

A new challenge to economic science: Global model simulation

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Abstract

The FUGI (Futures of Global Interdependence) global modeling system has been developed as a scientific policy modeling and future 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 co-existing on the planet Earth in the ever changing universe. The FUGI global model M200 classifies the world into 200 countries/regions where each national/regional model is globally interdependent. Each national/regional model has nine subsystems as population, foods, energy, environment, economic development, peace & security, human right, healthcare and quality of life (IT revolution). This is a super complex dynamic system model using *integrated multidisciplinary systems analysis* where number of structural equations is over 170.000. Economic model as a core includes major economic variables such as production of GDP, employment, expenditures of GDP, income distribution, prices, money, interest rates & financial assets, government finance, international balance of payments, international finance, foreign exchange rates and development indicators.

The purpose of this article is twofold, namely to provide information on *a new frontier science of economics: global model simulation* as well as appropriate policy exercise for sustainable development of the interdependent global economy. The world economy is facing “green” energy revolution to change from fossil to create alternative energy and energy saving technology against sky rocketing higher oil prices. Japan takes a lead in this field of technology innovation. Under such circumstances, Japan should take an initiative to create a new peaceful world through not only harmonized adjustments of Japanese economic policy but also wise cosmic mind to promote human solidarity with the ever changing nature will be desirable to adjust orbit of the fluctuated global economy. Japan should challenge for a new strategy to accelerate economic growth rates by “*CO₂ reducing environment investment*” based on technology innovations.

Keywords: FUGI global modeling system; integrated multidisciplinary systems analysis; Japan syndrome; alternative futures of Japanese economy; global model simulations; global coordination of polices

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1. INTRODUCTION

In the 21st century it is expected that “*global syndromes*” 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. As a matter of fact, development policy in the globalizing world should be modified in coping with such historical trends toward sustainable global economy. It is worth noting that, in the 21st century, integrated progress of science & technology and human mind will be desirable in the human society where consists of a globally interdependent complex system.

In the globalizing world, globally interdependent system structures are getting more and more complex so that nobody might easily percept cause and effect relationships at a first glance. Unfortunately, human brain intuitions are not so efficient enough to analyze impacts of synergy effects on complex policy mixtures. Therefore, policy makers should largely depend on scientific computer simulations of policy exercises in the globalizing world.

The FUGI (Futures of Global Interdependence) global modeling system has been developed as a scientific policy modeling and 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 (FGMS 200) 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 model 9.0 M200 is one of the most complex global models around the world. The number of equations is more than 170,000. See **Appendix A: The FUGI global modeling system (FGMS 200).***

The purpose of this article is twofold, namely to provide information on *a new frontier science of*

economics: global model simulation as well as appropriate policy exercise for sustainable development of the interdependent global economy. The world economy is facing “green” energy revolution to change from fossil energy to create alternative clean energy and energy saving technology against sky rocketing higher oil prices induced by speculations. Japan should take a lead in this field of technology innovation. Under such circumstances, Japan should escape from low growth trap induced by higher tax rate and incredible wastage of fiscal resources by malfunctioned bureaucracy seen as “Japan syndromes”, Japan should take an initiative to create a new peaceful world through not only harmonized adjustments of Japanese economic policy but also wise cosmic mind to promote human solidarity with the ever changing nature will be desirable to adjust orbit of the fluctuated global economy. Japan should challenge for a new strategy to accelerate economic growth rates by CO₂ reducing environment investment based on technology innovations.

2. OUTLINE OF FUGI GLOBAL MODELING SYSTEM

2.1. Regional classification

The FUGI global model 9.0 M200 divides the world into 200 countries and regions. For three major groupings there are (1) developed economies or advanced market economies (AME), (2) developing countries or developing economies (DME) and (3) economies in transition (EIT). The AME grouping contains the following sub-groupings; these are Developed Asia-Pacific, North America and Western Europe (including 15 member countries of the EU and EURO area). The DME 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: (a) Eastern Europe and (b) 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 designed seven 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 the United Nations ESCAP classification) and WB (for the World Bank classification). It is worth noting that a user of FGMS200 can easily make his own format, namely, G20 (G-20 countries groups) and CEPAL (UN Committee for Latin America). Such format classifications can be easily made within a few minutes in the **FUGI global modeling system (FGMS200)**.

Table1: Regional classification of FUGI global modeling system (FGMS200)

Regions	No...	Co de	Country name	Regions	No	Code	Country name
Developed Economies					56	SLB	Solomon Islands
Asia-Pacific	1	JPN	Japan		57	TON	Tonga
	2	AUS	Australia		58	TUV	Tuvalu
	3	NZL	New Zealand		59	WSM	Western Samoa
North America	4	CAN	Canada		60	VUT	Vanuatu
	5	USA	United States	Middle East Asia	61	BHR	Bahrain
Western Europe	6	BEL	Belgium		62	IRN	Iran, I.R. of
	7	DNK	Denmark		63	IRQ	Iraq
	8	FRA	France		64	ISR	Israel
	9	DEU	Germany		65	JOR	Jordan
	10	GRC	Greece		66	KWT	Kuwait
	11	IRL	Ireland		67	LBN	Lebanon
	12	ITA	Italy		68	OMN	Oman
	13	LUX	Luxembourg		69	QAT	Qatar
	14	NLD	Netherlands		70	SAU	Saudi Arabia
	15	PRT	Portugal		71	SYR	Syrian Arab Rep
16	ESP	Spain	72		ARE	United Arab Emirates	
17	GBR	United Kingdom	73		YEM	Yemen Rep	
18	AUT	Austria	North Africa		74	DZA	Algeria
19	FIN	Finland		75	EGY	Egypt	
20	ISL	Iceland		76	LBY	Libya	
21	NOR	Norway		77	MAR	Morocco	
22	SWE	Sweden		78	TUN	Tunisia	
23	CHE	Switzerland	Sub-Saharan Africa	79	AGO	Angola	
Developing Countries				80	BEN	Benin	
Far East Asia	24	CHN		China: mainland	81	BWA	Botswana
	25	HKG		China: Hong Kong	82	HVO	Burkina Faso
	26	MAC		China: Macau	83	BDI	Burundi
	27	TWN		Taiwan	84	CMR	Cameroon
	28	KOR		Korea, Republic of	85	CPV	Cape Verde
	29	PRK		Korea, North	86	CAF	Central African Rep.

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
	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

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	
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

	121	SDN	Sudan		166	VCT	St. Vincent
	122	SWZ	Swaziland		167	SUR	Suriname
	123	TZR	Tanzania		168	TTO	Trinidad and Tobago
	124	TGO	Togo		169	URY	Uruguay
	125	UGA	Uganda		170	VEN	Venezuela
	126	ZAR	Congo, Dem.Republic	Mediterranean	171	CYP	Cyprus
	127	ZMB	Zambia		172	MLT	Malta
	128	ZWE	Zimbabwe		173	TUR	Turkey
Latin America & Caribbean	129	ARG	Argentina		174	BIH	Bosnia and Herzegovina
	130	ATG	Antigua and Barbuda		175	CRO	Croatia
	131	BHS	Bahamas The		176	SVN	Slovenia
	132	BRB	Barbados		177	MDN	TFYR Macedonia
	133	BLZ	Belize		178	SIM	Serbia/Montenegro
	134	BMU	Bermuda	Economies in Transition			
	135	BOL	Bolivia	Eastern Europe	179	ALB	Albania
	136	BRA	Brazil		180	BGR	Bulgaria
	137	CHL	Chile		181	CZE	Czech Republic
	138	COL	Colombia		182	HUN	Hungary
	139	CRI	Costa Rica		183	POL	Poland
	140	CUB	Cuba		184	ROM	Romania
	141	DMA	Dominica		185	SLO	Slovakia
	142	DOM	Dominican Republic	CIS	186	ARM	Armenia
	143	ECU	Ecuador		187	AZE	Azerbaijan
	144	SLV	El Salvador		188	BLS	Belarus
	146	GRD	Grenada		190	GEO	Georgia
147	GLP	Guadeloupe		191	KAZ	Kazakhstan	
148	GTM	Guatemala		192	KYR	Kyrgyzstan	
150	GUY	Guyana		194	LTU	Lithuania	
151	HTI	Haiti		195	MOL	Republic of Moldova	
152	HND	Honduras		196	RUS	Russian Federation	
153	JAM	Jamaica		197	TJK	Tajikistan	
154	MTQ	Martinique		198	TKM	Turkmenistan	
155	MEX	Mexico		199	UKR	Ukraine	

156	MSR	Montserrat	200	UZB	Uzbekistan
157	ANT	Netherlands Antilles			

Source; FUGI global modeling system (FGMS 200)

2.2. Integrated multidisciplinary systems analysis

The design concept of FUGI global modeling (FGMS200) is based upon an innovational philosophy of humankind living on the planet Earth in the ever-changing dynamic Universe. It is worth noting that Cosmos is an entirely recycling system so that there might be no wastage of resources as seen in the current civilized human societies. In the Cosmic system *everything is interdependent and changing forever*. In order to adapt with such a dynamic cosmic system, humankind should modify present civilization in the globalizing world. Consciousness of co-existence of human beings with nature and solidarity of humankind will be needed. The more balanced progress between technological innovations and human minds may be necessary in order to create a desirable economic relationship and life support system of the Earth in the post-modern futures.

Current globalizing world economy has been affected by global syndromes that might not be solved by a short-sighted profit maximizing human behavior apt to money worship. Adam Smith (1723-1790) thought that profit maximizing human behavior will eventually create a harmonized wealthy society guided by "invisible hand" of God. Such kind of "belief" has been inherited to even academic disciplines of modern economics, in particular, "free trade". He is well known author of "The Theory of Moral Sentiments" (1759) and "An Inquiry into the Nature and Causes of the Wealth of Nations" (1776).

This myth is not true in the light of experience in a globalizing world economy. We see "global syndromes" such as increasing "miserable wealth gap" between the rich and the poor as well as "digital divides" between the educated people and the non-educated in addition to increasing "ecological destructions of a harmony between the nature and human activities" all over the world. Human beings, in particular, the highly educated rich people should learn a Classical wisdom such as mercy, awaken, aspiration, ascetic self-control, moderate, tolerance and harmonization with nature in order to create a *new human solidarity based on cosmic mind toward a global welfare society and peaceful world. Global enterprises also should pay much attention on SRI (socially responsible investing).*

The innovational system design concept of FUGI global modeling system has been influenced by the recent advancement of systems engineering, life science, biotechnology, information/communication technology and space technology. The new keywords are given below.

(1) *Systems science and engineering*, (2) *Lifeinformatic economics*, (3) *Global dynamic*

cooperation and policy coordination among the countries, (4) *Self-organization* in accordance with changing environment, (5) *Brain physiology* economics in collaboration with right and left brain, (6) *Fluctuation phenomenon (yuragi* in Japanese) considering alternative composite policy scenario simulations under *uncertainty* world and (7) *Global early warning* system for geographical and global risks. It is worth noting that quick policy prescription and coordinated policy actions might be feasible through early recognition on possible global risks.

It is worth noting that *FUGI global modeling system* using original “*integrated multidisciplinary systems analysis*” (*IMSA*) will be able to provide “*alternative futures of the Japanese economy in the global interdependence*” in order to adjust orbit of the fluctuated global economy by global model simulations.

2.3. Structure of global interdependence

Let us explain the *broad structure of global interdependence* in FUGI global modeling system. Current world economy consists of around 200 countries/ regions where each country / region model is increasing *global interdependence*. The most important *global interdependence variables* are world trade matrix (200 x 200), export/import prices, commodities prices in particular, oil prices, foreign exchange rates, stock market prices, ODA, private foreign direct investment, interest rate As LIBOR, particularly the US interest rates, fiscal & monetary policies, energy and environment policies etc. Certain countries are selected from the Regional Classification of 200 countries /regions for illustration of broad structures of global interdependence in FUGI global modeling system (see Fig.1).

Among 200 countries /regions, it is worth noting to note that economic geographical map is rapidly changing toward the end of this century. Apart from current super powers of the US, EU and Japan, so called BRICs (China, India, Brazil and Russia) are rapidly increasing economic powers so that their shares of real GDP and or nominal GDP in terms of the US dollar in the world economy might be changing rapidly.

According to FUGI global model simulations, the US will hardly maintain the current shares, although EU15 and Japan's share will be decreasing. It is reasonably expected that enlarged EU will play a greater role of globalizing world. Among the BRICs, the Chinese share is strikingly growing and will take over Japan's position sooner or later As a matter of facts, foreseeable changes in the geo-economic map will induce structural changes in the world trade and global interdependence.

The FUGI global modeling system includes more than 170,000 structural equations so that the reader might not understand the structure of the huge model at a glance. It is surprising for the reader to recognize that such a large complex dynamic system model is operational by a personal

computer, because dramatic “information technology innovation” has been occurred over the past only 40 years. It seems likely to be too hard job to find solutions of such sophisticated non-linear dynamic model using conventional mathematical formula. Instead of using the conventional mathematical formula, we have adopted computerized mathematics formula, so that system engineers might easily understand computerized modeling system and make computer simulation exercise using computer programming languages and iteration methods. *Computer simulation technology will strengthen traditional thinking of modeling; because human brain might have certain physical limitations to understand such sophisticated complex interrelated dynamic phenomenon at a glance.*

We would be better to explain very simple images of “*global interdependence*” on the FUGI global modeling system. Concept of the FUGI global modeling system is that *everything around the world is apt to change forever and interrelated*. At the same time, past historical experiences have certain effects on present situations and current human behaviors, in turn, will have impacts on the future situations of the world economy. Thus, business cycles tend to repeat similar historical *fluctuation* patterns in the major developed economies such as the US economy. In the globalizing world, every country around the world cannot survive alone segregated from the interdependent global economy but may survive in the co-existing world. Furthermore, in this uncertainty world, every country, in particular, the US may not find a proper way without a *navigation map* for operating systems of the world economy. This is why we have designed the FUGI global modeling system to provide information on globalizing world very quickly to human society.

Although the major core of the FGMS 200 is economic development subsystem, there are other related important subsystems such as population; foods, environment, human right, human health care, digital divide, peace and security for life supporting system of humankind on the Earth. For example, population increase of the Earth depends upon birth rates and death rates in each country. These ratios are depends on education, life expectancy at birth etc. Labor force increase depends on population dynamics and labor force participation rates. Thomas Robert Malthus (1766-1834) in his book, *An Essay on the Principle of Population*, first published in 1798 believes that population explosion may bring global poverty and unemployment. But this is not true in the light of simulations using FUGI global modeling system. Unemployment rates partly depend upon increasing rate of labor force but major factors are wage cost issues. If nominal wage rate increase would lower than those of labor productivity, employment opportunities will be increased. If labor hours would be shortened by work sharing, unemployment rates could be decreased. As a matter of facts, decreases in unemployment rates may increase real GDP growth rates.

As a core subsystem of “*economic development*,” labor productivity plays a significant role to raise per-capita income level and eventually overcoming poverty. Furthermore, it is reasonably

expected that labor productivity increase using robotics will provide with more free time to raise humanistic activities level and improve quality of life covering health care, digital divide in accordance with gradually shortenings of working hours in the global society in the futures. On the supply side, therefore, labor productivity increase is the most important factor to raise per-capita income and living standards. GDP growth potentials can be increased by not only labor force but also by capital assets, educational assets and technology assets. Non housing fixed investment and, in particular, R&D increase capital and technology assts to raise labor productivity in the developed market economies. On the other side, educational expenditure and ODA, in particular, technical co-operation can play greater role to increase growth potentials of the poor developing countries. Without increases in GDP growth potentials, sustainable development could not be achieved over the long-run in the global interdependent economy.

Apart from “global financial/economic crisis” as seen in the US originated *subprime loan issues* in 2007-2009, major factors to induce business cycles to interfere the sustainable development of the developed market economies seem likely to be *fluctuations* of fixed investment. For instance, increasing rates of non-housing investment in the US and Japan are explained mostly by profit rate to non-housing capital assets minus interest rates on loan. If profit rate is higher than interest rates, non- housing investment may increase while if interest rates overshoot, non-housing investments tend to shrink. Then depression period may be started. While depression periods continue, Federal Fund Rate (US) might be lowered compared with profit rates in order to escape from economic stagnation traps. Accordingly, economies will recover sooner or later and real growth rates will be accelerated toward ceilings restricted by GDP growth potentials on the supply side. Such kind of growth patterns and interest behaviors have been recorded as human historical memories so that business cycles might repeat in accordance with historical pattern recognition. It is however worth noting that the historical patterns of business cycles are not always remains same, but may be changeable in accordance with changing economic environment and policies.

For example, demand oriented Keynesian policy seems likely to be not so effective in the globalizing interdependent world economy. If the US would pursue such a policy, the US economy should be got in troubles of increasing twin deficits namely government budget and trade deficits (for reference, see simple explanatory notes on *Global Interdependence Table*). Depreciation of US dollars against the other major currencies such as EURO, Yen and Yuan may not solve the US structural trade deficits, but the US international competitiveness on price and non price should be improved by lowering employment costs and increasing R&D through technology innovations.

With regard to the sustainable development of the globalizing interdependent economy, “*fluctuations*” of the *stock market prices* also may play a significant role as seen a global coincidental market crash induced by “sub-prime loan crisis”. Today the assets, in particular, financial assets are major variables to explain the movement of private consumption expenditures

which have been explained by mostly disposal income, namely, compensation of employees and operating surplus after tax reduction. However, assets effects will have getting an increasing importance in the rich societies as A.C. Pigou (1877-1959) once suggested against J.M. Keynes. Fluctuations of stock market prices of the major power like the US will induce fluctuations of the world economy through information and financial flows in the interdependent global economy.

For the time being, the US will still play a significant role to sustain the global economy, but economic geographical map on a planet Earth is rapidly changing. Furthermore, there is still a hope in the global human society to strengthen a global consciousness on co-existence with nature for sustainable life support system of the Earth. For instance, through the UN, NGOs and volunteers, global consciousness and collaborations against desertification of the Earth by reclamation of forests will be increasing (see *Global Early Warning System* in *EOLSS*). Japan should take a lead on recognition of global consciousness on co-existence with nature for sustainable life support system of the Earth that will have an increasing importance in accordance with concerted progress in both cosmic mind and science & technology in the 21st space age.

2.4. Global Interdependence Table

It is worth noting that the key variable of *Global Interdependence Table* (originally designed by Onishi) is *trade matrix*. For the readers who are not familiar with mathematics, skip this mathematical note and proceed to policy implications of global interdependence table. Only for the readers who have a good knowledge of mathematics, we will show simple explanatory notes on “*Global Interdependence Table*” in the followings;

$$\mathbf{GDP\#} = \mathbf{E\#} - \mathbf{M\#} + \mathbf{CP\#} + \mathbf{CG\#} + \mathbf{GFCF\#} + \mathbf{IIS\#}$$

Where **GDP#**, **E#**, **M#**, **CP#**, **CG#**, **GFCF#** and **IIS#** are column vectors at constant market prices in terms of millions of US dollars. In the FUGI global modeling system, variables with # denote constant market prices and those without # denote current market prices. For instance, GDP denotes gross domestic product at current domestic market prices, GDP# denotes GDP at constant market prices and GDPS denotes current GDP in terms of *current* US dollar prices.

GDP#: Gross domestic products, **E#**: exports of goods and services, **M#**: imports of goods and services, **CP#**: private consumption expenditures, **CG#**: government consumption expenditures, **GFCF#**: gross fixed capital formation (**NHI#**: non-housing investment plus **HI#**: housing investment), **IIS#**: increase in stocks including statistical discrepancies.

$$E\#<1> = E\#<1, 1> + E\#<1, 2> + E\#<1, 3>----- + E\#<1, n>$$

$$\begin{aligned}
E_{\langle 2 \rangle} &= E_{\langle 2, 1 \rangle} + E_{\langle 2, 2 \rangle} + E_{\langle 2, 3 \rangle} \dots + E_{\langle 2, n \rangle} \\
E_{\langle 3 \rangle} &= E_{\langle 3, 1 \rangle} + E_{\langle 3, 2 \rangle} + E_{\langle 3, 3 \rangle} \dots + E_{\langle 3, n \rangle} \\
&\vdots \\
E_{\langle n \rangle} &= E_{\langle n, 1 \rangle} + E_{\langle n, 2 \rangle} + E_{\langle n, 3 \rangle} \dots + E_{\langle n, n \rangle}
\end{aligned}$$

Where $\langle n \rangle = 200$ in FGMS 200.

ETFOB# = $E_{\#} \text{ MAT} \langle \text{SUM } J \rangle$ in $E_{\# \langle I, J \rangle}$ trade matrix elements,

MTFOB# = $E_{\#} \text{ MAT} \langle \text{SUM } I \rangle$ in $E_{\# \langle I, J \rangle}$ trade matrix elements,

$E_{\# \langle I, J \rangle}$ denotes exports from a county $\langle I \rangle$ to country $\langle J \rangle$.

$E_{\#}$ and $M_{\#}$ are linear functions of **ETFOB#** and **MTFOB#** respectively.

For simple mathematical explanations of the model, suppose that $E_{\#}$ (= **ETFOB#**), $M_{\#}$ (= **MTFOB#**) and $CP_{\#}$ are linear functions of **GDP#**. **GDP#** vector can be easily calculated by the following simple mathematical formula.

GDP# is obtained from inverse matrix of $(\mathbf{I} - \mathbf{A} + \mathbf{B} - \mathbf{C})$ multiplied by a predetermined column vector $(\mathbf{CG}_{\#} + \mathbf{GFCF}_{\#} + \mathbf{IIS}_{\#})$, namely,

$$\mathbf{GDP}_{\#} = (\mathbf{I} - \mathbf{A} + \mathbf{B} - \mathbf{C})^{-1} * (\mathbf{CG}_{\#} + \mathbf{GFCF}_{\#} + \mathbf{IIS}_{\#})$$

Where \mathbf{I} : unit matrix. \mathbf{A} : export coefficients $n \times n$ matrix, \mathbf{B} : import coefficient diagonal matrix and \mathbf{C} : private average propensity to consume coefficient diagonal matrix. From this simple mathematical formula, the readers may be able to understand that an increase in $\mathbf{CG}_{\#}$, $\mathbf{GFCF}_{\#}$ and $\mathbf{IIS}_{\#}$ will increase in real GDP through multiplier effects $(\mathbf{I} - \mathbf{A} + \mathbf{B} - \mathbf{C})^{-1}$ in the interdependent global economy. This simple instructive global model is a demand oriented model. But FGMS 200 theoretical model has been designed as demand- supply integrated model. See **Appendix A: The FUGI global modeling system (FGMS200)**.

It is also worth noting that FGMS is non-linear system and its mathematical solution needs more complex iteration process.

2.5. Policy implications of global interdependence table

Apart from a tiresome mathematical model, we would be better to explain *policy implications of global interdependence table*.

If the gross fixed capital formation, GFCF in the interdependent global economy would increase by adequate policy measures such as expansion of R&D to induce more advanced “*technology innovations*” and “*energy revolutions*” for developing alternative energies against global warming gas emissions, it is reasonably expect that increased GDP will not only induce world trade expansion but also reduce global CO₂ emissions through global interdependence. The more global interdependence is developed in the globalizing world, the more trade expansion is expected. Every country around the world may enjoy benefits from US expansion of imports from the rest of the world.

However, trade expansion effects may not be equally distributed to every country around world. This is particularly true in case of the China-US trade relationships. Exports from China to the US will be enlarged more than the US imports from China. As a result, China will accumulate huge trade surplus with the US. On the other side, the US trade deficits will be strikingly enlarged. This means that global trade disequilibrium will be keen issues in the globalizing world. In order to cope with such global disequilibrium, not only the US should not cutback imports from China by introducing protectionist policy, but also China should open the doors increasing imports by mitigating tariff and non-tariff barriers. Exports of China to the US have been partly interfered by safety and healthy global standard. This is an example of “*appropriate trade policy*” in the globalizing world.

It is expected that while the US will continue trade deficits by 2020, private foreign direct investment together with government sovereign financial fund such as SWF (Sovereign Wealth Fund) may offset the US trade deficits to large extent in accordance with devaluation of US dollar against major currencies such as EURO and Yen. It is worth noting that the US dollar devaluation against other major currencies may not “*appropriate*” policy measures to improve the US trade deficits and structural disequilibrium in the globalizing world.

2.6. Software of FUGI global modeling system

In 2000-2007, Onishi, A designed a significant new software for the integrated global modeling system (consisting of interdependent 200 countries/ regions models) using a personal computer (Windows 2000/XP Professional/Vista). This expert software system, named as **FUGI global modeling system (FGMS 200)** has been researched and developed as a "package" for specific use in making computations for the FUGI global model 9.0 M 200PC. 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**.

FGMS200 can carry out automatic estimation of a given set of structural parameters of the model, applying OLS (ordinary least squares method) or MLBM (maximum likelihood method) by selecting the most appropriate combination of explanatory variables in a given estimation period. Automatic Error Correction System (**AECS**) allows making forecast simulations efficiently using error correction column vector “**d**” The target setting of a given variable, for instance, oil cutback requirement in a given period of the developed countries can be easily done using “**d**”. 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, 2003-2008 (<http://www.eolss.net>).

3. EXAMPLES OF ESTIMATED PARAMETERS OF GLOBAL MODEL

It is worth noting that through the use of FGMS200, automatic estimation of full set of parameters of the model is carried out very efficiently by automatically selecting either OLS (ordinary least squares) or MLBM (maximum likelihood method) in accordance with indicators of DW (Durbin-Watson ratio). They can make proper judgments whether Auto Correlation exist in a given time-series data. Because of constraints of spaces, we cannot show the full set of parameters of the model but illustrate only a few examples for reference purpose.

Population- Life expectancy at birth (Female)

< Japan >

$$E010 \text{ LOG (LIFEEXPF <JPN>) } = 4.3183 + 0.0443 * \text{ LOG (GDP\#.1 / NP.1)}$$

(4.63)

$$+ 0.0020 * \text{ LOG (GH\#. 1 + GSW\#. 1) / GDP\#. 1}$$

(2.07)

+ 0.0068*LOG (GEDU#.1/GDP#.1) - 0.0844*LOG (TFR)

(1.18) (-2.68)

R*R = 1.000 DW = 0.89

SE = 0.001 MLBM (1986 - 1999)

OIL

<Japan>

E0300 LOG (OIL / GDP#<JPN> = -10.80 - 0.4980* LOG (COAL.1 + GAS.1)/ENGYR.1)

(-3.56)

- 0.2165*LOG(ALTEGY.1/ENGYR.1)

(-0.035)

+ 0.0046*LOG (SUMT5 (ITI#) / (NHFC#))

(-0.035)

R*R = 0.9945 DW = 1.035

SE = 0.033 MLBM (1980 - 1999)

<USA>

E030 LOG (OIL / GDP#<USA>) = 10.88 - 0.0698* LOG (POIL/WPI)

(-2.38)

-1.0464* LOG (COAL.1 + GAS.1)/ENGYR.1)

(-4.66)

- 0.3902*LOG(ALTEGY.1/ENGYR.1)

(-5.95)

- 0.0832*LOG (SUMT5 (ITI#) / (NHFC#))

(-2.08)

R*R = 0.9933 DW = 1.329

SE = 0.018 MLBM (1978 - 1999)

< China- mainland>

$$E030 \text{ LOG (OIL / GDP\#<CHN>) = -14.12 - 0.0379* LOG (POIL/WPI)} \\ (-0.86))$$

$$-5.4508* \text{ LOG (COAL.1 + GAS.1)/ENGYR.1)} \\ (-5,50)$$

$$- 1.1602* \text{ LOG(ALTEGY.1/ENGYR.1)} \\ (-11.25)$$

$$R^*R = 0.9650 \quad DW = 0.6853 \\ SE = 0.139 \quad MLBM (1971 - 1999)$$

Production function:

<Japan>

$$E102 \text{ LOG (GDPP\# / LCLF <JPN>) = 1.8504 + 0.5236* LOG (NHFCS\#*CUR / LCLF)} \\ (3.75)$$

$$+ 0.0686* \text{ LOG (SUMT5 (ITI\#) / (NHFCS\#)} \\ (0.45)$$

$$R^*R = 0.9905 \quad DW = 0.95 \\ SE = 0.031 \quad MLBM (1983 - 1998)$$

Unemployment Rate:

<Japan>

$$E113 \text{ UNEMPR<JPN>= - 0.5363 + 0.0298*LOG LOG (LCLF*HOW)} \\ (1.59)$$

$$+ 0.2136* \text{ LOG (WSEI.1/LPI.1) - 0.0125*LOG (GFCF\#. 1/GDP\#. 1)} \\ (10.69 \quad (-1.57))$$

$$R^*R = 0.9620 \quad DW = 1.17 \\ SE = 0.002 \quad MLBM (1985 - 1998)$$

Prices

<Japan>

$$\begin{aligned} E250 \text{ DOT (WPI)} &= -0.0051 + 0.2650 * \text{DOT (PM)} + 0.3976 * \text{DOT (WSEI/LPI)} + \\ &\quad (7.29) \quad (2.74) \\ &+ 0.1008 * \text{DOT (IV\#.1)} \\ &\quad (0.69) \end{aligned}$$

$$\begin{aligned} R^*R &= 0.9253 & DW &= 2.37 \\ SE &= 0.030 & OLS &(1972 - 1999) \end{aligned}$$

$$\begin{aligned} E252 \text{ DOT (CPI)} &= -0.173 + 0.0282 * \text{DOT (PM)} + 0.8963 * \text{DOT (WSEI/LPI)} + \\ &\quad (0.82) \quad (3.26) \\ &+ 0.4048 * \text{DOT (TCR/100)} \\ &\quad (2.83) \end{aligned}$$

$$\begin{aligned} R^*R &= 0.7415 & DW &= 1.11 \\ SE &= 0.008 & MLBM &(1985 - 1999) \end{aligned}$$

<

Exports:

<Exports from Japan to USA>

$$\begin{aligned} E142 \text{ LOG (E\#MAT<JPN, USA>)} &= -4.6082 + 0.6624 * \text{LOG (GDP\#<USA>)}, \\ &\quad (1.04) \\ &-1.6411 * \text{LOG (PES<JPN>. 1 * FERSI<USA>. 1 / CPI<USA>. 1)}, \\ &\quad (-5.97) \\ &+ 0.4377 * \text{LOG (SUMT4 (RD\#<JPN>. 1)} \\ &\quad (1.30) \end{aligned}$$

$$\begin{aligned} R^*R &= 0.9834 & DW &= 0.5182 \\ SE &= 0.161 & MLBM &(1976-1999) \end{aligned}$$

<Exports from USA to Japan>

$$E143 \text{ LOG (E\#MAT<USA, JPN>) = -7.3445 + 1.2079*LOG (GDP\#<JPN>),}$$

(9.31)

$$-0.3851* \text{ LOG (PES< USA>. 1 / PESAME.1),}$$

(-2.08)

$$-0.3008* \text{ LOG (PES<USA>. 1 * FERSI<JPN>. 1 * (1 + CTR@<JPN>. 1 + NTB@<JPN>. 1) /}$$

$$\text{CPI<JPN>. 1))}$$

(-3.08)

$$R^*R = 0.9924 \quad DW = 1.91$$

$$SE = 0.050 \quad OLS (1976-1999)$$

Private consumption expenditures:

<Japan>

$$E152 \text{ LOG (CP\# <JPN>) = 7.7366 + 0.4227*LOG (DFI\# - (TPI\# + TYC\#))}$$

(4.13)

$$- 0.3054* \text{ LOG (CPI / (CPI + CPI.1) /2)) - 0.2757*LOG (ICC.1)}$$

(- 0.38) (2.63)

$$+ 0.0786* \text{ LOG (MTD.1 + SMV.1) / CPI.1)}$$

(1.54)

$$R^*R = 0.9975 \quad DW = 0.52$$

$$SE = 0.056 \quad MLBM (1973 - 1998)$$

Non-Housing Investment

< Japan >

$$E162 \text{ DOT (NHING\# <JPN>) = - 0.6170 + 3.4881*((OS\#.1 - TYC\#.1) / NHFCS\#.1 - IP.1 / 100)}$$

(2.64)

$$+ 0.4182* \text{ DOT (ETFOB\#.1)}$$

(2.36)

+ 1.0717*DOT (RD#.1)

(3.77)

+ 1.0126*(ITI#.1 / NHI#.1)

(2.52)

R*R = 0.8479 DW = 1.998

SE = 0.041 OLS (1981 - 1997)

Foreign Exchange Rate

<Japanese yen against US dollar>

E803 LOG (FERSI<JPN>) = 0.1353 + 1.9332*LOG (PGDP.1 / PGDP<USA>)

(10.84)

- 0.2845*LOG (ESMAT<JPN.USA> .1 / ESMAT<USA, JPN>. 1)

(- 3.06)

+ 0.0325*LOG (IC<USA>. 1 / IC.1) + 0.8318*LOG (FERIEUR)

(1.30)

(7.04)

R*R = 0.9709 DW = 1.93

SE = 0.076 OLS (1980-1999)

Note: Where () denotes T-statistics and DOT denotes percentage changes. (.1) denotes one year time lag. For further details of the notations, see Appendix A: FUGI global model 9.0 M200.

4. FUTURE SIMULATIONS OF THE WORLD ECONOMY, 2009-2020

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, oil prices and financial securities etc. 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 results, sharp increase in the US interest rates as long term bond yields that might induce sharp decrease of the US economic growth rates and the major engine of sustainable global economy will be lost. Same is true in the case of the US oriented sharp increase in oil prices by global “money game” speculations as well as sharp decrease in financial securities prices with regard to the US originated subprime loan issues. This is an example of the pessimistic scenario.

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*”. Akira 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 globalizing interdependent world 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 ($GDP\#.1 - GDP\#.2$) 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 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, although he made a

mistake as “labor theory of value” infected by “nightmares” of David Ricardo (1772-1823). 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. Marx 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*” as “*FUGI global Model*”. See [1] 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 scenario simulations of the global economy using the FUGI global modeling system. For instance, baseline simulations 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 simulations. Every day, we input new information and data to modify the *initial values* (CRS files), so that the baselines simulation might accommodate with ever changing the world economy. It is worth noting that *the future of the world global economy is not determined by destiny but could be changed by policy co-ordination among players*. This is why we have designed the FUGI global modeling system not only to make the *baseline* but also *alternative policy scenario simulations* *The following Scenario A: G20 collaboration projections made in 2009 are just for reference to show an exercise of global model simulations using FUGI global modeling system, because futures will have large degree “fluctuations “depending on human behaviors and policy co-ordinations.*

Scenario A: G20 collaboration

Everyone knows that current global economic crisis originated from the US subprime loan issue has been brought by the global “money game” on oil prices as well as sharp decrease in financial securities and stock market crash. The “global financial crisis” induced by the US originated “subprime loan issues” in 2008-9 has simultaneously turned into “global economic crisis” through “global interdependence without systemic global risk management”. In order to overcome such

“global syndrome”, international coordinated action should be necessary to build appropriate systemic global risk management and international order.

The US originated subprime loan securities have spread to unforeseeable huge extent in the globalizing world without any proper regulations against speculative activities of equity funds including hedge funds that might induce a spiral of systemic bankruptcy of financial institutions. As a result, all of a sudden decrease of subprime loan security prices has induced a global stock market crash. It is reasonably expected that sharp decreases in the capital equity ratios of major banks should bring about a chain of vicious circle of systemic collapse of financial institutions that might recollect Japan’s negative exemplum of “bad loans in dark age”. More restricted lending capacities of commercial banks, together with reduced capital stocks of private enterprises should decrease in investment activities in real sectors. As shown in the “*Global Interdependence Table*”, decreases in real domestic capital formation lead to shrinkage of world trade toward “global economic crisis”.

It is worth noting that the economic crisis in the US economy, having large shares of the world economy, tend to transmit to the rest of the world consisting of the global community through international trade, export-import prices, exchange rates, capital movements, stock market prices, financial market and investment funds including hedge fund etc. In this sense, the US economy should play the most important role for the stabilization of financial market and 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 cooperation should be needed for coping with new phenomena of global financial/economic crisis.

The following alternative projections made in early 2009 are just reference materials for policy makers to evaluate policy exercises of global model simulations, because futures will have large degree “fluctuations” depending on human behaviors and policy co-ordinations.

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 alternative policy scenario simulations namely, *Scenario A: G20 collaboration (see Table 1A)* but also *Scenario B: Global concerted policy for green revolution (see Table 1B).*

The US government has faced the US originated new “global financial /economic crisis” prevailing in 2009. In coping with a serious recession like “Great Depression” in 1930s, the US government has also introduced “economic recovery plan” to expand “effective demand” and create 3.5 million jobs. The government also has proposed “American recovery and reinvestment act” with public spending nearly 3.6 trillion dollars for stabilizing the financial system to be destroyed by a large amount of bad loans and stock market crash. Incredible systemic terrors have attacked the US economy such as bankruptcy of the major US banks like Bank of America and Citibank group, together with AIG, the world biggest life insurance corporation to insure US

banking system. It is also striking news that the US major automobile companies such as GM and Chrysler have suffered from bankruptcy and the government set out to reconstruct. Against such terrors, in addition to the urgent economic stimulus package, the new Obama government has also stressed the long-term development policy for creating a sustainable economy supported by alternative energy (15 billion dollars in 10 years), environment, education, healthcares (633.8 billion dollars in 10 years). These are lessons from “Great Depression”. According to FGMS simulations on possible impacts of the US *economic stimulus measures corresponding to 2% of GDP in 2009*, it is estimated that the real GDP growth rate in 2009 could be increased by 1.97% point compared with the Baseline figure.

Against “global economic crisis, G20 countries have introduced respectively collaborated actions to cut back of interest rates and expand “effective domestic demand” to sustain economic growth and secure employments by various safety- net measures such as tax cut and expansion of public expenditures in spite of increased government budget deficits from country to country. France and Germany in EU as a group have refrained from positive fiscal policy like the US, because of fears on increasing government budget deficits.

Japan has introduced a flat-rate benefit of 2 trillion yen to households to support private consumption expenditures. Because of a sharp fall down of exports in the amount of almost half, the Japanese real GDP in fourth- quarter of 2008 drastically decreased by 12.1 %. This is the second worst record since the post-World War II, next to “oil shock” in 1973. As a result, the export oriented Japanese economy has produced a large amount of unemployment and underemployment. The government has enforced to adopt additional business stimulus measures in 2009 fiscal year in the amount of 14 trillion yen as around 2% of GDP in spite of government debt outstanding reached to astronomical figure as 4344 trillion yen namely government debt outstanding GDP ratio as almost 150%. According to FGMS simulations on possible impacts of these fiscal policy measures, it is expected that the Japanese real GDP growth rate in 2009 will be increased by 1.87% point compared with the Baseline figure. However, nobody knows about “genuine figures” of economic stimulus measures, because 14 trillion yen is once pooled into “special account” different from “general account” of the general government budget and will allocate to each ministry and further distribute to “independent administration corporations”, public administration corporations and 46 Funds including newly created 30. The Japanese constituents should know such a complex system of deficit financing as resultant astronomical figures of government debt outstanding. The more tax is increased, the more black holes are enlarging in Japan, in spite that Japan should contribute to “Green Revolution” and sustainable development of the global economy, while avoiding wastage of fiscal resources.

On the other side, so-called BRICs such as China, India, Brazil and Russia have been affected by “global economic crisis”. Unemployment figure of Russia has reached 6 millions in 2009. In the

globalizing world economy, however, BRICs seem likely to become a countervailing power against the US oriented business cycles in the futures. Major cause of business cycles seems likely to be “fluctuations” of “induced fixed investment” so that government sovereign “autonomous” investment in these countries might have, to certain extent, resistance against the business cycles. For example, Chinese real GDP growth rate is hardly sustained at 6.1% for the first quarter of 2009. The Chinese government has introduced an appropriate economic policy against “global economic crisis” to expand “effective domestic demand” to sustain an 8% target economic growth rate and induce employment to large extent in 2009. It is hoped that global surveillance and regulations against unlimited freedom of speculations by global investment funds including hedge funds to induce unexpected turbulence of global interdependence economy would be realized in the futures.

It is also expected that the international organizations such as UN, UNCTAD, FAO, WHO, GATT, IMF, World Bank and OECD in line with G20 summit meeting will play a greater role in the sustainable development of the world economy in order to cope with potential risks as night mares of “*Great Depression*” initiated by stock market crash in New York in October 1929. The world economy was seriously affected from negative growth rates for the period 1930-1933. The outlet of “*Great Depression*” was a road to *World War II*. The emergence of newly organized international organizations after World War II seems likely to be outcome of awful experience in human history. It is worth noting that London G20 summit 2009 has announced the international joint recovery action plan in the amount of 5 trillion US dollars for the period, 2009-2010 against “global economic recession” such as strengthening IMF role, stability of financial system and introducing utmost economic stimulus measures in each country. London G20 summit has recognized an importance of terminating current Global Financial Crisis as soon as possible and further needs for international coordination of policies. For an alternative simulation on G20 collaboration against the global economic recession, it is expected that the global economy would recover by around 2% point compared with those of the baseline in 2009-2010 by global cooperation toward economic stimulus measures. Simulation results reveal that the US economic growth rate in 2009 will recover by 1.97% point compared with those of the baseline, through synergy effects of the US own economic stimulus measures plus repercussion of other G20 countries collaboration in the interdependent global economy. It is interesting to note that the US temporary decrease in GDP growth rate in 2009 will recover in 2010-2011, because of decrease in trade deficit, if adequate international collaborate policies against the depression might be introduced effectively.

According to G20 collaboration scenario simulation, average oil prices will increase at rather higher speeds with speculations and induce inflationary pressures. Increasing rates of Global CO₂ emissions will be maintained at 3.2% for the period, 2011-2020. As a result, the world economy will face serious dilemma to maintain the sustainable economy.

Table 1A: Projections of the world economy, 2009-2020**Scenario A: G20 collaboration****GDP# - GROSS DOMESTIC PRODUCT (CONST.) (AVERAGE PERCENTAGE CHANGES)**

UNIT : %	Actual		Estimate	Projection		
	2001-2005	2006-2010	2001-2010	2011-2015	2016-2020	2011-2020
World	2.6	2.4	2.5	2.9	3.4	3.2
Developed Economies	1.8	1.4	1.6	2	2.3	2.3
Developed Asia-Pacific	1.5	1	1.3	2.3	2.4	2.4
Japan	1.3	0.9	1.1	2.1	2.2	2.1
Australia	3.2	2.3	2.8	3.4	3	3.2
North America	2.4	1	1.7	2.1	2.7	2.4
Canada	2.5	1.6	2.1	2.6	2.8	2.7
United States	2.4	1.0	1.7	2	2.7	2.4
Western Europe	1.5	1.9	1.7	1.9	2.3	2.1
Euro Area	1.3	1.9	1.6	1.7	2.3	2
France	1.7	1.9	1.8	1.8	2.1	1.9
Germany	0.7	1.2	0.9	1.5	2.6	2
Italy	0.6	1.5	1	1.2	1.6	1.4
Non-Euro Area	2.2	1.8	2	2.2	2.3	2.3
United Kingdom	2.4	1.5	1.9	2.2	2.1	2.2
Developing Economies	4.5	5.2	4.9	4.8	5.3	5
Asia-Pacific	6.1	6.6	6.4	5.7	6.4	6
East Asia	6.9	6.7	6.9	5.9	6.7	6.3
China	9.6	8.2	8.9	7.2	8	7.6
Republic of Korea	4.9	2.9	3.9	3.6	4.3	3.9
Southeast Asia	4.3	4.5	4.6	4.5	4.3	4.4
Indonesia	4.3	4.4	4.9	4.8	5.2	5
South Asia	5.9	7.2	6.5	6.2	7.1	6.7
India	6.4	7.8	7.1	6.5	7.5	7
Middle East	3.2	2.8	3	4.3	3.3	3.8
Saudi Arabia	4	3	3.5	5.1	3	4
Africa	3.7	3	3.4	2.7	2.6	2.7
North Africa	3.5	2.1	2.8	2.2	1.9	2.1
Sub-Saharan Africa	3.8	3.5	3.7	3	2.9	2.9
South Africa	3.9	3.9	3.9	3.4	3.5	3.5

Latin America and Caribbean	2.3	3.6	2.9	3.3	3.8	3.6
Argentina	1.6	5.4	3.5	5.8	6.4	6.1
Brazil	2.2	2.9	2.5	2	3.3	2.6
Mexico	1.8	2.6	2.2	2.8	1.7	2.3
Mediterranean	3.8	5	4.4	4	3.4	3.7
Turkey	4.3	6.2	5.2	4.4	3.7	4.1
Economies in Transition	5.3	5.2	5.2	4.1	4.4	4.3
South-Eastern Europe	3.6	3.9	3.7	3.3	3.1	3.2
CIS	6.5	5.6	6	4.7	5.1	4.9
Russian Federation	6.1	5.4	5.8	4.4	5.2	4.8

Source: FUGI global modeling system

Table 2A: CO₂ emissions from fossil energy use, 2001-2020

Average percentage changes

Scenario A	Unit: %					
	Actual		Estimate	Projection		
	2001-2005	2006-2010	2001-2010	2011-2015	2016-2020	2011-2020
- LONG TERM -						
World	3.3	3.6	3.5	3	3.5	3.2
Developed Economies	1.3	0.4	0.8	1.1	1.8	1.4
Developed Asia-Pacific	1.2	0.4	0.8	0.8	1.4	1.1
Japan	-0.7	0.1	-0.3	-0.3	0.6	0.2
Australia	5	2.2	3.6	2.8	2.7	2.8
North America	1.5	-0.5	0.5	0.8	1.7	1.3
Canada	2.2	0.6	1.4	2.6	2.9	2.8
United States	1.5	-0.6	0.4	0.6	1.5	1.1
Western Europe	1	1.8	1.4	1.6	2	1.8
Euro Area	0.9	1.7	1.3	1.5	2.2	1.8
France	1	0.9	1	0.8	1.1	0.9
Germany	-0.2	0	-0.1	-0.4	0.7	0.2
Italy	0	1.4	0.7	2.2	3	2.6
Non-Euro Area	1.4	2	1.7	1.7	1.7	1.7
United Kingdom	0.5	1.1	0.8	1.7	1.5	1.6
Developing Economies	4.8	5.6	5.2	4	4.1	4
Asia-Pacific	6.3	6.5	6.4	4.2	4.2	4.2

East Asia	7.2	6.6	6.9	3.3	3.1	3.2
China	7.6	7.3	7.4	3.3	3	3.2
Republic of Korea	7.1	3.8	5.4	2.5	3.1	2.8
Southeast Asia	4	6.6	5.3	6.1	4.9	5.5
Indonesia	5.3	5.7	5.5	5.3	8.7	7
South Asia	4.6	5.8	5.2	6.3	7.8	7
India	4.9	6	5.5	6.4	8.1	7.3
Middle East	3.8	4.4	4.1	4.4	4.6	4.5
Saudi Arabia	0.4	2.1	1.3	1.9	1.2	1.6
Africa	1.7	2.1	1.9	2.3	2.9	2.6
North Africa	2.7	1.8	2.3	2.1	2.1	2.1
Sub-Saharan Africa	1.1	2.3	1.7	2.4	3.3	2.9
South Africa	0.4	2.3	1.3	2.9	3.3	3.1
Latin America and the Caribbean	0.1	3.5	1.8	3.2	3.4	3.3
Argentina	2.1	5.6	3.9	5.8	6.4	6.1
Brazil	-2.1	2	-0.1	0.5	1	0.8
Mexico	1.9	3	2.4	3.8	2.2	3
Mediterranean	3.9	5.2	4.6	4.1	3.5	3.8
Turkey	3.4	5.4	4.4	4.3	3.7	4
Economies in Transition	5.3	5.5	5.4	4.1	4.8	4.4
South-Eastern Europe	4.6	4.5	4.5	3.9	3.8	3.8
CIS	6.9	5.3	6.1	3.9	6	4.9
Russian Federation	5.9	4.9	5.4	3.4	6.5	4.9

Source: FUGI global modeling system

Notes: Pre-projection was made for the period, 1995-2008. .Projection periods are 2009-2020. This projection has been made at the end of June 2009 but has a large degree of “fluctuations” under uncertainty futures.

5. IMPACT OF CO₂ EMISSIONS ON THE WORLD ECONOMY

5.1. Global environment indicators: CO₂ emissions

In order to make the baseline projections of the global economy and CO₂ 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.

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.

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 (2009), *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 CO₂ emission country by 2010 and confront serious environment issues if proper policy measures for environment protection would not be introduced as soon as possible.

5.2. Alternative path of global economy against CO₂ emissions

Scenario B: Global co-operation for “green revolution”

In order to cut back global CO₂ 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 CO₂ 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 CO₂ emissions should be prerequisite against global warming. In order to cutback global CO₂ 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 CO₂ emissions by technology innovations for developing alternative energy and energy savings, it could not achieve the global targets without co-operation with the major CO₂ emission nations such as US, China, Russian Federation. In order to decrease global CO₂ 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 CO₂ 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 CO₂ 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.

Scenario B: Global cooperation and concerted policy for green revolution

Although a set of policy mixtures may be modified in any ways in the *Scenario B: global cooperation and coordination of polices for sustainable development of the interdependent global economy toward "green revolution"* after immediate short-term recovery policy measures in 2009-2010, we have assumed the followings for a policy exercise starting from 2011 to 2020;

Developed economies*

- (1) Average oil prices will be stabilized at reasonable levels by cutting back oil energy use by 5% per year in 2011-2005 and 10% per year in 2016-2020 (in the case of Japan, 5% in 2011-2005 and 20% in 2016-2020). It is reasonably expected that electric vehicles

- (EV) will replace the traditional internal combustion engines
- (2) Alternative energies other than fossils will be expected to increase 5% (10% in Japan) per year in 2011-2020 and 10% (20% in Japan) per year in 2006-2020. In addition to more safety nuclear, new entries of renewable energy such as solar, wind and superconductor and batteries for EV.
 - (3) *A new innovative investment together with research and development expenditures (R&D)* improving labor productivity and global environment will be expected to increase by 3% per year in 2011-2020.
 - (4) Private foreign direct investment (PFDI) will be expanded by 3% per year in 2011-2020.
 - (5) Official development assistance (ODA), in particular technical cooperation for renewable energy, energy savings and recycling technology transfer to developing countries will be increased by 2% per year in 2011-2020.
 - (6) In order to cope with unemployment issues, developed economies should make greater efforts for “work sharing” shortening regular labor hours and days in order to expand employment opportunities and improve quality of life,
 - (7) Global collaboration solidarity might be needed for enhancing cosmic mind to live on the planet Earth in order to realize the above scenario overcoming current economic crisis. (* In this exercise, *developed economies* cover FGMS country code 1-23).

Developing countries + Economies in transition

- (1) Oil requirements will be cutback by 2.5% per year in 2011-2015 and 5, 0% per year in 2016-2020.
- (2) Alternative energy will be increased by 2.5% per year in 2011-2015 and 5.0% per year in 2016-2020.

According to the FUGI global model simulation, both the Japanese and US economy will be able to sustain real GDP growth performance of 2.6% for the period 2011-2020 and cut back CO₂ emissions around 20 % compared with those of 2005 level by 2020. It is worth noting that China as the biggest CO₂ emission country will sustain rather high GDP growth rate of 7.5% and low CO₂ emission increasing rate of 1.0% for the period, 2011-2020 according to Global co-operation scenario (see Table 1B – 3B). It is reasonably expected that average oil prices will be stabilized for the period, 2011-2020, because of oil requirements will be expected to decrease to a large extent by green energy revolution, in particular, in Japan and the US (see Table 4B). It is worth noting that alternative energy will be likely to increase by more than 10 times by 2020 compared with those of 2005 (see Table 5B)..

Table 1B: Projections of the world economy, 2011-2020**Scenario B: Global co-operation for “green revolution”****GDP# GROSS DOMESTIC PRODUCT (CONST.) (AVERAGE PERCENTAGE CHANGES)****UNIT : %**

- LONG TERM -	Actual	Estimate	Projection			
	2001-2005	2006-2010	2001-2010	2011-2015	2016-2020	2011-2020
World	2.6	2.3	2.4	2.9	3.6	3.2
Developed Economies	1.8	1.1	1.5	2	2.7	2.4
Developed Asia-Pacific	1.5	0.5	1	2.4	2.9	2.6
Japan	1.3	0.3	0.8	2.3	2.9	2.6
Australia	3.2	2.7	2.9	3.4	3	3.2
North America	2.4	0.6	1.5	2	3.3	2.6
Canada	2.5	1.4	2	2.6	3.1	2.8
United States	2.4	0.6	1.5	1.9	3.3	2.6
Western Europe	1.5	1.8	1.7	1.8	2.1	2
EU	1.5	1.8	1.7	1.8	2.1	2
France	1.7	1.9	1.8	1.8	2	1.9
Germany	0.7	1.1	0.9	1.4	2.2	1.8
Italy	0.6	1.4	1	1.2	1.4	1.3
United Kingdom	2.4	1.5	1.9	2.3	2	2.1
Developing Economies	4.5	5.2	4.9	4.7	5.3	5
Asia-Pacific	6.1	6.5	6.3	5.7	6.4	6
East Asia	6.9	6.9	6.9	5.9	6.7	6.3
China	9.6	9.2	9.4	7.1	7.9	7.5
Republic of Korea	4.9	4	4.4	3.5	4.3	3.9
Southeast Asia(ASEAN)	4.3	4.9	4.6	4.5	4.5	4.5
Indonesia	4.3	5.3	4.8	4.7	5.2	5
South Asia	5.9	7.2	6.5	6.3	7.5	6.9
India	6.4	7.8	7.1	6.7	8	7.3
Middle East	3.2	2.8	3	4	2.7	3.3
Saudi Arabia	4	3	3.5	5.1	3	4
Africa	3.7	3	3.4	2.7	2.6	2.7
North Africa	3.5	2.1	2.8	2.2	1.9	2.1
Sub-Saharan Africa	3.8	3.5	3.7	3	2.9	3
South Africa	3.9	3.9	3.9	3.4	3.5	3.5
Latin America and the	2.3	3.6	2.9	3.3	3.7	3.5

Caribbean						
Argentina	1.6	5.4	3.5	5.8	6.4	6.1
Brazil	2.2	2.9	2.5	1.9	3.2	2.6
Mexico	1.8	2.4	2.1	2.9	1.8	2.4
Mediterranean	3.8	5	4.4	4	3.5	3.8
Turkey	4.3	6.2	5.2	4.4	3.7	4.1
Economies in Transition	5.3	5.2	5.2	4.1	4.4	4.3
South-Eastern Europe	3.6	3.9	3.7	3.4	3.4	3.4
CIS	6.5	5.6	6	4.7	5.1	4.9
Russian Federation	6.1	5.4	5.8	4.4	5.2	4.8

Source: FUGI global modeling system

Table 2B: CO₂ emissions from fossil energy use, 2011-2020
Scenario B: Global co-operation for green revolution

UNIT : %

	Estimate	Estimate	Projection		
- LONG TERM -	2006-2010	2001-2010	2011-2015	2016-2020	2011-2020
World	3.6	3.5	1.5	1.9	1.7
Developed Economies	0.4	0.8	-1	-1.8	-1.4
Developed Asia-Pacific	0.4	0.8	-0.5	-1.6	-1.1
Japan	0.1	-0.3	-1.3	-2.9	-2.1
Australia	2.2	3.6	0.9	0.5	0.7
North America	-0.5	0.5	-0.8	-2.5	-1.7
Canada	0.6	1.4	0.8	-0.5	0.2
United States	-0.6	0.4	-1	-2.8	-1.9
Western Europe	1.8	1.4	-1.5	-0.8	-1.1
EU	1.8	1.4	-1.5	-0.7	-1.1
France	0.9	1	-2	-1.7	-1.8
Germany	0	-0.1	-2.9	-0.7	-1.8
Italy	1.4	0.7	-1.8	-1.3	-1.5
United Kingdom	1.1	0.8	-2.1	-0.2	-1.2
Developing Economies	5.6	5.2	2.8	3.2	3
Asia-Pacific	6.5	6.4	2.9	3.1	3
East Asia	6.6	6.9	1.7	1	1.4
China	7.3	7.4	1.6	0.5	1
Republic of Korea	3.8	5.4	1.6	3.2	2.4

Southeast Asia(ASEAN)	6.6	5.3	5	7.2	6.1
Indonesia	5.7	5.5	5.1	7.6	6.3
South Asia	5.8	5.2	6	6.7	6.4
India	6	5.5	6.3	6.9	6.6
Middle East	4.4	4.1	3.1	4.5	3.8
Saudi Arabia	2.1	1.3	1	2.8	1.9
Africa	2.1	1.9	1.5	2.5	2
North Africa	1.8	2.3	1.3	1.9	1.6
Sub-Saharan Africa	2.3	1.7	1.7	2.8	2.2
South Africa	2.3	1.3	2.6	3.3	2.9
Latin America and the Caribbean	3.5	1.8	2.3	3.3	2.8
Argentina	5.6	3.9	5.3	6.4	5.9
Brazil	2	-0.1	-0.5	0.9	0.2
Mexico	3	2.4	3	2.4	2.7
Mediterranean	5.2	4.6	3.3	3.3	3.3
Turkey	5.4	4.4	3.6	3.8	3.7
Economies in Transition	5.5	5.4	2.9	4.2	3.6
South-Eastern Europe	4.5	4.5	3.1	3.3	3.2
CIS	5.3	6.1	3.4	5.4	4.4
Russian Federation	4.9	5.4	3.3	6.1	4.6

Source: FUGI global modeling system

Table 3B: CO₂ emissions from fossil energy use. 2011-2020

Scenario B: Global co-operation for green revolution

CO2EMN - CO2 EMISSION FROM FOSSIL ENERGY USE

UNIT : MTCE	Estimate		Projection	
	2005	2010	2015	2020
- LONG TERM -				
World	30428.31	36261.28	39108.89	43031.93
Developed Economies	12540.32	12763.17	12128.71	11074.57
Developed Asia-Pacific	1825.74	1858.01	1807.63	1663.71
Japan	1231.05	1239.43	1160.95	999.6
Australia	501.34	557.98	584.07	598.29
North America	6721.43	6547.13	6281	5523.45
Canada	605.63	622.5	646.94	632.18
United States	6115.81	5924.63	5634.06	4891.27

Western Europe	3993.14	4358.03	4040.09	3887.41
EU	3941.97	4301.79	3983.48	3838.72
France	534.54	559.15	506.52	465.11
Germany	1006.58	1005.48	866.38	837.59
Italy	403.25	431.6	394.38	369.76
United Kingdom	665.68	702.01	631.08	623.35
Developing Economies	13938.33	18338.69	21018.72	24634.56
Asia-Pacific	9597.78	13140.06	15138.31	17623.88
East Asia	6845	9431.89	10277.9	10828.21
China	5588.39	7936.12	8588.85	8789.31
Republic of Korea	844.77	1016.79	1101.22	1288.51
Southeast Asia(ASEAN)	1251.13	1722.26	2201.15	3120.25
Indonesia	428.05	564.33	722.11	1041.97
South Asia	1497.08	1981.28	2654.63	3670.8
India	1339.03	1791.65	2426.83	3387.23
Middle East	1380.45	1713.44	1994.1	2490.25
Saudi Arabia	380.25	421.66	443.27	509.68
Africa	940.05	1044.05	1126.16	1273.78
North Africa	337.9	370.05	393.95	433.85
Sub-Saharan Africa	602.15	674	732.21	839.93
South Africa	324.54	363.7	413.9	485.8
Latin America and the Caribbean	1619.29	1924.01	2152.67	2533.09
Argentina	176.96	232.44	301.09	411.01
Brazil	345.66	382.52	373.63	390.85
Mexico	498.66	577.41	670.63	753.23
Mediterranean	400.75	517.14	607.48	713.56
Turkey	253.26	330.11	394.15	474.52
Economies in Transition	3949.67	5159.42	5961.46	7322.8
South-Eastern Europe	328.61	408.67	475.01	559.58
CIS	2891.23	3741.6	4413.74	5732.06
Russian Federation	1846.98	2346.67	2753.81	3694.7

Source: FUGI global modeling system

Table 4B: Oil requirement, 2011-2020

Scenario B: Global co-operation for green revolution

OIL - OIL REQUIREMENT

UNIT : MT

	Actual	Estimate	Projection		
- LONG TERM -	2000	2005	2010	2015	2020
World	3933.92	4496.35	5302.54	5209.89	5240.00
Developed Economies	2073.02	2147.21	2186.06	1887.02	1503.12
Developed Asia-Pacific	346.9	360.23	364.7	326.97	262.25
Japan	289.05	277.95	283.61	243.68	182.59
Australia	49.58	61.54	73.04	76	72.67
North America	1031.47	1038.35	983.86	817.13	526.74
Canada	89.98	95.77	92.4	87.53	49.84
United States	941.49	942.58	891.46	729.6	476.9
Western Europe	694.66	748.63	837.5	742.92	714.13
EU	680.71	733.92	821.49	727.28	701.47
France	116.48	124.85	133.34	120.88	107.25
Germany	155.03	159.36	167.35	146.69	143.21
Italy	91.29	88.42	89.68	63.58	35.97
United Kingdom	90.96	102.07	109.86	93.97	86.99
Developing Economies	1648.04	2065.07	2737.02	2872.49	3183.43
Asia-Pacific	820.65	1180.01	1699.24	1813.03	1976.77
East Asia	462.87	769.9	1153.09	1149.96	1111.3
China	262.57	502.22	836.12	807.85	712.72
Republic of Korea	148.59	208.67	245.6	258.53	296.08
Southeast Asia(ASEAN)	220.31	247.92	343.49	422.14	623.93
Indonesia	57.02	66.67	88.01	104.8	111.1
South Asia	134.35	158.9	198.43	235.75	234.63
India	108.42	135.19	171.09	203.62	188.07
Middle East	240.38	255.28	294.81	288.64	316.84
Saudi Arabia	84.52	72.89	78.93	72.45	85.65
Africa	128.86	148.11	172.1	173.26	186.25
North Africa	54.98	62.51	70.87	76.21	87.05
Sub-Saharan Africa	73.88	85.6	101.23	97.05	99.2
South Africa	6.14	5.4	4.32	2.23	0.92
Latin America and the Caribbean	402.9	415.18	485.26	501.62	592.68
Argentina	24.57	26.93	37.54	49.58	70.31

Brazil	110.17	100.02	107.63	107.47	120.19
Mexico	110.33	119.94	133.33	146.48	160.04
Mediterranean	55.25	66.49	85.6	95.95	110.89
Turkey	39.36	48.11	62.32	71.65	84.5
Economies in Transition	212.86	284.08	379.46	450.38	553.44
South-Eastern Europe	25.45	31.71	41.58	45.21	54.15
CIS	147.97	204.39	256.89	311.61	416.99
Russian Federation	94.54	127.55	168.59	217.25	298.91

Source: FUGI global modeling system

Table 5B: Alternative energy. 2011-2020

Scenario B: Global co-operation for green revolution

ALTEGY - ALTERNATIVE ENERGY SUPPLY(METRIC TON)

UNIT : MTOE

	Actual	Estimate	Projection		
- LONG TERM -	2000	2005	2010	2015	2020
World	1104.99	1614.37	2058.5	3328.14	5410.84
Developed Economies	771.77	943.09	1065.13	1777.62	3142.36
Developed Asia-Pacific	108.5	135.21	161.64	491.93	1285.59
Japan	103.3	122.6	142.3	463.26	1249.85
Australia	1.06	5.7	10.14	16.66	22.09
North America	305.63	379.27	397.01	486.53	700.51
Canada	61.63	78.9	95.03	124.54	167.75
United States	244	300.37	301.98	361.99	532.76
Western Europe	357.65	428.62	506.47	799.16	1156.26
EU	349.8	420.63	498.29	789.87	1146.68
France	132.11	157.31	190.39	340.51	561.14
Germany	53.03	61	69.26	111.78	159.09
Italy	46.86	56.02	72.65	106.01	140.36
United Kingdom	31.7	40.37	47.22	81.03	119.36
Developing Economies	217	443.59	693.79	1047.25	1497.01
Asia-Pacific	90.26	132.16	195.1	296.05	454.14
East Asia	64.1	88.26	122.93	171.28	237.96
China	22.97	39.16	63.14	94.6	141.05
Republic of Korea	27.09	33.89	43.11	56.28	71.42
Southeast Asia(ASEAN)	13.52	16.77	20.29	27.99	39.06

Indonesia	3.49	4.99	7.38	12.81	21.23
South Asia	12.03	26.11	50.19	94.22	173.62
India	6.72	17.8	41.06	81.96	158.53
Middle East	7.03	13.4	17.75	23.72	28.35
Saudi Arabia	2.48	3.7	4.37	6.36	7.43
Africa	19.52	58.39	94.89	130.71	162.22
North Africa	0.93	5.42	8.81	12.82	15.62
Sub-Saharan Africa	18.59	52.98	86.08	117.88	146.6
South Africa	4.78	23.49	43.48	62.39	79.4
Latin America and the Caribbean	90.43	223.43	362.93	563.58	810.56
Argentina	4.67	9.91	20.92	37.46	60.25
Brazil	50.11	157.69	249.01	372.21	499.31
Mexico	12.36	15.3	19.7	27.14	31.6
Mediterranean	9.76	16.21	23.12	33.19	41.75
Turkey	5.98	10.38	15.35	23.11	29.76
Economies in Transition	116.22	227.69	299.58	503.28	771.48
South-Eastern Europe	10.91	16.53	23.03	29.46	37.64
CIS	94.84	198.54	256.8	447.36	702.43
Russian Federation	44.94	124.34	154.21	307.88	528.91

Source: FUGI global modeling system

6. POLICY EXERCISE AND SIMULATIONS OF FUTURES

The 21st century is an age of humankind challenge for *global syndrome* that is not so easily resolved in a single country framework. It is worth noting that the 21st century is also 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 might be an age of *terrorism and refugees* if future human society would not awaken by cosmic mind to create a new international order toward global citizenship and human solidarity on the planet Earth.

It is widely known among economists that the word of “*innovation*” has been brought by J. Schumpeter (1883-1950), author of *Capitalism, Socialism and Democracy* in economics. His idea has been derived from Darwin’s findings in Bioscience. This is a good example that the science of economics has been affected by the progress of science and technology in other related fields.

It is clear now that main roots of terrorism and refugees seem likely to be poverty and

international per capita income disparity (See *global early warning system for displaced persons* (Onishi 1986, 1987, 1990) and *FUGI global model for early warning of forced migration* (<http://www.forcedmigration.org>) Forced Migration Online, Refugee Studies Centre, University of Oxford. It is worth noting that global risks on peace and security such as terrorism might not be resolved by mere oppression by military forces. The more oppression by military powers increase, the more terrorist powers against oppression might increase. This might induce a vicious circle of poverty and refugees as well as battles against terrorism without outlets.

According to FUGI global model simulation, *international per capita income disparity* (IPCID) will be increasing in the coming decades, although the position of both China and India will be improved very rapidly in Asia. Major poor hardcore in Africa, however, will remain at almost standstill states. In terms of IPCID indicators (average per capita income of whole world = 100 expressed by 1995 constant prices in terms of US dollars), Japan enjoyed as No. 3 position next to Luxembourg and Switzerland in 1995. But the reader should not misunderstand that Japan is a paradise country. During the period, 2001-2006, so called “*black age*” for the Japanese economy, average nominal wage rate per worker was decreased while nominal GDP was registered minus growth, although real GDP growth rates were maintained hardly plus because of decreasing GDP deflator. As a result, Japan’s per capita income in terms of *current US dollars* was strikingly dropped from No.2 in 1993 to 18th in 2006. Such situation is improved to a large extent in 2009 on account of Yen appreciation against the US dollar as 195 Yen equivalent one US dollar.

It is worth noting that Japan is not paradise for immigrants because of very poor capacity to absorb refugees, although the population growth rates are decreasing. The official unemployment rate statistics of 4.4% (in 2005) and 4.9% (in 2008) do not include unemployed youngsters called as *NEET* (Not in Employment, Education or Training) and unemployment of increasing irregular workers. If Japanese unemployment figures would be recalculated based on German standard, they will nearly correspond to French and German unemployment rates.

The Japanese economic situation was worst for the period, 2008-9, because of “Global economic crisis”. As a result, tax revenues of the government have drastically decreased on account of slowing down of GDP (real/nominal) growth rate as the FUGI global model policy simulations show. As a result, government deficits could not be improved. This is a good example of *pessimistic scenario*. Therefore, The Japanese should recognize the needs for changes in policies for revitalization of the Japanese economy for coping with global risks in the globalizing world. There is a hope for Japan to escape from “Japan syndrome” if *appropriate* policies would be introduced in the coming near futures. It is worth noting that the Japanese should have potential capacities and talents for not only technology innovations but also progress in human minds toward “*Cosmic age*” beyond “*Global age*” in the coming centuries.

Table 7: IPCID – International Per-Capita Income Disparities

	AVERAGE PER CAPITA INCOME OF WHOLE WRD = 100			Unit: 1995 constant prices in terms of US dollars			
	1990	1995	2000	2005	2010	2015	2020
World	100	100	100	100	100	100	100
Developed Economies	508.9	522.5	539.8	550.1	561.5	563.9	569.5
Developed Asia-Pacific	670.6	690.4	661.2	669.2	669.8	660.3	672.9
Japan	720.8	741.5	706.1	710.8	710.6	694.3	705.6
North America	499.5	514.1	552.6	572	602.7	622	645.8
Canada	393.3	387.9	404	419.2	450.6	473.3	490.1
United States	511.2	528.1	569.1	588.7	619.1	637.7	662.1
Western Europe	454.3	464.6	482.8	486.5	486.1	478.9	466.8
EU15	443.8	454.5	473.4	477.3	476.7	469.3	457.6
France	526.2	530.1	559.4	560.3	557.4	537.9	529.3
Germany	580	589.4	596.7	578.8	570.7	547.8	533.1
Italy	370.4	380.1	378.9	377.2	368.8	356.1	334.5
United Kingdom	370.1	380.4	397.8	415.3	413.9	423.9	416.5
Developing Economies	23.8	27	28.1	30.2	32.2	35.3	38
Asia-Pacific	14.5	18.9	21	24.7	28.3	32.8	37.4
East Asia	17.8	24.9	29.7	37	43.5	51.4	60.2
China: Mainland	7	11.5	15.2	21.5	27.3	34.7	43.5
Southeast Asia(ASEAN)	24.7	31.4	31.2	33.5	37.2	40.7	43
Indonesia	15.6	20.5	18	19.5	21.5	24	25.6
Malaysia	66.2	87	88.7	94.6	104.8	115.5	123.5
Philippines	22.5	21.7	21.3	22.7	23.8	25.1	26
Singapore	367.6	504.4	587.1	609	698.7	760.6	830.3
Thailand	41.2	57.5	51.8	57.5	67.4	78	87.7
South Asia	6.8	7.7	8.4	9.6	11.1	13	15.4
India	6.8	7.8	8.7	10.3	12.3	15	18.3
Middle East	66.9	62.1	57.9	57	58.2	56.1	53.9
Africa	15.5	14.3	13.9	13.4	12.3	11.4	10
North Africa	27.7	26.7	27.1	27	24.8	23.3	20.9
Sub-Saharan Africa	12.6	11.5	10.9	10.4	9.6	9	7.9
Latin America and the Caribbean	71.6	76.4	74.9	72.1	70	75	77.2
Brazil	83.7	88.5	84.9	80.9	79	78.4	83.1
Mediterranean	82.5	80.4	83.2	86.4	86.6	90.1	88.3

Economies in Transition	58.2	39.6	38.7	46.4	52.6	57.9	61.1
Eastern Europe	60.9	58.1	63.1	70.5	77.1	81.3	81.6
CIS	57.2	33	30	38	44.1	49.8	54.2
Russian Federation	75.3	45.7	40.2	51.1	60.1	68.3	76.6
1 Japan	720.8	741.5	706.1	710.8	710.6	694.3	705.6
2 Australia	373.9	407.5	429.6	467	479.3	515	544
3 New Zealand	315.4	327.5	315	328.4	328.8	331.3	324.9
4 Canada	393.3	387.9	404	419.2	450.6	473.3	490.1
5 United States	511.2	528.1	569.1	588.7	619	637.7	662
6 Belgium	529.4	543.5	567.2	565.4	571.8	561.9	519.5
7 Denmark	639.3	693.8	722.6	742.3	751.5	707.4	697
8 France	526.2	530.1	559.4	560.3	557.4	537.9	529.3
9 Germany	580	589.4	596.7	578.8	570.7	547.8	533.1
10 Greece	219.1	221.6	236.8	268	257.5	258.4	253.3
11 Ireland	285.7	364.3	523.8	639.2	773	893.3	1071.9
12 Italy	370.4	380.1	378.9	377.2	368.8	356.1	334.5
13 Luxembourg	727.7	866.5	986.6	1050.2	1098.1	1117.5	1092.3
14 Netherlands	492.9	516.3	553.3	531.6	546.9	538.5	501.9
15 Portugal	199.6	212.8	230.7	226.3	220.2	227.6	231.4
16 Spain	273.5	283.4	309	330	339.6	350.9	343.2
17 United Kingdom	370.1	380.4	397.8	415.3	413.9	423.9	416.5
18 Austria	561.1	578.4	580.2	587.2	591.1	597.3	588.3
19 Finland	532.8	493.9	563.9	609.2	612.7	595.8	558.1
20 Iceland	544.2	521	572.9	575	615.8	611.1	597.3
21 Norway	592	675.3	693.8	709.4	753	742.7	711.2
22 Sweden	541.9	526.6	559.7	576.4	562.4	548.7	537.9
23 Switzerland	926.4	862.2	834.9	817.7	795.9	799	779.8
24 China: Mainland	7	11.5	15.2	21.5	27.3	34.7	43.5
25 China: Hong Kong	386.2	448.2	454.9	485.9	482.1	479.3	442.8
26 China: Macau	303.5	343.4	285.8	279.5	259.5	257.3	232.6
27 Taiwan(Province of china)	189.8	244.1	274.3	282	313.1	332.9	338
28 Korea: Republic of	163.6	218.1	237.7	270.6	287.1	304.8	319.5
29 Korea: North	40.3	36.1	31	29.9	28	27.4	26.4
30 Brunei	384.2	355.2	337.3	321	284.4	249.9	199.8
31 Indonesia	15.6	20.5	18	19.5	21.5	24	25.6
32 Malaysia	66.2	87	88.7	94.6	104.8	115.5	123.5

33 Philippines	22.5	21.7	21.3	22.7	23.8	25.1	26
34 Singapore	367.6	504.4	587.1	609	698.7	760.6	830.3
35 Thailand	41.2	57.5	51.8	57.5	67.4	78	87.7
36 Cambodia	5.2	5.9	5.8	6	5.8	5.6	5
37 Lao P. D. Rep	6.4	7.4	8	8.8	8.1	7.6	6.8
38 Myanmar (Burma)	40.6	49.8	59.6	65.2	71.1	76.5	76.6
39 Viet Nam	4.2	5.5	6.5	7.9	9.3	10.4	10.6
40 Afghanistan	0.4	0.3	0.2	0.2	0.2	0.2	0.2
41 Bangladesh	5.7	6.4	6.9	7.8	8.8	10.4	12.2
42 Bhutan	2.8	3.3	3.5	3.8	3.4	3.2	2.8
43 India	6.8	7.8	8.7	10.3	12.3	15	18.3
44 Mongolia	10.2	7.8	7.6	8.2	9.1	10.1	10.5
45 Nepal	3.7	4.1	4.2	4.3	4.2	4.3	4.2
46 Pakistan	8.3	9	8.5	8.2	7.6	7.4	6.8
47 Sri Lanka	12.1	14.6	16.2	16.9	17.5	18.8	19.5
48 Fiji	49	51	44.7	42.5	40.7	40.5	38.7
49 French Polynesia	351.3	358.4	350.1	356.1	343.6	336.1	313.5
50 Guam	49.1	49.5	48.4	48.1	45.8	45.5	43.5
51 Kiribati: Rep. of	11.4	11.5	11.1	10.2	9	8.2	7.2
52 Maldives	18.6	21.8	24.1	26	26	27.2	26.7
53 Nauru	49	49.9	46.6	46.3	43.3	41.3	37.5
54 New Caledonia	383.8	373.2	353.1	331	283.6	296.2	287.4
55 Papua New Guinea	18.2	23	19.6	17.3	16.3	15.7	14.5
56 Solomon Islands	16.1	17.3	11.2	9.1	8.1	7.5	6.8
57 Tonga	29.4	34.5	28.4	28.6	30	32.1	32.7
58 Tuvalu	49	49.9	47.2	45.7	41.9	39.5	35.7
59 Western Samoa	19.1	18.5	18.7	21.8	25.3	33.3	42.3
60 Vanuatu	32.3	28.1	26.7	24.4	21.9	20.3	18.1
61 Bahrain	180.2	197.1	195.5	216	225.1	240.4	246.1
62 Iran: I.R. of	20.9	23	23.3	26.2	28.4	31	32.8
63 Iraq	106.3	49.7	45.2	34.8	31.5	28.4	25.7
64 Israel	278.5	312.7	306.7	279.4	263.6	254.4	234.7
65 Jordan	20.2	22.7	20.1	19.4	17	18	20.5
66 Kuwait	213.7	314.9	261.1	238	210.6	181.6	141.3
67 Lebanon	50.3	74	70.9	74.4	76.5	79.2	77.5
68 Oman	104.5	112.5	97.7	85.1	79	78.7	71.9

69 Qatar	311.3	297.5	329.7	377.1	359.7	336.5	311.9
70 Saudi Arabia	143.6	140.3	119.7	119.4	130	120	116.7
71 Syrian Arab Rep	19.2	23.3	20.4	19.9	18.2	17.2	15.5
72 United Arab Emirates	413.7	388.1	382.6	441.7	520.3	528	533.9
73 Yemen Rep	5.6	4.9	5	4.6	4	3.5	2.9
74 Algeria	33.7	29.5	28.1	28	24.2	21.6	18.5
75 Egypt	18.6	19.4	21.1	21	19.8	19.1	17.4
76 Libya	95.8	85.8	74.1	64.5	52.9	44.5	35.5
77 Morocco	27	25.5	25.2	26.3	24.6	23.5	21.2
78 Tunisia	37.4	40.3	45.3	46.7	45.8	45.9	43.5
79 Angola	13.7	9.2	9.6	10.5	9.6	9	8.2
80 Benin	7.2	7.5	7.9	7.7	7.4	6.7	5.4
81 Botswana	64.1	66.6	70.8	77.4	83	80.9	68.7
82 Burkina Faso	4.5	4.5	4.6	4.5	4.1	3.8	3.4
83 Burundi	4.2	3.3	3	3.2	3.2	3.2	2.8
84 Cameroon	15.7	12.1	12.2	11.4	9.6	8.3	6.9
85 Cape Verde	23	25.9	26.8	28.2	28.6	29.7	29.6
86 Central African Rep.	7.5	6.8	6.2	5.6	4.9	4.3	3.7
87 Chad	4.7	4.3	4.3	3.9	3.4	3.1	2.6
88 Comoros	8.7	7.1	5.9	5.4	4.8	4.4	4
89 Congo	19.1	16.6	14.3	12.4	10.6	9.8	8.7
90 Djibouti	21.6	16.4	13.9	12.3	10.6	10.2	9.1
91 Eritrea	3.6	3.6	3.6	3.4	2.9	2.6	2.2
92 Equatorial Guinea	6.9	8.2	20	19.9	19.2	14.9	13.2
93 Ethiopia	2.2	2.1	2.2	2.2	2	1.9	1.6
94 Gabon	93.7	92.2	84.8	77.1	67.8	61.5	53.7
95 Gambia	7.7	6.9	6.4	5.9	5.2	4.8	4.2
96 Ghana	7.1	7.3	7.2	7	6.8	6.1	5.2
97 Guinea	10.9	10.3	11.2	12.5	13.4	14.3	14.7
98 Guinea Bissau	4.6	4.7	3.1	2.8	2.3	2	1.7
99 Ivory Coast	16.2	14.8	14.6	14.1	12.4	11.1	9.4
100 Kenya	7.3	6.7	6	5.3	4.6	4	3.5
101 Lesotho	7.6	8.9	9.9	10.4	9.9	9.5	8.5
102 Liberia	9.1	12	8.5	7.5	6.4	5.4	4.2
103 Madagascar	5.7	4.6	4.2	3.6	3	2.7	2.3
104 Malawi	2.9	3.1	3.1	2.9	2.6	2.3	2

105 Mali	4.9	5	4.9	4.5	3.8	3.4	2.8
106 Mauritania	9	9.2	8.9	8.1	7	6	4.9
107 Mauritius	60.7	71.5	81.5	85.1	85.3	92.7	91.4
108 Mozambique	2.9	2.8	3.3	3.3	3	2.7	2.2
109 Namibia	40	43.3	39	35.2	30.6	27.5	23.6
110 Niger	4.8	4.1	4.3	4.6	4.3	4.2	4.2
111 Nigeria	5.9	5.7	5.3	5.3	5.2	5.1	4.9
112 Reunion	221	252.6	260.8	263.1	255.6	258	250.3
113 Rwanda	6	4.9	5.2	5.2	4.4	3.8	3.1
114 St. Helena	6	3.1	2.8	2.7	2.5	2.5	2.4
115 Sao Tome & Principe	7.5	6.9	5.2	4.5	3.8	3.3	2.8
116 Senegal	11.7	10.8	10.7	9.7	8.3	7.2	6
117 Seychelles	129.3	135.2	126.5	115.4	99.3	87.2	72.7
118 Sierra Leone	5.7	4.1	3.1	2.9	2.6	2.5	2.2
119 Somalia	0.9	0.9	0.8	0.7	0.7	0.6	0.6
120 South Africa	87.4	80.8	78.1	80.6	79.9	78.9	72.3
121 Sudan	4.1	5.4	5.7	5.3	4.7	4.2	3.7
122 Swaziland	30.4	29.1	28	27.6	25.8	24.2	19.7
123 Tanzania	3.6	3.3	3.3	3.1	2.7	2.4	2.1
124 Togo	7.7	6.5	6.2	5.7	5	4.5	3.9
125 Uganda	5.1	6.1	6.5	5.7	5.5	5.3	4.8
126 Zaire	5.1	2.8	2.4	1.8	1.7	1.6	1.6
127 Zambia	9.9	8.5	8	7.4	6.6	6	5
128 Zimbabwe	14.3	13.1	12.2	9	7.9	7.2	6.2
129 Argentina	118.7	148.8	145.5	139.3	152.9	179.8	209.2
130 Antigua and Barbuda	143.3	151.9	155.3	155.9	145.8	148	129
131 Bahamas The	286.5	247.2	232.9	228	203.5	198.2	174.3
132 Barbados	151.2	140.5	147.1	142.4	130.9	123.9	111.3
133 Belize	52.7	55.6	55.7	59.2	59.5	61.7	60.8
134 Bermuda	660.7	659.4	617.8	581.6	526.4	488.1	432.5
135 Bolivia	17.2	18.1	17.5	16.8	17.5	18.9	19.9
136 Brazil	83.7	88.5	84.9	80.9	79	78.4	83.1
137 Chile	61.3	83.7	88.4	97	109.9	126.7	137.3
138 Colombia	43.5	48.1	41.7	41.7	40.9	41.3	39.8
139 Costa Rica	48.4	50.8	50.8	52.6	51.4	51.3	48.5
140 Cuba	48.6	53.2	48.9	49.3	46.9	45.7	42.4

141	Dominica	58.8	61.1	64.3	59.2	51.1	47.7	41.5
142	Dominican Republic	28	30.6	37.6	36.3	38.3	38.9	27.4
143	Ecuador	30.3	31.4	26.2	27.8	25.9	25.1	23.3
144	El Salvador	28.3	33.6	32.4	30.6	30	30.8	30.4
145	Greenland	412.9	434.2	419.4	436.6	424.2	418.5	390.2
146	Grenada	59.5	58.2	68.6	70.7	67.8	66.6	62.2
147	Guadeloupe	195.8	173.7	160.3	161.1	153.8	151.9	141.8
148	Guatemala	27.9	29.4	28.7	26.2	24.8	25.1	25.3
149	Guiana: French	117.1	91.4	84.4	76.3	67.6	59.2	47.5
150	Guyana	11.4	15	17.3	19.4	22	24.9	25.4
151	Haiti	9.3	7	6.5	6.1	5.5	5	4.4
152	Honduras	14	14	13.1	12.8	11	10.6	9.4
153	Jamaica	34.4	33.9	29.3	27	24.9	23.9	22.4
154	Martinique	280.3	301.6	310.2	315	299.8	290.7	267.2
155	Mexico	83.1	79.9	87.6	83.1	69.3	82.8	80.8
156	Montserrat	28.4	30.9	31.3	31.2	29.1	27.8	25.3
157	Netherlands Antilles	141.6	138.9	132.4	129.5	120.3	115.4	105.6
158	Nicaragua	9.4	8.6	8.7	8.3	7.7	7.4	6.8
159	Panama	51.8	60.2	62.5	64.9	64.7	64.7	59.9
160	Paraguay	37.3	37.3	31.1	28.2	25.6	24	21.4
161	Peru	41.3	50.2	48.2	50.3	56.8	66.1	72.9
162	Puerto Rico	213.3	228.5	238.1	261.9	266.6	277.5	257.5
163	St. Kitts Nevis	91.9	113.6	133.2	133.6	123.4	123.6	112.7
164	St. Lucia	65.4	72	76.4	85.3	88.5	91.5	86.7
165	St. Pierre Miquelon	28.4	30.9	34.1	31.5	27.8	26.1	23.4
166	St. Vincent	44.5	47.6	52.5	51.1	44.9	44.9	43.6
167	Suriname	16.2	16.4	16.5	22	26.8	30.9	32
168	Trinidad and Tobago	84.1	84.5	92.5	102.9	109.1	119.6	123.6
169	Uruguay	94.7	106.8	104.4	107.5	102.6	111.6	109
170	Venezuela	68.8	70.9	60	55.7	60.6	59.9	59.1
171	Cyprus	213.7	237.7	242.4	242.3	229.2	232.7	219.1
172	Malta	144.1	173.4	172.9	193.9	208	230.3	244.4
173	Turkey	53.2	55.6	56.9	58.6	58.4	59.7	58.1
174	Bosnia and Herzegovina	97.5	81.6	94.5	97.9	94.5	92.6	85.3
175	Croatia	118	83.9	92.3	107.1	116.1	121.6	122.8
176	Slovenia	206.6	188.7	201.7	224.3	235.8	254.5	263.9

177 TFYR Macedonia	27.2	25.8	26.4	26.5	26.5	27.9	27.7
178 Serbia/Montenegro	198.3	198.1	213.8	229.4	241.1	270.1	278.1
179 Albania	17.3	15.3	18	21.7	22.6	21.9	19.4
180 Bulgaria	35.2	30.9	27.3	32.6	35.9	37.3	37.9
181 Czech Republic	108.8	101	97.8	108.5	113.8	117.8	114.1
182 Hungary	99.7	87.5	100.1	113.5	124.6	139.7	157.4
183 Poland	59.5	65.5	76.8	82.7	90	92.8	91.2
184 Romania	32.4	28.9	24.4	29.2	32.2	34.4	35.5
185 Slovakia	78.9	65.1	73.1	83.7	97.9	105.4	106.9
186 Armenia	31.6	16.2	19.3	25.7	23.8	23	21.5
187 Azerbaijan	21.9	7.7	9.6	14.3	18.7	21.6	21.6
188 Belarus	56.7	35.3	44	54.5	71.7	96.3	111.8
189 Estonia	92.1	64.6	79.7	92.7	95.2	107.5	113.8
190 Georgia	43.4	11.6	14.7	19.1	22.5	27.3	31.7
191 Kazakhstan	41.6	24.2	25	34.4	43	50.2	55.9
192 Kyrgyzstan	32.1	14.6	16.9	18.5	19.1	19.5	18.9
193 Latvia	75.6	38.7	47.2	63.4	75.8	83.4	87.4
194 Lithuania	65.2	37	40.5	53.2	60.1	59.6	50.7
195 Republic of Moldova	36.4	14.2	10.7	13.1	11	10.9	9.8
196 Russian Federation	75.3	45.7	40.2	51.1	60.1	68.3	76.6
197 Tajikistan	14.7	6.9	7	9.2	10.3	10.4	10.3
198 Turkmenistan	23.7	13	13	21.5	24.8	28.6	32
199 Ukraine	40.6	19.1	16.1	23.3	27.6	31.5	33.3
200 Uzbekistan	27.5	19.8	19.6	19.2	17.9	17.2	15.8

Source: FUGI global modeling system.

The 21st century is an age of humankind challenge for *global crisis* that is not so easily resolved in a single country framework. This is why we have to collaborate in the globalizing world. As a Japanese proverb says “Wazawai tennjite fukutonasu” (Disasters may turn into fortunes). The same is true in the case of current “global economic crisis” as shown by policy simulations using FUGI global modeling system.

(1) *Impacts of oil saving technology on oil prices in the futures*

The uncertain “fluctuations” of global oil prices will provide an opportunity to develop alternative energy sources and energy saving technology in order to open the doors to use renewable energy and curve CO₂ emissions against global warming. For instance, the Japanese economy has become

much stronger against oil shocks after the oil crisis in 1970s because we have made greater efforts for creating alternative energies such as solar, super conductor and safety use of nuclear power plants, etc as well as energy saving technologies such as LED, robotics, super express train using super conductor and innovative electric vehicles (EV) etc. By the midst of the 21st century, it is reasonably expected that electric vehicles, including hybrid cars, will replace the present internal combustion engine vehicles. As a result, uncertain “*fluctuations*” of oil prices induced by money games as well as geographical risks will be mitigated as FUGI global model simulation shows.

(2) Impacts of new technology investment supported by R&D on the world economy

In order to increase *GDP growth potentials* the developed countries should increase research and development expenditures (R&D) to induce technology innovations for the long run. In 2005, Sweden takes lead to attain the highest R&D ratios to GDP, around 4.0%. Then Finland, Japan, the US, Germany and France follow as 3.5%, 3.2%, 2.6 %, 2.5% and 2.2% respectively. *FUGI global model simulation suggests that diffusion of technology innovations at the global level through increased R&D and technology transfer from the developed to developing countries should be much more stressed in the globalizing world as most effective means against a new “global economic crisis”.*

(3) Appropriate trade policy against a new global economic crisis

According to “*Global Interdependence Table*” originally designed by Onishi, *appropriate trade expansion policy* by mitigating tariff and non-tariff barriers will be needed to cope with global economic crisis It is worth noting that one of the major reasons of Chinese success story in economic development should depend upon higher increasing rates of exports on account of higher competitiveness with lower employment costs and stability of exchange rates. Without trade expansion on account of joining GATT, China could not become “a factory in the world” and take over the position of the Japanese economy in the globalizing world. Increasing global disequilibrium issues have appeared as a result of China success story. China continues to accumulate a huge amount of trade surplus and foreign exchange reserves, while the US trade deficit with China continues. In the coming near future, China should face the policy dilemma whether mitigating tariff and non-tariff barriers to increase imports, together with introducing more flexible foreign exchange rates against the US dollars. Because trade imbalances between the US and China will be very rapidly expanding, rather than those of the US and Japan trade relationships as well as those of EU. *Against “global financial/economic crisis”, the US should face serious policy dilemma to solve the twin deficits both trade and fiscal budget.*

(4) Expansion of private foreign direct investment coupled with ODA

Expansion of private foreign direct investment coupled with ODA; in particular, appropriate technical co-operation should be increased in coping with poverty at the global level. FUGI global model simulation shows that the international per-capita income disparity will increase rather than

decrease. This is one of the major causes of international instability for peace and security in this planet. Without sharp inflows of private foreign direct investment, China could not rapidly catch up advanced technology for exports so that China might narrow the international per-capita income disparities. As FUGI global model simulation suggests, expansion of both trade and private foreign direct investment will play a greater role of recovering economic growth rates of the world economy. China represents a success story of high economic performance and India will follow the Chinese pattern of economic growth if peace and security will be maintained. It is hoped that in Africa as well as Latin America, anti-feeling sentiments of nightmares against private foreign direct investment in the colonial age will be gradually turned into friendlier host country sentiments in the interdependent global economy.

(5) Needs for shortening regular labor hours and days to improve unemployment and quality of life

FUGI global model simulation suggests that a global mass unemployment issues may not be solved by defunct “Keynesian economics”. Although J.M.Keynes (1833-1946) thought that unemployment rate is a function of “*Effective Demand*” in “General Theory of Employment, Interest and Money” (1935-1936), employment costs also seem likely to play a greater role in Post Keynesian age. Unemployment rate also tends to increase in line with higher employment cost and increased supply of labor force, LCLF (adjusted by hours of work in case of EU, Japan and USA). Keynes introduced a positive fiscal and monetary policy to induce “*Effective Demand*” in coping with “Great Depression”. However, his idea was too short sighted to discuss the unemployment issues. He could not imagine that the globalizing world might face a dilemma how to sustain “*affluent*” society with energy and resources constraints within the planet Earth. He could not imagine that the future human society should adopt “*recycling system*” in order to save energy and resources for sustainable development of the global economy differed from Keynes proposal for any wastage of resources to induce employment. In the post Keynesian age, *lower employment cost and shortening regular labor hours as well as days will improve unemployment and quality of life (QOL)*. As FUGI global model simulation suggests that *diffusion of technology innovations at the global level through increased R&D and technology transfer from the developed to developing countries should be much more stressed in the globalizing world as most effective means against “global unemployment issues improving QOL”*. *Robotics to be appeared by technology innovations will play much greater role in place of labor force in the futures. It is expected that Japan will take a lead in robotics, because robotics has been already invented during Edo era. Foreigners might be surprised to notice the Japanese innovative idea on creating robotics.*

(6) Role of education and healthcare

FUGI global model simulation confirms that the role of *education and healthcare* should be more emphasized for improving labor productivity in the poor countries as Swedish economist, G. Myrdal once suggested in the light of his experience in India. There is a hope that not only India

but also the rest of developing countries should improve education and healthcare situation by self reliance efforts and global collaboration. *It is worth noting that the highly educated people may have higher probability to become the rich people of the society in the globalizing world. Unfortunately, the non educated poor people may have little opportunity to enter the rich strata in the globalizing world. This is why globalization might induce disparity between the rich and the poor not only at country level but also global level.*

However, the main objective of higher education in the future generations should not enlarge income disparities between the rich and the poor in the interdependent globalizing world but share common consciousness of cosmic mind toward solidarity of human beings irrespective of differences in culture, religion and race co-existing with ever changing nature on the planet Earth. It is hoped that such cosmic mind will eventually strengthen global citizenship.

In the globalizing highly technology oriented society, it is reasonably expected that obsolescence of knowledge will be going on rapidly so that people might learn in total life time span. In accordance with speed up of technology innovation, objective of higher education might be dwelt upon cultivating specific talent to induce “creativity”. This is why the author emphasizes the need for advancement of human spirit in line with technological progress.

(7) Needs for cosmic mind

It is worth noting that FUGI global modeling system is designed by “cosmic mind”. “Cosmic mind” means human solidarity to create common cosmic consciousness living on the planet Earth in the ever changing infinite dynamic cosmos by overcoming predilections on differences among races, cultures and religions. *Cosmic mind for peace and security with harmonization with nature at the planet level might be needed for coping with global warming and risks of terrorism. Harmonized progress of human spirit with technology should be needed at this planet Earth.*

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. The development of both hardware and software systems of high-technology computer has supported FUGI global modeling and policy simulations. The FUGI global modeling system represents a new frontier in economic science stimulated by information technology and life science.

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.*

In the futures of interdependent global economy, policy simulations using global modeling system should be needed to evaluate impacts of policy exercises. Nobody could estimate the possible impacts of policy mixtures. The globalizing world will be getting more and more complex system structure so that human brain might have a limit of reasoning about possible cause and effect relationships at a glance. Therefore, we have to largely depend upon advanced computer simulation technology. For instance, various policy scenario simulations should be tested in order to evaluate “*synergy effects of appropriate policy mixtures*”.

We need a navigation map to travel unknown globalizing world. This is particularly true to envisage development policy in the globalizing world. For instance, in the globalizing world, the “*appropriate*” trade policy might be desirable. In the textbook of trade policy, there are two extreme disciplines, namely *free trade* vis à vis *protectionism*. It is widely known that Classical economist; David Ricardo advocated “free trade” against “*protectionism*” in his book “*On the Principles of Political Economy and Taxation*” (1810). His original idea is that every country around world can enjoy “comparative advantage” through international trade and division of labor, even if it is inefficient to produce all products. His idea has been inherited in modern economics and reformed as Heckscher-Olin theorem.

However Neo-Classical “free trade” policy might be modified in the light of reality of globalizing world. Globalizing world economy consists of multi-dimensional countries/regions where there are different stages of development and resources are not equally distributed. Every country all over the world cannot alive on self-sufficiency. It is clear that every country need international trade and division of labor that might support “free trade”.

Since globalizing world market, however, will induce severe survival games on competition on not only prices but non-prices such as quality, design, safety, recycling, energy savings and ecology etc among players, it provides big business chance for new comers with talent. In order to survive in the globalizing world economy, every country around the world might make greater efforts for “*export diversification*” and “*import substitution*” trade policy that might provide opportunities for increase real GDP growth rates. Such kind of policy might be particularly recommended to newly industrializing developing countries. It is worth noting that traditional “free trade” theorem based on “comparative advantage” could not be applicable to the all over the countries. *Everything around the world is apt to change forever and interrelated* so that a concept of “comparative advantage” might not be considered as a given permanent interrelationship in the globalizing world.

For example, immediate after the Pacific War, everyone could not believe that Toyota would be able to overcome GM, since Toyota was far behind GM in all aspect such as technology and sales management power. Same thing is true in the case of Japanese origin global enterprises such as Honda, Sony, Panasonic, Canon, Nikon, Mitsubishi heavy industry, Hitachi, Toshiba, Sharp,

Nintendo and many others that have created brand image of “made in Japan”. Today Japan brand takes a lead in many *technology innovation* fields such as information technology, biotechnology, energy savings, more safety nuclear plant, solar and superconductor, nanotechnology, robotics, new materials, space-technology and etc. Nowadays, such defunct “myth” of “comparative disadvantage” of infant Japanese industry has turned into “comparative advantage” in the globalizing world. This is a lesson of Japanese experience for the late coming developing countries.

On the other hand, globalizing world, “disparity phenomena” will simultaneously proceed. Not only increasing IPCID and appearing “the richest strata” but also “working poor” is increasing important social issue. For instance, Japanese economy suffered from stagnant domestic demand for the period, 2001-2007. This means that domestic demand oriented enterprises face severe cutthroat survival games. Big global enterprises like Toyota could survive by making large profits from exports to the global market. Even smaller enterprises having specific skills and advanced technology such as “animated cartoon” have also fortunes to expand exports in the globalizing world, in spite that most of small and medium-scale businesses have faced increasing risks of bankruptcy. Labor share as well as wage cost is continuously decreasing and working poor has become usual phenomenon.

In the case of agriculture, situation is different from manufacturing sector. Japan depends upon imports to the large extent, although self sufficiency of rice is maintained by subsidy policy. For foods security and environment protection reasons, agriculture and forest industry will play a much important role in the futures, apart far from “comparative advantage” reformed by Heckscher-Olin theorem. It is of interest that there is a recent success story of Japanese agriculture to cultivate most expensive exportable products such as brand beef, fruits even rice and etc... Thanks to original idea and utmost efforts, the Japanese farmers have succeeded to produce delicious organic agricultural products, irrespective of the myth as “comparative disadvantage”. Although Japan is foods importing country, it has increasing power for diversified exports of specific agricultural products in the globalizing world market.

Therefore it is worth noting that the “*appropriate*” trade policy might be desirable. In this sense some “*appropriate*” policy measures might be acknowledged, although “endless” diversification of “new” exportable goods and substitution of import goods by introducing new substitute goods. Such kind of “*appropriate*” trade policy should vitalize the globalizing dynamic world economy in the futures.

Metaphorically speaking, the world's around 200 countries including the UN and non-UN members can be thought of as “*cells*” which, when separate and isolated should only act in a disconnected way, each in its own fashion. But when given information concerning the global human society, the possibility arises that each country can take in information on what it ought to

best to do, with the result that through a sort of feedback system the global economy will operate more smoothly. This is one of the hints given by the recent development of life science.

The transmission of information is an important aspect of life functions, absolutely essential for the existence and continuation of life. Humans furthermore have a capacity by which some information is consciously perceived as signals from outside as a result of which new and useful information can then be generated from inside "*human genome*" information, taking on, in other words, takes on a *self-organizing capacity*. There are vital characteristics of the life phenomenon.

The FUGI global modeling methodology has also received a large impact from of *brain physiology*. The human brain is made up of around 6 billion neurons, or nerve cells. The "right brain" has to do with what we call "*pattern recognition*," and specializes in the ability to grasp "images" and perceive things as a totality. The "left brain" displays an outstanding capacity to think logically in terms of symbols and words.

A thick belt of the inter-brain ridge links the information inputs handled by the left and right brains. Images taken in by the right brain are sent to the left brain, where they are logically analyzed and checked out to see if they correspond with reality, and are then fed back again into the right brain. In this way, the brain can make judgments and produce new information.

The working of the human brain, in which the neurons not only form a network through synapse but recognize each other, has provided some very useful hints for the construction of global models. This is because global models have the role of offering global information. If this information undergoes a feedback process reflecting itself in each country's actual policies, the future image of the world economy will change with the emergence of global information. In the future, mutual understanding can be expected to increase through global information exchanges, and it is only with this base that we can begin to talk about possibilities for *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*." Perhaps we will first have to develop a global system that will be conducive to the employment of such an *avant garde* model. But in this process, it may nevertheless be expected that current global models can give useful policy suggestions. 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 CO₂ 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, space technology 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, *it is worth noting that not only moderate harmonized adjustments of policies but wise cosmic mind to promote human solidarity with the ever changing nature will be desirable to adjust orbit of the ever changing futures of global interdependent economy.* It is worth noting that Cosmos is an entirely recycling system so that there might be no wastage of resources as seen in the current civilized human societies. In the Cosmic system *everything is interdependent and changing forever.* In order to adapt with such a dynamic cosmic system, humankind should modify present civilization in the globalizing world. Consciousness of co-existence of human beings with nature and solidarity of humankind will be needed. The more harmonized progress between technological innovations and human minds will be necessary in order to create a desirable human society and life support system of the Earth in the post-modern futures.

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Appendix A: The FUGI global modeling system (FGMS 200).