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Toward a Long-term Economic Damage Reduction from an Urban Disaster: Lessons from the 1995 Kobe Earthquake

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Abstract

I first present a re-estimation result of the long-term economic damage or the so-called indirect economic loss caused by the 1995 Hanshin-Awaji Earthquake (Hereafter, I call it Kobe Earthquake or Kobe EQ). I define the indirect loss as the difference between the without-disaster trend values of Gross Regional Product (GRP) and the actual GRP in the affected area. I show that the affected regional economy continued to be stagnant for a quite long period, resulting in its total values of indirect loss which exceed the officially announced direct loss values, i.e., ¥9.9 trillion. Based on this estimation, I pursue some policy implications to reduce long-term economic damage from future possible great urban disasters in Japan or elsewhere. It is my most significant finding is that, not only the destruction of supply side, but also such demand factors as housing investment and private consumption were major influential factors for the long-term stagnation. Nevertheless, the Kobe experience of its economic recovery after a more than two decades struggle shows that the industrial policy of the local government is very important for a long-term and sustainable recovery from a great urban disaster.

***Keywords**:* long-term economic damage, indirect damage, economic recovery, 1995 Kobe Earthquake, Policy implications for recover

1. Introduction

Many observers reported that Kobe and other devastated areas recovered very quickly beyond their original expectations. It is true that many buildings of both business offices and private houses as well as major public infrastructures were restored or reconstructed in the first few years. Of course, there are many cases that took more than one decade to be reconstructed, and that could not be done until now. However, reconstruction of visible buildings, public infrastructures and so on is an important but one-side aspect of the regional economic recovery. Another important aspect is a recovery of business activities and household livelihoods.

Horwich (2000) wrote a very influential paper on the recovery of Kobe EQ. He insisted that the regional economy had been recovering very swiftly mainly because the destructed physical production factors were easily substituted by importing from nearby areas (including Osaka) therefore no severe damage of supply side occurred. This is a typical view of market-oriented economists. A growing movement of the regional GRP for a first couple of years seemed to support the Horwich proposition. However, Toyoda and Kouch (1997) showed that, by a questionnaire research, that the industry damages were so large and would continue for several years, and that the damages were very differential by industry and by size of the firm. After several years of the earthquake, we could access to the objective macroeconomic data like GRP of the devastated area and Hyogo Prefecture. Toyoda (2008) estimated the indirect loss using GRP data and showed that it would be as large as the direct economic damage and continue to arise for more than 10 years. These studies are concerned with the production and supply side of the impact of Kobe EQ on the affected regional economy. Later, Okuyama (2014) analyzed how industrial structures changed after Kobe EQ using I-O tables of Kobe City and found that the most significant factor of the changes in interindustry relations were caused by the regional final demand. Okuyama (2016), using an autoregressive-distributed lag model, analyzed the long-run effect of Kobe EQ on GRP by measuring the total impact as deviations from the assumed long-run growth path of the

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Kobe economy and found that a significant negative long-run effect occurred. Okuyama (2016) also pointed out that some factors like adoption of new technology and movement of population would influence significantly on GRP but a further analysis would be required to identify their positive and negative effects. Okuyama (2014, 2016) referred to the importance of demand-side effects but his analyses were basically from the supply side of the regional economy.

PCIROJ (1998) analysed by questionnaire data how victims managed their expenditures for the first two years after the disaster. Sawada and Shimizutani (2008) and Sawada (2013) analyzed by questionnaire data how victims change their consumption behaviors by losing assets (particularly housing). Besides these microeconomic approaches to the demand side of the economic impact of Kobe EQ, Toyoda (2016) showed that the macroeconomic demand factors are most important causes of the prolonged stagnation of the affected regional economy.

In the following, I first present my estimation result of the economic impact of Kobe EQ in terms of indirect loss. In Section 2, I will show that not only supply chain but also demand chain are important for macroeconomic recovery of an affected region. In Section 3, some policy implications for recovery from a long-term economic damage with special reference to the experiences of Kobe will be presented.

2. Estimation of Indirect Economic Loss

A. Direct and Indirect Economic Losses

Let us make clear the difference between direct and indirect economic losses of disasters. I define direct economic loss as the sum of economic values of lost physical assets occurred immediately after a disaster. Indirect economic loss, on the other hand, is defined as the sum of lost amounts of value added in an affected area for a certain period. Economic impacts are usually evaluated only by the former direct economic loss.

Table 1 in Appendix shows the officially announced direct damages of the recent two great disasters in Japan, i.e., 1995 Kobe EQ and 2011 East Japan EQ and Tsunami. To understand the economic feature of an urban disaster, I also show the direct damage amounts per unit area of the 1995 and 2011 incidents in the 3rd and 5th columns in the table, respectively. Kobe EQ occurred in the urban region which is comparatively narrow but very dense with population and industry, while East Japan EQ and Tsunami occurred in the very broad region which consists of both urban and rural areas. As can been seen by the table, the total amounts of direct damage of the 2011 disaster is almost twice larger than the 1995 disaster. However, as far as the amounts per unit area concerned, the 1955 disaster is far greater than the 2011 disaster. For example, the amounts of damage of total stocks and social infrastructures of the 1995 disaster are approximately 5 times and 7 times larger than the 2011 disaster, respectively. This neglected aspect of an urban disaster causes several economic problems, which will be discussed below.

B. Movements of Gross Regional Product

There are several ways to measure indirect economic damage of a disaster. In this report, I define the indirect damage as the accumulated values of annual differences between the possibly attained GRP without disaster and the observed GRP with disaster for a certain period. Therefore, it is a very important and sensitive issue how to estimate the possibly attained values of GRP for each year assuming there were no earthquakes.

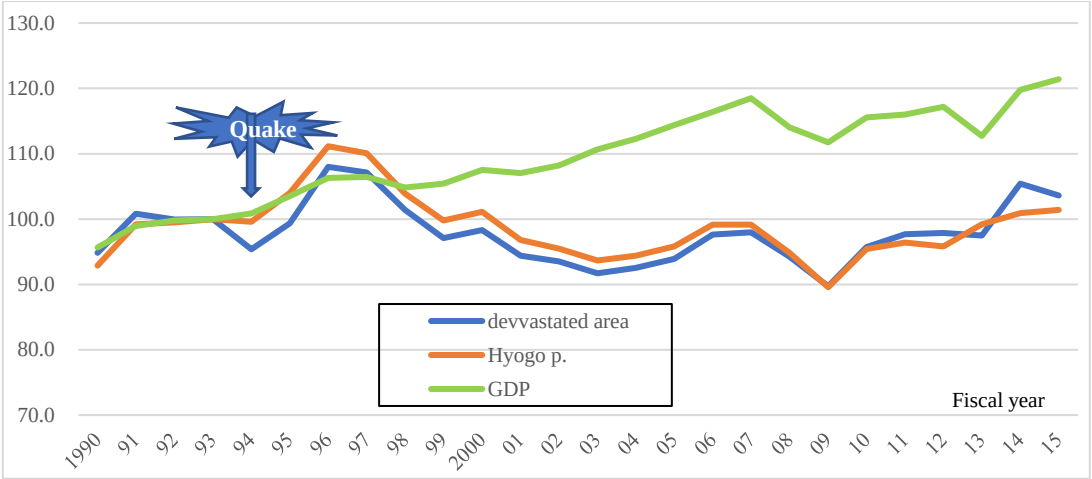


Figure1: GDP and GRP, standardized at 1993 = 100

Figure 1 shows the movements of the regional GRP of the disaster affected areas along with the Japan's Gross Domestic Product (GDP) for the period of 1990 – 2014. In the figure, the movement of GDP is shown in green, the one of Hyogo Prefecture in orange and the one of the devastated area (i.e., Kobe City and other 19 municipalities which were designated as the severely damaged area by the government) in blue. All three indicators are standardized as 100.0 at the fiscal year 1993. We can observe that, first, the regional economy had a tendency of a slower growth compared to the country's GDP even before the earthquake, but the gap became significantly larger after the incident for more than one decade, and secondly, the GRP of Hyogo Prefecture and the one of the devastated area moved very parallel at least until 2007.

C. Estimated Indirect Loss

In the following, we use the data for GRP of Hyogo Prefecture to estimate the indirect damage. To capture the above-mentioned trend of slower growth of the regional economy than the country, we use the data for 1985-1993. We also take the effect of nation-wide business activities on the regional economy into consideration to estimate the base line of the regional GRP without disaster. Namely, our intended equation is

$$HGRP = F(① trend,\ ② country's\ economic\ condition) \quad (1)$$

where *HGRP* denotes Hyogo Prefecture's GRP. It is well known that many macroeconomic time-series data have strong nonstationary natures. If we apply a regression analysis directly to equation (1), we may get a spurious result. I conducted a preliminary test to check the nonstationarity of *HGRP*. After estimating a regression equation with a trend for nonstationarity, I got the Dicky-Fuller statistic as 0.64, which is smaller than the 5 % critical value (i.e., 3.5). This means that *HGRP* has a unit root. Therefore, I use the one-year difference of *HGRP* (expressed as $\triangle HGRP$) as the dependent variable to escape from getting a spurious regression. For the proxy of the nation-wide economic condition, I use the growth rate of GDP (expressed as *GGDP*).

My final estimation result is

$$\triangle HGRP = -1970.90 + 212.41\ GGDP + 189.03\ T \quad (2)$$

(-22.83) (4.02) (3.43)

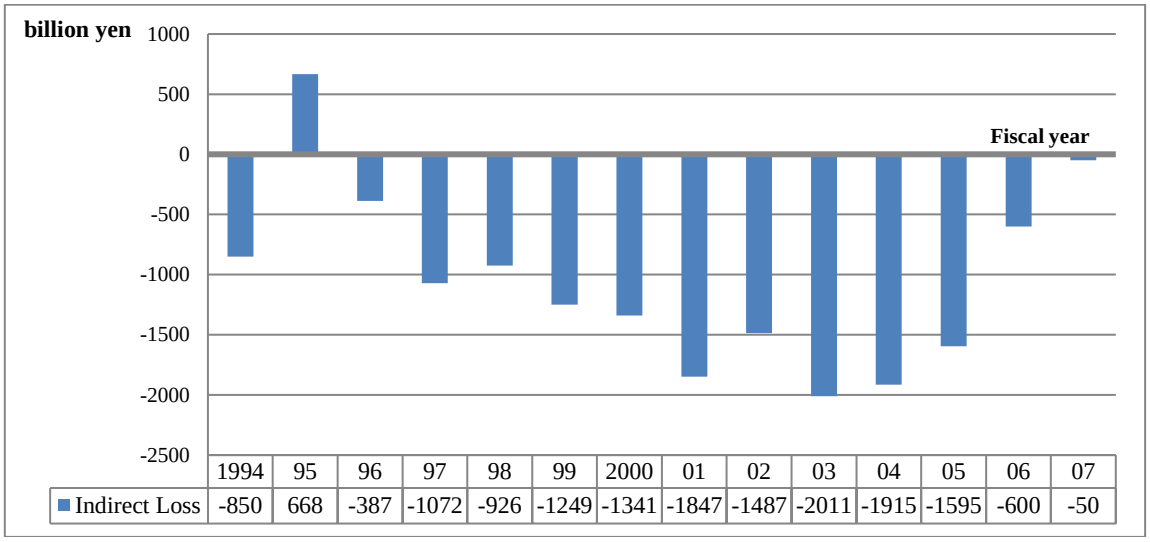
R^2 (adjusted) = 0.67, DW = 1.79

where *T* denotes the time trend, and DW is Durbin-Watson statistic. The values in parentheses show t-statistics. From equation (2), the predicted values of the level of *HGDP* is derived as follows.

$$HGRP^* = HGRP(-1) - 1970.90 + 212.41\,GGDP + 189.03\,T \quad (3)$$

Then, substituting the actual values of the explanatory variables in equation (3) for the year 1994 and afterwards, I get the predicted values of *HGRP**. This is an estimated base-line series of *HGRP* without disaster. Finally, I define the indirect damage as the difference between *HGRP** and *HGRP*, namely,

$$DAMAGE = HGRP^* - HGRP \quad (4)$$



	1994	95	96	97	98	99	2000	01	02	03	04	05	06	07
Indirect Loss	-850	668	-387	-1072	-926	-1249	-1341	-1847	-1487	-2011	-1915	-1595	-600	-50

Figure 2. Estimated Indirect Damages

Figure 2 shows the estimated values of *DAMAGE* of each year. It is seen that the indirect damage occurred every year (except 1995) for almost 13 years by 2007. The accumulated total losses minus gains revealed to be about 14.7 trillion yen, which exceeds the officially announced direct damage amounts (i.e., 9.9 trillion yen).

3. Causes of Long-term Economic Stagnation

A. Supply Side

1) Industrial Structure

Since the 1980s', the industrial structure in the disaster affected area, particularly in Kobe, had been gradually changing from manufacturing-oriented to service-oriented structure. Among GDP in Hyogo Prefecture, the shares of manufacturing and services were respectively about 30% and 18 % in 1990, but the order of the shares has now reversed; they are about 23% and 27%, respectively, in 2008. The great disaster occurred in the process towards a services-oriented economy. Some big establishments in the manufacturing sector were severely damaged and moved out to unaffected areas in Hyogo or other prefectures. The retail/wholesale sector was also severely damaged: about 10 thousand retail stores in Kobe and about 5 thousand stores in other affected areas were forced to close and could not reopen. The total number of business establishments in Hyogo Prefecture was about 270,000 before the earthquake, but decreased sharply after 1995 for several years and gradually after 2004; it is now some 200,000.

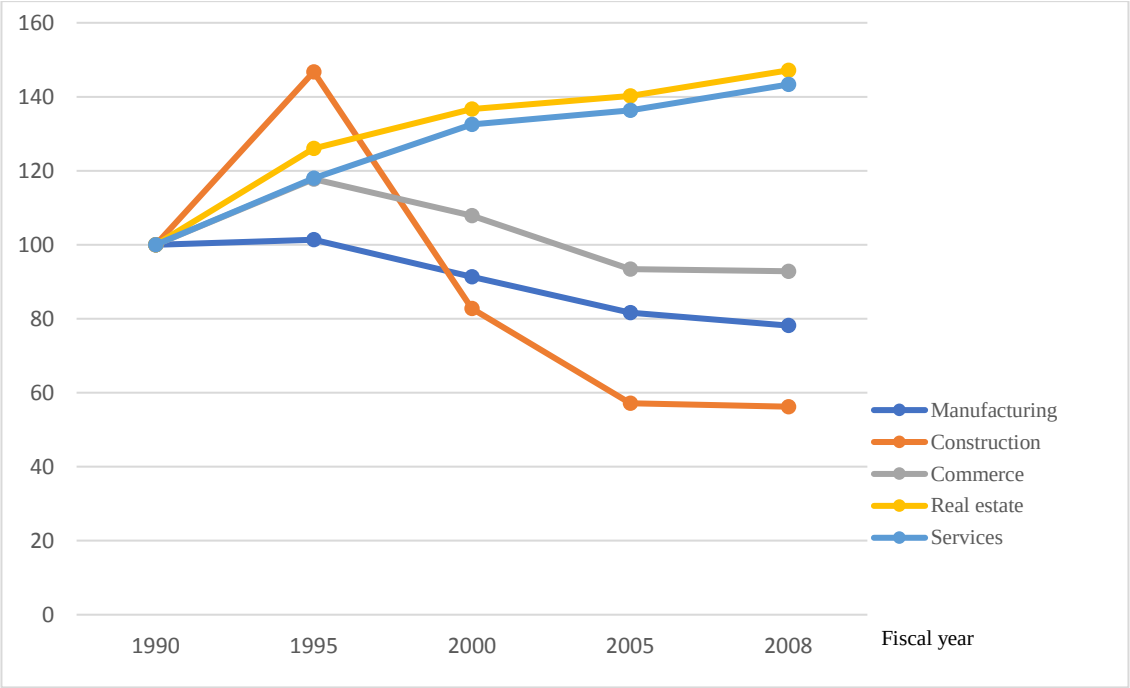


Figure 3. Structural Change in Industry in Hyogo Prefecture, 1990=100
(Source: the author made the figure based on Economic Statistics of Hyogo Prefecture)

Figure 3 shows the changing patterns of industrial structure in Hyogo Prefecture. As can been seen in the figure, not only the numbers of establishments but also amounts of value added in both the manufacturing and commerce sectors declined sharply for several years after the incident. The service industry grew at a moderate rate which was lower than the national average, but in recent years, particularly after 2010, it has been rapidly growing. The role of the service industry will be mentioned in the next section.

2) Supply Chain Problem

The supply chains have not been paid much attention in the case of Kobe EQ compared to such later disasters as 2007 Chuetsu-oki Earthquake and 2011 East Japan Disaster. There existed no big assembly or part factories related to car industry. However, some supply chain problems arose in the following very peculiar ways. First, some big factories of steel, rubber, food and pharmacy industries moved out to other areas. These establishments were parent companies with comparatively enough capital and managed to reopen production facilities at new sites. However, quite a few small and medium sized subsidiaries or affiliates could neither move out from the affected areas nor reopen their devastated factories. Many of them existed in Nagata and Hyogo Wards. The direction of supply chain break was opposite from the usual case: I call this “reverse supply chain”. Second, the facilities of Kobe Port were severely damaged, which caused another kind of negative impacts on the inter-industry relations. Some port-affiliated businesses were once severely damaged, but they have been gradually recovering as the amounts of cargo transactions at Kobe Port resumed to the pre-disaster level. Third, the chemical shoes industry, which was one of the traditional local industries in Kobe, was severely damaged because it constituted a special closed supply chain in the devastated Nagata Ward. All establishments which had been linked through part and final products of shoes were all together collapsed. This industry is still on the way to recovery. These special features of supply chains were some important causes of the long-term stagnation in the affected area.

3) Population and Employment

The movements of population in Kobe was very dramatic: it was about 1.5 million at the incident but about 100 thousand people moved out from the city (Actual numbers of movers would be far greater than this figure since many victims moved from one place to another inside the city). The number of population in Kobe resumed to its pre-disaster level after a decade but the rates of population recovery are different by wards. Population is related to production factors, i.e., labor force. However, there were

very high demand-supply mismatches of workers and the prolonged bad employment situation continued in the affected area. Figure 4 shows that the employment situation in the affected area was significantly weak compared to the national average, and even to Hyogo Prefecture. The movement of number of employees is related to the above-mentioned supply chain problems as well as the changing industrial structure.

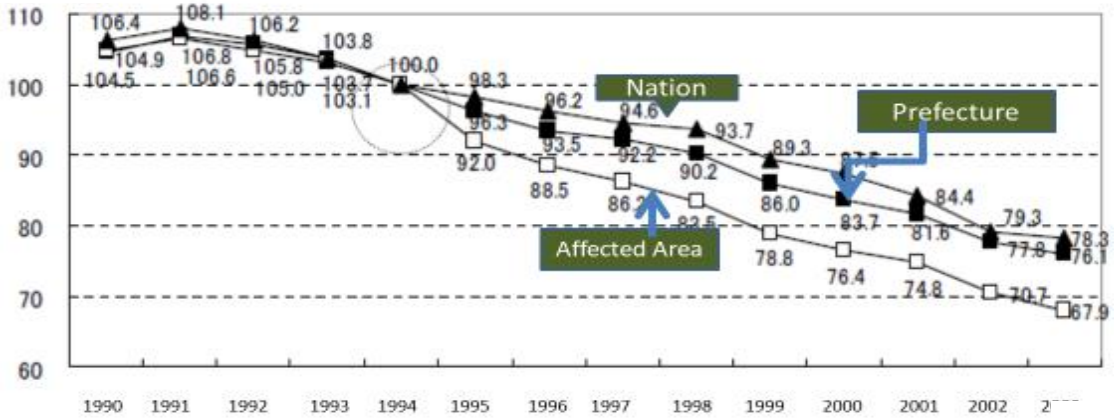


Figure 4. Number of Employees, 1994=100
(Source: Industrial Statistics, METI)

B. Demand Side

1) Macroeconomic Demand Chain

As mentioned in Introduction, there exist some empirical microeconomic analyses, e.g., PCIROJ (1998), Sawada and Shimizutani (2008), and Sawada (2008), on how severely affected households managed expenditures under constrains of income and various financial assets. However, it was not clearly pointed out until Toyoda (2016) that the most important factor of the long-term stagnation in the affected area was macroeconomic demand chain. We can observe the behaviors of the main macroeconomic factors of GRP in the affected area, i.e., in Hyogo Prefecture, in Figure 5. Most significant movements are private and public housing investment; immediately after the incident, house owners started to reconstruct their own private houses

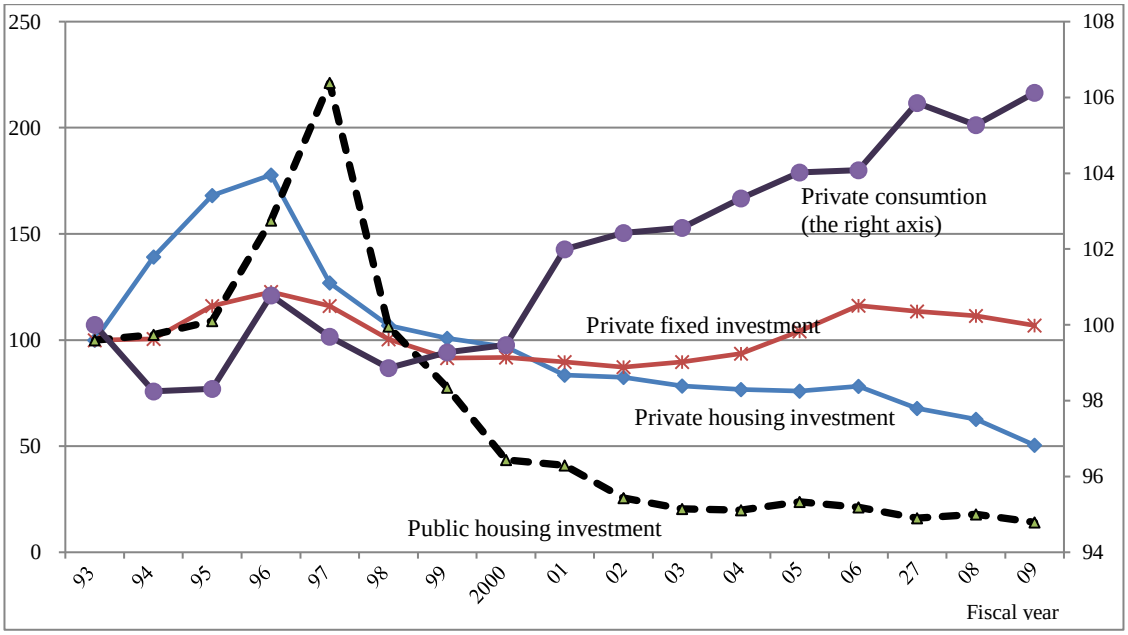


Figure 5. Movements of Main Factors of GRP in Hyogo Prefecture, 1993=100
(Note: Private consumption is measured on the right axis)
(Source: The author drew the figure based on Economic Statistics of Hyogo Prefecture)

as shown in blue line and this movement of private housing construction continued for about 5 years. After one year of the incident, various public housing projects began, and the public construction investment reached its peak in 1997. At the time of Kobe EQ, there was no system of supporting victims whose houses were completely or half damaged. Therefore, many victims were forced to reconstruct own houses by themselves. Although this upward trend in the first three or four years superficially seems to be a positive factor to push up the regional GRP, but, in realty, it worked negatively behind the consumption behavior. As the preceding microeconomic research showed in detail, severely affected households, particularly whose houses were totally collapsed or severely damaged, had to find funds for housing reconstruction by withdrawing their savings, making loans at discounted interest rates, truncating expenditures, etc. The macroeconomic private consumption, which is measured on the right axis and shown in purple line in Figure 5, decreased or very stagnant in the first 7 years after the disaster. This is a very abnormal phenomenon in usual macroeconomic experiences: private consumption is the most dominant factor in GDP or GRP, whose share usually occupies 50 to 70 percent, and steadily but not drastically grows. In the second and third years, it increased because the severely affected households had to buy new furniture and other domestic materials for newly built houses.

Decrease in disposable income arose not only to house-losers but also to job-losers. The decrease in the number of employees in the affected area as shown in Figure 4 also a factor of the decrease in aggregate disposable income. By various reasons, the disposable income decreased, which causes decrease in consumption. Then, macroeconomic situation became stagnant because private consumption is the major composing factor of GRP in the affected area.

Gunji et al. (2015) also presented an important implication of macroeconomic decline of consumption in the affected area by East Japan Disaster based on the so-called "permanent income hypothesis" and insisted that the decline is not only transitory but permanent.

2) Population and Consumption

The movement of population also affected on aggregate consumption in the affected area. The decrease in population for about a decade might give stronger impact on the demand side through decrease in consumption than on the supply side. But, I need more detail analysis to prove it.

3) Reconstruction Demand

Another important factor which caused the fluctuation of the indirect loss pattern was public investment expenditure, particularly housing investment. The central government made about 5or 6 trillion-yen expenditure mainly for restoration of social public facilities and partly for assisting public housing construction. However, the local governments in the affected areas also had to finance for building public housing. The public housing investment reached its peak in the third year (i.e., in 1997), then sharply declined and continued to be at a low level after 2003. The behavior of the indirect loss was significantly influenced by the housing investment, upward first and downward later.

4. Some Policy Implications

In this section, I will consider some implications and lessons from the prolonged economic stagnation in the affected area and from the policies for economic recovery taken by the local and central governments.

Figure 6 shows the real amounts of two major components, i.e., private consumption and housing investment, of GRP in Hyogo Prefecture for 1993-2009. We can easily find that the behavior of the estimated indirect loss in Figure 2 resembles the behavior of the sum of private consumption and housing investment.

First, it is clear to decrease the indirect loss that consumption should be kept stable or upward. As mentioned above, disposable income of severely affected victims decreased to cause stagnant consumption. Therefore. Some policy to prevent sharp decline of disposable income of severely affected victims is necessary. After Kobe EQ, this direction of policy improvement has been proceeded somehow through some kinds of income transfers to victims, e.g., enacting the Act on Support for Reconstructing Livelihoods of Disaster Victims. However, Japan's recovery budget, in principle, puts a heavier weight on the restoration of social public facilities and less weight on victims' livelihood recovery. We should

recognize that the national recovery management system, including disaster laws and recovery budget, is directly and indirectly related to the prolonged macroeconomic stagnation of the affected area.

Second, I would like to propose a scheme of smoothing allocation of recovery budgets over time. Although the blue part in Figure 6 includes private investment in addition to public investment, the figure gives us some important hints how to allocate public funds purposely to escape such a long-term stagnation as the case of Kobe EQ. In Japan, most recovery budgets are used for restoration of social public facilities in the so-called "recovery concentration period", say for two years or five years according to degrees of direct damage. If budget allocation is done from the long-term viewpoint of recovery, it will contribute to sustain the economic situation in an affected area through providing various job opportunities and more aggregate disposal income, and eventually shorten the period of stagnation which otherwise may arise. Of course, many basic infrastructures and social public facilities are necessary to be recovered as early as possible, but some big projects, which are adopted particularly for civil engineering measures for BBB, may be started some years later purposely. For instance, the airport construction in the case of Kobe EQ and the great seawalls in the case of East Japan Disaster might be started several years later. To realize this proposed system, we need to reform the current conventional budgetary and legal systems for disaster management.

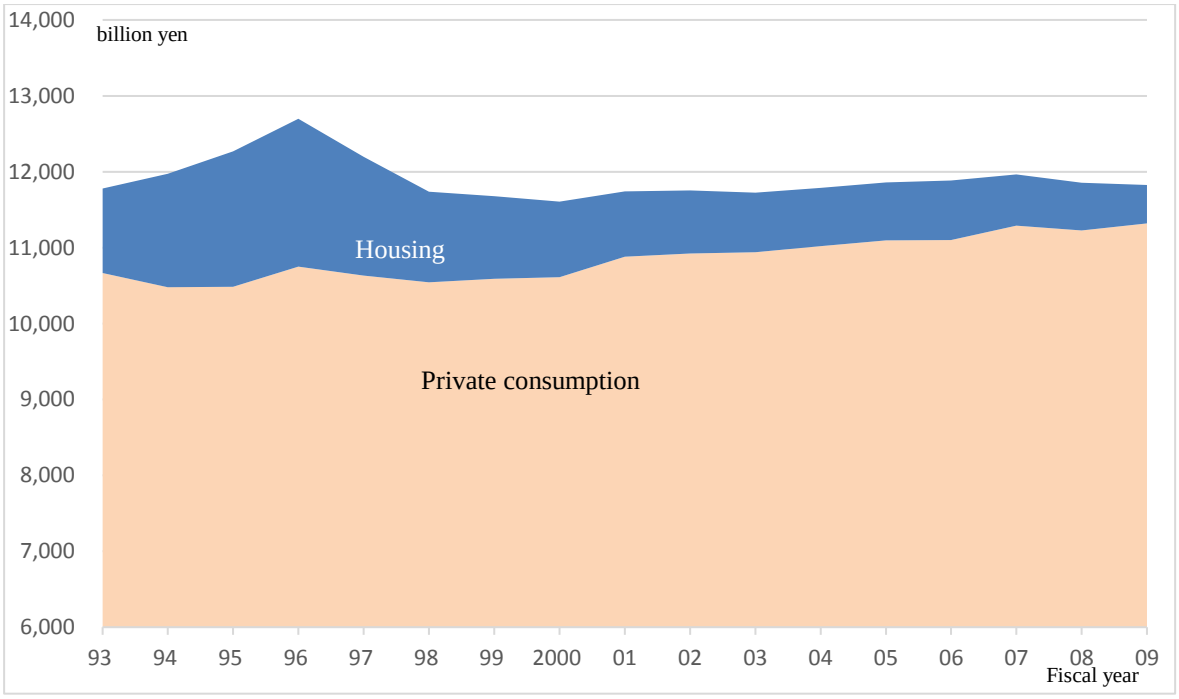


Figure 6. Major Demand Components of GRP in Hyogo Prefecture

Third and lastly, I would like to acknowledge the recent economy of Kobe has been growing quite steadily. It lost some major manufacturing establishments which contributed greatly to the local GRP, but it has been on the firm process from a manufacturing-oriented economy to a service-oriented economy. This process had been pursued by the city even before the disaster. The city had made public the city's goal toward an "urban resort city" in 1994. After the sudden incident, it searched various directions of both economic recovery and development through some new devices, like "enterprise zone" (a special kind of special economic zones). Some new plans for recovery including the special zone were rejected by the central government, but the local governments (both Hyogo Prefecture and Kobe City) continued to try to improve and develop the local economy. After many efforts of the local governments and people concerned, some good direction towards a special kind of service-oriented economy revealed after around 2005. The super computer "K" along with some scientific organizations are settled in Kobe Port Island. The "Kobe Biomedical Innovation Cluster" is a successful example,

which made a corner stone towards a direction of new ear of service-oriented city. The traditional service-oriented industries like tourism and commerce are also making progress.

There were some recovery projects which failed or were stopped on the way. For example, "Shanghai Yangtze River - Kobe exchange project", a trade and business promoting project between cities along the Shanghai Yangtze Valley and Kobe by using a specially built ship existed only for two years, 1997-1999. This project was begun by an outside advisor. This example gives an important lesson that a good and sustainable recovery plan from disasters should be considered and created mainly by local people and administration endogenously not mainly by the central government or outsiders exogenously or compulsorily.

5. Conclusions

After presenting an estimated result of indirect loss caused by Kobe EQ, I showed that the affected regional economy continued to be stagnant for about 13 years, resulting in its total values of indirect loss which exceed the officially announced direct loss values. To inquire into some causes of the long-term stagnation, I examined the movements of components of GRP of Hyogo prefecture from both supply and demand sides. For the supply side, I pointed out some features of area-specific supply chain problems, which were important causes of the stagnation. It is my most significant finding is that, not only the destruction of supply side, but also such demand factors as private consumption and housing investment were major influential factors for the long-term stagnation.

Based on the analysis, I proposed two policy implications. First, keeping private consumption stable or upward by some policy instruments is very important to prevent such a long-term macroeconomic stagnation as the case of Kobe EQ. Second, I proposed a scheme of smoothing allocation of recovery budgets over time to decrease possible indirect loss. Of course, these proposals are institutional issues and not easy to be accomplished. But the first proposal has already been embodied to some degree after Kobe EQ; for instance, a legal measure to support victims' livelihood reconstruction was enacted.

Finally, retrospecting some economic policies taken by Kobe City, I highly evaluated some advanced service-oriented recovery process, which were promoted endogenously by the local government and people concerned. However, I also low evaluated a terminated policy, which was inspired exogenously by an outside advisor. A good and sustainable recovery policy can be attained by local people and administration themselves not by outsiders.

Appendix

Table 1. Direct Economic Damages of 1955 Kobe EQ and 2011 East Japan EQ and Tsunami (billion yen)

	1955 Kobe EQ		2011 East Japan EQ & Tsunami	
	total amounts	amounts per unit area	total amounts	amounts per unit area
Direct stock damage	9,600	1,143	16,900	230
a) Buildings & housing	6,300	750	10,400	185
b) Lifeline facilities	600	71	1,300	23
c) Social infrastructure facilities	2,200	262	2,200	39
d) Others	500	60	1,100	20

(**Note**: Hyogo Prefecture is considered as the area of 1995 disaster, while Iwate, Miyagi and Fukushima Prefectures are considered of the area of 2011 disaster. Since the actual devastated area for the 1995 incident is narrower than Hyogo Prefecture and the one for the 2011 incident is broader than the referred three prefectures, the actual amounts per unit area for the 1995 disaster would be larger than the ones for the 2011 disaster).

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