아태연구 제19권 제1호(2012)

Dynamics and Divergence of Export Specialization in Korea*

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| 목 차 |

| 논문요약 |

이 논문은 1997년에서 2010년 사이의 UN 산업별 무역통계를 활용하여 한국의 수출특화를 중심으로 그 구조적 안정성과 동태적 변화 추이를 분석하고 있다. 갈토니안 회귀분석(Galtonian regression)과 이행확률행렬(Transition Probability Matrix) 등의 추정 방법론을 사용하였으며 그 주요 분석 결과는 다음과 같이 요약할 수 있다. 첫째, 한국의 비교우위패턴은 핵셔-오린(Heckscher-Ohlin) 모형의 예측에 부합하고 있다. 둘째, 한국의 현시된 비교우위는 산업별 특화의 심화로 이행하고 있다. 셋째, 한국의 비교열위 산업은 지속적인 비교열위에서 벗어나지 못하는 동태적 함정(dynamic trap)에 빠져있다. 넷째, 비숙련노동집약산업의 수출특화지수는 비교열위로 심화되는 반면 다른 산업은 높은 수출다각화로의 동태적 진행을 보이고 있다.

* This research was supported by Sogang Special Research Grant of 2011. The authors appreciate the financial support from Sogang University, Korea. Earlier version of the paper was presented at Sogang IIAS Research Series on International Affairs in 2011.
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▪ 주제어: 수출특화, 구조적 안정성, 현시 비교우위, 갈토니안 회귀분석, 마르코프 전이행렬

I. Introduction

Trying to explain the sectoral specialization and its evolution along the development path has been scrutinized in empirical trade literature. This issue is important because high degree of specialization, i.e., high concentration of resources in few sectors, could be risky if the economy is exposed to asymmetric shocks. The consequences may be particularly serious if such shocks hit the core sectors of the economy whose activity is intense.

This paper seeks to analyze the patterns and dynamics of Korea's export specialization in the period 1997-2010. The logic of export specialization was originally developed to explain the underlying reasons for international trade and predict the trade pattern resulting from changes in factor endowment and technology. Accordingly, free trade would allow countries to gain from increasing specialization in activities where they have comparative advantage under autarky. Seeking for this aim, we focus on the following research objectives:

- To assess the patterns and dynamics of Korea's export specialization.
- To analyze the mobility of Korea's revealed comparative advantage and the degree of export specialization.
- To derive some relevant policy implications for other developing countries based on the empirical findings.

The rest of this paper is structured as follows. Section 2 provides

the indicators we measure and the background for the analysis of export specialization. The in-depth analysis of the patterns and dynamics of Korea's export specialization is presented in Section 3. Concluding remarks are included in the final section.

II. Methodology

1. Measuring export specialization

The measurement of a country's relative export performance in individual products has been based on the concept of revealed comparative advantage(RCA). This concept was conceived by Blassa(1965), modified by Bowen(1983, 1985, 1986), and subsequently employed in a number of empirical studies for analyzing a country's comparative advantage in various sectors(Kalirajan and Shand 1998; Widodo 2009; Amador 2011; Le 2010; Amador et al. 2011). The index is calculated as follows:

$$RCA_{ij} = \left(\frac{X_{ij}}{\sum_{i=1}^{n} X_{ij}} \right) \cdot \left(\frac{\sum_{j=1}^{m} X_{ij}}{\sum_{i=1}^{n} \sum_{j=1}^{m} X_{ij}} \right)^{-1}$$

Where, X is exports, i is sector i, j denotes country j; n is total number of sectors, and m is total number of countries respectively.

The index can take on values between zero and infinity. A value of RCA greater than unity is interpreted that the country has a revealed comparative advantage in commodity i and vice versa. This occurs when the share of that commodity in the country's exports exceeds its share in reference group's exports. The advantage of using RCA

is that it considers the intrinsic advantage of a particular export commodity and is consistent with changes in an economy's relative factor endowment and productivity. The RCA index, however, has its own limitations. The major shortcoming of RCA index is its asymmetric property. The index has a fixed lower bound of zero and a variable upper bound.

Hillman(1980) developed a necessary and sufficient condition that has to be fulfilled to obtain a correspondence between the RCA index and pre-trade relative prices in cross-country comparisons for a given product.

$$1-\frac{X_{ij}}{X_{in}} \succ \frac{X_{ij}}{X_j}\left(1-\frac{X_j}{X_n}\right)$$

where Xij is exports of commodity *i* by country *j*, Xj is total exports of country *j*, Xin is the reference group's exports of commodity *i*, and X_n is the reference group's total exports. Assuming identical homothetic preferences across countries, the condition in equation above is necessary and sufficient to guarantee that changes in the RCA index are consistent with changes in relative factor-endowments. This condition guarantees that growth in the level of a country's exports of a commodity results in an increase in the RCA index.

2. Structural stability

(1) The stability in the distribution of RCA

The persistence of overall specialization pattern is undertaken through the Galtonian regression(Laursen 1998; Bojnec and Ferto 2008). This is the correlation between the RCA index in time period *t* and the index in subsequent time periods, allowing us to determine if there is any change in the structure of trade specialization between

the periods of interest. However, one problem with the raw RCA index is that sectors with revealed comparative disadvantage are concentrated between 0 and 1, while industries with revealed comparative advantage are spread between 1 and infinity. In order to solve this problem, several modifications have been suggested in the literature in order(Vollrath 1991; Laursen 1998; Proudman and Redding 2000; Proudman and Redding 2000; Amador et al. 2007). As suggested by Laursen(1998), we will use the RSCA index in this paper, which is computed as follows[1]:

$$RSCA_{ij} = \left(RCA_{ij} - 1\right)/(RCA_{ij} + 1)$$

The resulting index can take on values between −1 and +1. $RSCA_{ij}$ greater than zero indicates that country *j* has comparative advantage in product *i*. In contrast, $RSCA_{ij}$ less than zero implies that country *j* has a comparative disadvantage in product *i*. Following Dalum et al.(1998) we perform the following regression analysis:

$$RSCA_{ij}^{t2} = \alpha_i + \beta_i RSCA_{ij}^{t1} + u_{ij}$$

where superscripts t_1 and t_2 denote the start year and end year respectively. The dependent variable, RSCA at time t_2 for sector *i* in country *j*, is tested against the independent variable, which is the value of RSCA in year t_1; and are standard linear regression parameters and u_{ij} is a residual term.

- If β = 1: The specialization pattern does not alter from t_1 to t_2.
- If β > 1: The country's existing specialization increased in those commodity groups which have comparative advantage and weakened in those commodity groups which do not have comparative advantage.

1) Also see Yu et al.(2009), Amador et al.(2010) and Lee(2011).

- If $0 < \beta < 1$: The commodity groups in which comparative advantage were relatively weak are increasing their competitiveness, while those commodity groups that had strong comparative advantage were losing them. In other words, this implies a pattern of convergence in export specialization.
- If $\beta < 0$: The specialization pattern is either reversed or random.

According to Cantwell(1989) and Dalum et al.(1998), >1 is not a necessary condition for an increase in the overall specialization pattern. It can be shown that:

$$\sigma_i^{2t2} / \sigma_i^{2t1} = \beta_1^2 / R_i^2 \quad \text{thus,} \quad \sigma_i^{t2} / \sigma_i^{t1} = | \beta_i | / | R_i |$$

Where σ_i^2 is the variance of the dependent variable, and R is the correlation coefficient obtained from the regression. According to the above equation, the degree of changes in specialization depends on the interaction between $_i$ and R. A high estimated R implies that the overall structure of specialization is less mobile. In contrast, a low estimated R means that the ranking of sectors has changed significantly(more mobile).

- If $\beta_i = R_i$, the dispersion of a given distribution is unchanged.
- When $\beta_i > R_i$, there is an increase in the degree of specialization($\sigma-$ specialization).
- If $\beta_i < R_i$, the degree of specialization decreases($\sigma-$ despecialization).

(2) The intra-distribution dynamics

There are several measures of stability in the value of RCA index

for particular commodity groups from t_1 to t_2. Following Proudman and Redding(2000), and Brasili et al.(2000), Hinloopen and van Marrewijk(2001) and Bojnec and Ferto(2008), we employ Markov transition probability matrices to assess the mobility of revealed comparative advantage as measured by the RCA index. To this date, there is no consensus on the classification of the RCA index into appropriate categories. Drawing on Hinloopen and van Marrewijk(2001) and Hisanaga(2008), the RCA index is classified into four following categories:

- 0 < RCA≤1: Products without a comparative advantage.
- 1 < RCA≤2: Products with weak comparative advantage.
- 2 < RCA≤4: Products with medium comparative advantage.
- 4 < RCA: Products with strong comparative advantage.

In general, a stochastic process of X is considered Markovian if, for every n and all states $i_1, \cdots i_n$,

$$P[X_n = i_n \mid X_{n-1} = i_{n-1}, \ldots, X_1 = i_1] = P[X_n = i_n \mid X_{n-1} = i_{n-1}]$$

Our transition matrices are used as in a Markovian analysis. As the result, relative frequencies should be interpreted as probabilities. In this paper, the transition matrices are generated by a stationary Markov process:

$$P[X_n = j \mid X_{n-1} = i] = P[X_{n+k=j} \mid X_{n+k-1}]$$

for all states i and j, and k = (n-1),..., 1, 0, 1,...

The degree of mobility in patterns of specialization can also be analyzed through several other indices. The first index is M_1, which evaluates the trace(tr) of the transition probability matrix(Shorrocks 1978; Quah 1996). M_1 is calculated using the following formula:

$$M1 = \frac{K - tr(P_c^*)}{K - 1}$$

where K is the number of cells and tr(P_c^*) is the trace of the transition probability matrix. A higher value of the index indicates greater mobility, with a value of zero indicating perfect immobility.

The second index of mobility is M_2, which evaluates the determinant of the transition probability matrix(Geweke at al. 1986). M_2 is computed using the following formula:

$$M_2 = 1 - |\det(P^*)|$$

Where is the determinant of the matrix, which is calculated as follows: $|B| = \sum_{j=1}^{4} b_{1j} |C_{1j}|$ (Chiang 1984). In this paper, the cofactors $|C_{1j}|$ are of order 3.

The third index of mobility is M_3, which is based on the eigenvalues of the matrix(Sommers and Conlisk 1979). It is calculated as follows:

$$M_3 = 1 - \lambda_2$$

Where the λ^2 is the second largest eigenvalue of P^*.

3. The degree of the commodity concentration

In this study, the commodity concentration is estimated on the basis of Gini-Hirschman coefficient(GH). The index is calculated using the following formula:

$$GH = \sqrt{\sum_{i=1}^{n} \left(\frac{X_{it}}{X_t} \right)^2}$$

Where X_{it} is the value of exports of commodity group *i* in year *t*, and X_t is the total exports in year *t*. The GH coefficient can ranges from 0(export diversification) and 1(export specialization).

4. Data

The data for this research were taken from the United Nations Commodity Trade Statistics. The annual RCA indices will be calculated at 4-digit level of Standard International Trade Classification(SITC), but reported at either 3-digit level of SITC or factor-intensity product groups over the period 1997 to 2010[2]. The use of the RCA indices aims at determining whether Korea's export specialization has shifted overtime. These indices also provide useful information about potential trade prospects with trading partners.

III. Empirical results

1. Overview of Korea's export pattern

The structure of Korea's export based on factor intensity is presented in Table 1. As the data reveal, Korea's exports are dominated by technology-intensive and human capital-intensive products, which accounted for approximately 52.40 per cent and 21.40 per cent in the period 2009-2010 respectively. Unskilled labor-intensive products made up the third largest portion of exports, followed by primary and natural resource intensive products respectively.

The most discernable change is the increase in traditional

2) We follow Hinloopen and van Marrewijk(2008) for the classification of commodities.

dominance in exports by technology between the periods 1997-1998 and 2009-2010. This increase indicates a movement toward technology based economy.

<Table 1> Commodity share in Korea's total exports

Product groups	1997-98	1999-00	2001-02	2003-04	2005-06	2007-08	2009-10
Primary products	7.02	7.62	7.28	6.16	8.01	10.04	9.03
Natural resource-intensive products	3.05	2.53	2.44	2.26	2.56	2.69	2.30
Unskilled labor-intensive products	19.62	17.34	17.46	13.19	11.22	12.17	14.16
Technology-intensive products	42.20	49.45	49.21	52.80	53.65	51.60	52.40
Human capital-intensive products	23.14	21.64	22.95	24.47	24.36	23.23	21.40
3-digit sectors not classified	4.98	1.42	0.66	1.12	0.20	0.27	0.71

Source: The authors' own computation

At the same time, the share of primary products in total exports experienced a small increase. The share of human capital intensive products in total exports, the second largest commodity group, has been up and down during the same period. In contrast, the share of unskilled labor and natural resource intensive products in total exports has been decreasing. Another interesting feature of Korea's exports has been a relatively consistent increase in the share of primary products in total exports. Taken together, the export patterns of Korea have been in conformity with its factor-endowment.

2. The pattern of Korea's export specialization

RCA estimates for 773 available products at 4-digit SITC are

summarized in Tables 2. For the purpose of mitigating any random factors, which might affect RCA of a single year, we report 2-year average(1997-1998, 1999-2000, 2001-2002, 2003-2004, 2005-2006, 2007-2008 and 2009-2010).[3)]

<Table 2> Frequency Distribution of Korea's RCA index

RCA range	1997 - 1998	1999 - 2000	2001 - 2002	2003 - 2004	2005 - 2006	2007 - 2008	2009 - 2010
0 < RCA≤ 1	617	619	629	645	638	646	648
1 < RCA≤2	86	80	70	62	82	73	73
2 < RCA≤4	39	50	49	49	39	38	36
4 < RCA	31	24	25	17	14	16	16
Total	773	773	773	773	773	773	773
Mean-RCA	0.82	0.78	0.76	0.69	0.69	0.68	0.68
Maximum	8.85	7.73	8.48	7.78	10.52	12.45	11.60
Standard deviation	1.40	1.21	1.21	0.07	1.19	1.29	1.23

Source: The authors' computation using data from UNSD.

According to Table 2, approximately 80 percent of the product categories have the RCA value lower than or equal to unity during the whole period 1997-2010. The number of such product categories has been increasing slowly over time. During the same period, the number of product categories with high comparative advantage decreased, while the number of product categories with weak and medium comparative advantage is relatively stable. At the same time, the maximum value of RCA rose slightly. This indicates that the commodity structure of Korea's comparative advantage is moving towards specialization. Table 3 displays the breakdown of the percentage of the number of products having RCA index greater than

3) Our estimate RCA indices are consistent with the Hillman condition. The detailed results are available from the authors.

unity in the total number of each category.

As it is evident in Table 3, the proportion of products with comparative advantage declined slowly from 20.18 percent in 1997-1998 to 16.17 percent in 2009-2010. This means that there was a number of products being out of the product groups with comparative advantage.

<Table 3> The Proportion of Products with RCA Index Higher than Unity

Product groups	1997-98	1999-00	2001-02	2003-04	2005-06	2007-08	2009-10
Total	**20.18**	**19.92**	**18.63**	**16.56**	**17.46**	**16.43**	**16.17**
Primary products	18.29	17.07	18.29	23.17	20.73	14.63	14.63
Natural resource-intensive products	28.57	19.05	23.81	33.33	33.33	33.33	38.10
Unskilled labor-intensive products	26.92	26.92	26.92	26.92	23.08	19.23	15.38
Technology-intensive products	20.97	20.97	19.35	20.97	20.97	17.74	22.58
Human capital-intensive products	45.24	40.48	35.71	21.43	23.81	19.05	26.19

Source: The authors' computation using data from UNSD.

Human capital intensive products experienced greatest decline, with a drop of around 19.05 percentage points. This is followed by unskilled labor intensive and primary products, which lost approximately 12.54 and 3.66 percentage points respectively. In contrast, natural resource intensive products saw a moderate growth, which gained almost 10 percentage points. The corresponding figure for technology intensive products is about 2 percentage points.

Top 30 products categories in the RCA ranking for the periods 1997-1998 and 2009-2010 are displayed in Table 4. In terms of factor intensity classification, eight belonged to technology intensive products, eight are treated as being human capital intensive products, seven are classified as unskilled labor intensive products, two belonged to

natural resource intensive products, four are primary products and only one is from sector not classified in 1997-1998. By 2006-2008, thirteen belonged to technology intensive products, eight are treated as being human capital intensive products, four are classified as unskilled labor intensive products, four are primary products and only one belonged to natural resource intensive products.

<Table 4> 30 Products of Korea with Highest RCA index in 1997-19998 and 2009-2010

		2009-2010 Average			
Rank	SITC	Product Name	FI	RCA	Share
1	871	Optical instruments and apparatus	TEI	11.60	6.45
2	793	Ships, boats and floating structures	ULI	8.49	10.79
3	655	Knitted or crocheted fabrics	ULI	5.04	0.83
4	266	Synthetic fibres suitable for spinning	PP	5.02	0.22
5	513	Carboxylic acids	TEI	3.86	1.10
6	711	Steam & other vapour generating boilers	TEI	3.72	0.26
7	233	Synthetic rubber	PP	3.64	0.48
8	511	Hydrocarbons nes & their halogen	TEI	3.30	1.61
9	764	Telecommunications equipment & parts	TEI	3.06	8.61
10	724	Textile & leather machinery and parts	TEI	3.05	0.54
11	776	Thermionic, etc. valves, tubes, parts	TEI	2.90	8.47
12	674	Universals, plates & sheets of iron/steel	HCI	2.57	2.55
13	677	Iron/steel wire	HCI	2.54	0.19
14	884	Optical goods, n.e.s.	TEI	2.50	0.87
15	686	Zinc	NRI	2.40	0.18
16	269	Old clothing	PP	2.22	0.06
17	653	Fabrics, woven, of man-made fibres	ULI	2.16	0.57
18	583	Polymerization products	TEI	2.02	3.01

19	656	Tulle, lace, embroidery, ribbons	ULI	2.00	0.10
20	582	Condensation	TEI	2.00	1.45
21	672	Ingots and other primary forms	HCI	1.86	1.00
22	335	Residual petroleum products, nes.	PP	1.75	0.45
23	778	Electrical machinery & apparatus, n.e.s.	TEI	1.63	2.13
24	784	Parts & accessories of 722,781,782,783	HCI	1.62	3.49
25	781	Passenger motor cars	HCI	1.60	6.52
26	693	Wire products and fencing grills	HCI	1.50	0.15
27	692	Metal containers for storage & transport	HCI	1.50	0.20
28	625	Rubber tyres, tyre cases, etc. for wheels	HCI	1.49	0.76
29	522	Inorganic chemical elements	TEI	1.46	0.47
30	759	Parts & accessories suitable for 751, 752	TEI	1.42	1.76

1997-1998 Average

Rank	SITC	Product Name	FI	RCA	Share
1	971	Gold, non-monetary	SNC	8.85	4.97
2	883	Cinematograph film	TEI	8.63	0.07
3	266	Synthetic fibres suitable for spinning	PP	7.74	0.63
4	655	Knitted or crocheted fabrics	ULI	7.28	1.46
5	653	Fabrics, woven of man-made fibres	ULI	7.04	4.05
6	793	Ships, boats and floating structures	ULI	6.85	5.41
7	871	Optical instruments and apparatus	TEI	5.31	0.84
8	656	Tulle, lace, embroidery, ribbons, etc.	ULI	4.70	0.37
9	776	Thermionic, etc. valves, tubes, parts	TEI	3.91	14.56
10	611	Leather	NRI	3.88	1.03
11	657	Special textile fabrics	ULI	3.46	1.16
12	511	Hydrocarbons nes, etc.	TEI	3.14	1.04
13	677	Iron/steel wire	HCI	2.76	0.21
14	696	Cutlery	HCI	2.52	0.20
15	612	Manufactures of leather	NRI	2.37	0.27
16	763	Gramophones, dictating, sound recorders	HCI	2.35	0.87

17	674	Universals, plates & sheets of iron/steel	HCI	2.34	2.35
18	847	Clothing accessories of textile fabrics	ULI	2.32	0.42
19	693	Wire products and fencing grills	HCI	2.26	0.21
20	761	Television receivers	HCI	2.24	1.00
21	625	Rubber tyres, tyre cases, etc. for wheels	HCI	2.22	1.11
22	672	Ingots and other primary forms	HCI	2.09	1.09
23	651	Textile yarn	ULI	2.01	1.24
24	775	Household elect.& non-elect. equipment	TEI	2.00	1.35
25	277	Natural abrasives,n.e.s	PP	1.97	0.03
26	334	Petroleum products refined	PP	1.91	3.53
27	513	Carboxylic acids	TEI	1.89	0.57
28	583	Polymerization products	TEI	1.85	2.60
29	233	Synthetic rubber	PP	1.77	0.19
30	582	Condensation	TEI	1.64	1.10

Source: The authors' computation based on UNSD database.

Note: PP=Primary products; NRI=Natural resource intensive; ULI=Unskilled labor intensive; HCI=Human capital intensive; TEI=Technology intensive; SNC: Sector not classified.

Table 5 presents the percentage of the number of products in total number of products according to the level of RCA in 1997-1998 and 2009-2010. As indicated, between 1997-1998 and 2009-2010, there was a shift toward comparative disadvantage, indicating greater specialization in Korea's exports. This is illustrated by the fact that the share of products with comparative advantage decreased. This means that Korea relied on a smaller range of export products.

<Table 5> Proportion of the Products by Level of RCA

Product Categories	4 <RCA	2<RCA ≤4	1<RCA ≤2	0<RCA ≤1	Total
			(1997-1998)		
Primary products	0.82	1.65	4.12	93.42	100.00

Natural resource-intensive products	4.92	1.64	8.20	85.25	100.00
Unskilled labor-intensive products	11.71	6.31	18.92	63.06	100.00
Technology-intensive products	3.04	4.78	11.30	80.87	100.00
Human capital-intensive products	3.97	12.70	19.05	64.29	100.00
Total	3.89	5.06	11.15	79.90	100.00
			(2009-2000)		
Primary products	0.41	1.65	2.47	95.47	100.00
Natural resource-intensive products	0.00	3.28	13.11	83.61	100.00
Unskilled labor-intensive products	3.60	4.50	7.21	84.68	100.00
Technology-intensive products	4.35	6.96	13.04	75.65	100.00
Human capital-intensive products	0.79	7.14	16.67	75.40	100.00
Total	2.08	4.67	9.47	83.79	100.00

Source: The authors' computation based on UNSD database.

When individual product categories are examined, dichotomy has emerged. For example, with regard to the primary products, there was a shift toward comparative disadvantage. Natural resource intensive products shifted away from high comparative advantage and comparative disadvantage, and a shift towards weak and medium comparative advantage. Unskilled labor and human capital intensive products shifted towards comparative disadvantage. In contrast, technology intensive products shifted towards comparative advantage. This is reasonable since the scope and the level of technology in Korea has improved significantly in recent years.

3. Structural stability of Korea's revealed comparative advantage

(1) The stability in the distribution of RCA

The stability of RCA index obtained by Galtonian regression is listed in Table 6[4]. This method allows us to determine whether or not the Korean economy has become more or less specialized in the structure of exports. As the data reveal, the value of is lower than but close to unity. This means that the commodity groups in which comparative advantage were relatively weak are increasing their competitiveness, while those commodity groups that had strong comparative advantage were losing them. So the overall trade patterns of Korea have not changed significantly from the period 1997-2010. However, the /R ratios show that the pattern of revealed comparative advantage has diverged. They suggest a movement towards specialization.

<Table 6> The Galtonian Regression Results

$RSCA_{ij}^{t1}$	$RSCA_{ij}^{t2}$	Constant	β	R	β /R	t-test	Observations
1997	1998	-0.045	0.921**	0.876	1.051	(98.17)	1370
1998	1999	0.003	0.965**	0.901	1.071	(111.57)	1370
1999	2000	-0.011	0.950**	0.912	1.042	(119.24)	1370
2000	2001	0.001	0.962**	0.910	1.057	(117.66)	1370
2001	2002	-0.021	0.944**	0.879	1.074	(99.63)	1370
2002	2003	-0.036	0.939**	0.908	1.034	(116.50)	1370
2003	2004	-0.055	0.940**	0.924	1.017	(128.70)	1370
2004	2005	-0.043	0.940**	0.899	1.045	(110.51)	1370
2005	2006	-0.051	0.948**	0.926	1.025	(130.32)	1370

4) The Galtonian regression results for the product categories by factor intensity(two-year average) are reported in the Appendix 1A, 1B, 1 C, 1D and 1E.

2006	2007	-0.030	0.961**	0.898	1.070	(109.89)	1370
2007	2008	-0.038	0.958**	0.940	1.019	(146.25)	1370
2008	2009	-0.028	0.960**	0.932	1.030	(136.85)	1370
1997	2009	-0.265	0.584**	0.379	1.542	(28.88)	1370

Source: The authors' computation.

Note: * Significant at 0.05 level; ** Significant at 0.01 level.

(2) The intra-distribution dynamics

The assessment of the dynamics of RCA indices can be obtained through the analysis of the transition probability matrix, which shows the probability of passing from a state to another between the start period(1997-1998) and the end period(2009-2010)[5]. The estimated transition probability matrix is presented in Table 7. At a glance, the initial and final distributions indicate a decline in RCA index for Korea. Specifically, 78.8 percent of the products were at comparative disadvantage status in 1997-1998. This figure increased to 83.8 percent in 2009-2010.

<Table 7> Transition Probability Matrix (1997-1998 and 2009-2010)

Period 1997-1998 \ Period 2009-2010				
RCA	**a**	**b**	**c**	**d**
a	0.932	0.049	0.018	0.002
b	0.581	0.279	0.093	0.047
c	0.385	0.308	0.256	0.051
d	0.258	0.226	0.226	0.290
Initial distribution	0.798	0.111	0.050	0.040
Final distribution	0.838	0.094	0.047	0.021

Source: The authors' computation based on UNSD at 3-digit SITC.

5) The transition probability matrices for 1997-1998 and 1999-2000, 1999-2000 and 2001-2002, 2001-2002 and 2003-2004, 2003-2004 and 2005-2006, 2005-2006 and 2007-2008, and 2007-2008 and 2009-2010 are reported in the Appendices 2A, 2B, 2C, 2D, 2E and 2F.

An in-depth analysis of the transition probability matrix suggests several important characteristics. First, the values of RCA index are relatively persistent from the period 1997-1998 to the period 2009-2010 for observations within class a(comparative disadvantage). For example, the value of the diagonal element is 0.932 for class a. This implies that the probability of a product with a comparative disadvantage in the period 1997-1998 being the same status in the period 2009-2010 is 0.932. The probability of moving from class a to class b(weak comparative advantage) and class c(medium comparative advantage) is 0.049 and 0.018 respectively. There is very low chance of moving from class a to class d(high comparative advantage).

Second, unlike the observations in class a, the observations for RCA index in class b(weak comparative advantage), class c(medium comparative advantage) and class d(high comparative advantage) reveal significant variation in their pattern. With regard to class b, the probability of losing comparative advantage for those observations beginning with a weak comparative advantage is relatively high(0.581). There is low chance of moving from class b to class c or d. Within class c, the probability of an observation remaining in this class in the period 2009-2010 is only 0.256. The probability of moving from class c to class a or class b is relatively high(0.385 and 0.308 respectively). For class d, the probability of remaining in the same status or moving to other classes is equal.

The stickiness of class a overtime can be explained by the changing composition of factor endowment in Korea. Korea is neither a natural resource nor unskilled labor abundant country. Instead, Korean economy has accumulated capital and skilled labor sometimes artificially initiated by the government. The country's gross domestic expenditure on research and development(R&D) as percentage of GDP is 3.36 percent in 2008, which is higher than that of UK(1.77 percent),

Germany(2.68 percent) and USA(2.79 percent). At the same time, the country's tertiary academic attainment in population age of 25-64 is 38 percent, which is higher than that of Germany(26.4 percent), France(28.9 percent) and UK(36.9 percent).

<Table 8> The Mobility Index from 1997 to 2008

From	To	M_1	M_2	M_3
1997-1998	1999-2000	0.297	0.671	0.125
1999-2000	2001-2002	0.257	0.623	0.090
2001-2002	2003-2004	0.353	0.748	0.163
2003-2004	2005-2006	0.369	0.765	0.189
2005-2006	2007-2008	0.289	0.669	0.099
2007-2008	2009-2010	0.223	0.572	0.053
1997-1998	2009-2010	0.748	0.991	0.523

Source: The authors' computation.

The values of M_1 show that there is low degree of mobility from 1997-1998 to 1999-2000, from 1999-2000 to 2001-2002, from 2005-2006 to 2007-2008, and from 2007-2008 to 2009-2010. However, there is a moderate degree of mobility from 2001-2002 to 2003-2004 and from 2003-2004 to 2005-2006 due the mobility in class b and c. In terms of ranking, three indices provide the same result: the period from 2003-2004 to 2005-2006 is the most dynamic, while the period from 2007-2008 to 2009-2010 is the most static. The empirical results in the study are overall consistent with those of Lee(1995) and Choi and Lee(2010) in that they all showed that changes in comparative advantage in Korea had been dynamic and flexible. Lee(1995) argued that Korea gained dynamic comparative advantage by artificially nurturing capital intensive industries within labor abundant environment. Also, in his study, labor intensive industries maintained their competitiveness by specializing their products, even though most of them were losing their comparative advantage.

4. The degree of the commodity concentration

Table 9 reports the breakdown of the Gini-Hirschman index into five commodity groups according to the factor intensity for the period from 1997 to 2010. As before, these commodity groups include primary products(PP), natural resource intensive products(NRI), unskilled labor intensive products(ULI), technology intensive products(TEI) and human capital intensive products(HCI).

<Table 9> The Gini-Hirschman Index

Year	Total	PP	NRI	ULI	TEI	HCI
1997	0.15	0.30	0.30	0.30	0.13	0.23
1998	0.14	0.29	0.34	0.27	0.14	0.24
1999	0.12	0.29	0.33	0.25	0.16	0.23
2000	0.11	0.28	0.34	0.25	0.14	0.23
2001	0.12	0.26	0.33	0.28	0.14	0.23
2002	0.13	0.24	0.33	0.31	0.15	0.23
2003	0.13	0.24	0.34	0.34	0.17	0.25
2004	0.14	0.23	0.33	0.34	0.20	0.26
2005	0.15	0.23	0.33	0.39	0.22	0.26
2006	0.17	0.23	0.34	0.44	0.24	0.26
2007	0.17	0.24	0.32	0.46	0.24	0.28
2008	0.18	0.24	0.30	0.51	0.25	0.29
2009	0.21	0.23	0.32	0.55	0.27	0.28
2010	0.19	0.25	0.31	0.49	0.26	0.28
β	0.016**	-0.008**	-0.001	0.027**	0.027**	0.008**
t-test	(4.47)	(-4.56)	(-1.07)	(9.07)	(11.02)	(7.89)
AdjR^2	0.593	0.603	0.011	0.862	0.903	0.825

Source: The authors' computation based on UNSD data.

Note: * Significant at 0.05 level; ** Significant at 0.01 level. PP=Primary products; NRI=Natural resource intensive; ULI=Unskilled labor intensive; TEI=Technology intensive; HCI=Human capital intensive.

According to data in Table 9, unskilled labor intensive products register the highest degree of specialization. This means that exports of products in this group are concentrated on a few products. In fact, tankers of all kinds(SITC 97322) accounts for 47.06 percent of total mineral resource intensive exports. In contrast, human capital intensive products exhibit the lowest degree of specialization. The exports of products in this group are spread among a large number of export lines. There is only one product category(SITC 67491), which makes up approximately 21 percent of total human capital intensive products.

Following Ferto(2007), we perform the regression in which the log of GH index is regressed on a simple time trend. The results show a significant downward trend in the degree of specialization in primary products and an ambiguous reduction in the degree of specialization in natural resource intensive products. In contrast, there is a significant increase in the specialization of exports in all other remaining commodity groups. The empirical results show a significant increase in the export of human capital and technology intensive products. This situation can be explained by the ability of the RCA index to support the catch up process, in which, an economy can shift its comparative advantage from one sector to another by changing the factor proportion and opening up of its markets. In this case, developing countries take over unskilled labor intensive product lines from Korea so that Korea could concentrate its resources on the producing and exporting human capital and technology intensive products.

IV. Conclusion

This paper employs various analytical tools to investigate the patterns and dynamics of Korea's export specialization during 1997

and 2010.

Conclusions made from this empirical analysis are summarized as follows. *First*, Korea follows the Heckscher-Ohlin model. In other words, the patterns of Korea's export specialization have become more in conformity with its factor endowment. Technology and human capital intensive products are those product categories, which enjoy comparative advantage. *Second*, regarding the stability of the distribution of RCA, the Galtonian regression results suggest that the pattern of Korea's export specialization has more or less diverged. The results show that there is a movement towards specialization. *Third*, regarding the intra-distribution dynamics, there is a relatively high degree of persistence among industries, which initially have no comparative advantage(class a). Industries with weak comparative advantage(class b) and medium comparative advantage(class c) have a relatively high probability of moving towards the position of comparative disadvantage, and low probability of moving towards the position of high comparative advantage. This suggests a low degree of mobility in pattern of trade for classes a, and a moderate mobility in the pattern of trade for class d, and higher degree of mobility in the pattern of trade for classes b and c. *Fourth*, while unskilled labor intensive products show relatively high degree of export specialization, other product categories exhibit relatively high degree of export diversification. Overall, there is a upward trend in the degree of specialization for all commodity groups. *Fifth*, although there is evidence that human capital and technology intensive products has gained comparative advantage, it is still far from being strong comparative advantage in these product categories. *Finally*, Korea's exports are heavily dominated by technology and human capital intensive products. However, there was a discernable reduction in the share of unskilled labor intensive products in total exports.

For the developing countries, which are in the process of capital accumulation and technology upgrading, specialization in the human capital and technology intensive sectors are pivotal to the country's economic development in dynamic sense. Therefore, efforts to increase the national human capital stock, invest in R&D activities, promote trade liberalization and take part in the global production sharing are effective remedies for them to shift their comparative advantage from traditional inefficient sectors to knowledge and technology based ones.

| Appendices |

<Appendix 1A> The Galtonian Regression Results for Primary Products

$RSCA_{ij}^{t1}$	$RSCA_{ij}^{t2}$	Constant	β	R	β /R	t-test	Observations
1997-1998	1999-2000	-0.083	0.902	0.928	0.972	38.69	243
1999-2000	2001-2002	-0.076	0.915	0.949	0.965	46.57	243
2001-2002	2003-2004	-0.067	0.934	0.969	0.964	60.98	243
2003-2004	2005-2006	-0.033	0.965	0.972	0.993	63.79	243
2005-2006	2007-2008	-0.055	0.938	0.950	0.988	47.06	243
2007-2008	2009-2010	-0.032	0.966	0.979	0.987	73.65	243
1997-1998	2009-2010	-0.288	0.687	0.784	0.876	19.63	243

Source: The authors' computation.

Note: * Significant at 0.05 level; ** Significant at 0.01 level.

<Appendix 1B> The Galtonian Regression Results for Natural Resource Intensive Products

$RSCA_{ij}^{t1}$	$RSCA_{ij}^{t2}$	Constant	β	R	β /R	t-test	Observations
1997-1998	1999-2000	-0.065	0.971	0.949	1.023	23.23	61
1999-2000	2001-2002	0.023	0.980	0.947	1.035	22.53	61
2001-2002	2003-2004	-0.020	0.936	0.964	0.970	28.01	61
2003-2004	2005-2006	-0.052	0.920	0.922	0.998	18.25	61
2005-2006	2007-2008	-0.030	0.948	0.961	0.987	26.66	61

2007-2008	2009-2010	-0.037	0.951	0.973	0.978	32.49	61
1997-1998	2009-2010	-0.192	0.676	0.684	0.989	7.20	61

Source: The authors' computation.

Note: * Significant at 0.05 level; ** Significant at 0.01 level.

<Appendix 1C> The Galtonian Regression Results for Unskilled Labor Intensive Products

$RSCA_{ij}^{t1}$	$RSCA_{ij}^{t2}$	Constant	β	R	β /R	t-test	Observations
1997-1998	1999-2000	-0.016	0.930	0.956	0.973	33.81	111
1999-2000	2001-2002	-0.028	0.951	0.953	0.999	32.67	111
2001-2002	2003-2004	-0.143	0.904	0.930	0.972	26.39	111
2003-2004	2005-2006	-0.107	0.925	0.937	0.987	28.11	111
2005-2006	2007-2008	-0.110	0.909	0.928	0.979	26.10	111
2007-2008	2009-2010	-0.064	0.940	0.972	0.967	43.13	111
1997-1998	2009-2010	-0.404	0.621	0.703	0.883	10.33	111

Source: The authors' computation.

Note: * Significant at 0.05 level; ** Significant at 0.01 level.

<Appendix 1D> The Galtonian Regression Results for Technology Intensive Products

$RSCA_{ij}^{t1}$	$RSCA_{ij}^{t2}$	Constant	β	R	β /R	t-test	Observations
1997-1998	1999-2000	-0.003	0.942	0.919	1.025	35.21	230
1999-2000	2001-2002	0.041	0.958	0.958	1.000	50.43	230
2001-2002	2003-2004	-0.025	0.927	0.949	0.977	45.22	230
2003-	2005-	0.023	0.978	0.956	1.023	49.31	230

2004	2006						
2005-2006	2007-2008	-0.011	0.964	0.952	1.012	47.15	230
2007-2008	2009-2010	0.000	0.961	0.964	0.997	55.12	230
1997-1998	2009-2010	-0.001	0.707	0.684	1.033	14.17	230

Source: The authors' computation.

Note: * Significant at 0.05 level; ** Significant at 0.01 level.

<Appendix 1E> The Galtonian Regression Results for Human Capital Intensive Products

$RSCA_{ij}^{t1}$	$RSCA_{ij}^{t2}$	Constant	β	R	β /R	t-test	Observations
1997-1998	1999-2000	-0.062	0.895	0.919	0.974	25.97	126
1999-2000	2001-2002	-0.015	0.955	0.946	1.010	32.49	126
2001-2002	2003-2004	-0.097	0.882	0.916	0.963	25.48	126
2003-2004	2005-2006	-0.046	0.922	0.926	0.996	27.32	126
2005-2006	2007-2008	-0.080	0.894	0.884	1.012	21.02	126
2007-2008	2009-2010	-0.020	0.905	0.901	1.005	23.07	126
1997-1998	2009-2010	-0.246	0.586	0.611	0.959	8.59	126

Source: The authors' computation.

Note: * Significant at 0.05 level; ** Significant at 0.01 level.

<Appendix 2A> Transition Probability Matrix (1997-1998 and 1999-2000)

Period 1997-1998 \ Period 1999-2000	RCA	a	b	c	d
	a	0.971	0.026	0.003	0.000
	b	0.186	0.686	0.128	0.000
	c	0.077	0.128	0.744	0.051
	d	0.032	0.000	0.258	0.710
	Initial distribution	0.798	0.111	0.050	0.040
	Final distribution	0.801	0.103	0.065	0.031

Source: The authors' computation based on UNSD at 3-digit SITC.

<Appendix 2B> Transition Probability Matrix (1999-2000 and 2001-2002)

Period 1999-2000 \ Period 2001-2002	RCA	a	b	c	d
	a	0.981	0.019	0.002	0.000
	b	0.263	0.613	0.113	0.013
	c	0.000	0.180	0.760	0.060
	d	0.042	0.042	0.042	0.875
	Initial distribution	0.801	0.103	0.065	0.031
	Final distribution	0.814	0.091	0.063	0.032

Source: The authors' computation based on UNSD at 3-digit SITC.

<Appendix 2C> Transition Probability Matrix (2001-2002 and 2003-2004)

Period 2001-2002 \ Period 2003-2004	a	b	c	d
a	0.978	0.022	0.000	0.000
b	0.400	0.529	0.057	0.014
c	0.000	0.204	0.796	0.000
d	0.080	0.040	0.240	0.640
Initial distribution	0.814	0.091	0.063	0.032
Final distribution	0.834	0.080	0.063	0.022

Source: The authors' computation based on UNSD at 3-digit SITC.

<Appendix 2D> Transition Probability Matrix (2003-2004 and 2005-2006)

Period 2003-2004 \ Period 2005-2006	a	b	c	d
a	0.961	0.037	0.002	0.000
b	0.242	0.694	0.048	0.016
c	0.061	0.306	0.592	0.041
d	0.000	0.000	0.353	0.647
Initial distribution	0.834	0.080	0.063	0.022
Final distribution	0.825	0.106	0.050	0.018

Source: The authors' computation based on UNSD at 3-digit SITC.

<Appendix 2E> Transition Probability Matrix
(2005-2006 and 2007-2008)

Period 2005-2006	Period 2007-2008			
RCA	a	b	c	d
a	0.973	0.025	0.002	0.000
b	0.268	0.610	0.110	0.012
c	0.077	0.154	0.692	0.077
d	0.000	0.071	0.071	0.857
Initial distribution	0.825	0.106	0.050	0.018
Final distribution	0.836	0.094	0.049	0.021

Source: The authors' computation based on UNSD at 3-digit SITC.

<Appendix 2F> Transition Probability Matrix
(2007-2008 and 2009-2010)

Period 2007-2008	Period 2009-2020			
RCA	a	b	c	d
a	0.983	0.015	0.002	0.000
b	0.164	0.726	0.110	0.000
c	0.026	0.263	0.684	0.026
d	0.000	0.000	0.063	0.938
Initial distribution	0.836	0.094	0.049	0.021
Final distribution	0.838	0.094	0.047	0.021

Source: The authors' computation based on UNSD at 3-digit SITC.

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| **논문투고일**: 2012년 04월 02일 |
| **논문심사일**: 2012년 04월 05일 |
| **게재확정일**: 2012년 04월 16일 |

ABSTRACT
Journal of Asia-Pacific Studies Vol. 19. No. 1 (2012)

Dynamics and Divergence of Export Specialization in Korea

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This paper examines the dynamics and divergence of Korea's export specialization. Using various analytical tools, our empirical findings are summarized as follows: First, Korea follows the Heckscher-Ohlin model in that the patterns of Korea's comparative advantage have become more in conformity with its factor endowment. Second, the pattern of Korea's revealed comparative advantage has been diverged moving towards specialization. Third, while RCA indices in class a (products comparatively disadvantaged) is persistent, the corresponding figure for other classes exhibit moderate variation in their pattern. Fourth, while unskilled labor intensive products show relatively high degree of export specialization, other product categories demonstrate relatively high degree of export diversification. We find that there exists an upward trend in the degree of specialization for all commodity groups. Finally, Korea's exports are heavily dominated by technology and human capital intensive products.

Key words: Export Specialization, Structural Stability, Revealed Comparative Advantage, Galtonian Regression, Markov

Transition Probability Matrix