Analysis of the Macroeconomic Impact of the Tohoku-Pacific Ocean Earthquake

*Presented to the Special Ministerial Meeting
on the Countermeasures to the Earthquake Disaster*

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Cabinet Office

Macroeconomic Impact of the Tohoku-Pacific Ocean Earthquake: Analytical Framework

(1) Coverage

・ Prefectures Covered : Hokkaido, Aomori, Iwate, Miyagi, Fukushima, Ibaraki, and Chiba
・ Period Covered :　　FY2011- FY2013

(2) Impact on Stocks (Social Capital, Housing, Private Plant & Equipment) : Direct Damages

・ Estimate Damages done to Stocks in the Disaster Area
　　Buildings, Social Infrastructure (such as Roads, Harbors, Airports) etc.

(3) Impact on Flows (GDP) : Indirect Damage and Reconstruction of Stocks

A. Impact on GDP in the Disaster Area
　　⇒　Decline in Production due to Damages done to Private Plant & Equipment
B. Impact on GDP in the Non-Disaster Area
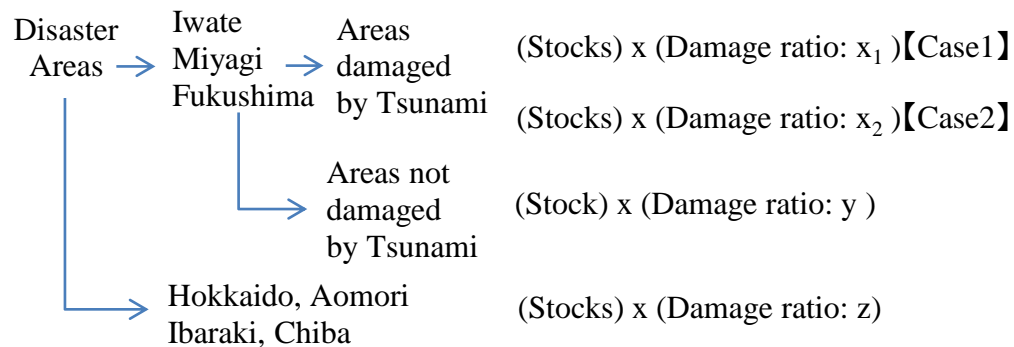　　⇒　1) via Supply-Chain Connections
　　　　2) via Constraint on Electric Power Supply
C. Reconstruction of the Damaged Stocks
　　⇒　Impact of the Reconstruction of the Damaged Stocks over a number of years

Damages done to the Stocks (Social capital, Housing, Private Plant & Equipment)
（Rough image of the magnitude obtained by making various assumptions）

Assumptions

Disaster Areas → Iwate Miyagi Fukushima → Areas damaged by Tsunami
(Stocks) x (Damage ratio: x_1)【Case1】
(Stocks) x (Damage ratio: x_2)【Case2】

Areas not damaged by Tsunami
(Stock) x (Damage ratio: y)

Hokkaido, Aomori Ibaraki, Chiba
(Stocks) x (Damage ratio: z)

Stocks
・Buildings （Housing, private plant & equipment, excluding electricity, gas and water supply, etc.)
・Electricity, gas and water supply
・Social infrastructure (roads, harbors, airports, etc.)
・Others （city parks, etc.）

Damage ratios
x_1 twice the damage ratio at the Great Hanshin-Awaji Earthquake
x_2 same damage ratio as x_1, except that for buildings which is assumed to be larger as a result of greater damage made by Tsunami
y   same as the damage ratio at the Great Hanshin-Awaji Earthquake
z   damage ratios set according to the seismic intensity
        (damage ratios x and y vary according to different categories of stocks)

(Note) Data is based on the database constructed for the "Prefectural Economic and Fiscal Model " (Cabinet Office 2009)

Estimate of damages to the stock

・Case1
Damaged stocks in disaster areas amount to around <u>16 trillionYen</u>
(Total stocks in the disaster areas are estimated to be around 175 trillion yen)

Damaged stocks in Iwate, Miyagi and Fukushima amount to around 14 trillion yen
（Total stocks in the three prefectures are estimated to be around 70 trillion yen)

・Case2
Damaged stocks in disaster areas amount to around <u>25 trillion Yen</u>
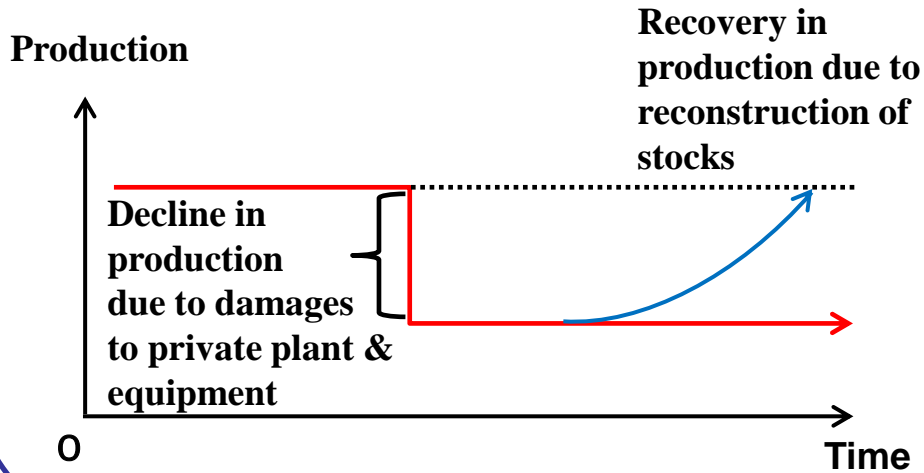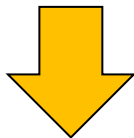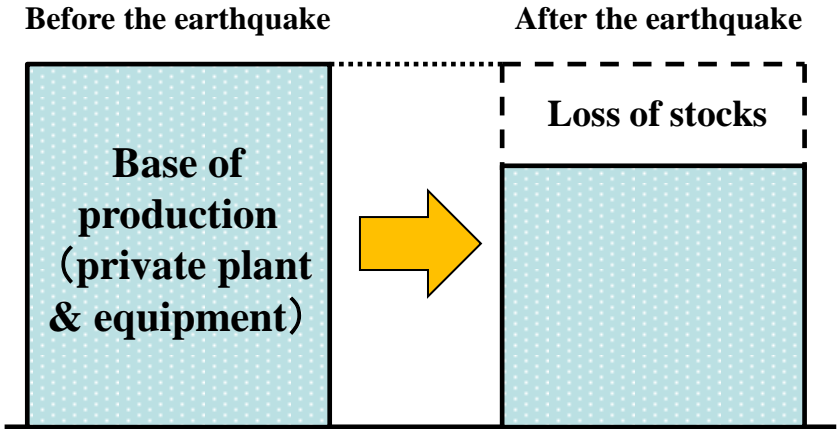(Total stocks in the disaster areas are estimated to be around 175 trillion yen)

Damaged stocks in Iwate, Miyagi and Fukushima amount to around 23 trillion yen
（Total stocks in the three prefectures are estimated to be around 70 trillion yen)

(Reference)
Damaged stock in the Great Hanshin-Awaji Earthquake
        around 9.6 trillion yen （National Land Agency's estimate)
        around 9.9 trillion yen （Hyogo prefecture's estimate)
（Total stocks in Hyogo prefecture is estimated to be around 64 trillion yen)

Impact on GDP in the Disaster Area

Decline in production due to damages done to private plant & equipment

Before the earthquake   After the earthquake

Loss of stocks

Base of production
(private plant & equipment)

Production

Recovery in production due to reconstruction of stocks

Decline in production due to damages to private plant & equipment

O   Time

Result of the Estimation

Total private plant & equipment in Japan before the earthquake — around 1,200 trillion yen

Damages to private plant & equipment by the earthquake — around 9～16 trillion yen

$\left(\text{Ratio to total private plant & equipment} \quad -\frac{3}{4} \sim -1\frac{1}{4}\% \right)$
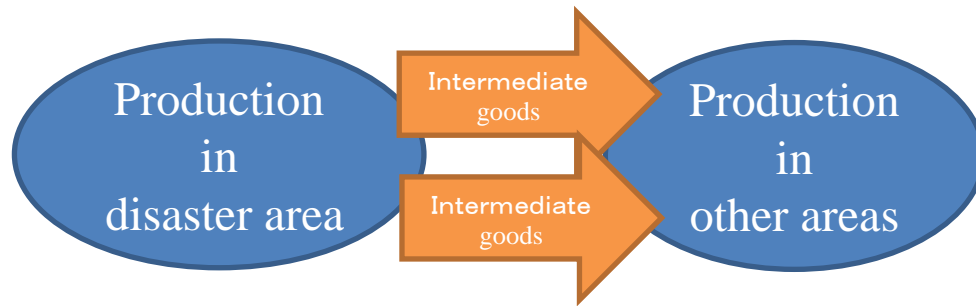
×

$\left(\dfrac{\text{Capital's share in income}}{\text{Capital-output ratio}} \right)$
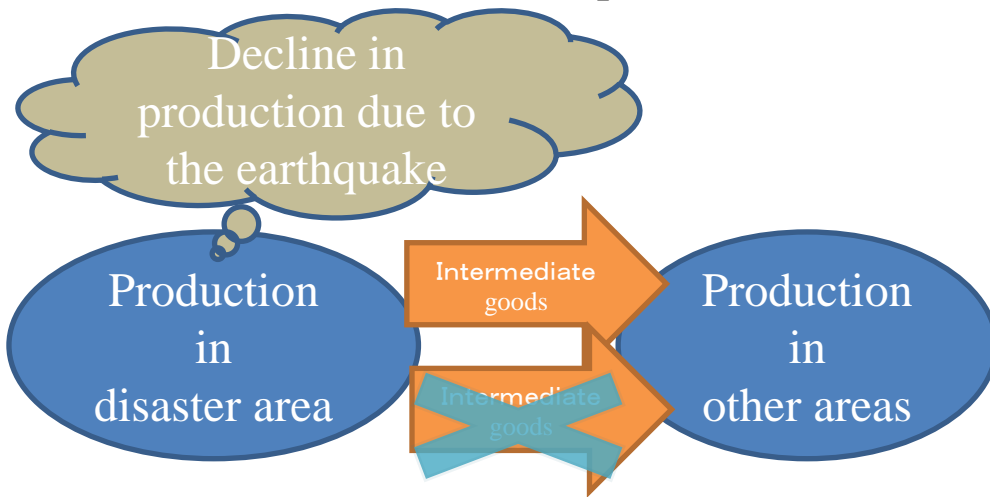
Impact on GDP (per year)
$-1\frac{1}{4} \sim -2\frac{1}{4}$ trillion yen

Impact on GDP via supply-chain connection

＜Before the earthquake＞

Production in disaster area

→ Intermediate goods →

→ Intermediate goods →

Production in other areas

＜After the earthquake＞

Decline in production due to the earthquake

Production in disaster area

→ Intermediate goods →

Intermediate goods

Production in other areas

Assumptions and the result of the estimation
・Decline in supply of intermediate goods from disaster area

Estimated from the decline in GDP in disaster area during the first half of FY2011.

⇩

・Decline in GDP in other areas due to the decline in production

Around $-\frac{1}{4}$ trillion yen during the first half of FY2011.

(Notes)
1. The estimate does not consider increase in production in other areas that would take place in order to cover decline in production in disaster area.
2. The estimate was obtained by applying the relationship between Tohoku and other areas as given in the Regional Input-Output table.

Example

A car-parts factory in Tohoku area was hit by the earthquake. It resulted in the shut-down of production in car factories in other areas.

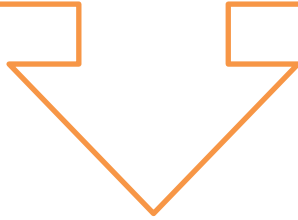# Impact on GDP via Constraint on Electric Power Supply

＜Situation so far＞

Demand and supply of electricity after the earthquake（at peak：MW）

	3/14	3/15	3/16	3/17	3/18
Estimated demand	41,000	37,000	38,000	38,000	40,000
Supply capacity	31,000	33,000	33,000	33,500	34,000

(*) Estimated demand is the prediction by the Tokyo Electric Company on the previous day.
Actual demand was less than the supply capacity due to planned power cuts and savings of electricity.

Decline in GDP by planned power cut, etc.

	FY2011		FY2012	FY2013
	First half	Second half		
	$-\alpha_1$	$-\alpha_2$	$-\beta$	$-\gamma$

It is difficult to estimate the impact in exact numbers because it is subject to significant uncertainty surrounding the reactions of the economic agents.

＜Reactions＞

<u>Enterprises</u>：adjusting operation, private generation, utilizing plants in other areas, saving electricity at offices, and working at home

Company	Reactions
Steel A	adjusting operation, considering production in alternative plants in non-disaster areas
Chemical B	supplying power to plants by private power generation
Restaurant C	saving electricity in shops, suspend late-night operations, endorsing head office staff to work at home
Transportation D	operate under special timetable, saving electricity at stations, suspending some of automatic ticket gates

<u>Household</u>：Saving electricity at homes

<u>Electric Power Company</u>：
Doing its utmost to secure the stable power supply as early as possible

Reconstruction of the damaged stocks

Framework and Assumptions

<Framework>
Investment (capital formation by both private and public sectors) will be made intensively over a number of years to reconstruct the damaged stocks. Positive impact of the investment on the economy is estimated.

<Assumptions>
The damaged stock is assumed to be reconstructed in three years. The assumption is based on the experience of the Hyogo prefecture at the time of the Great Hanshin-Awaji Earthquake where total net fixed capital formation during the three years following the earthquake amounted to more than 10 trillion yen, amount of damaged done to the stocks in the prefecture. Allocation of investment over the three years is also assumed to be the same as the case of Hyogo prefecture in the Great Hanshin-Awaji Earthquake.

Case1 Damaged stocks: around 16 trillion yen
Case2 Damaged stocks: around 25 trillion yen

It is assumed that investment equivalent to the amount of damaged stock will be made in the three years between FY2011 and FY2013.
In case of Hyogo, the peak of the investment was in the second year.

Estimates

Case1 **(Damaged stocks: around 16 trillion yen)**
FY2011: 5 trillion yen (1st half 2 trillion yen, 2nd half 3 trillion yen), FY2012: 6 trillion yen, FY2013: 5 trillion yen
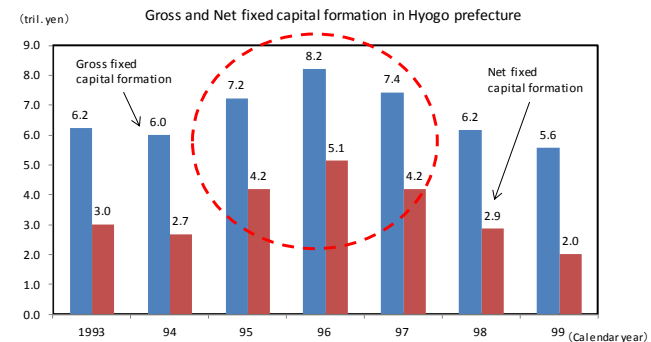
Case2 **(Damaged stocks: around 25 trillion yen)**
FY2011: 7¾ trillion yen (1st half 3 trillion yen, 2nd half 5 trillion yen), FY2012: 9½ trillion yen, FY2013: 7¾ trillion yen

※ In this estimate, it is assumed that it takes 3 years to reconstruct the damaged stocks. If it takes 5 years to reconstruct the damaged stock, an example of the annual pattern would be 1½～2½ trillion yen in the 1st half of FY2011, 2½～3¾ trillion yen in the 2nd half of FY2011, 4¾～7½ trillion yen in FY2012, and 3½～5¾ trillion yen in FY2013.

The Case of Great Hanshin-Awaji Earthquake

In Hyogo prefecture, investment was made intensively during the three years following the earthquake. As a result , total net fixed capital formation during the three years amounted to more than 10 trillion yen, which was equivalent to the amount of stock damaged by the earthquake.

Gross and Net fixed capital formation in Hyogo prefecture
(tril. yen)

	Gross fixed capital formation	Net fixed capital formation
1993	6.2	3.0
94	6.0	2.7
95	7.2	4.2
96	8.2	5.1
97	7.4	4.2
98	6.2	2.9
99	5.6	2.0

(Calendar year)

The Macroeconomic Impact of the Tohoku-Pacific Ocean Earthquake
（Image of the impact obtained on the basis of various assumptions）

This table is compiled by the Cabinet Office to obtain an image of the macroeconomic impact of the Tohoku-Pacific Ocean Earthquake on the basis of various assumptions. This table, in principle, mainly covers damages done to stocks by the earthquake and their influence on the real economy which can be analyzed quantitatively at this point in time. It is necessary to take enough margin in interpreting the figures in the table. In addition, it is necessary to take into account the limitation coming from the fact that not all of the specific circumstance that the disaster area face was able to be reflected in the table.

(Real GDP, trillion yen)

| | | FY 2011 | | | | FY 2012 | | FY 2013 | |
		First half		Second half					
Stock	**Damages to the stocks (Social capital, Housing, Private plant & equipment)**			**around 16～25 trillion yen**					
Flow	**Impact on GDP in the disaster area** Decline in production due to the damage done on private plant & equipment	$-1\frac{1}{4}$ ～ $-\frac{1}{2}$		$-1\frac{1}{4}$ ～ $-\frac{1}{2}$		$-2\frac{1}{4}$ ～ $-1\frac{1}{4}$		$-2\frac{1}{4}$ ～ $-1\frac{1}{4}$	
	Impact on GDP in the non-disaster area (1) via supply-chain connections	$-1\frac{1}{4}$ ～ $-\frac{1}{4}$ (*2)		—		—		—	
	Impact on GDP in the non-disaster area (2) via constraint on electric power supply [*3]	$-\alpha_1$		$-\alpha_2$		$-\beta$		$-\gamma$	
	Impact of Reconstruction of damaged stocks (assuming a scenario where reconstruction takes 3 years) Increase in production corresponding to the gross fixed capital formation [*4]	2 ～ 3		3 ～ 5		6 ～ $9\frac{1}{2}$		5 ～ $7\frac{3}{4}$	
	Total impact on GDP	$\frac{1}{2}-\alpha_1$ ～ $2\frac{1}{4}$		$2-\alpha_2$ ～ $4\frac{1}{4}$		$3\frac{3}{4}-\beta$ ～ $8\frac{1}{4}$		$2\frac{3}{4}-\gamma$ ～ $6\frac{1}{2}$	
	In percent of real GDP (annualized)	$\frac{1}{4}-a_1$ ～ $\frac{3}{4}$		$\frac{3}{4}-a_2$ ～ $1\frac{1}{2}$		$\frac{3}{4}-b$ ～ $1\frac{1}{2}$		$\frac{1}{2}-c$ ～ $1\frac{1}{4}$	

(*1) This table shows the difference from a baseline which corresponds to real GDP which would have realized if the Tohoku-Pacific Ocean Earthquake did not occur. When calculating the ratio to real GDP, estimated real GDP for FY2010 as shown in the government economic outlook (Cabinet Decision in January 2011) is used.

(*2) The figures are for the case where increase in production in other firms to cover the decline in production in the disaster area does not occur.

(*3) According to private-sector estimates, the impact on production by the power supply reduction for a month or until the end of April in districts where electricity is supplied by the Tokyo Electric Power Company is estimated to be around -0.2% to -0.5% at annual rate. It is necessary to take an enough margin in interpreting these estimates. It is also expected that the impact could be smaller as a result of countermeasures taken in the future.

(*4) It assumes that the damaged stocks would be reconstructed in three years. If it takes five years to reconstruct the damaged stocks, increase in production corresponding to the gross fixed capital formation would be 1½～2½ trillion yen in the first half of FY2011, 2½～3¾ trillion yen in the second half of FY2011, 4¾～7½ trillion yen in FY2012, and 3½～5¾ trillion yen in FY2013.