

12-01 (Vol. 001)

2012. 6. 21.

HRI

Korea Economic Review

- Estimating the GDP of North Korea

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Weekly Assessment of Major Economic Indicators (6.1~6.7)

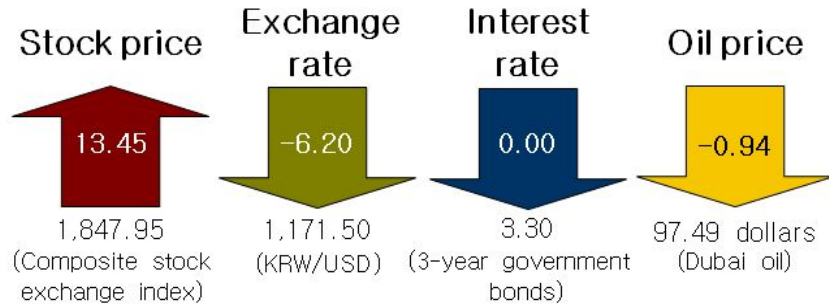
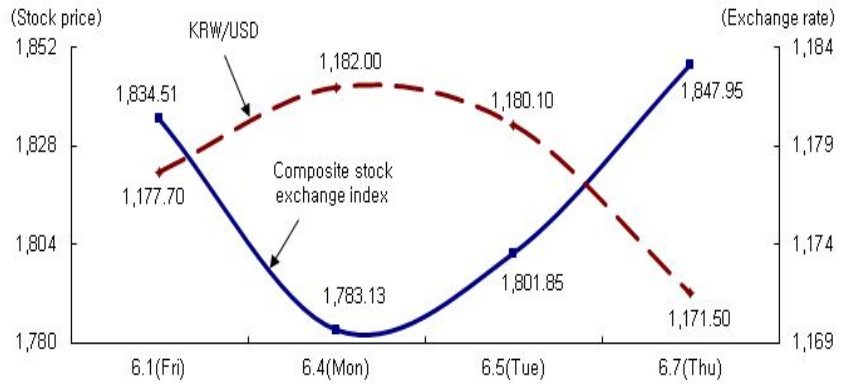


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□ Editor : Yu Byounggyu, Director of Economic Research Division (2072-6210, bkyoo@hri.co.kr)
 □ Written by : Kim Cheon-Koo, Senior Researcher (2072-6211, ck1009@hri.co.kr)

Executive Summary

□ Estimating the GDP of North Korea

■ The HRI North Korea GDP Estimation Model

In August 2011, the Hyundai Research Institute was able to estimate North Korea's GDP per capita using its self-developed HRI North Korea GDP Estimation Model that utilizes infant mortality rates, one of the indicators of health. This report utilizes an improved version of the existing model that incorporates yearly grain output to produce more detailed results.

■ 2011 North Korea GDP Per Capita Estimation

According to calculations using the improved estimation model, North Korea's GDP per capita increased from 688 USD in 2010 to 720 USD in 2011, a difference of 32 USD.

In 2011, North Korea's GDP per capita was 3% of South Korea's (23,749 USD). Economically, North Korea trails behind other Communist countries (China: 5,194 USD, Laos: 1,204 USD, Vietnam: 1,362 USD). The countries showing similar income levels as North Korea are Bangladesh (690 USD), Nepal (644 USD), and Zimbabwe (735 USD).

■ 2011 General State of North Korea's Economic Growth

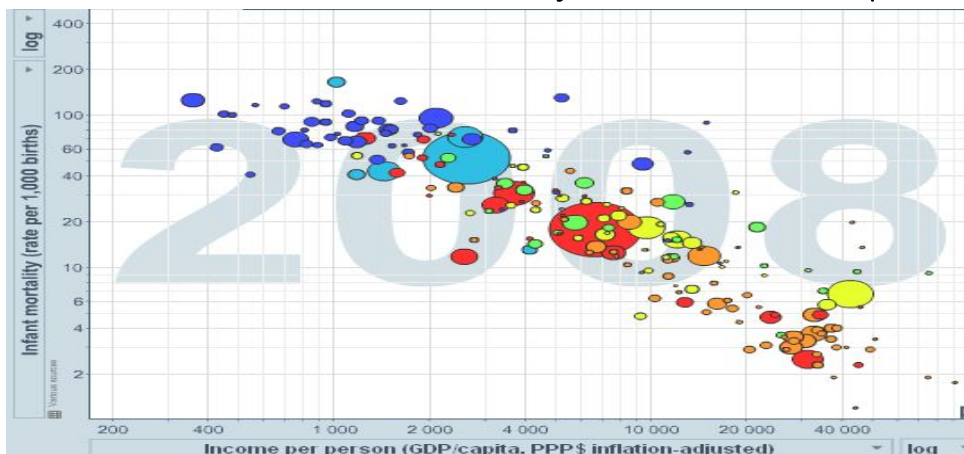
(Domestic) North Korea's economy in 2011 showed some growth as a result of improvements in crop harvesting and the concentrated short-term efforts of the government to build a "strong and prosperous state." The Food and Agriculture Organization (FAO) reports that in 2011, North Korea produced 4,740,000 tons of grain, an increase of 7.2% compared to 4,420,000 tons produced in 2010. In addition, as 2012 was the year of "strong and prosperous" growth in North Korea, concentrated state effort was invested into securing increased provisions for families, constructing 100,000 residences, and resolving the issues of power shortages.

(Overseas) In terms of international relations, North Korea increased its trade with China, progressed its maintenance of the Kaesong Industrial Complex, and continued to receive international aid. China-North Korea trade reached a turnover of 5.63 billion USD, a steep increase of 62.4% compared to 3.47 billion USD recorded in 2010. Trade at the Kaesong Industrial Complex reached 1.7 billion USD, a 17.7% increase compared to 1.44 billion USD in 2010. International aid totaled 97.71 million USD, the highest amount recorded since 2007, showing over a three-fold increase in aid provision compared to 21.78 million USD provided in 2010.

I. HRI North Korea GDP Estimation Model

- **(Methodology)** The HRI North Korea GDP Estimation Model estimates North Korea's income levels through analyzing the correlations between national economic growth and infant mortality rates.
 - The HRI North Korea GDP Estimation Model offers a more effective means of estimation, as it utilizes a health indicator (infant mortality rates) and thus improves upon the problems of the previous estimation model.
 - The health indicator used in the HRI estimation model is a fairly reliable physical indicator, as verified by the UN and other international aid agencies
 - Infant mortality rate is the most suitable indicator for calculating North Korea's income levels because it reacts sensitively to the deterioration of personal hygiene, nutrient deficiency, the reduction of medical coverage, and the worsening of general health, all of which are affected by changes in business cycles¹⁾
 - HRI's model increases the accuracy of the estimation of North Korea's GDP by taking into consideration the individual characteristics of other underdeveloped countries regarded as similar to North Korea in terms of economic development.²⁾
 - A health indicator is used to compensate for the problems of the price structure utilized by the Bank of Korea and in other research.
- **(Limitations)** However, the infant mortality rate utilized in the HRI North Korea GDP Estimation Model is assessed every five years, limiting the analysis of yearly changes.

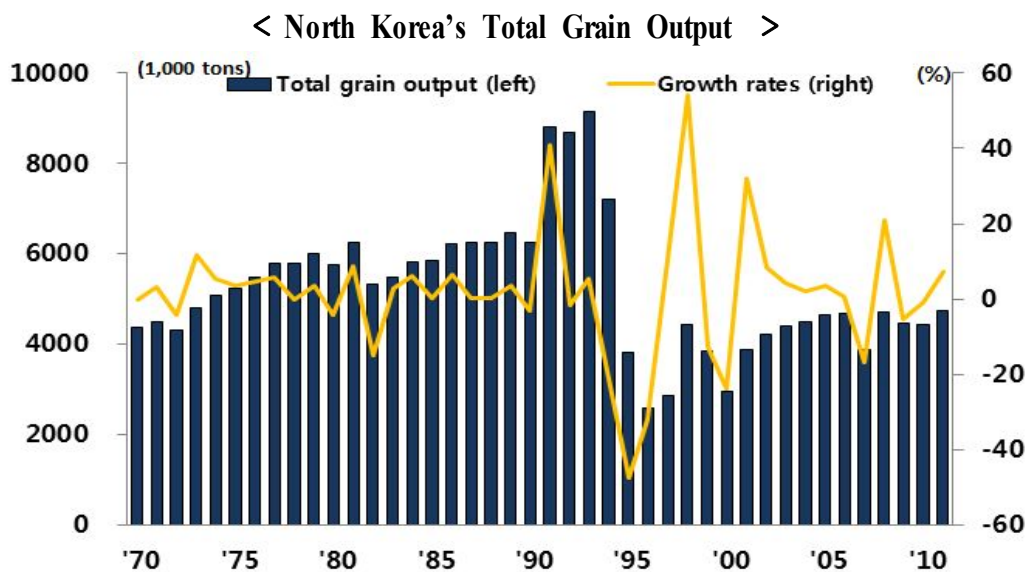
< Correlations between Infant Mortality Rates and GDP Per Capita >



Source : UN, Child Mortality, IMF
 Note : GDP per capita and infant mortality rates have been log-transformed.

- 1) The correlation between infant mortality rates and GDP is -0.97 , a higher correlation than with other health indicators.
- 2) Overestimations occur when North Korea's growth rates are calculated using South Korea's price structure. When South Korea's exchange rate systems are used to convert North Korean GDP to USD standards, the results are only useful for comparison with South Korean data.

- **(Changes)** The results of the estimation model have been enhanced by incorporating yearly grain output into the calculations, on top of the 5-year infant mortality rates previously used, allowing for the calculation of yearly figures³⁾
- **Infant mortality rates:** By utilizing grain output data in conjunction with the infant mortality rates reported by the UN, infant mortality rates can be calculated in units of one year.
 - Grain output has been used to reduce the interval of infant mortality rates from five to one.⁴⁾
 - The figures used in the model are derived from FAO's year-end crop survey of North Korea.
- The FAO reports that from 1961-2011, North Korea has produced an average of 5.7 million tons of grain per year.
 - Grain output amounted to about 4 million tons in 1970, and until the early 1990s the output continued to rise.
 - After recording a record-high 9.14 million tons of grain in 1993, grain output took a steep downfall to 2.6 million tons produced in 1996, resulting in a severe shortage of food.
 - Transitioning into the 2000s, grain output showed weak growth and was unable to recover back to early 1990s-levels.



Source : FAO
 Note : From 1961 to 2011, N. Korea's grain output was an average of 5.007 million tons. The minimum value was 2.593 million tons (1996), and the maximum value was 9.137 million tons (1993)

3) Although the model has been made more explanatory, it still cannot account for sudden economic changes.

4) North Korea's infant mortality rates and grain production rates correlate at a very high value of -0.6.

II. North Korea's GDP Per Capita in 2011

- GDP has been calculated utilizing infant mortality rates and GDP per capita panel data from 198 countries from 2000-2008, while incorporating an individual characteristic of the country after analyzing the correlation between infant mortality rates and GDP.
- **Regression analysis** : A regression analysis was performed through a fixed effect-model panel analysis with GDP per capita set as the dependent variable and infant mortality rates set as the independent variable.

$$\text{(Regression Analysis)} \quad y_{it} = \alpha + \beta x_{it} + u_i + e_{it}$$

$$i=\text{country}, t=\text{year}$$

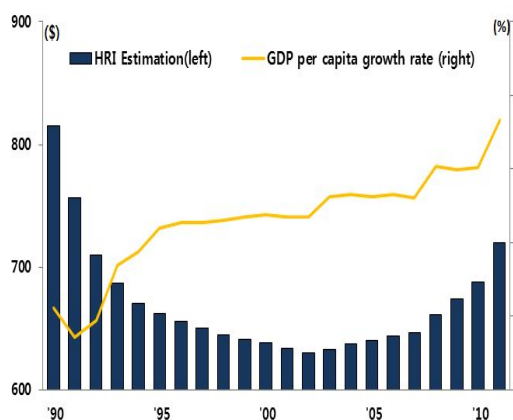
- **Dependent variable**(y_{it}) : The dependent variable was determined by log-transforming the GDP per capita data of 198 countries from 2000-2008, as reported by the IMF.
- **Independent variable**(x_{it}) : The independent variable was determined by log-transforming the infant mortality rates of 198 countries from 2000-2008, as reported by Child Mortality and the UN.
 - By integrating grain output data with the UN's infant mortality data, infant mortality rates can be calculated in units of one year.
- **North Korea's characteristic** (u_i) : North Korea's characteristic is assumed to be the same as those of other underdeveloped countries.
 - In the case of a fixed effect, each country has its own unique u_i .
 - To estimate North Korea's characteristic (u_i), the characteristics of other countries with less than 3,000 USD GDP per capita were found, averaged, and assumed to be the same as North Korea's characteristic.⁵⁾

5) Individual analyses were performed for countries with less than 1000 USD, 2000 USD, and 3000 USD income, and it was determined that North Korea's individual characteristic was closest to that of countries with less than 3000 USD income.

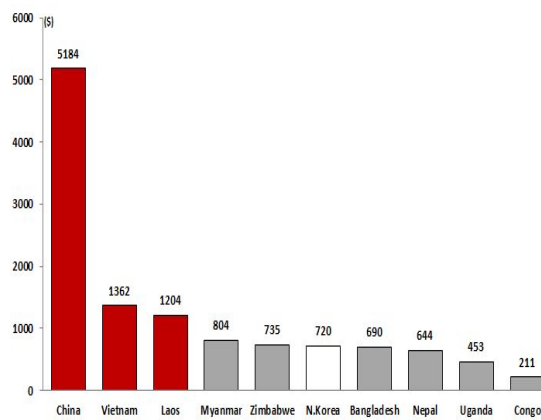
○ (Results) A regression analysis⁶⁾ reveals North Korea's 2011 GDP per capita to be 720 USD, a 32 USD increase from 688 USD in 2010.

- **North Korea's economy over time** : It is estimated that North Korea's 2011 GDP per capita was 720 USD, an increase from 688 USD in 2010.
 - In 1987, North Korea recorded a GDP per capita of 986 USD, marking the zenith of its economic power. Due to continued negative growth, however, the figures fell to the mid 600s in the early 2000s.
 - Entering the 2000s, North Korea experienced a small economic improvement, but it has not yet been able to recover its economy back to late 1980s-levels (its time of peak economic health).
 - However, the economy has shown steady improvement, with GDP per capita increasing from 674 USD in 2009, to 688 USD in 2010, and to 720 USD in 2011.
- **Comparisons of countries** : North Korea's GDP per capita is lower than those of other Communist countries and amounts to about 3% of South Korea's.
 - North Korea's GDP per capita is greatly lower than those of other Communist countries: China (5,194 USD), Laos (1,204 USD), Vietnam(1,362 USD).
 - Countries with similar income levels as North Korea are Bangladesh (690 USD), Nepal (644 USD), and Zimbabwe (735 USD).
 - While North Korea's GDP per capita is showing signs of recovery as of 2011, it amounts to just 3% of South Korea's (23,749 USD), which is similar to South Korea's GDP per capita in the mid-1970s.

< North Korea's GDP Per Capita >



< A Comparison of GDP Per Capita by Country >



Source: Estimations by the Hyundai Research Institute

Note 1 : The figures shown are as of 2011.
 Note 2 : Red indicates Communist countries.

6) The regression analysis resulted in $\alpha = 11.13$, $\beta = -0.69$ with a level of significance of 1%. This reveals that when the log value changes by 1 unit, the log of GDP per capita decreases by 0.69.

< Estimations for North Korea's GDP Per Capita >

(Unit: USD)

Year	S. Korea	North Korea				
		HRI	Bank of Korea	UN	Kim Byeong-yeon	N. Korea's Official Figures
1970	255	636	-	388	587	-
1971	291	661	-	416	598	-
1972	322	686	-	448	606	-
1973	404	704	-	482	617	-
1974	559	724	-	521	639	-
1975	607	747	-	563	641	-
1976	825	772	-	577	653	-
1977	1,043	802	-	592	626	-
1978	1,443	819	-	609	700	-
1979	1,693	837	-	626	654	-
1980	1,660	856	-	642	721	-
1981	1,826	878	-	656	760	-
1982	1,927	897	-	810	744	-
1983	2,113	912	-	795	768	-
1984	2,300	929	-	745	738	-
1985	2,355	946	-	723	738	-
1986	2,702	965	-	805	732	-
1987	3,402	986	-	836	744	-
1988	4,548	920	-	764	765	-
1989	5,556	863	-	811	786	-
1990	6,303	815	1,146	735	720	-
1991	7,276	757	1,115	663	683	-
1992	7,714	710	1,013	593	599	990
1993	8,402	687	969	503	554	991
1994	9,727	670	992	384	562	722
1995	11,735	662	1,034	222	549	587
1996	12,518	656	989	479	489	482
1997	11,505	650	811	462	472	464
1998	7,607	645	573	456	412	458
1999	9,778	641	714	452	426	454
2000	11,292	638	757	462	466	464
2001	10,631	634	706	476	433	478
2002	12,100	630	762	468	465	490
2003	13,460	633	818	471	476	524
2004	15,082	637	914	473	478	546
2005	17,531	640	1,056	549	497	-
2006	19,722	644	1,108	578	496	-
2007	21,695	647	1,152	601	471	-
2008	19,296	661	1,065	555	-	-
2009	17,193	674	932	499	-	-
2010	20,759	688	1,074	-	-	-
2011	23,749	720	-	-	-	-

III. 2011 General State of North Korea's Economic Growth

- (Domestic) North Korea's increases in crop output due to improvements in economy in 2011, and its concentrated efforts in 2012 to establish itself as a "strong and prosperous state," appear to have contributed to economic growth.
- **Agricultural industry** : According to data reported by the FAO in December, North Korea is estimated to have produced 4.74 million tons of grain in 2011, a possible increase of 7.2% compared to 4.42 million tons produced in 2010.
 - Rice output is predicted to have amounted to 2.48 million tons, a 2.2% increase compared to 2.43 million tons produced in 2010. Corn output is predicted to have increased by 9.4%, from 1.86 million tons in 2010 to 2.03 million tons in 2011.
 - In terms of livestock, while North Korea has maintained the same number of cattle and pigs, 577,000 and 2,269 million respectively, the number of chickens and rabbits has sharply increased, to 15.843 million and 32.01 million, respectively.
 - A "strong and prosperous state" : Welcoming 2012 as the year of establishing a strong and prosperous state, the government has focused its efforts into securing food, constructing 100,000 new residences, and resolving issues regarding power shortages.
 - To secure food for domestic use in 2011, North Korea promoted further trade with China, maintained active contact with overseas relief organizations, and ensured that a fixed quantity of food was procured from trade and overseas resident employees.
 - Regarding electrical power, the government is in the process of constructing three power plants: Heecheon, Eorangcheon, and Mt. Baekdu Youth. Once completed, these plants will increase the supply of power to 400,000 kW.
 - As the construction of 100,000 residences in Pyongyang City is the key agenda that symbolizes the establishment of a strong and prosperous state, full government support is being concentrated into securing financial resources, distributing construction materials, and advancing the process of construction.

< North Korea's Grain Output >

(Unit: 1,000 tons, %)

	2006-2010	2010	2011(E)
Rice	2,226	2,426	2,479 (2.2)
Corn	1,711	1,858	2,032 (9.4)
Wheat	145	83	127 (53.0)
Other	138	55	104 (89.1)
Total	4,220	4,422	4,742 (7.2)

Source: World Food Programme (WFP), Food and Agriculture Organization (FAO)

Note: Figures marked in parentheses are increase rates compared to the previous year's figures.

< North Korea's Livestock >

(Unit: 1,000 heads, %)

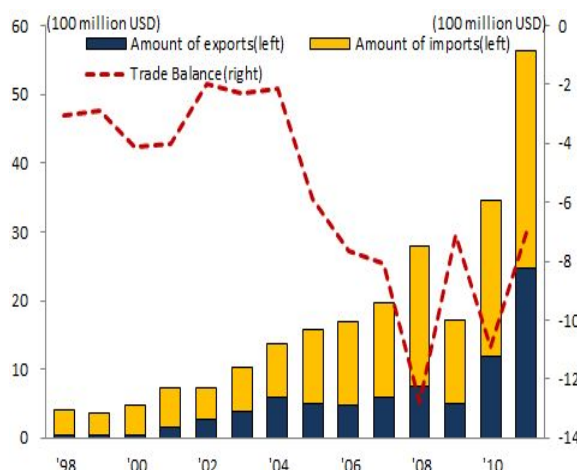
	2009	2010	2011(E)
Cattle	576 (0.0)	577 (0.2)	577 (0.0)
Pigs	2,150 (-1.3)	2,248 (4.6)	2,269 (0.9)
Goats	3,570 (3.7)	3,556 (-0.4)	3,657 (2.8)
Chickens	13,859 (-1.5)	14,943 (7.8)	15,843 (6.0)
Ducks	8,900 (51.4)	5,936 (-33.3)	6,002 (1.1)
Rabbits	28,500 (7.7)	28,571 (0.2)	32,010 (12.0)

Source: World Food Programme (WFP), Food and Agriculture Organization (FAO)

Note: Figures marked in parentheses are increase rates compared to the previous year's figures.

- (Overseas) North Korea expands trade, its main source of foreign currency revenue, and continues to develop the Kaesong Industrial Complex, while the international community contributes to North Korea's economic growth.
- **North Korea-China Trade:** The trade turnover between North Korea and China in 2011 reached 5.63 billion USD, a steep increase of 62.4% compared to figures from the same term of the previous year.
 - North Korea's exports to China increased by 107.4% compared to last year's figures, reaching 2.46 billion USD. Imports reached 3.17 billion USD, an increase of 38.9% compared to figures from the same term of the previous year.
 - The trade deficit between NK and China has shown improvement, from 1.09 billion USD in 2010 to 700 million USD in 2011.
- North Korea's top five items exported to China: anthracite coal, minerals, clothing, steel, and fish/shellfish, accounted for 87.2% of all exports.
 - Anthracite coal export to China amounted to 950 million USD, a 226.4% increase compared to 290 million USD from the same term of the previous year. The export of minerals amounted to 300 million USD, a 70.7% increase compared to 200 million USD from the same term of the previous year.
 - Clothing export to China amounted to 300 million USD, a 152.1% increase compared to 120 million USD from the same term of the previous year.
 - Steel export to China amounted to 130 million USD, a 53.0% increase compared to 80 million USD from the same term of the previous year.

< North Korea-China Trade >



Source: The Korea International Trade Association

< North Korea's Major Items of Export to China >

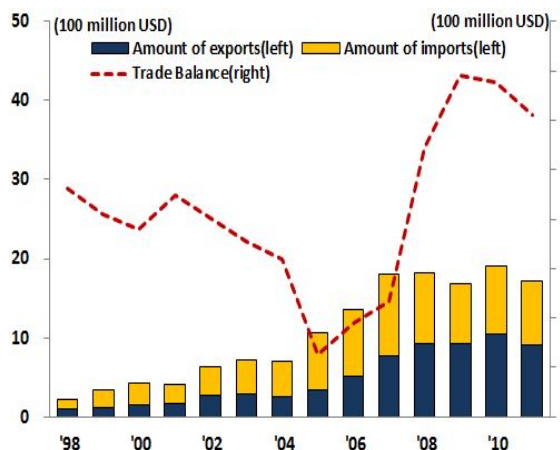
(Unit: 1 million USD, %)

Rank	Item	2010	2011	Increase Rate
1st	Anthracite coal	291.2	950.5	226.4
2nd	Minerals	196.7	335.8	70.7
3rd	Clothing & Apparel	120.0	302.4	152.1
4th	Steel	81.9	125.3	53.0
5th	Fish/shell fish	51.2	67.9	32.7

Source: The Korea International Trade Association
 Note: Figures for 2010 and 2011 are accumulations of figures from January to October.

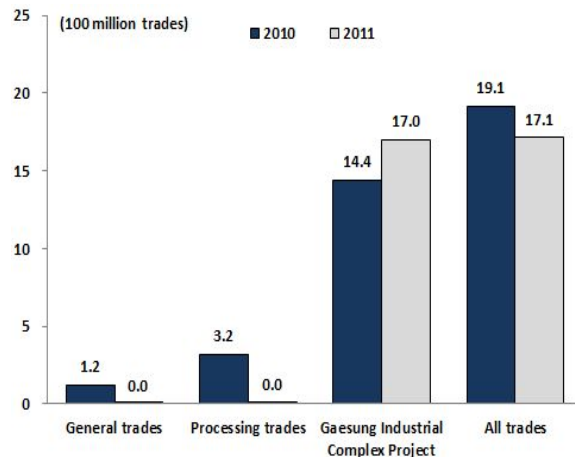
- **N. Korea-S. Korea trade:** The trade turnover between North and South Korea continued to increase until the mid-2000s and began to plateau after 2008, and recorded 1.71 billion USD in 2011, a decrease of 10.4% compared to figures from the previous year.
- N. Korea's exports to S. Korea amounted to 910 million USD, a decrease of 12.8% compared to figures from the same month of the previous year, while N. Korea's imports from S. Korea amounted to 800 million USD, a decrease of 7.9% compared to figures from the same month of the previous year.
- The trade deficit between N. Korea and S. Korea decreased by a small margin, from 180 million USD in 2010, to 110 million USD in 2011.
- While North Korea engaged in a nearly negligible amount of general trades and processing trades, the total trade turnover of the Kaesong Industrial Complex increased by a large margin.
- Compared to 120 million USD in 2010, the turnover for general trade in 2011 was lower by 99.8%, at 200,000 USD.
- Processing trades also amounted to 3.7 million USD, a downfall of 98.8% compared to 320 million USD recorded in 2010.
- Trade for the Kaesong Industrial Complex increased greatly, by 17.7%, from 1.44 billion USD in 2010 to 1.7 billion USD in 2011.

< Trade in North/South Korea >



Data: Korea Customs Service, The Korea International Trade Association

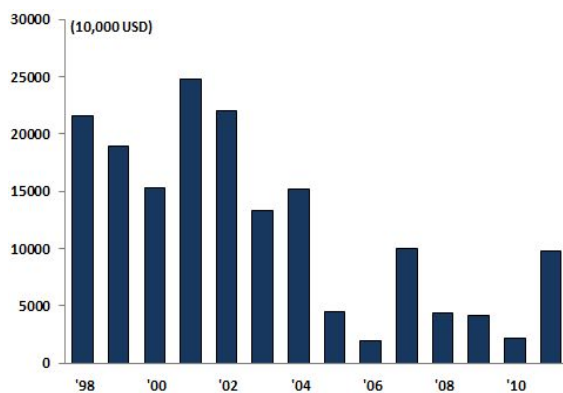
< Trade in North/South Korea by Category >



Data: Ministry of Unification

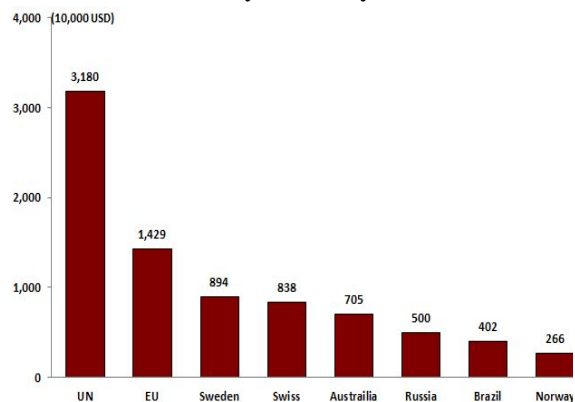
- **International aid:** While the support of North Korea by the international community dropped sharply after the period of the North Korean Famine (Arduous March), in which N. Korea experienced extreme economic distress, it increased greatly in 2011.
- In 2011, North Korea strengthened its relations with overseas relief organizations and became significantly more cooperative in heeding to their requests for increased monitoring and access to closed-off areas.
- International aid amounted to 97.71 million USD in 2011, the highest figure recorded since 2007 and more a three-fold increase compared to 21.78 million USD of aid provided in 2010.
- The UN's emergency aid to North Korea amounted to 31.8 million USD, which comprises 32.7% of total aid. European countries provided the most aid: 14.29 million USD (European Union), 8.94 million USD (Sweden), and 8.38 million USD (Switzerland).

< International Aid to North Korea >



Data: UN Office for the Coordination of Humanitarian Affairs (UNOCHA)

< 2011 Amounts of North Korean Aid by Country >



Data: UN Office for the Coordination of Humanitarian Affairs (UNOCHA)

- **Although North Korea is currently attempting to pursue more open policies, including currency reform, the reform of certain markets, and the establishment of special economic zones at Shinuiju and Najin/Seonbong, its economic conditions remain at par with mid-1970s levels and, classifying North Korea as still a food-deficit country.**
- For North Korea's economy to recover, an economic base must be established, and agricultural reforms must be made in terms of productivity.

- A structured economic base that establishes a foothold for social overhead capital, energy, resource development, and logistics networks, all of which provide a foundation for industry, must first be created for any substantial growth to take place within the North Korean economy.
- North Korea's crop yield for rice, which amounts to 4.3 tons per hectare, only amounts to about 60% of that of South Korea's. As such, reforms in productivity appropriate to the needs of North Korea must be made, including further technological development, the increase of investments, and improved methods for crop cultivation.

Kim Cheon-Koo, Senior Researcher (02-2072-6211, ck1009@hri.co.kr)

<Appendix> List of Countries by 2011 GDP(nominal) per capita(US \$)
(unit : \$)

Rank	Country	GDP per capita	Rank	Country	GDP per capita
1	Luxembourg	122,272	41	Estonia	16,880
2	Qatar	97,967	42	Trinidad and Tobago	16,693
3	Norway	96,591	43	Antigua and Barbuda	16,284
4	Switzerland	84,983	44	Barbados	15,799
5	Australia	66,984	45	Hungary	14,808
6	UAE	66,625	46	Uruguay	14,672
7	Denmark	63,003	47	Croatia	14,529
8	Sweden	61,098	48	Equatorial Guinea	14,374
9	Netherlands	51,410	49	Chile	13,970
10	Canada	51,147	50	Poland	13,967
11	Singapore	50,714	51	Russia	13,236
12	Austria	50,504	52	Lithuania	13,190
13	Finland	50,090	53	Brazil	12,917
14	Ireland	48,517	54	Saint Kitts and Nevis	12,687
15	United States	48,147	55	Latvia	12,226
16	Belgium	48,110	56	Seychelles	11,117
17	Kuwait	46,461	57	Gabon	10,982
18	Japan	45,774	58	Kazakhstan	10,951
19	Germany	44,556	59	Mexico	10,803
20	France	44,401	60	Argentina	10,640
21	Iceland	43,226	61	Turkey	10,576
22	United Kingdom	39,604	62	Lebanon	10,474
23	New Zealand	38,227	63	Venezuela	10,409
24	Italy	37,046	64	Botswana	8,844
25	Brunei	36,521	65	Romania	8,666
-	Hong Kong	34,393	66	Malaysia	8,617
26	Spain	33,298	67	Mauritius	8,520
27	Israel	32,298	68	Costa Rica	8,489
28	Cyprus	31,435	69	Panama	8,421
29	Greece	27,875	70	South Africa	8,342
30	Slovenia	25,939	71	Grenada	7,913
31	Korea, South	23,749	72	Saint Lucia	7,522
32	Bahrain	23,410	73	Azerbaijan	7,510
33	Bahamas	23,175	74	Suriname	7,281
34	Portugal	22,699	75	Bulgaria	7,243
35	Malta	22,058	76	Colombia	6,980
36	Oman	21,681	77	Dominica	6,833
37	Taiwan	21,592	78	Montenegro	6,668
38	Czech Republic	20,925	79	Maldives	6,499
39	Saudi Arabia	19,890	80	Saint Vincent and the Grenadines	6,447
40	Slovakia	17,889	81	Serbia	6,267

Rank	Country	GDP per capita	Rank	Country	GDP per capita
82	Iran	6,260	122	Philippines	2,255
83	Belarus	6,118	123	Bolivia	2,246
84	Namibia	6,087	124	Honduras	2,105
85	Peru	5,614	125	Moldova	2,022
86	Dominican Republic	5,406	126	Sudan	1,939
87	Jamaica	5,376	127	Kiribati	1,832
88	Thailand	5,281	128	Papua New Guinea	1,712
89	China	5,184	129	Ghana	1,588
90	Angola	5,061	130	Nigeria	1,541
91	Macedonia	5,012	131	Uzbekistan	1,529
92	Algeria	5,001	132	India	1,527
93	Bosnia and Herzegovina	4,715	133	Djibouti	1,500
94	Tunisia	4,593	134	Yemen	1,460
95	Jordan	4,542	135	Solomon Islands	1,457
96	Turkmenistan	4,362	136	São Tomé and Príncipe	1,382
97	Ecuador	4,352	137	Vietnam	1,362
98	Belize	4,349	138	Zambia	1,355
99	Albania	4,131	139	Cameroon	1,234
100	El Salvador	3,831	140	Mauritania	1,227
101	Fiji	3,806	141	Laos	1,204
102	Congo, Republic of the	3,792	142	Nicaragua	1,202
103	Cape Verde	3,737	143	Pakistan	1,164
104	Tonga	3,648	144	Senegal	1,096
105	Ukraine	3,575	145	Côte d'Ivoire	1,049
106	Indonesia	3,469	146	Lesotho	1,040
107	Paraguay	3,421	147	Kyrgyzstan	970
108	Swaziland	3,332	148	Chad	920
109	Iraq	3,306	149	Cambodia	912
110	Guyana	3,202	150	Kenya	882
111	Guatemala	3,177	151	Tajikistan	862
112	Morocco	3,162	152	Comoros	853
113	Mongolia	3,131	153	Burma	804
114	Georgia	3,098	154	Mali	796
115	Vanuatu	3,081	155	Benin	756
116	Syria	3,050	156	Haiti	739
117	Samoa	3,049	157	Zimbabwe	735
118	Armenia	3,048	158	Korea, North	720
119	Egypt	2,922	159	Bangladesh	690
120	Sri Lanka	2,864	160	Burkina Faso	670
121	Bhutan	2,299	161	East Timor	649

Rank	Country	GDP per capita
162	Nepal	644
163	Gambia	620
164	Guinea-Bissau	586
165	Rwanda	585
166	Afghanistan	575
167	Mozambique	551
168	Tanzania	550
169	Togo	511
170	Central African Republic	483
171	Eritrea	473
172	Uganda	453
173	Guinea	438
174	Madagascar	428
175	Niger	428
176	Ethiopia	351
177	Malawi	350
178	Sierra Leone	347
179	Liberia	258
180	Congo, Democratic Republic of the	211
181	Burundi	197

Source : IMF, Estimations by the Hyundai Research Institute.