0.010 4.054***	0.012 4.498***	0.011 4.684***
TER	0.006 3.486***	0.004 2.544**	0.004 2.396***	0.006 3.239***	0.004 2.284**	0.004 2.545 **
BSTC	0.000 1.079	0.000 1.100	0.001 2.087**	0.000 0.950	0.000 0.947	0.001 2.115**
N_AUTO_RCA		20.310 3.131***			19.835 3.031***	
NGDP			0.000 8.043***			0.000 8.009 ***
NGDPPC			0.002 2.799***			0.002 2.933***
NI100			-1.950 -4.237***			-2.111 -4.152***
NTER			0.699 3.845***			0.716 3.762***
NBSTC			-0.019 -0.480			-0.017 -0.419
C	0.051 0.850	0.032 0.536	-0.040 -0.681	0.069 1.134	0.050 0.822	-0.037 -0.621
R-squared	0.245	0.259	0.386	0.252	0.265	0.389

Source: Result from E-views7. Period Included = 8(2003~2010), Cross-section Included =103, Total panel observation = 539

<Table 9> Empirical Results of Automotive Industry (2), Coefficient and t Value

Auto	OLS			Period Fixed		
	1	2	3	1	2	3
Log(GDP)	0.134 8.088***	0.131 7.863***	0.116 6.840***	0.134 8.082***	0.131 7.868***	0.117 6.866***
Log(GDPPC)	-0.025 -0.696	-0.036 -0.989	-0.016 -0.407	-0.019 -0.524	-0.030 -0.816	-0.009 -0.233
I100	0.004 1.992**	0.004 2.232**	0.006 2.780 ***	0.003 1.469	0.004 1.731	0.005 2.353**
TER	0.004 2.445**	0.004 2.080**	0.001 0.808	0.004 2.478**	0.004 2.119**	0.002 0.888
BSTC	0.002 3.344***	0.001 3.130***	0.002 3.486***	0.002 3.377***	0.001 3.150***	0.002 3.523***
N_AUTO_RCA		13.180 2.070**			12.072 1.880*	
Log(NGDP)			0.088 3.032***			0.086 2.946***
Log(NGDPPC)			-0.082 -2.083**			-0.080 -2.020**
NI100			-0.364 -1.002			-0.391 -1.034
NTER			0.577 3.052***			0.566 2.892***
NBSTC			-0.024 -0.581			
C	-3.019 -6.934	-2.869 -6.520	-4.202 -6.504	-3.055 -6.942	-2.909 -6.526	-4.238 -6.494
R-squared	0.289	0.295	0.325	0.296	0.301	0.328

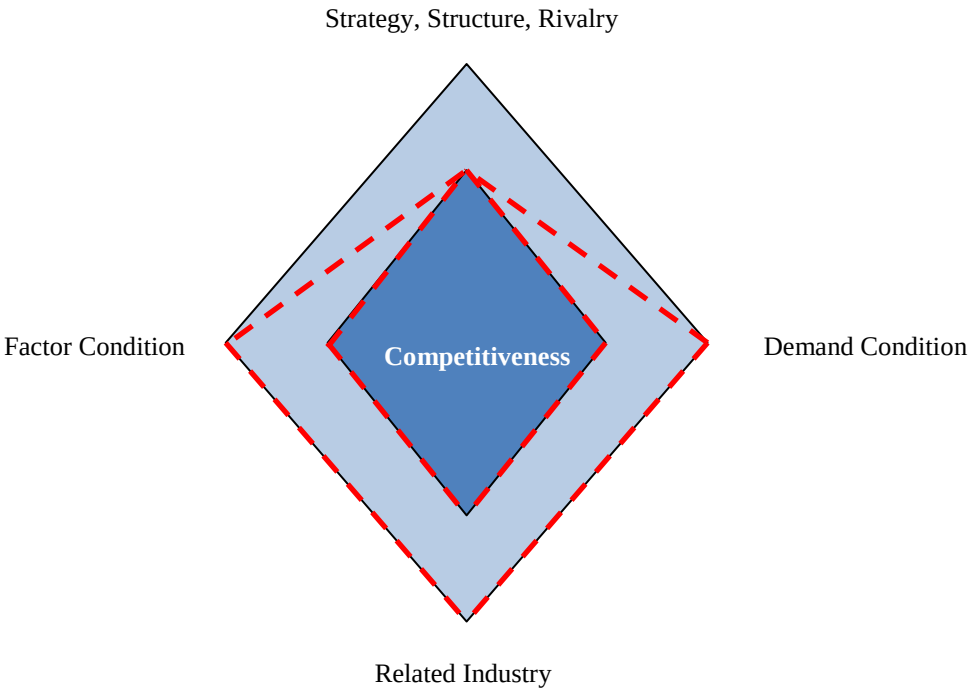
Source: Result from E-views7. Period Included = 8(2003~2010), Cross-section Included =103, Total panel observation = 539

The empirical results show the strong impact of both domestic and international conditions on the competitiveness of automotive industry. Except the GDP per capita, all domestic conditions, GDP, tertiary education enrollment ratio, internet users per 100 people, and business start-up cost are positively correlated. Like high-tech and ICT industries' cases, this reconfirms the importance of bigger market size (GDP) and lower wage (GDP per capita) for the competitiveness of industry. Meanwhile, it is noteworthy that tertiary education enrollment ratio and business start-up cost are positively correlated with competitiveness unlike other industries above. This shows the characteristics of automotive industry. Automotive industry requires more high educated labors compared to other industry. This implies the technology in automotive industry might be more complex. Also, the higher business start-up cost enhances the competitiveness of automotive industry. This condition plays a role as high entrance barrier of the industry. It can be interpreted that although it is difficult to start business in the automotive industry, once it enters, the high entrance barrier protects the business from potential challengers. Thus, the level of industrial protection is an important condition for the competitiveness of the automotive industry.

Also the neighboring countries' industrial competitiveness is appeared to be significant in automotive industry. As the neighboring countries become more competitive, the home country's competitiveness in the automotive sector would be increased.

Concerning the international conditions, the GDP, GDP per capita, tertiary education enrollment ratio of neighboring countries are positively correlated while the internet users per 100 people has a negative correlation. Compared to high-tech and ICT industry, the automotive industry tends to be more affected by neighboring countries' conditions. Based on this result, the double diamond model for automotive industry is presented as below.

<Figure 8> Double Diamond Model of Automotive Industry



Source: Based on the result from E-views7

V. Conclusion

1. Summary

Because of the importance of manufacturing industry and the export as main source for the economic growth, industrial global competitiveness has been the main interest for the economists, policymakers, firm executives and scholars. To find out the determinants of industrial competitiveness, many attempts have been made by the scholars and economists. Some studies have included primary conditions. However, not many studies have accounted for the impact of changing conditions in neighboring countries in addition to the more conventional home country's domestic conditions. This thesis examined the impact of both conditions on the industry's global competitiveness. To find out the determinants, the modified double diamond model is used as a key tool to carry on the panel regression analysis.

According to the results, each industry's determinants appear to be different. The high-tech industry is affected by domestic GDP, GDP per capita, internet users, business start-up cost and neighboring countries' GDP. In terms of the ICT Industry, the determinants are domestic GDP, GDP per capita, internet users, tertiary education, business start cost and neighboring countries' industrial competitiveness, GDP and business start-up cost. The case of the automotive

industry shows a stronger correlation with neighboring countries' conditions. The determinants of the automotive industry are domestic GDP, GDP per capita, internet users, tertiary education, business start cost and neighboring countries' industrial competitiveness, GDP, GDP per capita, tertiary education and internet users. (See Table 10)

<Table 10> Summary of Results from Penal Data Analysis

RCA	High-tech	ICT	Automotive
GDP	(+)	(+)	(+)
GDPPC	(-)	(-)	(-)
I100	(+)	(+)	(+)
TER	•	(-)	(+)
BSTC	(-)	(-)	(+)
N RCA	•	(+)	(+)
NGDP	(+)	(+)	(+)
NGDPPC	•	•	(+)
NI100	•	•	(-)
NTER	•	•	(+)
NBSTC	•	(-)	•
R-squared	0.359	0.263	0.389

Source: Based on the result from E-views, Penal data regression results (Period fixed, without logarithm)

The result implies that the determinants of competitiveness are different from industry to industry. Thus, strategies to enhance competitiveness should be respectively designed and carried out for each industry. Also the business model should be developed according to each industry's characteristics.

2. Limitations and Further Studies

There are some limitations in this study.

First, since the RCA which was used to measure global competitiveness is based on UN Comtrade data, it is difficult to track the re-export. If a country does not produce but import and re-export commodities, it will be counted in RCA although the country does not manufacture them.

Second, because of availability of business start-up cost data from World Bank, this study only tested 8 years of period in the panel regression.

Third, the distance is from one capital city to another capital city. Thus, for two countries that are actually quite close to each other from border to border, but relatively far apart between the capitals, the results might be skewed. In order to make up for this limitation, this study uniformly applies 4 kilometers as distance to countries that share borders. However, in order to measure more accurately, a more sophisticated way needs to be designed.

In spite of some limitations, this study is still worthy of investigation since it tries to identify what kind of impact neighboring countries have on the competitiveness of home country's industries. While this study limits the scope to arguably the three most important manufacturing industries – High Tech, ICT and Automotive, the same method could be applied to investigate determinants of competitiveness of other manufacturing industries. Moreover, this study's unique feature of accounting for the impact from other countries could be further developed to identify industrial characteristics of each region.

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3. Internet Resources

OECD (http://stats.oecd.org/)

UNCTAD (http://stats.unctad.org)

The World Bank (http://data.worldbank.org)

United Nations Commodity Trade Statistics Database (http://comtrade.un.org)

International Trade Data (http://www.macalester.edu/research/economics/PAGE/HAVEMAN/Trade.Resources/TradeData.html).

Appendix

Appendix I

High-tech Industry Commodity Code and Description

511	Hydrocarbons, n.e.s., & halogenated, nitr. derivative
512	Alcohols, phenols, halogenat., sulfonat., nitrat. der.
513	Carboxylic acids, anhydrides, halides, per.; derivati.
514	Nitrogen-function compounds
515	Organo-inorganic, heterocycl. compounds, nucl. acids
516	Other organic chemicals
522	Inorganic chemical elements, oxides & halogen salts
523	Metallic salts & peroxysalts, of inorganic acids
524	Other inorganic chemicals
525	Radio-actives and associated materials
531	Synth. organic colouring matter & colouring lakes
532	Dyeing & tanning extracts, synth. tanning materials
533	Pigments, paints, varnishes and related materials
541	Medicinal and pharmaceutical products, excluding 542
542	Medicaments (incl. veterinary medicaments)
551	Essential oils, perfume & flavour materials
553	Perfumery, cosmetics or toilet prepar. (excluding soaps)
554	Soaps, cleansing and polishing preparations
562	Fertilizers (other than those of group 272)
571	Polymers of ethylene, in primary forms
572	Polymers of styrene, in primary forms
573	Polymers of vinyl chloride or halogenated olefins
574	Polyethers, epoxide resins; polycarbonat., polyesters
575	Other plastics, in primary forms
579	Waste, parings and scrap, of plastics

581	Tubes, pipes and hoses of plastics
582	Plates, sheets, films, foil & strip, of plastics
583	Monofilaments, of plastics, cross-section > 1mm
591	Insectides & similar products, for retail sale
592	Starche, wheat gluten; albuminoidal substances; glues
593	Explosives and pyrotechnic products
597	Prepared addit. for miner. oils; lubricat., de-icing
598	Miscellaneous chemical products, n.e.s.
751	Office machines
752	Automatic data processing machines, n.e.s.
759	Parts, accessories for machines of groups 751, 752
761	Television receivers, whether or not combined
762	Radio-broadcast receivers, whether or not combined
763	Sound recorders or reproducers
764	Telecommunication equipment, n.e.s.; & parts, n.e.s.
776	Cathode valves & tubes
792	Aircraft & associated equipment; spacecraft, etc.
871	Optical instruments & apparatus, n.e.s.
872	Instruments & appliances, n.e.s., for medical, etc.
873	Meters & counters, n.e.s.
874	Measuring, analysing & controlling apparatus, n.e.s.
881	Photographic apparatus & equipment, n.e.s.
882	Cinematographic & photographic supplies
883	Cinematograph films, exposed & developed
884	Optical goods, n.e.s.
885	Watches & clocks

Appendix II

ICT Industry Commodity Code and Description

76381	Video-recording or reproducing apparatus, whether or not incorporating
72655	Offset printing machinery, sheet fed, office type
75	Office machines and auto. data processing machines
761	Television receivers, whether or not combined
762	Radio-broadcast receivers, whether or not combined
763	Sound recorders or reproducers; television recorders
7641	Electrical apparatus for line telephony or teleg.5
7642	Microphones; loudspeakers; headphones; amplifiers
7643	Transmission apparatus for radio-broadcasting, etc.
76482	Television cameras
76483	Radar, radio-navigat. aid, -remote control apparatus
76491	Parts & accessories for apparatus of heading 7641
7722	Printed circuits
7723	Electrical resistors, other than heating resistors
773	ELECTR DISTRIBT.EQPT NES
776	Cathode valves & tubes; diodes; integrated circuits
7786	Electric capacitors, fixed, variables or adjustable
8713	Microscopes (non-optical) ; diffract. apparat., n.e.s.
873	Meters & counters, n.e.s.
874	Measuring, analysing & controlling apparatus, n.e.s.
87469	Parts & accessories for instruments of 8746

Appendix III

Automotive Industry Commodity Code and Description

7132	Internal combustion piston engines for propelling vehicles
71382	Other compression-ignition internal combustion engines (diesel or semi-diesel)
7139	Parts, n.e.s, for the internal combustion piston engines
74419	Parts of the trucks and tractors
7783	Electrical equipment, n.e.s., for internal combustion engines and vehicles; parts thereof
77831	Electrical ignition or starting equipment of a kind used for spark-ignition or compression-ignition internal combustion engines
77833	Parts of the equipment of heading 778.31
77834	Electrical lighting or signalling equipment
77835	Parts of the equipment of heading 778.34
784	Parts and accessories of motor vehicles
7841	Chassis fitted with engines, for motor vehicles
7842	Bodies (including cabs), for motor vehicles
7843	Other parts and accessories of motor vehicles
78431	Bumpers, and parts thereof
78432	Other parts and accessories of bodies (including cabs)
78433	Brakes and servo-brakes and parts thereof
78434	Gearboxes
78435	Drive-axles with differential, whether or not provided with other transmission components
78436	Non-driving axles, and parts thereof
78439	Other parts and accessories
781	Passenger Motor Vehicles exlusing Bus
782	Goods, Special Transport Vehicles
783	Road Motor Vehicles NES

더블 다이아몬드 모델을 통한
제조산업 국제경쟁력의 결정요인 연구
– 하이테크, ICT, 자동차산업을 중심으로

국문초록

18 세기 후반부터 제조산업은 성장의 주요동력으로 여겨져 왔다. 특히 최근의 금융위기 이후, 제조산업의 중요성이 다시 강조되고 있다. 그간 산업경쟁력의 결정요인에 대한 많은 연구가 행해졌지만 주로 국내요소의 결정요인수준에서 연구들이 많이 이루어진 반면 자국의 산업경쟁력에 영향을 미치는 주변국가의 요소에 대해서는 많은 연구가 이루어지지 않고 있다. 이에 본 논문에서는 수정된 더블 다이아몬드 모델을 사용하여 자국 제조산업의 국제경쟁력의 결정요인으로서 국내결정요인과 함께 주변국가의 요소를 국외 결정요인으로 분석하였다. 한편 분석을 위해 제조업 중 하이테크, ICT, 자동차산업을 연구대상으로 범위를 한정하였다.

연구결과에 따르면 각 산업마다 경쟁력에 영향을 미치는 결정요인 중 특히 주변국가들이 미치는 영향이 매우 상이한 것으로 나타났다. 하이테크산업은 주변국가의 영향 중 수요조건의 영향을 가장 많이 받는 것으로 나타났으며 ICT 산업은 수요조건, 기업전략, 구조 및 경쟁의 영향을 많이 받는 것으로 나타났다. 한편 자동차 산업의 경우 다른 산업들에 비해 주변국의 영향을 가장 많이 받는 것으로 나타났으며, 주변국의 조건 중 요소조건, 관련 및 지원산업, 수요조건의 영향을 크게 받고 있는 것으로 나타났다. 따라서 본 연구는 제조업의 경쟁력 강화를 위해서는 세부산업별로 나누어 접근할 필요가 있으며 주변국가들의 영향도 다루어야 한다는 점을 시사하고 있다.

기존 연구들과 비교했을 때 본 연구는 그 동안 많이 다루어지지 않았던 주변국가들의 영향을 다루었다는 점에서 가치가 있으며, 본 연구에서 사용된 분석틀로 향후 다른 제조산업의 경쟁력 및 특정 지역의 제조산업경쟁력의 결정요인분석으로 연구를 확대해 볼 수 있을 것이다.

Keywords: 제조업, 국제경쟁력, 더블 다이아몬드 모델, 국제생산공유, 주변국가

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