Alternative path of the global economy against CO_2 emissions
Policy simulations of FUGI global modeling system

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Abstract

In the 21st century it is expected that global syndrome will be appeared in the human society. The global issues seem likely to confront with every country around the world co-existing on the planet Earth. Green house gas will induce global warming effects that might bring about serious influences on changes in climates and ecological system.

The FUGI (Futures of Global Interdependence) global modeling system has been developed as a scientific policy simulation tool of providing global information to the human society and finding out possibilities of policy coordination among countries in order to achieve sustainable development of the global economy under the constraints of rapidly changing global environment. The FUGI global model M200 classifies the world into 200 countries/regions where each national/regional model is globally interdependent through oil prices, energy requirements, international trade, export/import prices, financial flows, ODA, private foreign direct investment, exchange rates, stock market prices and global policy coordination etc. The purpose of this article is twofold, namely to provide information on the futures of global economy under the constraints of energy requirements and CO_2 emissions up to 2020 as well as strategy for sustainable development of the interdependent global economy.

Keywords: FUGI global modeling system; integrated global model for sustainable development, outlook for global economy, 20006-2020; CO_2 emissions; global energy requirement; global policy coordination

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1. Introduction

In the 21st century it is expected that global syndrome will be appeared in the human society. The global issues seem likely to confront with every country around the world co-existing on the planet Earth. Green house gas will induce global warming effects that might bring about serious influences on changes in climates and ecological system. Global changes in circulation patterns of atmosphere will cause unusual weather conditions and natural disasters brought in various phenomena such as floods, drought and desertification etc. Permanent Ice Rivers of high land area on Swiss Alps, Kilimanjaro and Himalaya as well as ice shelves of North and South Pole have already started to get melt away. Tropical deceases will spread to the non-tropical zones. Increasing desertification has become key issues in not only Australia but also China and Mongolia. Dry yellow sands produced to large extent in China and Mongolia has threatened even to Japan in monsoon seasons.

It is worth noting that, in the 21st century, integrated progress of science, technology and economic development will be seen in the human society where consists of a globally interdependent complex system. The information technology innovation will give tremendous impacts on economic development, human life and culture. Historically speaking, global climate changes induced by human behaviors in the increasingly interdependent global economy on the planet Earth are a rather new experience and challenge for the human society.

On the other hand, it is also expected that the 21st century will be an age of terrorism and refugees, if humankind could not jointly cope with poverty and international per-capita income disparity (IPCID) with common consciousness of living on the planet Earth and humanistic cosmic mind, irrespective of diversification among race, religion and culture coexisting on the same globe.

Under these circumstances, the **FUGI** (*Futures of Global Interdependence)* global modeling system seems likely to play a significant role in efforts to envisage the future of global interdependence and to provide global information on the economic development and environmental changes through alternative policy scenario simulations for the sustainable development.

Project FUGI was started in 1976 with the cooperation of three Japanese institutions, namely, the University of Tokyo, Osaka University and Soka University, under the sponsorship of the National Institute for Research Advancement in Tokyo. The original FUGI model consisted of three parts: a Global Input-Output Model (GIOM), a Global Resources Model (GRM), and a Global Economic Model (GEM), Types I, M15.

Yoichi Kaya, Faculty of Engineering, the University of Tokyo, Yutaka Suzuki, Faculty of Engineering, Osaka University, and the author coordinated the designing of these models, respectively (Onishi 1977). Work in progress was reported at the IIASA global modeling symposium in 1977 and the years following. The first generation FUGI global economic model (Type I, M15) designed by the author was the development of the Multi-Nation Economic Model which was originally designed by the author in 1965 and applied the 15 countries in Asia for the purpose of projections of the Asian economy (Onishi 1965). Drawing on experiences with global modeling in the 1970s, the author developed a fourth-generation FUGI global economic model (Type IV, M62) that divided the world into 62 countries/regions and consisted of approximately 30,000 equations. It was first made public at a seminar on comparative simulations of global economic models held at Stanford University, June 25-26, 1981(Onishi 1981). The United Nations Secretariat, Department of International Economic and Social Affairs, Projections and Perspective Studies Branch for the purpose of long-term projections and policy simulations of the world economy soon afterward adopted this model for use. It was used from 1981 to 1991, when it was replaced by the new generation FUGI global model, Type VII, M80.

For the period 1985-86, a new generation of the FUGI global model was designed as a *global early warning system for displaced persons* (Onishi 1986, 1987, 1990) during the period 1990-95, the FUGI model 7.0 M80 was designed as an integrated global model for sustainable development (Onishi 1993, 1994a, 1994b, 1995).

During the period 1991-1999, the author designed a significant new software system for global modeling. This expert software system, named as FGMS (FUGI Global Modeling System) using an IBM R/S 6000 workstation was researched and developed as a package for specific use in making computations for the FUGI global model 9.0 (Type IX) M200/80 (Onishi 1991,1993,1994a,1994b,1995,1998,1999,2001a) and M200 (0nishi,2000).

In 2000-2007, this expert system has entered the new stage of **FGMS 200** using a personal computer (Windows 2000/XP/Vista) for running the FUGI global model 9.0, M200PC. This latest M200 model, consisting of more than 150,000 equations, classifies the world into 200 countries/regions so that the model can make the forecast simulations of the global economy with interdependent 200 countries/regions (Onishi 2001b, 2005).

The current global model simulation exercises using FGMS200 cover the baseline projection of the global economy, energy requirement and CO_2 emissions, 2006-2020. The model can provide information not only on the baseline projections but also alternative policy scenario simulations for global coordination. One of the most

important features of FUGI global modeling system is quick adaptability with ever changing in global environment and statistical data. It is worth noting that this advanced global modeling system is designed to manipulate by only one person using a personal computer in spite of huge complex system.

2. Outline of FUGI global modeling system

2.1. Regional classification

The FUGI global model 9.0 M200PC divides the world into 200 countries and regions. For three major groupings there are (1) developed or advanced market economies (AME), (2) developing economies (DGE) and (3) economies in transition (EIT). The AME grouping contains the following sub-groupings; these are developed market countries including the developed Asia-Pacific, North America, member countries of the EU and other Western Europe. The DGE grouping contains the following sub-groupings as Asia-Pacific (subdivided into East Asia, Southeast Asia, Southwest Asia and Pacific Islands); Middle East; Africa (subdivided into North Africa and Sub-Saharan Africa); Latin America & Caribbean; and Mediterranean. The EIT grouping includes two sub-groupings: South-Eastern Europe and Commonwealth of Independent States (CIS). Ultimately, this global model divides the world as a whole into 200 countries/regions. Because all most of all developed market economies, developing economies and economies in transition are treated as country units, the model has the advantage of being able to analyze precise country-specific relationships within the framework of global interdependence. We have prepared for six global table formats such as CGM (above-mentioned regional classification), EU (for the European Commission), IMF (for IMF classification), UN (for the United Nations classification), UNCTAD (for UNCTAD classification), UNESCAP (for UNESCAP classification) and WB (for the World Bank classification). It is worth noting that the global table format of FGMS200 can be easily modified in accordance with new regional classification.

2.2. Model structure

The FUGI global modeling system classifies the world into 200 countries/regions. Each country/regional model is globally interdependent through direct linkages of the world trade matrices, export/import prices, primary commodities prices, foreign exchange rates, official development assistance, private foreign direct investment,

external debt, interest rates and etc. It is also globally interdependent through indirect linkages such as population changes, economic development policies, energy policies, environmental policies, etc.

Each national/regional model consists of integrated nine major sub-systems: (I) population, (II) foods, (III) energy, (IV) environment, (V) economic development, (VI) peace and security, (VII) human rights, (VIII) health care and (IX) digital divide. Economic development system as a major core of the model has eleven economic sub-blocs. It includes (1) labor and production at constant prices, (2) expenditure on GDP at constant prices, (3) income distribution: profit-wage, (4) prices, (5) expenditure on GDP at current prices, (6) money, interest rate & financial assets, (7) government finance, (8) international balance of payments, (9) international finance, (10) foreign exchange rate and (11) development indicators. The FUGI global modeling system (9.0 M200) is one of the most complex global models around the world. For further details of the model, see *Integrated Global Models for Sustainable Development*, UNESCO Encyclopaedia of Life Support System, EOLSS Publisher, Oxford, UK, 2005 (http://www.eolss.net) and *Futures of global interdependence (FUGI) global modeling system, integrated global model for sustainable development*, Journal of Policy Modeling 27(2005) 101-135.

3. **Projections of the global economy, 2006-2020**

The 21st century will be an age of integrated technology innovations in the fields of information technology, biotechnology, new energy as solar and superconductor, nanotechnology, robotics, new materials , space-technology and etc. On the other hand, it is expected that this century will be an age of terrorism and refugees. Therefore, we cannot predict futures of the world economy, because the futures would have a large degree of "*fluctuation phenomenon*" that we might depict the futures as either optimistic or pessimistic images. For instance, the interdependent world economy will face not only transmission phenomenon of business cycles induced by the US economy but also global risk as such as speculations on the major currencies and oil prices. Because the deficits of current balance of payments of the US economy will be enlarged, all over sudden depreciations of the US dollar against major currencies might be occurred by speculations. As a result, sharp increase in the US short-term interest rates as well as long term bond yields that might induce sharp decrease of the US economic growth.

Same is true in the case of unexpected sharp increase in oil prices by speculations.

During the period, 2004-2005, WTI (West Texas Intermediate), representative oil price index in the US sharply increased by speculations from 28.89 $/Barrel in 2004 to 66.05 $/Barrel in 2006. Federal Fund Rate (FFR) was raised sharply against possible pressures of inflation from 1.35% in 2004 to 5.25% in 2006. As a matter of fact, the US real GDP growth rate was deceased from 3.9% in 2004 to 3.2% in 2006. If oil prices would continue a sky rocketry higher increase, the US economy could not sustain reasonable real GDP growth. Sharp increase in the FFR as well as long term bond yields that might induce sharp decrease of the US economic growth as a major engine of sustainable global economy might be lost. This is an example of the pessimistic scenario.

With regard to business cycles, John Hicks (1904-89) of Oxford University presented an interesting trade cycle model in his book entitled "*A Contribution to the Theory of the Trade Cycle*" (1950). According to his theory, business cycles may be occurred by the "*fluctuations"* in induced investments based on "acceleration principles". Onishi verified existing traditional trade cycle theories using 200 countries database and FUGI global modeling system. It is worth noting that the major causes of business cycles are very complex phenomenon in the global interdependent economy. Hick's trade cycle model based on "acceleration principles" is *mathematically* elegant, but we hardly find out *econometrically* best significant relationships between gross fixed investments in real terms and increment of real GDP with one year time lag in most of the developed economies. Fluctuations of non housing investments in these economies can be more adequately explained by those of operating surplus, interest rates, exports and R&D rather than increments of real GDP. In this sense, econometrics method seems likely one of the most powerful tools for testing economic theories.

It is worth noting that the business cycles of the US economy, having large shares of the world economy, will tend to transmit to the rest of the world consisting of the global community through international trade, export-import prices, exchange rates, capital movements and stock market prices, etc. The gross fixed investments play a significant role to induce business cycles of the US economy and increasing rates of the non-housing investments are mostly affected by the ratios of profit/ non-housing fixed capital minus interest rates on fixed investments. In this sense, the US economy will play the most important role for the sustainable development of the global economy. However, the US economy alone may not have the responsibility in the global community but international policy coordination and co-operation might be much better in the futures of global interdependent economy.

On the other side, Karl Marx (1818-1883), well known author of "*Das Kapital*"

(1867) has discovered that dynamism of the market economy is dwelt on business cycles. Depression gives positive repercussion on revitalizing the private sector of the market economy though severe survival competitions as seen in the Japanese economy for the depression periods, 2001-2005. In order cope with the depression, Japanese private enterprises have made utmost efforts to increase R&D for overcoming survival games in the international markets. He designed "*Reproduction Schema*" that gives an image of 10 % sustainable development model through the balanced growth between the producer and consumption goods sectors. Such kind of idea has been succeeded by Wasily Leontief (1906-1999) in his "Input-Output Model" that seems likely to be the original roots of his Global Economic Model (See *Integrated Global Models for Sustainable Development, EOLSS).* Onishi also designed an original multi-nation growth model. See Onishi, A (1965) Projections of Economic Growth and Intra-Regional Trade for the Developing ECAFE Region, 1960-1970, Developing Economies, Vol. 3(2); pp.158-172, June 1965. This presents the original idea of FUGI global modeling system. Apart from FUGI global modeling system, Klein also has initiated his original idea on international linkages of national models as Project Link system (See *Integrated Global Models for Sustainable Development, EOLSS).*

Under such circumstances, we would be better to start with the baseline projections of the world economy using the FUGI global modeling system. The baseline projections mean that what will be most likely futures, if the structural parameters of the model, estimated from the past data covering latest information, would not be drastically changed. Because of advanced modeling technology, we can efficiently carry out the baseline projections. Every day, we input new information and data to modify the *initial values* (CRS files), so that the baselines projection might accommodate with ever changing the world economy. It is worth noting that the future of the world economy is not determined by destiny but could be changed by policy co-ordination. This is why we have designed the FUGI global modeling system not only to make the *baseline* projections but also *alternative policy scenario simulations* .It is worth noting that the baseline projections are changing day by day in order to accommodate with ever changing data and information.

According to the baseline projections, the world economy is expected to be 3.0% and 3.1% during the periods 2001-2010 and 2011-2020, following an average growth of 2.6% during the 1990s. For the developed economies taken as a whole, the average annual real economic growth rate will be 2.3% during the 2001-2010 and is expected to maintain to an average 2.2%, in the following periods, 2011-2020. For the period from 2001-2005, the annual average percentage growth rates of the US economy will be

2.4% and sustain 3.2% in 2006-2010. Similar “fluctuation” of the US economy may be seen for the period, 2011-2020. The US economy might be suffered from around 10 year’s business cycles (so called Jugular’s cycle) according to FUGI global model simulations (See Figure 1B). Although the Japanese economy, simultaneously, declined to the low growth of 1.3% for the period, 2001-2005, the annual average of growth rates will attain 2.6% in 2006-2010. It is expected that the Japanese economic growth rates will be 1.4% in 2011-2015, 2.8% in 2016-2020 and 2.1% in 2011-2020, thanks to the technology innovation through increased research and development expenditures (R&D). On the other hand, the EU 15 economy as a group is expected to sustain 1.5% in 2001-2005 and 2.3% in 2006-2010. As a result of creating EURO-zone in 2000 and enlargement of EU, it is expected that EU economy as a group will maintain around 2% growth for the period, 2011-2020...

In the developing economies, the average growth rate of 3.1% in the 1980s was accelerated to an average 4.6% in the 1990s. The vitalization of real economic growth in the developing countries as a group may be anticipated, with the average annual growth rate of 5.4% for the period,2006-2010 and 5.1% in 2011-2020 (See Table 1. Fig. 1A and 1D).

It is worth noting that the average annual growth rate of the developing economies in the Asian-Pacific region is expected to maintain 6.1% in the following periods, 2001-2020. The Chinese economy recorded a high average annual economic growth of 10.1% during the period 1991-2000, but is expected to maintain its high growth for the period, 2006-2020. The Chinese GDP growth rate of an average 9.4% in 2001-2010 is expected to maintain the high growth rate of 7.6% in 2011-2020. India is expected to follow the growth patterns of China and maintain an average of around 7% growth rates based on rich human resources, comparable with those of China for the period, 2005-2020. In the FGMS projections, it is assumed that India will invite private foreign direct investments to a large extent and export oriented pattern of growth, coping with increasing deficits of current balance of payments to be derived from higher oil prices and higher GDP growth performance by introducing alternative energies and energy savings technology. India takes a lead in the numbers of IT (Information Technology) engineers in the world.

It is reasonably expected that the higher oil prices will give positive repercussions on the oil exporting countries while negative impacts on oil importing courtiers as seen FUGI global model projections.

For reference, Figures are shown on real GDP growth rates (Fig.1A, 1B, 1C, 1D, 1E). It is worth noting that these projection figures are changing day by day so that we might

carry out forecast simulation exercise everyday in the uncertainty world. The FUGI global modeling system has been developed in order to provide up-to-date global information to the human society very quickly for the purpose of global cooperation and policy coordination among the countries around the world under uncertain futures of global interdependence.

Fig.1A: Projections of Global Economy 2006-2020: Real GDP Growth Rates

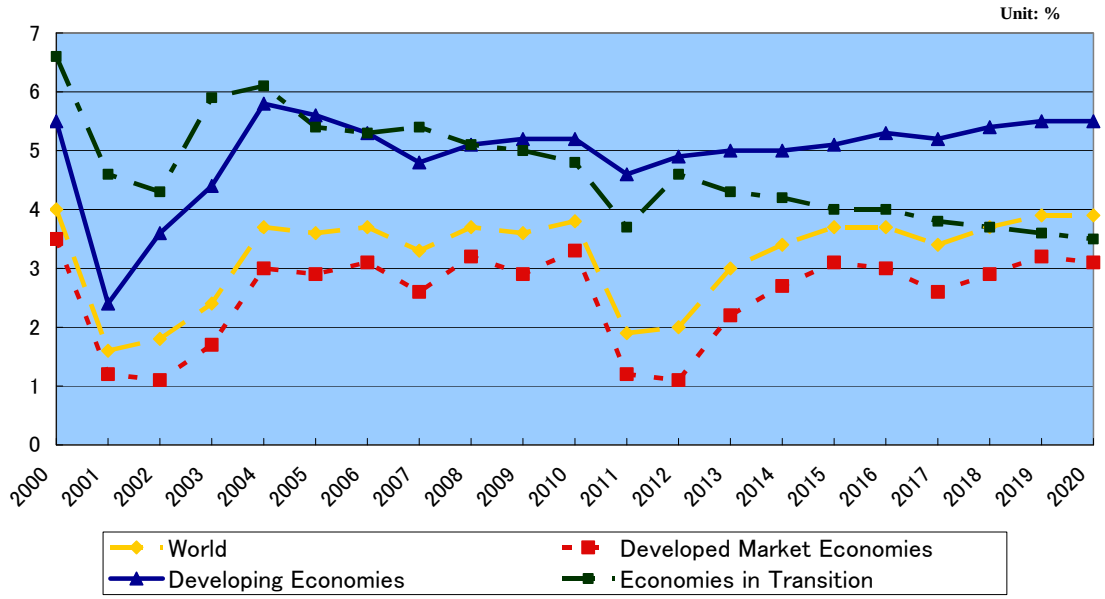


Fig.1B: Projections of World, EU, Japan and US Economy 2006-2020: Real GDP Growth Rates

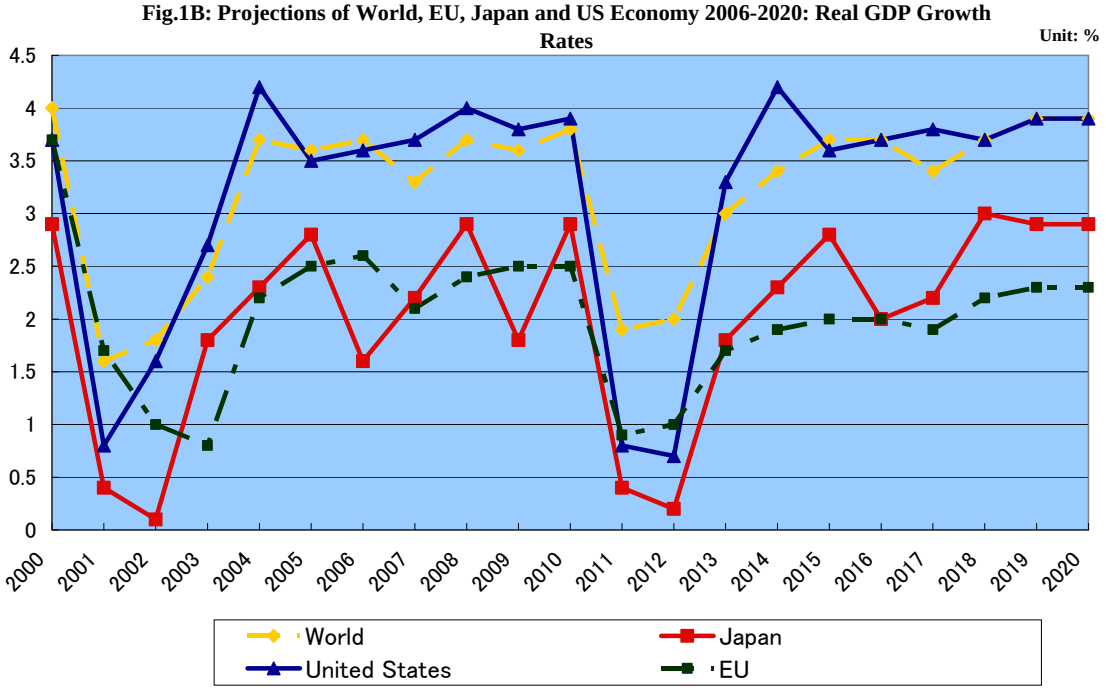


Fig.1C: Projections of EU Economy 2006-2020: Real GDP Growth Rates

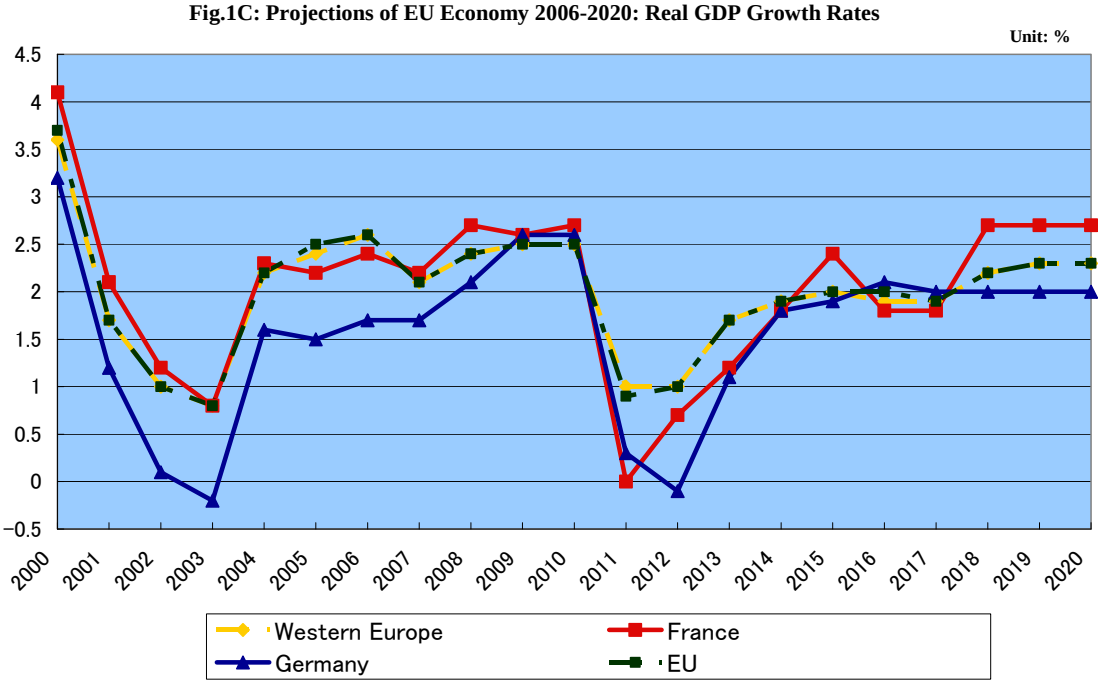


Fig.1D: Projections of Asian Economy 2006-2020: Real GDP Growth Rates

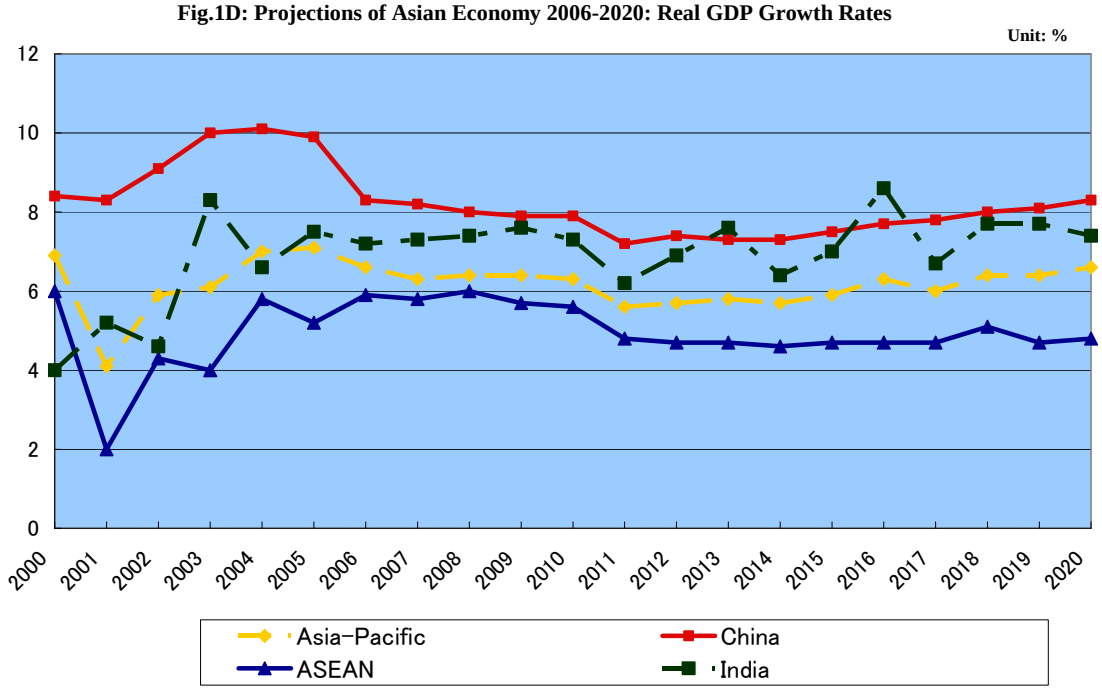
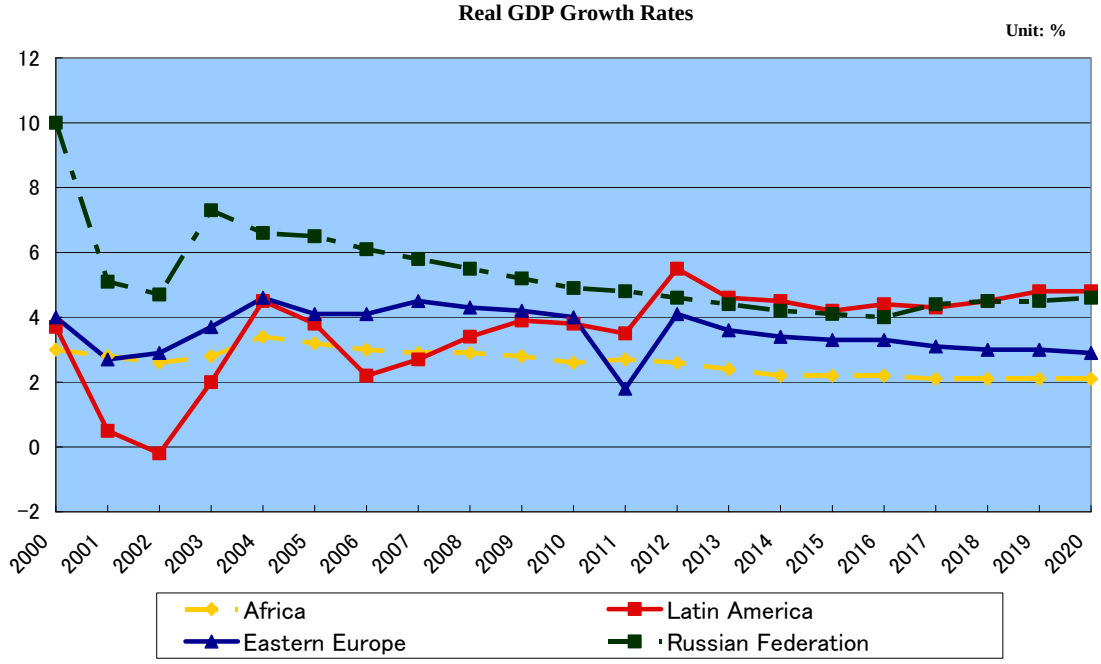


Fig.1E: Projections of Africa, Latin America and Eastern Europe Economy 2006-2020: Real GDP Growth Rates



Source: FUGI global modeling system.

Notes: For the periods.2000-2005, numerical figures are estimated by pre-projections using the FUGI global modeling system (FGMS 200). If actual data for the periods, 1995-2005 are given, estimated figures are automatically replaced to actual figures in this system. Projection period is set for 2006-2020.

The **FGMS 200** software system consists of (1) **CONTROL**, data file control systems for listing, loading, printing, and updating time-series country data file (**CNT**), time-series region data file (**RGN**) , cross country data file for initial conditions of the model (**CRS**),as well as variable (**VAR**) data files; (2) **DSERVE**, supplementary data servicing programs for updating and storing **RGN.DAT** file, etc; (3) **ESTIMATE**, estimating parameters of the model, using Automatic Parameter Estimating System **(APES)** to select automatically the most appropriate sets of explanatory variables ; (4) **SIMULATE**, making simulations using the FUGI global model;(5) **OUTGT**, printing out simulation results in forms of 170 world tables, each country tables and world trade matrices;(6) **UTILITY**, receiving data from **FUGIDB** to initialize and overwrite the time-series data, **RGN.DAT,** as well as to create variable data files, **VAR.DAT**. A user of **FGMS200** can carry out automatic estimation of a given set of structural parameters of the FUGI global model, using OLS (ordinary least squares method) as well as MLBM (maximum likely food method) and making forecast simulations efficiently, using Automatic Error Correction System (**AECS**). This expert AI system has already entered the stage of practical application. It is hoped that the FUGI global modeling system (**FGMS 200)** can contribute to progress in the integrated global model for sustainable development. For further details of **FGMS 200**, see *Users Guide*. FUGI global model 9.0 M200, *Integrated Global Models for Sustainable Development*, UNESCO Encyclopaedia of Life Support System, EOLSS Publisher, Oxford, UK, 2003 (http://www.eolss.net).

Table 1: Projections of Global Economy, 2006-2020

Annual average growth rates of real GDP (at 1995 prices) **Unit:%**

- -	Actual 2001-2005	Projection 2006-2010	2001-2010	2011-2015	2016-2020	2011-2020
World	2.6	3.5	3	2.6	3.6	3.1
Developed Economies	1.9	2.7	2.3	1.6	2.8	2.2
Developed Asia-Pacific	1.5	2.6	2.1	1.6	2.9	2.2
Japan	1.3	2.6	1.9	1.4	2.8	2.1
Australia	3.2	3.3	3.2	3.3	3.5	3.4
North America	2.4	3.2	2.8	1.9	3.4	2.6
Canada	2.5	3.2	2.9	1.8	3.1	2.5
United States	2.4	3.2	2.8	1.9	3.4	2.6
Western Europe	1.5	2.3	1.9	1.4	2.2	1.8
EU15	1.5	2.3	1.9	1.4	2.2	1.8
Euro Area	1.3	2.3	1.8	1.3	2.3	1.8
France	1.7	2.4	2.1	1.1	2.5	1.8
Germany	0.7	2.2	1.4	1.0	2.0	1.8
Italy	0.6	1.6	1.1	1.0	1.4	1.2
United Kingdom	2.4	2.2	2.3	2.4	2.2	2.3
Developing Countries	4.5	5.4	5.0	4.7	5.4	5.1
Asia-Pacific	6.1	6.9	6.5	5.6	6.4	6.1
East Asia	6.9	7.2	7.1	5.6	6.5	6.1
China	9.6	9.2	9.4	7.2	8.0	7.6
Southeast Asia	4.3	5.6	5.0	4.5	4.7	4.6
Indonesia	4.3	5.7	5.0	4.9	5.1	5.0
South Asia	5.9	6.9	6.4	6.2	7.2	6.7
India	6.4	7.5	6.9	6.6	7.6	7.1
Middle East	3.2	3.5	3.3	3.8	3.1	3.5
Saudi Arabia	4.0	3.0	3.5	5.1	3.0	4.0
Africa	3.1	3.5	3.3	3.1	3.5	3.3
North Africa	3.2	3.6	3.4	3.2	3.6	3.4
Sub-Saharan Africa	3.0	3.4	3.2	3.0	3.4	3.2
Latin America and the Caribbean	2.3	3.4	2.8	3.6	4.6	4.1

Brazil	**2.2**	**2.9**	**2.5**	**2.4**	**4.6**	**3.5**
Mexico	**1.8**	**1.5**	**1.7**	**3.6**	**4.0**	**3.8**
Mediterranean	**4.2**	**5.8**	**5**	**4.3**	**3.6**	**3.9**
Turkey	**4.3**	**6.2**	**5.2**	**4.4**	**3.7**	**4.1**
Economies in Transition	**5.3**	**5.1**	**5.2**	**4.1**	**4.4**	**4.3**
South-Eastern Europe	**3.6**	**3.7**	**3.6**	**3.5**	**3.2**	**3.3**
Russian Federation	**6.1**	**5.4**	**5.8**	**4.4**	**5.2**	**4.8**

Notes: Pre-projection was made for the period, 1995-2005. Projection periods are 2006-2020.

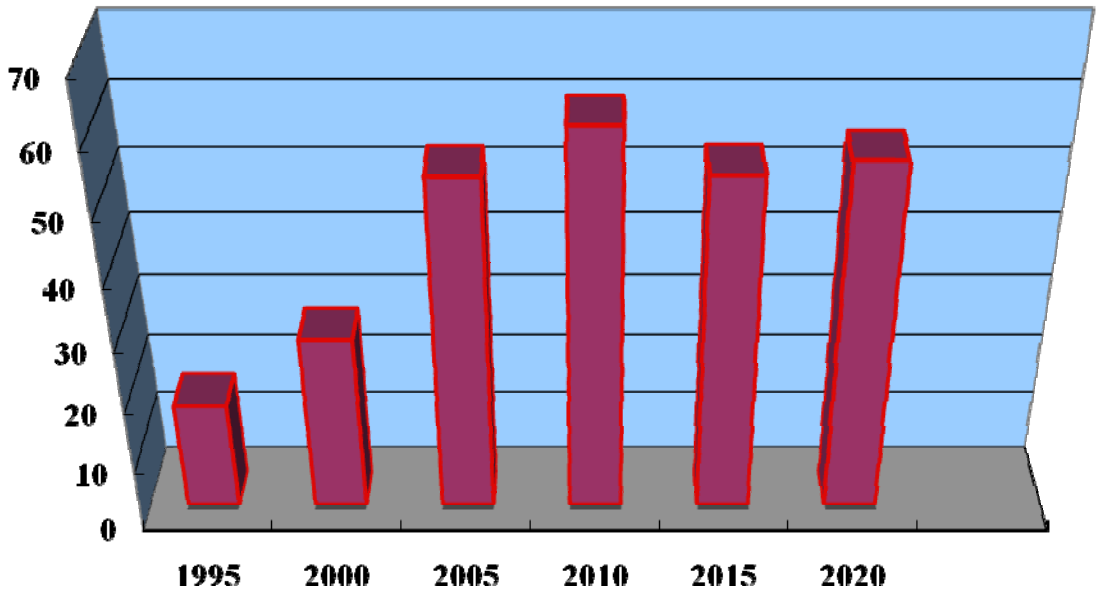
Source: FUGI global modeling system.

4. Global environment indicators: CO_2 emissions

In order to make the baseline projections of the global economy and CO_2 emissions, we have to face one of the most key issues on average oil price trends that might have a large degree “fluctuations” by speculations. In the FUGI global modeling system, average oil prices are explained by weighted average export prices of developed economies, shares of global oil consumption to global energy requirement and dummy variables as geographical risks etc. so that development of alternative energy such as solar, biomass, nuclear as well as fossil energy savings technology such as EV (electric vehicles), super conductor might oppress sharp increase in oil price in the long-run.

Fig.2A shows average oil price trends, adopted in the Baseline scenario. Of course, average oil prices may be modified in accordance with alternative scenarios. For instance, it would be possible to assume that development of alternative energy and energy saving technologies will be accelerated by global policy coordination against global warming on the planet Earth. This is an optimistic scenario. On contrary, we can adopt more pessimistic scenario that each nation would not take into account of international co-ordination polices against global warming and continue current pattern of fossil energy consumption without taking care of futures.

Fig.2A: Average Oil Price Trends, adopted in the Baseline



Note: Oil prices are in terms of US dollar per barrel. Graphs are expressed in five years interval.

Source: FUGI global modeling system.

Table 2: Projections of CO_2 emissions from fossil energy use, 2006-2020

Annual average changes **Unit: %**

	Estimate	Projection				
	2001-2005	2006-2010	2001-2010	2011-2015	2016-2020	2011-2020
World	3.3	4.1	3.7	2.9	3.8	3.4
Developed Economies	1.4	1.9	1.6	0.9	2.5	1.7
Developed Asia-Pacific	1.2	2.0	1.6	0.8	2.8	1.8
Japan	-0.7	2.4	0.8	-0.2	2.5	1.1
Australia	5.0	2.6	3.8	3.0	3.4	3.2
North America	1.6	1.6	1.6	0.9	2.6	1.7
Canada	2.2	2.4	2.3	1.8	3.2	2.5
United States	1.5	1.5	1.5	0.8	2.5	1.7
Western Europe	1.0	2.1	1.6	1.2	2.3	1.8
EU15	1.0	2.1	1.6	1.3	2.3	1.8

Euro Area	**0.9**	**2.1**	**1.4**	**1.1**	**2.4**	**1.8**
France	**1.1**	**1.3**	**1.2**	**0.3**	**1.6**	**0.9**
Germany	**-0.2**	**0.7**	**0.3**	**-0.5**	**0.7**	**0.1**
Italy	**0.1**	**1.8**	**0.9**	**1.9**	**2.7**	**2.3**
United Kingdom	**0.5**	**1.7**	**1.1**	**1.5**	**1.7**	**1.6**
Developing Countries	**4.8**	**5.6**	**5.2**	**4.0**	**4.4**	**4.2**
Asia-Pacific	**6.3**	**6.6**	**6.4**	**4.1**	**4.5**	**4.3**
East Asia	**7.2**	**6.8**	**7.0**	**3.4**	**3.2**	**3.3**
China	**7.6**	**7.3**	**7.4**	**3.4**	**3.1**	**3.3**
Southeast Asia	**4.0**	**6.6**	**5.3**	**5.2**	**6.5**	**5.9**
Indonesia	**5.3**	**5.8**	**5.6**	**5.7**	**9.1**	**7.3**
South Asia	**4.6**	**5.5**	**5.0**	**6.3**	**7.9**	**7.1**
India	**4.9**	**5.7**	**5.3**	**6.5**	**8.2**	**7.4**
Middle East	**3.8**	**4.0**	**3.9**	**4.8**	**4.8**	**4.8**
Saudi Arabia	**0.4**	**0.7**	**0.6**	**3.1**	**1.4**	**2.2**
Africa	**1.2**	**2.1**	**1.6**	**2.0**	**2.1**	**2.1**
North Africa	**2.4**	**2.1**	**2.3**	**2.1**	**2.1**	**2.1**
Sub-Saharan Africa	**0.5**	**2.1**	**1.3**	**2.0**	**2.1**	**2.1**
Latin America and Caribbean	**0.1**	**3.4**	**1.7**	**3.4**	**4.2**	**3.8**
Brazil	**-2.1**	**2.1**	**0.0**	**0.7**	**1.9**	**1.3**
Mexico	**1.9**	**2.2**	**2.1**	**4.2**	**4.6**	**4.4**
Mediterranean	**3.3**	**5.2**	**4.2**	**4.2**	**3.6**	**3.9**
Turkey	**3.4**	**5.3**	**4.4**	**4.4**	**3.8**	**4.1**
Economies in Transition	**5.3**	**5.4**	**5.3**	**4.2**	**4.6**	**4.4**
South-Eastern Europe	**4.6**	**4.3**	**4.4**	**4.0**	**3.8**	**3.9**
CIS	**6.9**	**5.2**	**6.0**	**4.1**	**5.7**	**4.9**
Russian Federation	**5.9**	**4.7**	**5.3**	**3.6**	**6.6**	**5.1**

Notes: Pre-projection was made for the period, 1995-2005. Projection periods are 2006-2020.

Source: FUGI global modeling system.

CO_2 emissions are derived from fossil energy use. Fossil energy consists of oil, coal and gas. Contribution rates of each category to CO_2 emissions are calculated by a formula; CO2ETF*(0.996 * COAL + 0.804 * OIL + 0.574 * GAS). The highest CO2 emission energy is coal and the lowest is gas. Oil is situated in medium. *Futures of CO_2 emissions have a large degree of "fluctuations" in accordance with policy scenarios and technology innovations on alternative energy and fossil energy savings.*

Table 3: CO_2 emissions from fossil energy use, 2000-2020

Unit:MTCE

	2000 Actual	2005 Estimate	2010 Projection	2015	2020
World	25811.54	30412.06	37188.49	42978.96	51809.93
Developed Economies	11745.08	12560.35	13766.47	14443.52	16399.47
Developed Asia-Pacific	1716.34	1825.48	2017.04	2098.5	2411.88
Japan	1276.18	1231.06	1385.97	1370.81	1553.47
Australia	393.43	501.34	569.10	659.17	781.70
North America	6234.66	6740.95	7308.57	7629.65	8679.59
Canada	543.74	605.84	683.37	747.72	874.98
United States	5690.92	6135.11	6625.20	6881.93	7804.61
Western Europe	3794.09	3993.92	4440.85	4715.38	5308.00
EU15	3713.28	3909.55	4333.84	4619.95	5209.56
Euro Area	2793.27	2921.99	3237.29	3434.38	3900.34
France	507.39	534.73	572.25	580.24	627.11
Germany	1015.06	1006.49	1057.84	1030.02	1136.75
Italy	403.53	403.39	440.42	484.77	554.11
United Kingdom	650.72	665.87	724.60	780.72	847.86
Developing Countries	11013.83	13901.85	18295.95	22225.18	27506.31
Asia-Pacific	7056.97	9580.49	13163.22	16070.44	20037.91
East Asia	4828.49	6828.21	9479.60	11185.81	13097.98
China	3876.76	5588.39	7937.13	9390.92	10951.84
Southeast Asia	1026.01	1250.35	1723.2	2223.51	3047.61
Indonesia	330.14	428.4	568.33	750.85	1164.02
South Asia	1198.07	1497.36	1955.79	2656.49	3887.7
India	1051.89	1339.03	1766.91	2420.62	3597.58
Middle East	1146.39	1380.51	1682.05	2126.8	2684.59
Saudi Arabia	372.17	380.54	393.63	458.35	491.58
Africa	868.78	920.13	1022.98	1132.14	1253.01
North Africa	295.53	332.19	369.4	407.47	451.68
Sub-Saharan Africa	573.25	587.94	653.58	724.67	801.34
Latin America and the Caribbean	1610.27	1619.88	1915.16	2264.66	2779.11
Brazil	384.81	345.66	384.27	398.27	437.79

Mexico	**454.73**	**500.13**	**557.48**	**684.96**	**857.68**
Mediterranean	**243.46**	**285.91**	**368.25**	**451.98**	**539.63**
Turkey	**214.46**	**253.30**	**328.48**	**406.60**	**489.07**
Economies in Transition	**3052.63**	**3949.87**	**5126.08**	**6310.25**	**7904.14**
South-Eastern Europe	**262.47**	**328.69**	**404.93**	**492.80**	**593.21**
CIS	**2072.72**	**2891.13**	**3726.36**	**4556.76**	**6017.65**
Russian Federation	**1385.34**	**1847.02**	**2322.59**	**2769.32**	**3808.63**

Notes: Pre-projection was made for the period, 1995-2005. Projection periods are 2006-2020.

Source: FUGI global modeling system (FGMS200).

Table 2 and Table 3 show projections of CO_2 emissions from fossil energy use, 2000-2020. It is of interest to note that annual average increasing rates of global CO_2 emissions for the period, 2010-2020 will not so much decrease compared with the period, 2000-2010. Although increasing rates of CO_2 emissions from the developed economies tend to be stabilized, those of developing countries as well as transition economies will much higher than developed economies. As a result, global CO_2 emissions from fossil energy use will be increasing steadily from 25,810 MTCE (metric ton canon equivalent) in 2000 to 51,810 MTCE in 2020. *It is worth noting that CO_2 emissions from China will surpass the US that is the world largest CO_2 producing country by 2010*; *although annual average increasing rates of CO_2 emissions from China will decrease from 7.4% in 2000-2010 to 3.3% in 2010-2020. However, CO_2 emissions per capita, 2000-2020 will show entirely different pictures* (See Table 4).

Table 4: CO_2 emissions per capita, 2000-2020

Unit: TCE (per 1000 persons)

	Actual	**Estimate**	**Projection**		
	2000	**2005**	**2010**	**2015**	**2020**
World	**4.2529**	**4.731**	**5.4747**	**5.9987**	**6.8682**
Developed Economies	**13.9054**	**14.7639**	**16.0891**	**16.7704**	**18.9643**
Developed Asia-Pacific	**11.4987**	**12.2381**	**13.5727**	**14.1172**	**16.2984**
Japan	**10.0789**	**9.7693**	**11.0839**	**10.9865**	**12.5348**
Australia	**20.9363**	**26.152**	**29.2489**	**33.5746**	**39.7442**

North America	20.216	21.4543	22.9153	23.6254	26.6214
Canada	17.5452	19.5885	22.1695	24.3537	28.5898
United States	20.5143	21.6581	22.9951	23.5489	26.4175
Western Europe	9.8045	10.3100	11.4428	12.1013	13.5846
EU15	9.905	10.4197	11.5313	12.2439	13.7696
Euro Area	9.588	10.0218	11.0831	11.7049	13.253
France	8.5955	8.9539	9.4779	9.5130	10.1805
Germany	12.3476	12.2295	12.8428	12.4887	13.7733
Italy	7.0510	7.1126	7.8023	8.5405	9.7263
United Kingdom	11.0706	11.2933	12.2508	13.1588	14.246
Developing Countries	2.2781	2.6802	3.3001	3.7665	4.3916
Asia-Pacific	2.1578	2.7628	3.5961	4.1807	4.9856
East Asia	3.505	4.7847	6.4251	7.3449	8.3401
China	3.0372	4.2303	5.8203	6.6878	7.5935
Southeast Asia	1.985	2.2707	2.9496	3.6066	4.7099
Indonesia	1.5583	1.8986	2.363	2.9333	4.2806
South Asia	0.8755	1.0106	1.2289	1.568	2.1715
India	1.0386	1.233	1.5323	2.0005	2.8617
Middle East	6.7123	7.266	7.9844	9.1447	10.4928
Saudi Arabia	17.267	15.1836	13.5835	13.7631	12.9278
Africa	1.1083	1.0499	1.0474	1.0428	1.0401
North Africa	2.0609	2.1184	2.1647	2.2041	2.2644
Sub-Saharan Africa	0.8951	0.8171	0.8108	0.8045	0.7972
Latin America and the Caribbean	3.1037	2.9096	3.2169	3.5744	4.1177
Brazil	2.2636	1.916	2.0142	1.9854	2.0906
Mexico	4.5985	4.6962	4.8935	5.6632	6.7312
Mediterranean	3.4977	3.8359	4.666	5.4763	6.2965
Turkey	3.2274	3.5502	4.3395	5.1297	5.9341
Economies in Transition	7.8282	10.1115	13.0395	15.6732	19.0335
South-Eastern Europe	4.7952	6.0088	7.3974	8.8811	10.4601
CIS	7.1957	9.9907	12.7694	15.2293	19.4116
Russian Federation	9.4493	12.8179	16.3402	19.4332	26.4853

Notes: Pre-projection was made for the period, 1995-2005. Projection periods are 2006-2020.

Source: FUGI global modeling system (FGMS200).

According to the baseline projections, CO_2 per capita (TCE per 1000 persons) of the developed countries as a group will increase from 13.9 in 2000 to 18.9 in 2020, while those of the developing countries will increase 2.3 in 2000 to 4.4 in 2020.

The highest level CO_2 per capita will be maintained by the US from 20.5 in 2000 to 26.4 in 2020 but the US position will be taken over by Russian Federation in 2020. It is worth noting that CO_2 per capita of Russian Federation will rapidly increase from 9.4 in 2000 to 26.5 in 2020.

High economic growth countries with large population such as China (India) will also rapidly increase CO_2 per capita from 3.0 (1.0) in 2010 to 7.6 (2.9) in 2020 but the figures are surprisingly lower than those of the US and Russian Federation.

Among the developed countries, CO_2 per capita of Japan and Germany will keep lower level from 10.1 and 12.3 in 2000 to 12.5 and 13.8 in 2020 respectively ,because of CO_2 saving technologies.

Among the developing countries with larger population , CO_2 per capita of Brazil will be kept at lower level of 2.3 in 2000 and 2.1 in 2020, because of increasing alternative energy such as biomass.

The following Table 5 provides information on alternative energy ratio to total energy requirements.

Table 5: Alternative energy ratio to total energy requirements

Unit: Ratio

	Actual	Estimate	Projection		
	2000	2005	2010	2015	2020
World	0.1100	0.1331	0.1437	0.1659	0.1815
Developed Economies	0.1576	0.1759	0.1926	0.2288	0.2489
Developed Asia-Pacific	0.1559	0.1783	0.1902	0.3467	0.4005
Japan	0.1869	0.2197	0.2245	0.4224	0.4854
Australia	0.0086	0.0354	0.0580	0.0713	0.0804
North America	0.1220	0.1379	0.1562	0.1643	0.1736
Canada	0.2310	0.2545	0.2836	0.2917	0.3097
United States	0.1090	0.1231	0.1388	0.1459	0.1526
Western Europe	0.2108	0.2319	0.2466	0.2629	0.2753
EU15	0.2070	0.2290	0.2450	0.2608	0.2732

Euro Area	**0.2251**	**0.2511**	**0.2715**	**0.2918**	**0.3071**
France	**0.4185**	**0.4459**	**0.4801**	**0.5121**	**0.5447**
Germany	**0.1325**	**0.1502**	**0.1682**	**0.1866**	**0.1967**
Italy	**0.2422**	**0.2708**	**0.3071**	**0.3436**	**0.3729**
United Kingdom	**0.1191**	**0.1416**	**0.1511**	**0.1575**	**0.1616**
Developing Countries	**0.0559**	**0.0871**	**0.1024**	**0.1129**	**0.1243**
Asia-Pacific	**0.0406**	**0.0434**	**0.0467**	**0.0540**	**0.0642**
East Asia	**0.0437**	**0.042**	**0.0427**	**0.0476**	**0.0552**
China	**0.0211**	**0.0243**	**0.0271**	**0.0324**	**0.0407**
Southeast Asia	**0.0376**	**0.0383**	**0.0337**	**0.0313**	**0.0291**
Indonesia	**0.0309**	**0.0346**	**0.0399**	**0.0438**	**0.0418**
South Asia	**0.0311**	**0.0528**	**0.0746**	**0.0962**	**0.1166**
India	**0.0212**	**0.0430**	**0.0712**	**0.0957**	**0.1189**
Middle East	**0.0166**	**0.0256**	**0.0273**	**0.0265**	**0.0243**
Saudi Arabia	**0.0179**	**0.0249**	**0.0279**	**0.0292**	**0.0294**
Africa	**0.0537**	**0.1249**	**0.168**	**0.1856**	**0.1960**
North Africa	**0.0092**	**0.0452**	**0.0641**	**0.0758**	**0.0829**
Sub-Saharan Africa	**0.0713**	**0.1563**	**0.2061**	**0.2245**	**0.2352**
Latin America and the Caribbean	**0.1208**	**0.2521**	**0.3201**	**0.3537**	**0.3832**
Brazil	**0.2775**	**0.5720**	**0.6573**	**0.7003**	**0.7288**
Mexico	**0.0709**	**0.0817**	**0.0900**	**0.1052**	**0.1206**
Mediterranean	**0.0794**	**0.1032**	**0.1105**	**0.1084**	**0.1034**
Turkey	**0.0793**	**0.1086**	**0.1173**	**0.1144**	**0.1081**
Economies in Transition	**0.0917**	**0.1337**	**0.1352**	**0.1725**	**0.2007**
South-Eastern Europe	**0.1133**	**0.1355**	**0.1481**	**0.1499**	**0.1538**
CIS	**0.0999**	**0.1471**	**0.1480**	**0.1951**	**0.2231**
Russian Federation	**0.0735**	**0.1439**	**0.1407**	**0.2122**	**0.2528**

Notes: Pre-projection was made for the period, 1995-2005. Projection periods are 2006-2020.

Source: FUGI global modeling system (FGMS200).

Alternative energy consists of all sort of energy excluding fossil energy. For instance, It includes nuclear, biomass, solar, batteries, other renewals and superconductor etc. At this time (2007), *nuclear energy* plays a greater role in the developed countries such as France and Japan. In Japan nuclear power plants are not so popular, because of nightmare of Hiroshima-Nagasaki but nuclear energy deems as one of the important

transition energy sources until new clean energy age will appeared. In place of nuclear, *solar energy* will play much greater role in Japan and Germany where new technology frontiers in HC (*hybrid cars)* and *EV (electric vehicles)* will rapidly expanding. It is also worth noting that Japan and Germany will take lead in the development of innovational energy savings technology such as *super conductor*. Super conductor uses natural electric phenomena of super conductivity where electric resistance of materials becomes zero in very low absolute temperature, for example, in outer space. Intensive research for *super alloy* to induce superconductivity in relatively moderate temperature is also going on. Experimental super express trains using super conductor have been already succeeded in Japan and Germany. There is a hope that *super conductor seems likely play ultimate energy saving technology in the futures of global human society.*

Among the developing countries, Brazil like agricultural resource rich country will play greater role in using *biomass* in place of fossil energy. On the other side, China has been not only succeeded in high economic growth performance, enjoying extraordinary large foreign exchange reserves but also will become the world largest CO_2 emission country by 2010 and confront serious environment issues if proper policy measures for environment protection would not be introduced as soon as possible.

6. Alternative path of global economy against CO_2 emissions

In order to cut back global CO_2 emissions, we should confront dilemma of sustainable development of the global economy. A surprising proposal made by *Limits to Growth (1972)* is zero growth of the global economy. If the global economy will confront with zero growth, it seems likely to induce global crises such as *Great Depression* in 1930s. Unemployment will become serious issues. Global issues such as poverty, international per-capita disparity, peace and security could not solve in the human society. Zero growth may cutback CO_2 emissions but could not solve trade-off between environment issues and desirable development of the global economy.

Alternative simulation by FGMS (FUGI global modeling system) reveals that cutbacks of global CO_2 emissions should be prerequisite against global warming. In order to cutback global CO_2 emissions, it should be needed for international co-operation and co-ordination of development strategy. Even if EU and Japan will co-operate and co-ordinate the policies toward cut back of CO_2 emissions by technology innovations for developing alternative energy and energy savings, it could not achieve the global targets without co-operation with the major CO_2 emission nations such as US, China, Russian Federation. In order to decrease global CO_2 emissions, it is

desirable to join the developing countries as a group. This is a very difficult job, because most of the developing countries should have keen interest and priority to develop their economies in order to overcome poverty rather than environment protection. This is why the developed countries should promote official development assistance (ODA), in particular, technical co-operation to the developing countries. Technology transfer from the advanced to developing countries are pre-requisite for achieving the target of cut back global CO_2 emissions.

Advanced economies should make utmost efforts to increase R & D as well as investments for alternative energy and energy savings. *The FUGI global model simulations affirm that not only increased R&D together with investments will increase rates of development of global economy but also decrease global CO_2 emissions.* There is a hope that global warming could be protected if information on early warning for possible fears on the planet Earth would be shared beyond differences between culture, race, and religion on common conscious of cosmic minds.

7. Conclusion

The FUGI global modeling system (FGMS200) has been developed as a scientific tool of policy simulations for providing global information to the human society and finding out possibilities of policy coordination among countries in order to achieve sustainable development of the world economy in coping with global warming.

It is worth noting that mutual understanding can be expected to increase through global information exchanges, in particular, on global warming phenomenon and we can seriously talk about possibilities for *increasing international cooperation and policy coordination*.

The functioning of the individual cells that support human life depends on both genetic information and non-genetic information generated through "*creative*" endeavors such as learning. It is still in the future for a global model to be developed that will in fact have a similar capacity for "*self-organization.*" An important phenomenon discovered through research in biotechnology is the so-called "*fluctuation phenomenon*." It may be appropriately said that the presence of fluctuations seems to be a basic and necessary element for the evolution of life. And again, this is a very important element in thinking about the global economy. Forecast simulations based on present baseline scenarios accommodate a large degree of "fluctuation" in light of the current unstable situation.

At the same time, there is of course the possibility of controlling this situation and changing its course through more energetic international policy coordination, or, in the terminology of biotechnology, "*dynamic cooperation*" among countries. *There are indeed many kinds of possibilities for invigorating the global economy, raising its growth rate, greatly reducing CO_2 emissions promoting innovations opening up new 21st century frontiers. It is reasonably expected that* the 21st century will be an age of integrated technology innovations in the fields of information technology, biotechnology, new energy as solar and superconductor, nanotechnology, robotics, new materials, spacetechnology and etc.

By demonstrating these possibilities of *integrated technology innovations* through future simulations using the latest FUGI global modeling system, we can exercise alternative policy scenario simulations for the global economy and can offer suggestions to those responsible for policy-making in the world's various countries. In keeping with these innovations, it will no doubt advance to new frontiers in economic science, while keeping much of its heritage of traditional economics. We ought to actively pursue this vision in *new frontier of economic science*, and in this regard we see FUGI global modeling system as one of the important intellectual challenges in the 21st century.

In conclusion, the author emphasizes the needs for policy co-ordination in the sustainable global economy.

(1) The moderately higher oil prices will provide an opportunity to develop alternative energy sources and open the doors to curve CO_2 emissions at the global level.
(2) Diffusion of energy saving technology and alternative energy innovations such as solar, biomass, super conductor, in line with hybrid cars and EV (electric vehicles) at the global level through increased R&D and technology transfer from the developed to developing countries.
(3) Expansion of ODA, in particular, technical cooperation coupled with private foreign direct investment in coping with poverty at the global level.
(4) The role of education, health care through technical cooperation should be more emphasized for improving labor productivity and per capita income in the poor countries/regions in the same globe.
(5) Cosmic mind for peace and security at the global level might be needed for coping with risks of global terrorism in the 21st century. *Cosmic mind means human solidarity to create common cosmic conciseness of living on the planet Earth in the ever changing infinite dynamic cosmos.*

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The latest FUGI model as an integrated global model can not only provide global information on the sustainable development but displaced persons or refugees that might be seen as serious global issues in the 21st century.

Appendix A: Regional classification of FUGI global modeling system (FGMS200)

Regions	No...	Code	Country name
Developed Market Economies			
Asia-Pacific	**1**	**JPN**	**Japan**
	2	**AUS**	**Australia**
	3	**NZL**	**New Zealand**
North America	**4**	**CAN**	**Canada**
	5	**USA**	**United States**
Western Europe	**6**	**BEL**	**Belgium**
	7	**DNK**	**Denmark**
	8	**FRA**	**France**
	9	**DEU**	**Germany**
	10	**GRC**	**Greece**
	11	**IRL**	**Ireland**
	12	**ITA**	**Italy**
	13	**LUX**	**Luxembourg**
	14	**NLD**	**Netherlands**
	15	**PRT**	**Portugal**
	16	**ESP**	**Spain**
	17	**GBR**	**United Kingdom**

Regions	No.	Code	Country name
	56	**SLB**	**Solomon Islands**
	57	**TON**	**Tonga**
	58	**TUV**	**Tuvalu**
	59	**WSM**	**Western Samoa**
	60	**VUT**	**Vanuatu**
Middle East Asia	**61**	**BHR**	**Bahrain**
	62	**IRN**	**Iran, I.R. of**
	63	**IRQ**	**Iraq**
	64	**ISR**	**Israel**
	65	**JOR**	**Jordan**
	66	**KWT**	**Kuwait**
	67	**LBN**	**Lebanon**
	68	**OMN**	**Oman**
	69	**QAT**	**Qatar**
	70	**SAU**	**Saudi Arabia**
	71	**SYR**	**Syrian Arab Rep**
	72	**ARE**	**United Arab Emirates**
	73	**YEM**	**Yemen Rep**

	18	AUT	Austria
	19	FIN	Finland
	20	ISL	Iceland
	21	NOR	Norway
	22	SWE	Sweden
	23	CHE	Switzerland
Developing Economies			
Far East Asia	24	CHN	China: mainland
	25	HKG	China: Hong Kong
	26	MAC	China: Macau
	27	TWN	Taiwan(Province of china)
	28	KOR	Korea, Republic of
	29	PRK	Korea, North
Southeast Asia	30	BRN	Brunei
	31	IDN	Indonesia
	32	MYS	Malaysia
	33	PHL	Philippines
	34	SGP	Singapore
	35	THA	Thailand
	36	KHM	Kampuchea Dem
	37	LAO	Lao P. D. Rep
	38	BUR	Myanmar (Burma)
	39	VNM	Viet Nam
South West Asia	40	AFG	Afghanistan
	41	BGD	Bangladesh
	42	BTN	Bhutan
	43	IND	India
	44	MNG	Mongolia
	45	NPL	Nepal
	46	PAK	Pakistan
	47	LKA	Sri Lanka
Pacific Islands	48	FJI	Fiji
	49	PYF	French Polynesia
	50	GUM	Guam
	51	KIR	Kiribati, Rep. of
	52	MDV	Maldives
North Africa	74	DZA	Algeria
	75	EGY	Egypt
	76	LBY	Libya
	77	MAR	Morocco
	78	TUN	Tunisia
Sub-Saharan Africa	79	AGO	Angola
	80	BEN	Benin
	81	BWA	Botswana
	82	HVO	Burkina Faso
	83	BDI	Burundi
	84	CMR	Cameroon
	85	CPV	Cape Verde
	86	CAF	Central African Rep.
	87	TCD	Chad
	88	COM	Comoros
	89	COG	Congo
	90	DJI	Djibouti
	91	ERI	Eritrea
	92	GNQ	Equatorial Guinea
	93	ETH	Ethiopia
	94	GAB	Gabon
	95	GMB	Gambia, The
	96	GHA	Ghana
	97	GIN	Guinea
	98	GNB	Guinea Bissau
	99	CIV	Ivory Coast
	100	KEN	Kenya
	101	LSO	Lesotho
	102	LBR	Liberia
	103	MDG	Madagascar
	104	MWI	Malawi
	105	MLI	Mali
	106	MRT	Mauritania
	107	MUS	Mauritius
	108	MOZ	Mozambique
	109	NAM	Namibia

	53	NRU	Nauru
	54	NCL	New Caledonia
	55	PNG	Papua New Guinea
Regions	**No.**	**Code**	**Country name**
	113	RWA	Rwanda
	114	SHN	St. Helena
	115	STP	Sao Tome & Principe
	116	SEN	Senegal
	117	SYC	Seychelles
	118	SLE	Sierra Leone
	119	SOM	Somalia
	120	ZAF	South Africa
	121	SDN	Sudan
	122	SWZ	Swaziland
	123	TZR	Tanzania
	124	TGO	Togo
	125	UGA	Uganda
	126	ZAR	Congo, Dem.Republic
	127	ZMB	Zambia
	128	ZWE	Zimbabwe
Latin America & the Caribbean	129	ARG	Argentina
	130	ATG	Antigua and Barbuda
	131	BHS	Bahamas The
	132	BRB	Barbados
	133	BLZ	Belize
	134	BMU	Bermuda
	135	BOL	Bolivia
	136	BRA	Brazil
	137	CHL	Chile
	138	COL	Colombia
	139	CRI	Costa Rica
	140	CUB	Cuba
	141	DMA	Dominica
	142	DOM	Dominican Republic

	110	NER	Niger
	111	NGA	Nigeria
	112	REU	Reunion
Regions	**No**	**Code**	**Country name**
	158.	NIC	Nicaragua
	159	PAN	Panama
	160	PRY	Paraguay
	161	PER	Peru
	162	PRI	Puerto Rico
	163	KNA	St. Kitts Nevis
	164	LCA	St. Lucia
	165	SPM	St. Pierre Miquelon
	166	VCT	St. Vincent
	167	SUR	Suriname
	168	TTO	Trinidad and Tobago
	169	URY	Uruguay
	170	VEN	Venezuela
Mediterranean	171	CYP	Cyprus
	172	MLT	Malta
	173	TUR	Turkey
	174	BIH	Bosnia and Herzegovina
	175	CRO	Croatia
	176	SVN	Slovenia
	177	MDN	TFYR Macedonia
	178	SIM	Serbia/Montenegro
Economies in Transition			
Eastern Europe	179	ALB	Albania
	180	BGR	Bulgaria
	181	CZE	Czech Republic
	182	HUN	Hungary
	183	POL	Poland
	184	ROM	Romania
	185	SLO	Slovakia
CIS	186	ARM	Armenia

143	ECU	Ecuador
144	SLV	El Salvador
146	GRD	Grenada
147	GLP	Guadeloupe
148	GTM	Guatemala
150	GUY	Guyana
151	HTI	Haiti
152	HND	Honduras
153	JAM	Jamaica
154	MTQ	Martinique
155	MEX	Mexico
156	MSR	Montserrat
157	ANT	Netherlands Antilles

187	AZE	Azerbaijan
188	BLS	Belarus
190	GEO	Georgia
191	KAZ	Kazakhstan
192	KYR	Kyrgyzstan
194	LTU	Lithuania
195	MOL	Republic of Moldova
196	RUS	Russian Federation
197	TJK	Tajikistan
198	TKM	Turkmenistan
199	UKR	Ukraine
200	UZB	Uzbekistan

Source; FUGI global modeling system (FGMS 200)

Appendix B. FUGI global modeling system (FGMS200)