ECONOMIC CONTAGION UNDER UNCERTAINTY: CGE WITH A MONTE CARLO EXPERIMENT

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Abstract

Economic contagion is increasingly felt as economic interdependence deepens in today's economy. This study quantitatively investigates how economic shocks of a certain country influence a different country. Usually, a positive shock has a positive influence, and a negative shock has a negative influence. For instance, the monetary crisis of Europe affected the Asian economy as well as the economy of Europe itself. The Chinese economy, which recently accomplished the most remarkable economic growth in the Asian region, has also declined in rates of growth, and has become a risk factor for the global economy. The downturn of the economy in regions with economic power may have a negative influence on the economy of other countries. Under such circumstances, this study quantitatively analyzes the economic shock influence of a certain country to other countries, at the same time there is a possibility of influence to the opposite direction supposing the economic shock occurs under uncertainty. The model employed in the study uses the general algebraic modeling system (GAMS), it uses the global trade analysis project (GTAP) database, which is compiled as a computable general equilibrium (CGE) model using multiple countries' data. Moreover, this database is constantly updated to a recent year to feature more realistic knowledge. Furthermore, this study uses the Monte Carlo experiment to model uncertainty. This is realizable by adding the random number of a normal distribution to the exogenous variables of the model.

Keywords: Economic Contagion, Multi-country Computable General Equilibrium Model, Monte Carlo Experiment

JEL classification: C15, C68, D58, O53, R13

1. Introduction

The global economy has thrived remarkably because of globalization. However, the development of the global economy has recently met a crossroads. The holdup is the considerable influence of economic growth from one economy to other countries. If one representative country's economic growth is high, it will not be a problem. However, if its economic growth stops, growth of the other countries may start to decrease. The global economy has experienced big crises in the past, but all crises after 1990 met the global economy without causing havoc to the global economy. For example, the 1997 Asian financial crisis, the subprime mortgage crisis, the Greek bond crisis, and the European sovereign debt crisis, and so on. The word "contagion" started to be used to refer to these phenomena around the 1990s.

Contagion is defined as "the spread of market changes or disturbances from one regional market to others. Contagion can refer to the diffusion of either economic booms or economic crises throughout a geographic region" (*Investopedia*, 2016). Economic contagion is increasingly watched as economic interdependence deepens. In its definition, a positive shock has a positive influence, and a negative shock has a negative influence. For instance, the

♦ The author would like to thank the useful comments given by participants attending the 59th Annual North American Meetings of the Regional Science Association International (November 2012), AGI seminar (December 2015) and the 53rd Annual Meeting of the Japan Section of the Regional Science Association International (October 2016). The author would like to thank Editage (www.editage.jp) for English language editing. The author is responsible for all remaining errors.

monetary crisis of Europe affected the Asian economy as well as the economy of Europe itself. The Chinese economy, which accomplished the most remarkable economic growth in the Asian region, has also recently waned in rates of growth. Interdependence is also one of the reasons of the downturn of the economy in Europe. Likewise, the downturn of China's domestic economy may also be considered. Moreover, the downturn of the economy of a region with economic power may have a negative influence on the economy of other countries. Lately, the United Kingdom decided to leave the EU in a plebiscite. The flounder of the Chinese economy is thought to be more severe than the official statistical publications, and while the world is confused, the politicians' introverted-oriented remarks are valued by some countries. The current state of affairs may be a trial for keeping up globalization. It can also be said, that the global economy's uncertainty of the future is rising by these phenomena.

Obviously, it may not become a contagion. Even if a country suffers a negative shock, others may not be affected. Such situations are known as a decoupling.[1] This study quantitatively investigates to what magnitude the economic shock of a certain country should affect a different country, and mentions the possibility of whether it will be a contagion or a decoupling. Concerning the methodology, this study adopts a multi-country computable general equilibrium (CGE) model instead of using an econometric model. The empirical literature on testing for contagion (especially financial contagion) has focused on increases in the correlation of returns between markets during periods of crisis. In this case, the vector autoregression (VAR) model is predominantly used to measure contagion. However, to estimate a VAR model, a sufficient time series sample is required. Moreover, the estimated result cannot necessarily judge whether it is a contagion or not.[2] Then, it is the purpose of this research to propose another method.

Several studies of contagion focus mainly on the financial market (therefore it will be called "financial contagion"). On the other hand, the CGE model estimates economic contagion through international trade by adding the number of handled goods (this model does not deal with the financial market). It is almost entirely different from former studies on this subject. The global trade analysis project (GTAP) model is widely used all over the world as a multi-country CGE model.[3] The CGE model is built on the data of a specific year, and the GTAP model is not an exception. However, the base year is updated every so often. Additionally, the GTAP model can also compute various countries (regions) and custom industries. Therefore, if this model is used, the influence of contagion can be investigated in many countries at the same time.

As another feature of this study, the uncertain situation of an economy is assumed. When seeing the world's situation nowadays, you can find out that uncertainty to the future is high. Hence, if an economic forecast is also considered uncertain, it is desirable. This study adopts the Monte Carlo experiment to consider the uncertainty about an economic fluctuation.[4] Because distribution of changes occur with other variables subject to uncertainty, the possibility of a wider economic fluctuation can be considered. Furthermore, when judging whether it shows economic propagation, the direction of change of other variables (here positive or negative rates) is important. Therefore, it is possible to explore the robustness of the direction of change by simulating uncertainty of the variables.

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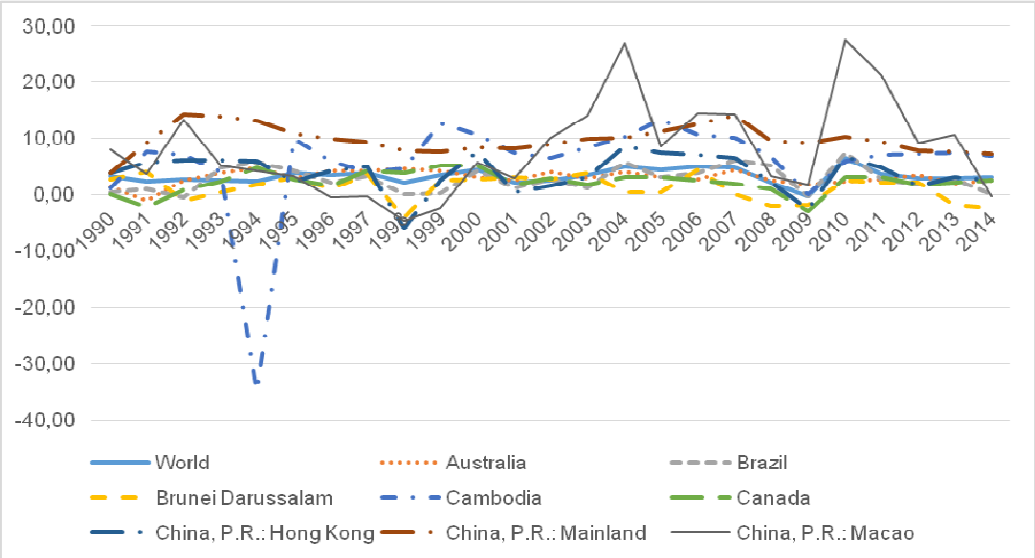
[1] Decoupling is defined as "the occurrence of returns on asset classes diverging from their expected or normal pattern of correlation. Decoupling takes place when two different asset classes that typically rise and fall together move in opposing directions, such as one increasing and the other decreasing (*Investopedia*, 2016)". Rise of the developing countries called BRICs (Brazil, Russia, India and China) have increased the public attention to the meaning of decoupling. Nevertheless, economic growth is also recently decreasing in these countries.

[2] These arguments are introduced by *Wikipedia* ("Financial contagion", sited on 16th Aug, 2016). Therefore, we do not site related literatures in this study.

[3] In detail, see Hertel, eds. (1997).

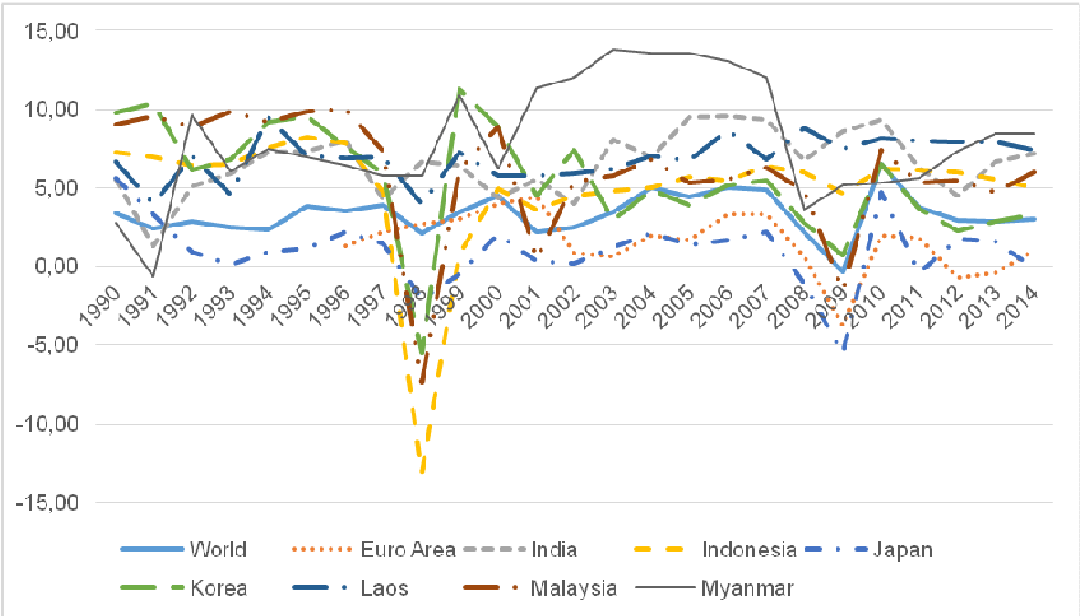
[4] Now, literature on the CGE model is also diverse and it is very difficult to introduce them in detail. The combination of the CGE model and the Monte Carlo experiment has never been used in the field, for example, the research of Abler et al. (1999) and Harris and Robinson (2001) are relatively old.

Figure 1 Economic Growth Rates of the Selected Regions (1) (1990–2014)



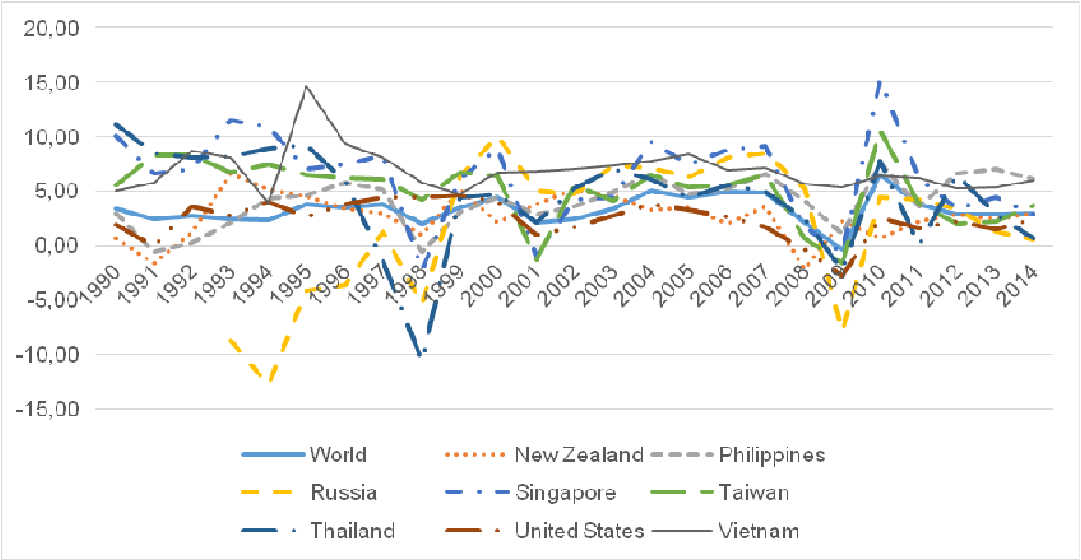
(Source) IMF: *International Financial Statistics* (January, 2016) and http://ecodb.net/

Figure 2 Economic Growth Rates of the Selected Regions (2) (1990–2014)



(Source) IMF: *International Financial Statistics* (January, 2016) and http://ecodb.net/

Figure 3 Economic Growth Rates of the Selected Regions (3) (1990–2014)



(Source) IMF: *International Financial Statistics* (January, 2016) and http://ecodb.net/

2. Evidence

Figure 1 to Figure 3 show graphs of the economic growth rate of the selected economies, which include several Asian countries.[5] Furthermore, in 1990 and afterwards, there have been two spells of economic crises. The first time was the Asian financial crisis in 1997, and the second time was the subprime mortgage crisis in 2009. Moreover, the European Union with the Greece crisis, continued a downturn until 2011, their hope of economic convergence is not possible at the present time. It can be said that Greece and the European Union, is one example of economic contagion in a negative direction. Obviously, all countries in the contagions above did suffer from a reduction of growth, which can be regarded as a decoupling.

Table 1 and Table 2 show the percentage in two standards of growth, one showing growth rate 0% or more ("Positive growth rate" is indicated in the table), and the other a global average of these countries ("Higher than world growth" is indicated in the table). First on Table 1, for each year you can appreciate the countries' results, and the contraction of the economy in 1998 and on 2009, portraying an economic crisis. Additionally in 1998, in comparison with the global average, because the economic crisis was mainly in Asia, their growth rates were below average, the Asian continent contracted more than half its economy. Second, there was a positive growth rate in many countries, as you can see in Table 1, in the first years of the 2000s, the majority of the countries exceeded the global average, and their performance was also stable. Third, Table 2 shows the economic growth rate of each region in 1990 and afterwards, China, India, Laos, and Vietnam had positive growth rates during these periods. On the other hand, in Brunei, Japan, and Russia, about 1/4 of the period had negative growth. It turns out that the economic growth of Japan was very low.

Second, in comparison with the global average, China and Laos are the only ones that have fulfilled economic growth every year. On the other hand, Brunei, Canada, the European Union, Japan, and the United States recorded less than the global average in many years. This analysis is simple; however, a possibility of both a contagion and a decoupling could be discerned.

[5] Selection of the countries is integrated with the candidate country of the simulation which introduces next.

Table 1 Percentage of the Economic Growth Rate of Selected Regions (year base, %)

Year	Positive growth rate	Higher than world growth	Year	Positive growth rate	Higher than world growth
1990	100.00	59.09			
1991	78.26	63.64	2003	100.00	66.67
1992	91.30	68.18	2004	100.00	62.50
1993	95.83	78.26	2005	100.00	58.33
1994	91.67	82.61	2006	100.00	66.67
1995	95.83	65.22	2007	100.00	70.83
1996	92.00	66.67	2008	84.00	62.50
1997	92.00	66.67	2009	48.00	54.17
1998	56.00	45.83	2010	100.00	50.00
1999	92.00	66.67	2011	96.00	54.17
2000	100.00	62.50	2012	96.00	62.50
2001	92.00	62.50	2013	92.00	54.17
2002	100.00	83.33	2014	88.00	45.83

(Note) Selected regions defined as Table 2. It shows percentages of the region beyond the two standards calculated from the selected regions (24 regions) in each year.

(Source) Author's calculation

Table 2 Percentage of the Economic Growth Rate of Selected Regions (region base, %)

Region	Positive growth rate	Higher than world growth	Region	Positive growth rate	Higher than world growth
World	96.00				
Australia	96.00	44.00	Korea	96.00	76.00
Brazil	92.00	36.00	Laos	100.00	100.00
Brunei	76.00	16.00	Malaysia	92.00	88.00
Cambodia	96.00	88.00	Myanmar	96.00	88.00
Canada	92.00	24.00	New Zealand	92.00	36.00
Hong Kong	92.00	60.00	Philippines	92.00	68.00
China	100.00	100.00	Russia	72.73	54.55
Macao	80.00	76.00	Singapore	88.00	80.00
Euro Area	84.21	10.53	Taiwan	92.00	80.00
India	100.00	92.00	Thailand	88.00	68.00
Indonesia	96.00	84.00	United States	92.00	28.00
Japan	76.00	8.00	Vietnam	100.00	96.00

(Note) It shows percentages of the year beyond the two standards calculated from the selected years (1990-2014, 1996-2014 in Euro Area, 1993-2014 in Russia) in each region.

(Source) Author's calculation

Table 3 Simple Description of GTAP Data

		intermediate		expenditure		export		transportation	output
		Region 1	Region 2	Region 1	Region 2	Region 1	Region 2		
intermediate	R1	vdfm	vifm	vdfm	vifm	vxmd	vxmd	vst (vtwr)	vom
	R2	vifm	vdfm	vifm	vdfm	vxmd	vxmd	vst (vtwr)	vom
tax	R1	rtfd	rtfi	rtfd	rtfi				
	R2	rtfi	rtfd	rtfi	rtfd				
factor tax subsidy		vfm rtf rto	vfm rtf rto						
output		vom	vom	vom	vom				

(Source) The GTAP 8 Database and author

(Note) All variables are defined by Rutherford (2010).
vom: Aggregate output.
vfm: Endowments, firms' purchases at market prices.
vdfm: Intermediates, firms' domestic purchases at market prices.
vifm: Intermediates, firms' imports at market prices.
vxmd: Trade, bilateral exports at market prices.
vst: Trade, exports for international transportation. Aggregate of "vtwr".
vtwr: Trade, margins for international transportation at world prices.
rtxs: Export subsidy (rate).
rtms: Import taxes (rate).
rto: Output subsidy (rate).
rtf: Primary factor and commodity taxes (rate).
rtfd: Firms' domestic tax (rate).
rtfi: Firms' import tax (rate).
vifm = vxmd + vtwr + rtxs + rtms (zero profit condition for import).

3. Model and Simulation

Under such a context, this study quantitatively analyzes the economic shock influence from some countries to other countries, at the same time the possibility of a reduction in the rate of growth is presumed when an economic shock occurs under uncertainty. The model employed is the general algebraic modeling system (GAMS) code which Rutherford (2010) advocates, this study also uses the trade data from the GTAP.[6]

Table 4 Mapping Information

Production Factor		Production Sector		Country (Region)	
lab	Unskilled labor	agri	Agriculture	aus	Australia and New Zealand
skl	Skilled labor	mine	Mining	chn	China
cap	Capital	food	Food	hkg	Hong Kong
res	Resources	text	Textiles	jpn	Japan
lnd	Land	wood	Wood	kor	Korea
		peto	Petroleum Chemical	idn	Indonesia

[6] GTAP model has also calculation software (General Equilibrium Modelling PACKage, GEMPACK). However, the way GTAP is rewritten in the GAMS code tends to make an extension and a correction of the model. Although various improvements were considered for the Rutherford model in this study, the original model was used as it was, and the present study only added the Monte Carlo experiment code.

Production Factor		Production Sector		Country (Region)	
		meta	Metals	mys	Malaysia
		moto	Motor vehicles	twn	Taiwan
		elec	Electronic equipment	phl	Philippines
		mech	Machinery and others	sgp	Singapore
		egwp	Electricity, Gas, Water	tha	Thailand
		cons	Construction	vnm	Vietnam
		trad	Trade	asa	Other ASEAN countries
		ntra	Transport	ind	India
		wtra	Water transport	can	Canada
		atra	Air transport	usa	United States
		comm	Communication	bra	Brazil
		serv	Other services	eeu	European Union
				rus	Russian Federation
				xwd	Rest of the World

(Source) The GTAP 8 Database and author

Table 5 Growth Rate for Estimation

	2007-14	average		2007-14	average
aus	1.243	1.028	tha	1.251	1.028
chn	2.054	1.094	vnm	1.586	1.059
hkg	1.275	1.031	ind	1.758	1.073
jpn	1.028	1.003	can	1.134	1.016
kor	1.311	1.034	usa	1.092	1.011
twn	1.313	1.035	bra	1.286	1.032
idn	1.564	1.057	rus	1.210	1.024
mys	1.453	1.048	asa	1.836	1.079
phl	1.519	1.054	eeu	1.038	1.005
sgp	1.502	1.052	xwd	1.288	1.032

(Source) IMF: *International Financial Statistics* (January, 2016) and http://ecodb.net/

Table 6 Simulation Design

Simulation	Sector	Country	Frequency
Simulation 1	Consumption	China (chn)	0.05
Simulation 2	Consumption	EU (eeu)	0.01
Simulation 3	(Unskilled) Labor	China (chn)	0.10
Simulation 4	Simulation 1 + Simulation 2		
Simulation 5	Simulation 1 + Simulation 3		
Simulation 6	Consumption	India (ind)	0.05

(Note) We use a random number of a normal distribution whose average is 1 in the Monte Carlo experience.

(Source) Author

Data from the GTAP can be taken out independently, when these variables indicate a structure of the input-output table, shown in Table 3. To use the GTAP database, it is necessary to first aggregate the production factor, the production sector, and the regions.[7] In this study, the production factor was not aggregated. However, Table 4 aggregates 18 commodities (production sectors) and 20 regions (countries). These are specific to the typical

[7] The GTAP 8 database, boasts dual reference years, 2004 and 2007, as well as 129 regions for all 57 GTAP commodities. We use 2007 for the reference year and estimate to the statistics of the year 2014.

Asian country's economic sectors, these industries are added to the GTAP calculation, the selection of industries has been made independently by the author

However, when making 2007 the base year, a problem surges of not using the most recent data. That is because the Chinese gross domestic product (GDP) was smaller than the Japanese GDP in that year. The Chinese GDP passed Japan's in 2010. Therefore, it is more desirable to use a recent database. The GTAP has already published the GTAP 9 database, which includes the reference year of 2011, but it is not efficient to wait for new data to be published. Therefore, to renew the GTAP data, this study considered updating the report to 2014.

We worked the estimation of 2014 data based on the 2007 data.

- 1. Multiply the items using the growth rate of Table 5 for "vom", "vfm", "vdfm", "vifm", "vxmd" and "vtwr" of Table 3.
- 2. Estimating the adjustment parameter from the condition of vom = vdfm + rtfd + vifm + rtfi + vfm + rtf + rto of Table 3.
- 3. Recalculate the "vfm", "vdfm", "vifm".
- 4. Estimating the adjustment parameters from conditions of vifm = vxmd + vtwr + rtxs + rtms of Table 3.
- 5. Recalculate the "vxmd", "vtwr", "vst" (aggregate of "vtwr").
- 6. Estimating the adjustment parameters from condition of vom = vdfm + vxmd + vst.
- 7. Recalculate the "vom".
- 8. Repeat (2 to 7).

This study reports six simulations by using estimated data. The Monte Carlo experiment is applied because it can model uncertainty. It is realizable by adding the random number of a normal distribution to the exogenous variables of the model. The normal random number which has an average of 1, and the calculated standard deviation is multiplied to one or two variables. Table 6 shows the variable, target country, and the standard deviation that performs the simulation.[8] Simulation 1 is a case where Chinese consumption demand has uncertainty. Simulation 2 is a case where the European Union's consumption demand has uncertainty. Simulation 3 is a case where Chinese labor supply has uncertainty. Simulation 4 is a case where consumption demand in China and the European Union have uncertainty. Simulation 5 is a case where Chinese consumption demand and labor supply have uncertainty. Simulation 6 is a case where India's consumption demand has uncertainty. The uncertainty characteristics are taken up as a reference for the selection of a country in this study. Regarding the uncertainty of consumption demand and labor supply, the intention of people's behavior is likely to change dramatically due to changes in the economic situation. The standard deviation differs in each simulation, in order that it may assemble the influence of a simulation result to some extent. For example, consumption in United States and the European Union is much larger than China's (Table 7), so we set the degree of uncertainty at 5% in China, and 1% in the European Union, respectively. On the other hand, although the share of labor in China is high, the influence of uncertainty of Chinese labor has on a foreign country is not great, we set the degree of uncertainty to 10%.[9]

[8] In GAMS code, vom ("c", r) is consumption demand and evom ("lab", r) is (unskilled) labor supply ("evom" is disaggregated of "vfm"). These variables show the monetary value and they are exogenous in the model. For the endogenous variables, the model sets up change of quantity (*Y*, *FT* and so on) and change of a price (*P*, *PF* and so on) which sets the initial value to 1, respectively.

[9] This setting was decided after doing simulation experiments many times.

4. Result

The result of each simulation is introduced below. First, Table 7 shows the estimation result for use by all simulations. The GDP of China exceeds Japan's, but it does not reach that of the United States and the European Union. In addition, value added (unskilled) labor in China is relatively high. Table 8 to Table 13 show the change of the GDP of each country by using 200 experiments for every simulation. The table reports the maximum, the minimum, the average, and the standard deviation. For example, in the Simulation 1 (Table 8), when consumption demand of China has 5% of uncertainty, the GDP of China receives more than a 5% change in the standard deviation, and there is more than 30% difference between the maximum and the minimum. Moreover, the change of about 4% is set to other countries, and the influence to the global economy by the fluctuation of the Chinese economy can be seen.[10] However, it can be said that this is about the same rate of change of the European Union's economy. Simulation 2 (Table 9) has grown the GDP to 1% of uncertainty from the consumption demand of the European Union. The European Union has also more than 3% change in the standard deviation, and about a 3% change in foreign countries. This is because the level of consumption of the 27 countries of the European Union is very large as shown in Table 7. Therefore, it can be said that the influence of 1% of uncertainty to the global economy is considerable.

Next, when the (unskilled) labor supply of China has 10% of uncertainty (Simulation 3), and about a 4% change in the standard deviation, there is hardly any effect to other countries. Because the uncertainty of supply of labor is affected by domestic production, is not affected directly by foreign trade, it is considered not to cause change to other countries (Table 10).

Since Simulation 4 (Table 11) and Simulation 5 (Table 12) are a combination of the above-mentioned simulations, the result depends on two uncertainties that reshape the positive or negative change of the GDP.

Finally, we will introduce the case of India where future growth can be expected (Table 13). When the consumption demand of India has 5% of uncertainty, the GDP of India takes more than a 6% change in the standard deviation. However, influence to the global economy stops at about 2% of change in the standard deviation. It turns out that influence from a country to another country by uncertainty of consumption demand is largest in the European Union, second in China, and last in India. The uncertainty of consumption demand is related to the initial value of the consumption demand.[11]

However, the direction of change is not known, taking from the above result, and it is not yet validated whether it is a contagion or a decoupling. Below we will discuss positive or negative outcomes from the results. We totaled the entries and the positive or negative values of the 200 experiments. Table 14 shows how many of the 200 experiments differed in the sign in each region (country). Here, for each simulation, when signs differ even once, 1 time is counted as causing uncertainty. In other words, 200 times means that in each simulation, some region always shows a different sign. Furthermore, 0 times means that the same sign is shown in all regions.

As far as Table 14 is concerned, it shows the change of quantity of production of many industries, and the amount of consumption, so we can see that the signs may differ in each region. Yet, the GDP shows some differences on all simulations. For example, in Simulation 1 and in Simulation 2, the influence uncertainty brings remains only in the change of quantity, and all regions can be referred to as having the same sign. This can be interpreted as a highly

[10] In the Rutherford model, the region which is the largest initial value of the representative agent is set as the numeraire region. Because the value of the representative agent is fixed in the numeraire region, there is no fluctuation in the representative agent after a simulation, and the fluctuation of the GDP is also small. When the data of this study was used, the initial value of the representative agent of the United States is the largest in the model. Because of the fluctuation of the GDP of the United States becoming small, when it is simulated, the rest of the world (xwd) is set as the numeraire region in this study.

[11] In this model, we assume the economy of 27 Euro countries are aggregated as one region. Obviously, a different result will be expected when the European Union is taken apart in several areas or countries.

probable likeliness that the economy will be affected by contagion in each region. On the other hand, in the case of Simulation 3, it is the contrary, and it serves as a decoupling event. Nevertheless, from Table 10, we can see the likeliness of a decoupling, since the changes that affect other countries are very small. When the uncertainty of consumption demand exists in China and the European Union randomly, the result of Simulation 4 shows that there is a possibility of decoupling. Additionally, the possibility of decoupling exists when consumption demand and labor supply are uncertain.

Table 7 Initial (Monetary) Value and Share of Consumption, (Unskilled) Labor, and GDP (billion USD, %)

	Consumption		Labor		GDP	
aus	693.365	1.77	381.082	2.08	1256.390	1.89
chn	2686.705	6.85	2548.499	13.92	6950.825	10.44
hkg	158.163	0.40	56.404	0.31	274.841	0.41
jpn	2567.578	6.54	1229.793	6.72	4550.522	6.84
kor	739.889	1.89	403.625	2.20	1395.598	2.10
twn	280.257	0.71	154.086	0.84	548.376	0.82
idn	421.354	1.07	210.399	1.15	680.296	1.02
mys	113.274	0.29	79.419	0.43	274.678	0.41
phl	153.696	0.39	54.398	0.30	224.260	0.34
sgp	101.098	0.26	63.449	0.35	249.754	0.38
tha	157.861	0.40	73.767	0.40	313.505	0.47
vnm	72.942	0.19	28.370	0.15	106.648	0.16
ind	1287.651	3.28	713.328	3.90	2168.014	3.26
can	915.957	2.33	459.387	2.51	1596.433	2.40
usa	10866.294	27.69	5051.520	27.59	15427.127	23.18
bra	1047.983	2.67	489.378	2.67	1765.119	2.65
rus	808.839	2.06	294.348	1.61	1560.909	2.34
asa	46.255	0.12	18.614	0.10	75.523	0.11
eeu	10313.136	26.28	3624.866	19.79	17368.993	26.09
xwd	5812.897	14.81	2377.513	12.98	9779.709	14.69
	39245.194		18312.245		66567.520	

(Source) Calibrated by author based on the GTAP 8 Database (reference years of 2007)

Table 8 Change of GDP (Simulation 1)

	aus	chn	hkg	jpn	kor
max	1.135015	1.190151	1.145222	1.141910	1.139505
min	0.907114	0.875085	0.899191	0.901436	0.902436
average	1.006497	1.009378	1.006954	1.006792	1.006650
std dev	0.040292	0.055557	0.043522	0.042533	0.041945
	twn	idn	mys	phl	sgp
max	1.151083	1.137238	1.144489	1.142552	1.153363
min	0.894690	0.905374	0.899253	0.900394	0.891993
average	1.007216	1.006597	1.006902	1.006799	1.007282
std dev	0.045357	0.041002	0.043395	0.042845	0.046266
	tha	vnm	ind	can	usa
max	1.142400	1.124727	1.137756	1.136622	1.138509
min	0.900429	0.910397	0.904242	0.905193	0.903808
average	1.006789	1.005855	1.006590	1.006542	1.006629
std dev	0.042814	0.037990	0.041304	0.040932	0.041512
	bra	rus	asa	eeu	xwd
max	1.133085	1.128793	1.127625	1.138382	1.051904
min	0.908408	0.911797	0.911580	0.903685	0.964808
average	1.006402	1.006214	1.006120	1.006614	1.002520
std dev	0.039719	0.038357	0.038221	0.041514	0.015393

(Source) Author's calculation

Table 9 Change of GDP (Simulation 2)

	aus	chn	hkg	jpn	kor
max	1.080046	1.084368	1.085306	1.083755	1.084305
min	0.918316	0.913583	0.912702	0.914188	0.913464
average	1.002709	1.002839	1.002875	1.002818	1.002829
std dev	0.028855	0.030464	0.030790	0.030246	0.030470
	twn	idn	mys	phl	sgp
max	1.085199	1.080592	1.081309	1.083899	1.084909
min	0.912315	0.917808	0.916499	0.913831	0.912274
average	1.002848	1.002729	1.002726	1.002813	1.002822
std dev	0.030830	0.029045	0.029394	0.030331	0.030778
	tha	vnm	ind	can	usa
max	1.083051	1.084075	1.082115	1.081485	1.082550
min	0.914700	0.914132	0.915976	0.916615	0.915524
average	1.002784	1.002841	1.002768	1.002746	1.002782
std dev	0.030025	0.030320	0.029637	0.029410	0.029795
	bra	rus	asa	eeu	xwd
max	1.079825	1.079034	1.078630	1.094796	1.031152
min	0.918581	0.919581	0.920109	0.903725	0.968640
average	1.002703	1.002685	1.002677	1.003230	1.001075
std dev	0.028769	0.028454	0.028291	0.034100	0.011162

(Source) Author's calculation

Table 10 Change of GDP (Simulation 3)

	aus	chn	hkg	jpn	kor
max	1.003048	1.110497	1.003724	1.011001	1.012501
min	0.996242	0.893268	0.992010	0.983830	0.981810
average	1.000072	0.996474	0.999927	1.000137	1.000165
std dev	0.001192	0.038692	0.002017	0.004754	0.005369
	twn	idn	mys	phl	sgp
max	1.011560	1.006062	1.012862	1.006634	1.023321
min	0.982401	0.992925	0.982590	0.988739	0.968666
average	1.000116	1.000162	1.000232	1.000011	1.000431
std dev	0.005096	0.002313	0.005319	0.003102	0.009605
	tha	vnm	ind	can	usa
max	1.012203	1.022218	1.010335	1.008319	1.010152
min	0.983757	0.978818	0.986746	0.988972	0.986028
average	1.000232	1.000820	1.000221	1.000160	1.000172
std dev	0.004986	0.007724	0.004144	0.003394	0.004229
	bra	rus	asa	eeu	xwd
max	1.004139	1.000828	1.003860	1.010728	1.003771
min	0.995148	0.999511	0.999297	0.985334	0.995555
average	1.000110	1.000045	1.000295	1.000186	1.000099
std dev	0.001585	0.000245	0.000867	0.004453	0.001450

(Source) Author's calculation

Table 11 Change of GDP (Simulation 4)

	aus	chn	hkg	jpn	kor
max	1.136315	1.172474	1.145965	1.142993	1.142365
min	0.887405	0.862698	0.878611	0.881052	0.881256
average	1.011143	1.014949	1.011914	1.011645	1.011476
std dev	0.053866	0.068402	0.057920	0.056709	0.056354
	twn	idn	mys	phl	sgp
max	1.148648	1.137936	1.142081	1.143426	1.149625
min	0.875359	0.885962	0.881033	0.880104	0.873569
average	1.012234	1.011300	1.011708	1.011655	1.012312
std dev	0.059520	0.054598	0.056877	0.057026	0.060265
	tha	vnm	ind	can	usa
max	1.142635	1.135517	1.139538	1.138422	1.140295
min	0.880688	0.887126	0.884024	0.885058	0.883467
average	1.011618	1.010488	1.011333	1.011247	1.011398
std dev	0.056795	0.052926	0.055249	0.054779	0.055534
	bra	rus	asa	eeu	xwd
max	1.135184	1.132448	1.131683	1.151190	1.052981
min	0.888425	0.891342	0.891560	0.876005	0.957266
average	1.011013	1.010745	1.010632	1.011813	1.004351
std dev	0.053319	0.051955	0.051720	0.058547	0.020685

(Source) Author's calculation

Table 12 Change of GDP (Simulation 5)

	aus	chn	hkg	jpn	kor
max	1.141646	1.239613	1.151858	1.146892	1.144021
min	0.918769	0.887801	0.910665	0.909216	0.909280
average	1.007980	1.007970	1.008378	1.008372	1.008226
std dev	0.041669	0.067151	0.045102	0.044586	0.044117
	twn	idn	mys	phl	sgp
max	1.156415	1.143316	1.149187	1.148528	1.156127
min	0.902856	0.915996	0.906909	0.910291	0.894735
average	1.008862	1.008188	1.008613	1.008269	1.009247
std dev	0.047558	0.042548	0.045571	0.044588	0.049626
	tha	vnm	ind	can	usa
max	1.147354	1.127044	1.142984	1.142090	1.143667
min	0.908124	0.914370	0.912450	0.914329	0.911948
average	1.008470	1.007962	1.008217	1.008110	1.008214
std dev	0.044922	0.040648	0.043205	0.042668	0.043433
	bra	rus	asa	eeu	xwd
max	1.139522	1.135521	1.134020	1.143366	1.053812
min	0.919246	0.924168	0.923654	0.911619	0.968137
average	1.007892	1.007621	1.007775	1.008213	1.003160
std dev	0.041148	0.039553	0.039453	0.043476	0.016070

(Source) Author's calculation

Table 13 Change of GDP (Simulation 6)

	aus	chn	hkg	jpn	kor
max	1.067289	1.068417	1.068454	1.066936	1.066162
min	0.955574	0.953899	0.953634	0.955226	0.955418
average	1.003221	1.003246	1.003241	1.003187	1.003141
std dev	0.019424	0.019954	0.020022	0.019455	0.019303
	twn	idn	mys	phl	sgp
max	1.066873	1.069518	1.063551	1.066090	1.063462
min	0.954546	0.954474	0.956594	0.955204	0.956267
average	1.003160	1.003336	1.002998	1.003128	1.002981
std dev	0.019592	0.019977	0.018668	0.019337	0.018727
	tha	vnm	ind	can	usa
max	1.065346	1.058091	1.257004	1.066217	1.066528
min	0.955456	0.956585	0.869950	0.955787	0.955402
average	1.003083	1.002616	1.013656	1.003154	1.003164
std dev	0.019170	0.017880	0.065877	0.019224	0.019356
	bra	rus	asa	eeu	xwd
max	1.064026	1.066022	1.081176	1.065993	1.023553
min	0.957014	0.956740	0.949280	0.955475	0.983699
average	1.003040	1.003171	1.003975	1.003130	1.001105
std dev	0.018633	0.018986	0.022795	0.019265	0.006970

(Source) Author's calculation

Table 14 Number of Different Signs in 200 Experiences

	Simulation 1	Simulation 2	Simulation 3	Simulation 4	Simulation 5	Simulation 6
consumption	200	200	200	200	200	200
agri	200	0	0	179	113	200
mine	200	200	200	200	176	200
food	200	200	200	200	200	200
text	200	200	200	200	195	200
wood	200	200	200	200	200	200
peto	200	200	200	200	200	200
meta	200	200	200	200	200	200
moto	200	200	200	200	200	200
elec	200	200	200	200	200	200
mech	200	200	200	200	200	200
egwp	200	200	200	200	200	200
cons	200	200	200	200	200	200
trad	200	200	200	200	200	200
ntra	200	200	200	200	200	200
wtra	200	200	200	200	200	200
atra	200	200	200	200	200	200
comm	200	200	200	200	200	200
serv	200	200	200	200	173	200
gdp	0	0	200	11	55	0

(Note) After a simulation, if the sign for all regions is the same, it will not be counted; it will be counted only if at least one region marks a different sign. This table illustrates a case where a different sign is counted at the time of conducting the Monte Carlo experiment 200 times.

(Source) Author's calculation

5. Concluding Remarks

This study explains the possibility of economic contagion or a decoupling between many countries by the framework of the CGE model. The methodology gave uncertainty to the (fixed) variable in a CGE model, analyzed the width and the direction of change by conducting a Monte Carlo experiment. As a result, the uncertainty of consumption demand provides change in the same direction as other countries. Therefore, if positive, the influence affects the global economy, but if it is negative, it will influence the global economy with negative outcomes. However, if uncertainty happened randomly in two or more countries, it will not necessarily become a contagion. On the other hand, the uncertainty of labor supply brings about the possibility of decoupling, although the influence to other countries is small.

The economic conditions of the present era seem to just spread negatively. Obviously, the problem will be solved if the consumption demand of China or the European Union (big economies with magnitude) is improved. Nonetheless, if not damaged, a country may become an example to follow.

All situations possible were not considered, and it will be necessary to pursue a more realistic situation of this experiment in future studies.

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