

Ecological Modernization in Northeast Asia

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ECOLOGICAL MODERNIZATION IN TRANSITION ECONOMIES

The transition of former socialist countries should be not only economic, i.e., from a planned to a market economy, but also environmental, i.e., the realization of an environmentally friendly economy. Planned economies were extraordinarily inefficient, involved extensive and heavy industries that relied on obsolete and aging technologies, and, because they paid little for resources, were wasteful, which placed heavy burdens on the environment. Transition countries find it difficult to overcome old habits and develop more environmentally friendly businesses.¹ Climate change is one of the most important policy tasks because it relates to the construction of an efficient market economy as well as the contribution to international climate change cooperation.

We consider this environmental transition in a broader historical context. Since the 1980s, some environmental social scientists have discussed and developed a theory of ecological modernization. Joseph Huber, a founder of the theory of ecological modernization, reported that environmental problems could be resolved through superindustrialization. For Huber, this meant addressing environmental problems primarily through the transformation of production via the development and

1 On the other hand, centrally planned economies left some positive legacies. Ürge-Vorsatz et al. (2006) point out a high share of organized modes of transport, concentrated land-use planning, district heating networks, a low rate of individual consumerism, and a high level of reusing and recycling.

application of more sophisticated technologies. Huber defined the spirit of ecological modernization as a dirty and ugly industrial caterpillar that transforms into an ecological butterfly. He also proposed that ecological modernization was an inevitable phase in the development of an industrial society. He argued that ecological modernization is a phase that follows industrial breakthrough (1789–1848) and the construction of an industrial society (1848–1980). Throughout all three stages, the driving forces are the economy and technology, but the third stage of development is driven by the need to reconcile the impacts of human activity with the environment (Murphy, 2000, 2001).

Since the new stage of ecological modernization started, significant changes have occurred in the style of environmental policy in most industrial countries (Christoff, 2006). They have aimed to shift industry beyond reactive end-of-pipe approaches towards anticipatory and precautionary solutions that minimize wastes and pollution through the efficient use of resources. They tried to transform society via the integration of environmental concerns into economic policies, production, and consumption practices. The role of government also changes from so-called command-and-control regulations to more sophisticated and market-oriented approaches, such as environmental taxes and charges, framing of emissions trading market, and other economic instruments.

In brief, this approach considers environmental problems as an efficiency problem, and improving the economic and environmental efficiency (eco-efficiency) of each industry and economy overall driven by market forces can resolve them. From this viewpoint, ecological modernization is also important for transition countries as well as advanced industrial countries. In the transition period, former socialist countries also have introduced many economic instruments, such as resource pricing, pollution charges, and ecological funds. Further, in the era of globalization, we can extend the ecological modernization perspective to the global level beyond nation states. The point is whether or not global capitalism can develop reflexively and organize a world economy in a sustainable manner. If ecological modernization is also a global process, it will direct a global market economy into more sustainable directions.

The purpose of this paper is to examine the present situations of ecological modernization in global capitalist economies, transition

economies, and Northeast Asia. This report is from a macroeconomic viewpoint.

MAJOR COUNTRIES EMITTING CO₂ AND THEIR EMISSIONS

When efforts are made to solve climate change problems, the most important policy target is the total emissions of a country and the entire world economy. Regarding this, Herman E. Daly, a prominent environmental economist, reports that environmental macroeconomics should take into consideration the scale of an economy (Daly, 1996). According to Daly, economists have recognized the independence of the goals of efficient allocation and just distribution and are in general agreement that it is better to let prices serve efficiency and equity with income distribution policies. However, today's human economic activity is so large that economists should try to determine what constitutes the optimal scale of a macroeconomy relative to the environment. Therefore, proper scale becomes a third, independent policy goal and requires a third policy instrument. Thus, in the era of the environment, we have not just two but three policy targets and values: allocation (efficiency), distribution (justice), and scale (sustainability).

Table 1 shows the CO₂ emissions of the top 25 emitting countries, including the transition economies of Russia, Ukraine, Poland, and China, in 1992 and 2004.² In 1992, Kazakhstan (258.87 million ton) and former Czechoslovakia (159.87 million ton) were included in the top 25 list; however, in the 2004 list, Taiwan and Thailand replaced them. In 2004, the 25 countries with the largest CO₂ emissions accounted for about 84% of the world's CO₂ emissions. The top emitter is the United States, with 21.9% of the global emissions, and the top 5 emitters, U.S., China, Russia, Japan, and India, contribute about 54% of the global CO₂ emissions.

² In the paper, data from The Energy Information Administration (EIA) homepage are used. In the EIA database, data of the republics of the former Soviet Union before 1991 are not included.

Table 1. CO2 Emission Countries and Their Emissions from the Consumption and Flaring of Fossil Fuels (in million metric tons of carbon dioxide)

Region/Country	1992	2004	Change				
				Australia	276.24	386.18	39.8
United States	5,068.78	5,912.21	16.6	Mexico	311.15	385.46	23.9
China	2,421.74	4,707.28	94.4	Saudi Arabia	233.04	365.07	56.7
Russia	2,009.96	1,684.84	-16.2	Ukraine	560.83	363.51	-35.2
Japan	1,039.84	1,262.10	21.4	Spain	240.56	361.90	50.4
India	654.37	1,112.84	70.1	Brazil	234.59	336.71	43.5
Germany	883.82	862.23	-2.4	Taiwan	130.36	308.00	136.2
Canada	483.27	587.98	21.7	Indonesia	171.83	307.68	79.1
United Kingdom	571.86	579.68	1.4	Poland	321.02	287.65	-10.4
Korea, South	289.94	496.76	71.3	Netherlands	214.10	266.99	24.7
Italy	411.21	484.98	17.9	Thailand	99.86	218.59	118.9
South Africa	317.02	429.56	35.4	Turkey	136.43	211.69	55.2
France	382.64	405.66	6.0	25 countries total	17,697.35	22,727.45	28.4
Iran	232.86	401.91	72.6	world total	21,246.78	27,043.57	27.3

Source: Data from the EIA database.

As shown in the table, the worldwide total emissions have increased by 27.3%, and only 4 countries (Russia, Germany, Ukraine, and Poland) have decreased their emissions. Taking into consideration that the emissions of Germany include those of former East Germany, only transition economies have decreased their emissions.

In order to prevent further climate change, the increase of total CO2 emissions must be stopped. At least these major countries will need to participate in the international framework to keep the global carbon level sustainable. However, under the present circumstances, in which major developing countries are in a high growth period and many countries are reluctant to set quantity targets, it is difficult to regulate the scale of emissions directly. Therefore, it is more realistic to substitute other indices for the scale.

Regarding the goal and strategy of the post-Kyoto climate policy, many proposals have been made, and the carbon intensity and carbon

per capita are typical indices for setting the framework. Carbon intensity targets are supported by many developed and developing countries, including the United States, which is reluctant to take radical measures to reduce its emissions of greenhouse gases. This approach does not set a limit to total emissions; therefore, carbon intensity is viewed as a realistic national target. For example, after the Kyoto Protocol, the United States announced an alternative plan to reduce its carbon intensity by 18% by 2012. The U.S. avoided setting a cap target and tried to achieve this target through technological innovation. On the other hand, carbon per capita is a key index for international equity. The main international principle to deal with a climate change problem is common but differentiated responsibility, which is prescribed in the United Nations Framework Convention on Climate Change. Carbon per capita is the most important indicator for an international target setting from a distributional viewpoint. Therefore, it is supported by many developing countries and NGOs.³

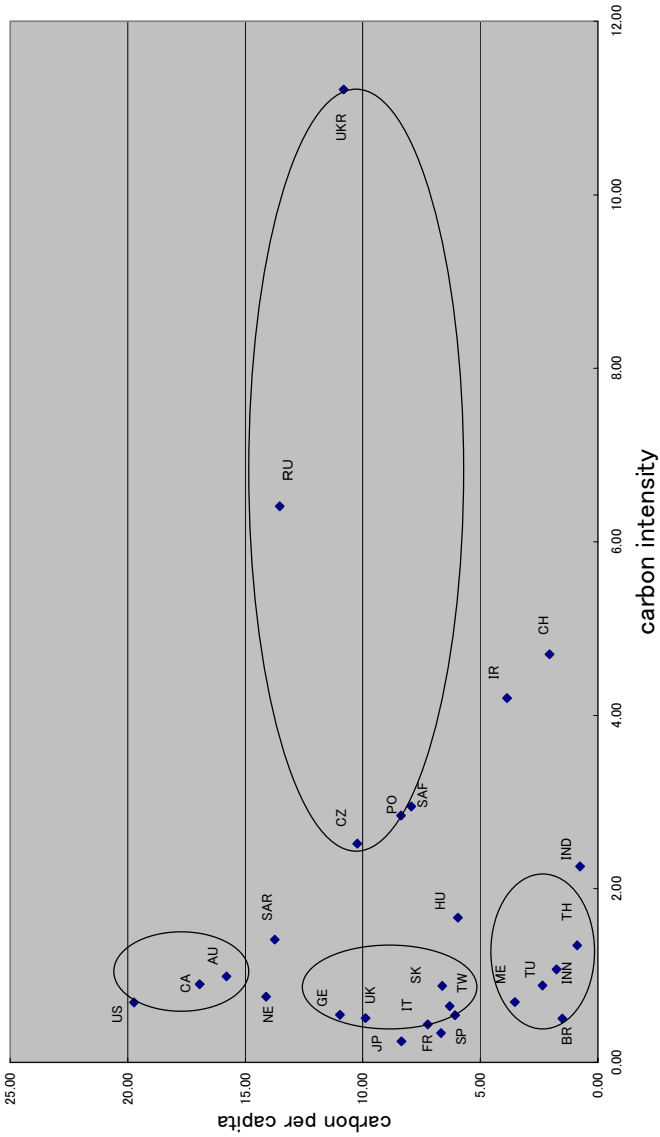
Carbon intensity and carbon per capita are the second best indices. A carbon map is a tool used to illustrate these two indicators.

CARBON MAP OF MAJOR CO₂-EMITTING COUNTRIES

Usually a carbon map is a geographical map in which each area's CO₂ emissions are filled. The carbon map used here is a graph that shows the CO₂ emissions of each country from the viewpoint of both efficiency and equity. The x-axis of the map is the carbon intensity. It shows the CO₂ emissions per GDP and indicates the eco-efficiency of the country. The y-axis is the CO₂ per capita, which indicates the inter-

³ For example, the British NGO Global Common Institute (GCI) has proposed a Contraction & Convergence strategy. This approach regulates both total carbon emission and carbon per capita. According to the NGO, as contraction occurs, a North-South convergence of international shares occurs. Accelerating the convergence to equal shares per head relative to the global rate of contraction respects the principle of equity. This is the constitutional way of solving the climate's opportunity-cost to developing countries while sharing future constraint at rates that avoid dangerous climate change (GCI homepage).

Fig. 1. Carbon Map of Major Emitting Countries



Note: Countries shown are Canada (CA), Mexico (ME), the United States (U.S.), Brazil (BR), France (FR), Germany (GE), Italy (IT), the Netherlands (NE), Poland (PO), Spain (SP), Turkey (TU), the United Kingdom (U.K.), Russia (RU), Ukraine (UKR), Iran (IR), Saudi Arabia (SAR), South Africa (SAF), Australia (AU), China (CH), India (IND), Indonesia (INN), Japan (JP), South Korea (SK), Taiwan (TW), Thailand (TH), Czech Republic (CZ), and Hungary (HU). **Source:** Data from EIA homepage.

national distribution of CO₂ emissions.⁴ From the viewpoint of international equity and justice, it is desirable that the disparity of the index among countries be small.

Fig. 1 is a carbon map of the above top 25 CO₂ emission countries plus two transition countries, Czech and Hungary. As shown in the figure, the CO₂ emission patterns can be classified into four main groups. The first is the group of energy-intensive developed countries (the United States, Canada, and Australia) that have very high carbon per capita and moderate carbon intensity. The second is the group of energy-saving developed countries (Germany, the United Kingdom, France, Italy, the Netherlands, Spain, Japan, and Taiwan), in which the level of carbon per capita is moderate and the carbon intensity is relatively low.⁵ The third is the group of transition economies (Russia, Ukraine, Poland, Czech, and Hungary), in which carbon per capita is moderate and the carbon intensity is at a high level. The fourth is the group of developing countries (Mexico, Turkey, Indonesia, and Thailand), in which carbon per capita is very low and the carbon intensity is relatively low.

4 Carbon intensity is the total carbon dioxide emissions from the consumption and flaring of fossil fuels per dollar of GDP using Purchasing Power Parities, which is expressed in the paper in metric tons of carbon dioxide per 2,000 U.S. dollars. Carbon per capita is the per capita carbon dioxide emissions from the consumption and flaring of fossil fuels, which is expressed in metric tons of carbon dioxide.

5 Thus, we can point out two different groups among developed countries. Bataille et al. (2007) analyze the G7 countries to clarify why the countries' per capita greenhouse gas (GHG) intensity differs. They apply decomposition analysis and analyze five national circumstances: structure of the industrial sector, climate of the commercial and residential sectors, population distribution in the passenger and freight transportation sectors, imports and exports of fossil fuels, and access to low GHG electricity. According to their analysis, climate and geographic size can have a significant effect on a country's GHG intensity. From the result, they insist that these factors are inflexible national characteristics and cannot be altered by policy. However, they also point out that these inflexible factors explain only a part of the high carbon emissions per capita, which, in the case of the U.S., represent 24% of the total emission. It would seem that these facts cannot completely justify the energy-intensiveness of these countries.

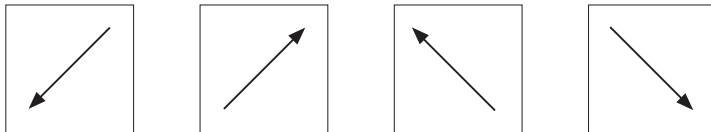
Some countries are located in boundary areas. Among transition countries, Hungary is nearest the area of energy-saving developed countries. The carbon per capita of China and India is at the level of that of developing countries, but their carbon intensity is relatively high for the group. The locations of these countries reflect their commitment to a planned or market economy. Some oil-producing countries, especially Iran, are characterized by a relatively high carbon intensity level. Saudi Arabia is located in near the area energy-intensive developed countries.

As the figure indicates, the carbon intensity of transition economies is relatively high. In particular, the carbon intensity of Russia and Ukraine is at an extraordinary high level, and this is apparently the result of an inefficient socialist planned economy. Thus, the realization of an ecological modernization process to improve economic efficiency and eco-efficiency via transition to a market economy is important for such countries.

DYNAMICS OF CARBON EMISSIONS IN A TRANSITION PERIOD

Next, the dynamics of carbon emissions will be examined. Taking into consideration the convergence and contraction process, in order to resolve the climate change problem, each country in the carbon map should move to the area around the origin where both the carbon intensity and carbon per capita are at lower levels. From such a point of view, there are four patterns regarding the movement of a country on a carbon map (Fig. 2).

Fig. 2. Movement Patterns on a Carbon Map



1. convergence 2. divergence 3. development 4. collapse

In the above four types of movement, pattern 1 is “convergence,” in which both carbon intensity and carbon per capita decline; this is the most desirable pattern from the viewpoint of climate change policy. Pattern 2 is “divergence,” in which both the carbon intensity and carbon per capita of a country increase. This pattern shows an extensive development with worsening of the economic and environmental efficiency and is the worst pattern from the environmental viewpoint. Pattern 3 is “development,” in which carbon per capita increases and carbon intensity improves. This pattern shows intensive development relative to pattern 2. Pattern 4 is “collapse,” in which the carbon intensity increases and carbon per capita declines, and this pattern is undesirable from both the economic and the environmental viewpoints.

Using these patterns, we can evaluate and classify the carbon movements of the above major emitters. Fig. 3 shows the carbon dynamics of the major emitting countries in Fig. 1 from 1992 to 2004.

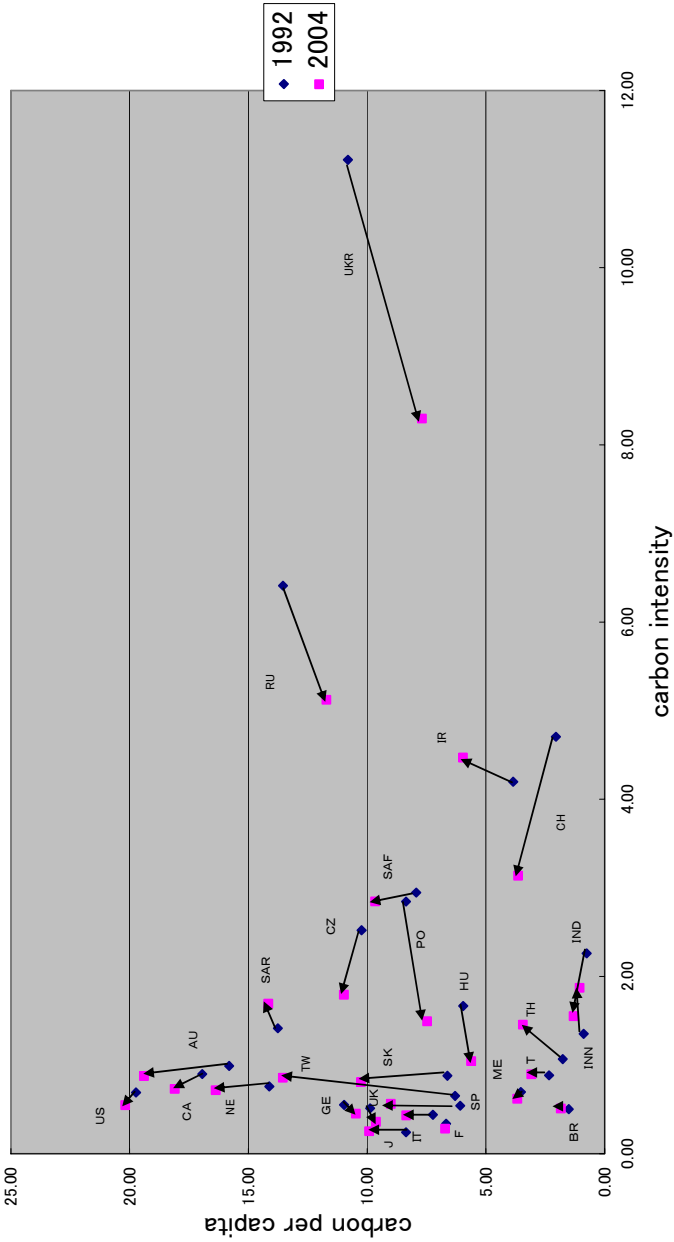
From the figure, these countries can be classified into three patterns:

- Pattern 1 (convergence): Germany, Poland, the United Kingdom, Russia, Ukraine, and Hungary.
- Pattern 2 (divergence): Brazil, Spain, Turkey, Iran, Saudi Arabia, Indonesia, Japan, Taiwan, and Thailand.
- Pattern 3 (development): Canada, Mexico, the United States, France, Italy, the Netherlands, South Africa, Australia, China, India, South Korea, and Czech.

This result shows that a global contraction & convergence process has not yet occurred. In particular, it is worrisome that energy-intensive developed countries such as the United States, Canada, and Australia have increased their carbon per capita. It is also notable that the movements of oil-producing countries, such as Saudi Arabia, Iran, and Indonesia, are in the “divergence” group. This is probably because recent high oil prices have led these countries to waste energy and other resources. As one of the major oil-producing countries, Russia’s trend in the future may be reflected in this movement.

Regarding transition countries, almost all of them have improved their carbon intensity and show a convergence process. Carbon intensity (CO₂ emission per GDP) is the product of the energy intensity (energy

Fig. 3. Carbon Dynamics of Major Emitting Countries



Source: Data from the EIA homepage.

consumption per GDP) and fuel mix (CO₂ emission per energy consumption). The energy intensity reflects both a country's levels of energy efficiency and its economic structure. The fuel mix indicates the proportions of energy derived from carbon-intensive fuels. Therefore, a decline of carbon intensity is a result of an energy intensity decline or a fuel mix change (from coal to oil, gas, renewable energy, or nuclear energy).

Table 2. Carbon and Energy Intensity Change in Transition Countries, 1992–2004

	Carbon intensity %	Energy intensity %
Russia	-20.0	-15.8
Ukraine	-26.0	-16.9
Czech	-32.8	-23.7
Hungary	-37.1	-29.9
Poland	-47.4	-43.8
China	-33.0	-30.0

Note: The standard year of Czech is 1993.

Source: Data from the IEA homepage.

Table 2 shows changes in the carbon and energy intensity of transition countries between 1992 and 2004. The table shows that carbon intensity improvements in transition economies are mainly brought by energy intensity declines, i.e., structural changes in that regard.

The energy intensity of transition countries is thus improved, but there are still sizable carbon (and energy) intensity gaps between transition countries and energy-saving developed countries. Üрге-Vorsatz et al. (2006) argue that economic and energy system reforms alone will not close the energy intensity gap and that further substantial targeted efforts towards the improvement of energy efficiency are required.

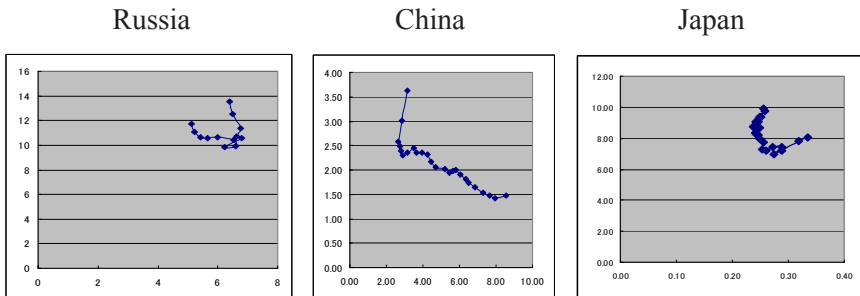
ECOLOGICAL MODERNIZATION IN NORTHEAST ASIA

Finally, we focus on Northeast Asia and analyze the recent trends of three major countries in the area, i.e., Russia, China, and Japan. The total CO₂ emissions of the three countries plus South Korea amount to about

30% of the global emissions. These three countries are located in different country groups and movement patterns in the above carbon maps: Japan, energy-saving developed country, divergence; Russia, transition country, convergence; and China, developing country, development.

Fig. 4 shows each country's carbon map from 1980 (Russia from 1992) to 2004. Tracing their movements on a yearly basis shows the various features of their ecological modernization process.

Fig. 4. Carbon Dynamics of Northeast Asian Countries

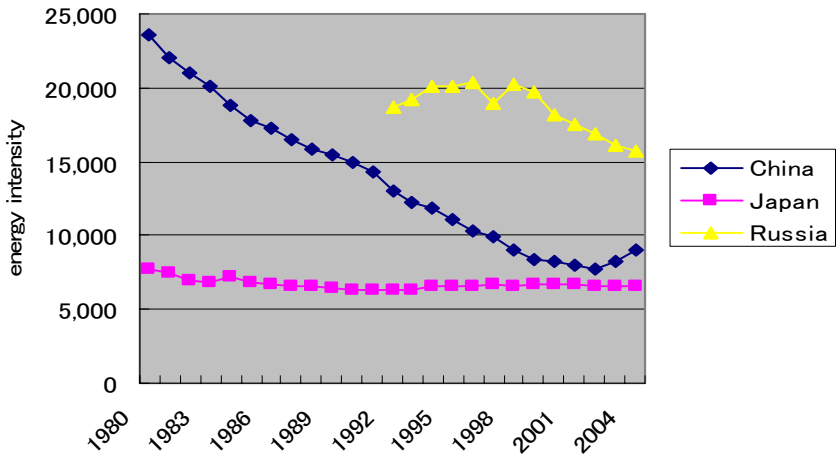


Source: Data from the EIA homepage.

The movement of Russia is “convergence” during the entire period, but it is composed of three stages: collapse (from 1992 to 1994)→convergence (from 1994 to 1999)→development (from 1999 to 2004). The movement of China is “development” during the entire period; from 1980 to 2002, it shows the same trend, but, since 2002, the trend has been changing to “divergence.” The movement of Japan is “divergence” in the entire period, but it is composed of: convergence (from 1980 to 1987)→development (from 1987 to 1999)→divergence (from 1999 to 2004).

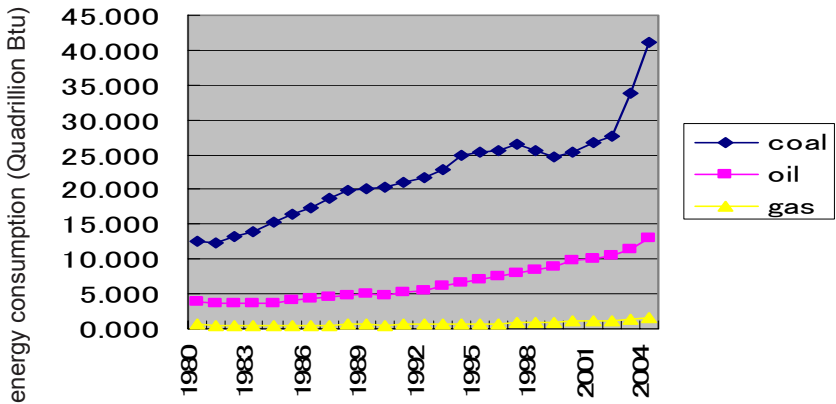
The results clearly show that the ecological modernization process in Northeast Asia is now stopping. Since 2002, Japan and China have both shown the “divergence” pattern, i.e., both carbon intensity and carbon per capita have worsened. In particular, China has completely reversed its trend since the start of the 21st Century. Russia had shown the “convergence” pattern after the chaos of the Soviet Union’s collapse but is now changing to the “development” pattern as well.

Fig. 5. Energy Intensity of Russia, China, and Japan



Note: The Energy intensity is the total primary energy consumption per dollar of GDP using Purchasing Power Parities. It is expressed in Btu per 2,000 U.S. dollars.
Source: Data from the EIA homepage.

Fig. 6. China's Total Energy Consumption



Source: Data from the EIA homepage.

Now, recent reverse movements in Northeast Asian countries by other factors which affect the carbon intensity will be examined. Fig. 5 shows the energy intensity of the three countries, Russia, China, and Japan. As the figure indicates, the energy intensity of China had consistently decreased during the 1980s and 1990s, but, in the 2000s, it began to increase. On the other hand, Japan's energy intensity has remained very low since the 1980s and is at the bottom line of energy intensity; thus, it seems difficult for Japan to seek further energy savings in the same way. The Japanese "divergence" process in recent years may reflect this situation.

Russia's energy intensity is still at a relatively high level in the figure; therefore, there seems to be considerable room for further energy savings. However, when we take into consideration the present trend of oil-producing countries under the condition of high oil prices, it seems quite probable that Russia will move to the "divergence" pattern sooner or later.

Fuel mix is another important factor which determines the carbon intensity. The economic structures of China and the Russian Far East are principally based on coal, and it is important for them to change the economic structures from such a coal-based economy to one based on cleaner energies because coal is the dirtiest and most carbon-intensive of fossil fuels. Recently, Russia has shown its intent to promote the gasification of the Russian Far East. In 2005, President Putin ordered the acceleration of a national program to connect 11 million people in 53 regions by 2008 to improve the living standards in the country.⁶ If this program is really implemented, the area's environment is expected to improve because coal power generation is the main contributor to regional air pollution.

However, there is no sign of improvement in this direction. China's coal consumption has been significantly increasing since the start of the 21st Century, which indicates that fuel mix is also worsening (Fig. 6).

⁶ "Gazprom gasification program to cover 11 million Russians – Putin," 25/10/2006 Novosti. Recently, Novosti reported that Russia will invest 20 billion rubles (about \$760.5 million) in gasification projects in the country's 58 regions ("Russia to invest \$760.5 million in gasification projects in 2007," 18/02/2007).

The Energy Information Administration (EIA)'s "International Energy Outlook 2007" (IEO, 2007: Chapter 7) predicts the energy-related CO₂ emissions in 2030. This report has some important and interesting suggestions for our analysis. First, the share of coal in the world energy-related CO₂ emissions is projected to increase in 2030 (from 39% in 2004 to 43% in the reference case). The increasing share of coal is reflective of its important role in the energy mix of non-OECD countries, especially, China and India. As both economies expand, coal will become a greater part of the world energy mix and play a correspondingly larger role in the composition of the world's CO₂ emissions. In other words, the Chinese coal-based economy will continue in the future. Second, IEO 2007 simulates two alternative cases: an alternative macroeconomic case (high and low growth rate cases) and an alternative world oil price case (high and low oil price cases). The result is that there is a 5% difference between the 2030 CO₂ emissions in the two world oil price cases but a 24% difference between the two macroeconomic cases. This means that the price mechanism of oil has a lesser effect on reducing CO₂ emissions. In the world oil price cases, natural gas prices are affected more strongly than coal prices. Because natural gas prices are projected to rise with oil prices in the high price case, both oil and gas lose their market share to coal.⁷

In the case of Russia, the situation cannot be expected to improve in the long run. Table 3 shows the electricity fuel mix projections of

7 Lanne and Liski (2004) consider per capita CO₂ emission trends from fossil fuel burning in 16 early industrialized countries over the period 1870–2028. Their hypothesis is that of an inverted U, i.e., early industrialized countries have had three phases in their emission development. The first phase was that of the fast growth of per capita emissions, as early industrialization in general heavily relied on coal. The second phase was characterized by less growth due to the shift from solid to non-solid fuels (from coal to oil and natural gas). The third phase followed the oil price shock of the 1970s, which permanently changed the structure of emissions from fossil fuels and possibly led to downward sloping per capita emission trends. However, they find relatively little evidence for the late downturns during the oil price shocks. They point out that the main reason for this is the temporary transition from liquid to solid fuels during the 1970s.

the Russian energy strategy and the IEA's World Energy Outlook 2000 (OECD/IEA, 2002). Major differences exist in natural gas and coal. Whereas the WEO projects the TPES (total primary energy supply) fuel mix largely to follow current trends, the Russian outlook assumes a shift away from natural gas to coal. In the Russian projections, the share of nuclear energy is also higher than the WEO projection. OECD/IEA (2002) points out that this is a reflection of the Russian energy security policy.

Table 3. Comparison of WEO and Russian Projections of the Electricity Fuel Mix to 2020

	WEO projections			Russian energy strategy projections		
	2000	2010	2020	2000	2010	2020
Natural gas	42%	47%	61%	42%	39%	34%
Coal	17%	18%	14%	17%	26%	29%
Petroleum products	7%	4%	3%	7%	3%	3%
Hydro-electricity	18%	17%	14%	18%	16%	12%
Nuclear	15%	13%	9%	15%	15%	21%
Other	1%	1%	1%	1%	1%	1%

Source: OECD/IEA (2002), p. 62.

Thus, neither of the two key factors which determine carbon intensity, energy intensity and fuel mix, is able to improve the CO2 emission pattern. China's high growth rate and high oil prices have a multiplicative negative effect on ecological modernization. At present, the Chinese government emphasizes energy savings, and further policy measures are needed for regional contraction and convergence.

CONCLUSION

The ecological modernization process driven by market forces is expected to overcome climate change problems in the world and in Northeast Asia. The fuel price mechanism should play a central role in the process. As we have seen, however, it is likely that oil prices will adversely affect the ecological modernization process in Northeast Asia.

Higher oil prices, on the one hand, weaken incentives to save energy in Russia and, on the other hand, strengthen the coal-based economies of China and the Russian Far East.

At any rate, transition to a market economy in itself no longer brings about the ecological modernization process. More active measures, including cap approaches, will be necessary in the area, and regional cooperation for the environment should be promoted.

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