Does the Rare Natural Disaster Necessarily Harm the Society?

Masafumi MORISUGI[1], Kazunori NAKAJIMA[2]
and Naoki SAKAMOTO[3]

[1]Professor, Faculty of Urban Science, Meijo University
(4-3-3 Nijigaoka, Kani, Gifu 509-0261, Japan)
E-mail: morisugi@meijo-u.ac.jp
[2]Associate Professor, School of Human Science and Environment, University of Hyogo
(1-1-12 Shinzaike-honcho, Himeji, Hyogo 670-0092, Japan)
E-mail: nakajima@shse.u-hyogo.ac.jp
[3]Associate Professor, Faculty of Literature and Social Sciences, Yamagata University
(1-4-12 Kojirakawa-machi, Yamagata, Yamagata 990-8560, Japan)
E-mail: nsakamoto@human.kj.yamagata-u.ac.jp

Abstract

Does such a natural disaster that is extremely large and rare like the Great East Japan Earthquake in 2011 always and necessarily harm the economy? This is our primitive question.

With respect to Miyagi Prefecture in Japan, though it is the nearest place to the seismic center of the East Pacific Offing Earthquake, but it has enjoyed so much high real economic growth rate in recent years as 11.6% in 2012, 4% in 2013, and 0% in 2014 (for reference, consumption tax rate was raised in 8% from 5% in Japan in 2014). Meanwhile, the annual real gross regional product of Miyagi Pref. exceeded 9 trillion yen (strangely, this value almost accords to the estimated total Miyagi's facilities damage due to the earthquake) that they had never experienced for these ten years or more at least. These tendencies are approximately similar about neighboring Iwate Pref. where the damage of the tsunami was much heavy.

In the old days, Joseph Schumpeter (1934) proposed the concept of "Creative Destruction" as "process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one". Such a notion has been used to construct the so-called endogenous growth model of R&D type or technological progress as Romer (1990) or Aghion and Howitt (1992). As described in Chapter 7 of Barro & Sala-i-Martin (2004), when a product or technique is improved, the new good or method tends to displace the old ones.

Then, is it possible to think in this way? The process of destruction itself may be one of the crucial points to invite great and new success of economic growth. Of course, the recent economic outcomes of Miyagi Pref. are heavily dependent on government funding and investment for restoration. Besides, special procurement boom after the earthquake must have pushed up a rate of operation of several regional capital and labor, and also gross products and incomes. Even if we recognized these things, one still cannot judge whether the nowadays' remaining high of the gross products is transient symptom or not.

Therefore, in this study, we try to extract some points those are more advantageous after the rare disaster than ever in economic meaning. Besides, such situations that the rare disaster has positive economic impacts on the society can be expressed in a relatively easy way with the representative Neo-Classical growth model referring to Ramsey (1928), Cass (1965), and Koopmans (1965). Operating appropriately several parameters in this model, we will explain clearly the mechanism to show an equilateral economic effect induced by the subject disaster.

Let assumes that the society is a closed and one country economy. And, it is also supposed that the economy located on the steady-state equilibrium (or the balanced growth path) at the first stage. At one point in time, the rare disaster occurs and eliminates the amount of capital in the society instantaneously. This is the most primitive effect that the rare disaster may have impacts on the society. Contrary to what one might think, even in such a simple framework without any ingenuity, one can find an economic advantageous point of the society after rare disaster compared with the before. With the analytical instrument, the following theoretical knowledge can be derived by a few calculations as comparative statistics or solving differential equations with functional specification and linear approximation.

(1) The economy grows faster than ever in a transition to the new steady-state equilibrium.

Without any additional assumptions, one can derive such a result from the original Ramsey model and the typical phase diagram. The economy might be scarce of capital immediately after the rare disaster in the meaning of the Neo-classical production function settings. Therefore, interest rate and the efficiency of investment are quite high, then economic growth has proceeded. It shows rather consistency with the empirical facts of Miyagi and Iwate Pref. mentioned above.

Next, we consider another situation that may happen to this society after the rare disaster. In a typical case, the residents in the society has come to make prediction of higher frequency to occur such a disaster than ever. In a framework of Neo-classical growth model, such a situation can be described as increase of capital depreciation rate (or expectation of it) and of utility discount rate. Then, such a theoretical guess as below can be derived with some calculations in a manner of comparative statistics.

(2) The economy makes up the transition to the new steady-state equilibrium faster than a prediction.

In this case, the steady-state equilibrium has sift after the rare disaster. Consumption and capital equipment (and also gross product) per capita effective labor on the new steady-state equilibrium would be smaller than the ones on the old steady-state equilibrium. Therefore, the new equilibrium locates nearer the economy point of immediately after the rare disaster than the one of old equilibrium, so convergence speed to the new steady-state may be faster than it was thought. The inhabitants may realize that their society was recovered so early.

Strictly speaking, it is impossible to make an exact diagnosis whether the current status of Miyagi or Iwate Pref. is under such a circumstance or not from only few statistics at our hand. Nevertheless, from the empirical fact that these prefectures have enjoyed the gross products more than ever for these years, it is thought that the theoretical guess mentioned above does not have much validity.

Third, this situation is right the main point of this article.

(3) Products, consumption, and capital equipment of the economy after the rare disaster are higher than ever.

Here, we make an assertion that such a situation can be caused by the power of "Creative Destruction". As spoke in the beginning, original meaning of "Creative Destruction" is that the new and superior products and technologies displace the old inferior ones, then the latter is forced to the withdrawal from the market. However, if such a superior good or technology already exists in the society, the phenomenon of "Creative Destruction" does not occur immediately by all means. Because, there is a plenty of barriers to entry in reality. Therefore, what we point out here is that the destruction induced by the large-scale disaster may be one of the opportunity to introduce such superior technologies to the market. For an example, land-use pattern in urban zone might be reset due to a large earthquake. Then the planner could implement more intensive and efficient zoning, therefore the society realized more refined production and distribution manner.

In our model, it means increasing of parameter of Neo-classical production function. Logical consequence here is just reverse one to the case of (2). It also shows rather consistency with the empirical facts of Miyagi and Iwate Pref. mentioned above. On the other hand, consumption and capital equipment per capita effective labor on the new steady-state equilibrium would be larger than ever, therefore the new equilibrium locates far from the economy point of immediately after the rare disaster. It means that one can enjoy high growth rate for a long period of a transition to the new equilibrium and also that the steady-state growth rate of new equilibrium is larger than ever.

Finally, the reason to cause such a situation explained as below is almost the same as the case of (3), so to speak, another interpretation of "Creative Destruction".

(4) The economy of the new equilibrium grows faster than the one of old equilibrium.

In a context of endogenous growth model framework, technological progress rate is also endogenous variable. For an instance, several disaster prevention goods have been selling like wildfire after the year of 2011 in Japan. In addition to that, for houses, furniture, and vehicles related, much of technological development enhancing the safety when the disaster occurs have been seen in nowadays. It can be said as "something good coming from something bad".

With our model, we can derive such results. Consumption and capital equipment (and also gross product) per capita effective labor on the new steady-state equilibrium would be smaller than the ones on the old steady-state equilibrium. But, "effective labor" means the technological coefficient in Hicks neutral manner multiplies labor population. Therefore, one should be cautious and recognize the result here is different with the case of (2). The scale of economy becomes evidently larger compared with the one of before disaster. Nevertheless, the economy may make up the transition to the new steady-state equilibrium faster than a prediction as the case of (2).

Which one has been occurred in the real world? Currently we don't have any correct answer to

the question. But, understanding in such a theoretical manner must be much useful to ascertain the situation where we are in. In this paper, we conduct more kinds of theoretical experiments, and finally lighting it up with substantial facts of the past rare disasters, robustness of the theory is examined.

1. Main text

Here introduce the paper, and put a nomenclature if necessary, in a box with the same font size as the rest of the paper. The paragraphs continue from here and are only separated by headings, subheadings, images and formulae. The section headings are arranged by numbers, bold and 10 pt. Here follows further instructions for authors.

Nomenclature	
A	radius of
B	position of
C	further nomenclature continues down the page inside the text box

1.1. Structure

Files must be in MS Word only and should be formatted for direct printing, using the CRC MS Word provided. Figures and tables should be embedded and not supplied separately.

Please make sure that you use as much as possible normal fonts in your documents. Special fonts, such as fonts used in the Far East (Japanese, Chinese, Korean, etc.) may cause problems during processing. To avoid unnecessary errors you are strongly advised to use the 'spellchecker' function of MS Word. Follow this order when typing manuscripts: Title, Authors, Affiliations, Abstract, Keywords, Main text (including figures and tables), Acknowledgements, References, Appendix. Collate acknowledgements in a separate section at the end of the article and do not include them on the title page, as a footnote to the title or otherwise.

Bulleted lists may be included and should look like this:

- First point
- Second point
- And so on

Ensure that you return to the 'Els-body-text' style, the style that you will mainly be using for large blocks of text, when you have completed your bulleted list.

Please do not alter the formatting and style layouts which have been set up in this template document. As indicated in the template, papers should be prepared in single column format suitable for direct printing onto paper with trim size 192 x 262 mm. Do not number pages on the front, as page numbers will be added separately for the preprints and the Proceedings. Leave a line clear between paragraphs. All the required style templates are provided in the file "MS Word Template" with the appropriate name supplied, e.g. choose 1. Els1st-order-head for your first order heading text, els-abstract-text for the abstract text etc.

1.2. Tables

All tables should be numbered with Arabic numerals. Every table should have a caption. Headings should be placed above tables, left justified. Only horizontal lines should be used within a table, to distinguish the column headings from the body of the table, and immediately above and below the table. Tables must be embedded into the text and not supplied separately. Below is an example which the authors may find useful.

Table 1. An example of a table.

An example of a column heading	Column A (t)	Column B (t)
And an entry	1	2

And another entry	3	4
And another entry	5	6

1.3. Construction of references

References must be listed at the end of the paper. Do not begin them on a new page unless this is absolutely necessary. Authors should ensure that every reference in the text appears in the list of references and vice versa. Indicate references by Clark et al. (1962) or Deal and Grove (2009) or Fachinger (2006) in the text.

Some examples of how your references should be listed are given at the end of this template in the 'References' section, which will allow you to assemble your reference list according to the correct format and font size.

1.4. Section headings

Section headings should be left justified, bold, with the first letter capitalized and numbered consecutively, starting with the Introduction. Sub-section headings should be in capital and lower-case italic letters, numbered 1.1, 1.2, etc, and left justified, with second and subsequent lines indented. All headings should have a minimum of three text lines after them before a page or column break. Ensure the text area is not blank except for the last page.

1.5. General guidelines for the preparation of your text

Avoid hyphenation at the end of a line. Symbols denoting vectors and matrices should be indicated in bold type. Scalar variable names should normally be expressed using italics. Weights and measures should be expressed in SI units. All non-standard abbreviations or symbols must be defined when first mentioned, or a glossary provided.

1.6. File naming and delivery

Please title your files in this order 'procedia acronym_conference acronym_authorslastname'. Submit both the source file and the PDF to the Guest Editor.
Artwork filenames should comply with the syntax "aabbbbbb.ccc", where:
- a = artwork component type
- b = manuscript reference code
- c = standard file extension
Component types:
- gr = figure
- pl = plate
- sc = scheme
- fx = fixed graphic

1.7. Footnotes

Footnotes should be avoided if possible. Necessary footnotes should be denoted in the text by consecutive superscript letters[1]. The footnotes should be typed single spaced, and in smaller type size (8 pt), at the foot of the page in which they are mentioned, and separated from the main text by a one line

---

[1] Footnote text.

space extending at the foot of the column. The Els-footnote style is available in the MS Word for the text of the footnote.

Please do not change the margins of the template as this can result in the footnote falling outside printing range.

2. Illustrations

All figures should be numbered with Arabic numerals (1,2,3,….). Every figure should have a caption. All photographs, schemas, graphs and diagrams are to be referred to as figures. Line drawings should be good quality scans or true electronic output. Low-quality scans are not acceptable. Figures must be embedded into the text and not supplied separately. In MS word input the figures must be properly coded. Preferred format of figures are PNG, JPEG, GIF etc. Lettering and symbols should be clearly defined either in the caption or in a legend provided as part of the figure. Figures should be placed at the top or bottom of a page wherever possible, as close as possible to the first reference to them in the paper. Please ensure that all the figures are of 300 DPI resolutions as this will facilitate good output.

The figure number and caption should be typed below the illustration in 8 pt and left justified [*Note:* one-line captions of length less than column width (or full typesetting width or oblong) centered]. For more guidelines and information to help you submit high quality artwork please visit: http://www.elsevier.com/artworkinstructions Artwork has no text along the side of it in the main body of the text. However, if two images fit next to each other, these may be placed next to each other to save space. For example, see Fig. 1.
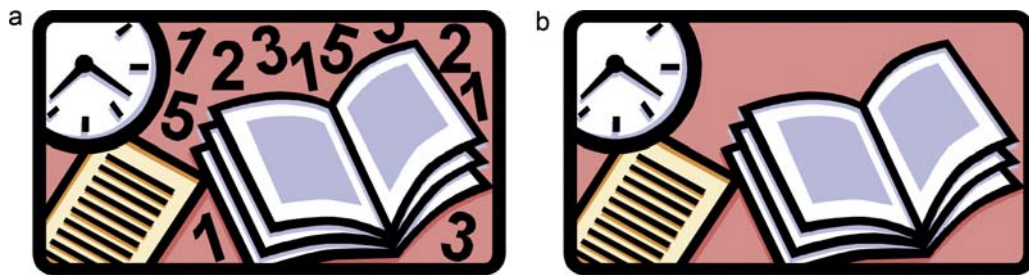

Fig. 1. (a) first picture; (b) second picture.

3. Equations

Equations and formulae should be typed in Mathtype, and numbered consecutively with Arabic numerals in parentheses on the right hand side of the page (if referred to explicitly in the text). They should also be separated from the surrounding text by one space.

$$\rho = \frac{\overset{\Gamma}{E}}{J\left(T = \mathrm{const.}\right)\cdot\left(P\cdot\left(\frac{\overset{\mathrm{F}}{E}}{E}\right) + \left(1 - P\right)\right)} \tag{1}$$

4. Online license transfer

All authors are required to complete the Procedia exclusive license transfer agreement before the article can be published, which they can do online. This transfer agreement enables Elsevier to protect the copyrighted material for the authors, but does not relinquish the authors' proprietary rights. The copyright transfer covers the exclusive rights to reproduce and distribute the article, including reprints, photographic reproductions,

microfilm or any other reproductions of similar nature and translations. Authors are responsible for obtaining from the copyright holder, the permission to reproduce any figures for which copyright exists.

Acknowledgements

Acknowledgements and Reference heading should be left justified, bold, with the first letter capitalized but have no numbers. Text below continues as normal.

Appendix A. An example appendix

Authors including an appendix section should do so before References section. Multiple appendices should all have headings in the style used above. They will automatically be ordered A, B, C etc.

A.1. Example of a sub-heading within an appendix

There is also the option to include a subheading within the Appendix if you wish.

References

Clark, T., Woodley, R., De Halas, D., 1962. Gas-Graphite Systems, in *"Nuclear Graphite"*. In: Nightingale, R. (Ed.). Academic Press, New York, pp. 387.

Deal, B., Grove, A., 1965. General Relationship for the Thermal Oxidation of Silicon. Journal of Applied Physics 36, 37–70.

Deep-Burn Project: Annual Report for 2009, Idaho National Laboratory, Sept. 2009.

Fachinger, J., den Exter, M., Grambow, B., Holgerson, S., Landesmann, C., Titov, M., Podruhzina, T., 2004. Behavior of spent HTR fuel elements in aquatic phases of repository host rock formations, 2nd International Topical Meeting on High Temperature Reactor Technology. Beijing, China, paper #B08.

Fachinger, J., 2006. Behavior of HTR Fuel Elements in Aquatic Phases of Repository Host Rock Formations. Nuclear Engineering & Design 236, 54.