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Disentangling the effects of multiple treatments—Measuring the net economic impact of the 1995 great Hanshin-Awaji earthquake☆

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ABSTRACT

We propose a panel data approach to disentangle the impact of "one treatment" from the "other treatment" when the observed outcomes are subject to both treatments. We use the Great Hanshin-Awaji earthquake that took place on January 17, 1995 to illustrate our methodology. We find that there were no persistent earthquake effects. The observed persistent effects are due to structural change in Hyogo prefecture.

1. Introduction

To evaluate the impact of certain "treatment" on some economic entity, one has to compare the outcomes of this entity in "treated" and "untreated" states. Unfortunately, econometricians often only have data in "one" or the "other" state, not simultaneously in both states. Therefore, in evaluating the impact of a "treatment", econometricians have to construct "counterfactuals". Econometricians have come up with many ingenious approaches to construct counterfactuals (e.g. Abadie and Gardeazabal (2003), Abadie et al. (2010), Heckman and Robb (1984), Heckman et al. (1998), Hsiao et al. (2012), Rosenbaum and Rubin (1983)). A fundamental assumption of all these approaches is that the observed data for an entity under the "treatment" is only the outcome of this specific "treatment" after controlling the impact of certain causal factors. However, in many cases, the observed outcomes could be due to several "treatments" working simultaneously. In this paper we propose a panel data approach to disentangle the impact of "one treatment" from the "other" when the observed data are the outcomes of "both" working in the same time using the Great Hanshin-Awaji earthquake impact as an illustrative example.

The Great Hanshin-Awaji earthquake took place on January 17, 1995. "The quake killed sixty-four hundred people, left more than three hundred thousand homeless, and did more than a hundred billion of dollars in damage" (Surowiecki, 2011). However, there are disagreements about the long-term impact of the earthquake on the Kobe region (Hyogo prefecture). On the one side, Horwich (2000), Becker (2005) and others claimed that the quake did not have much impact on Kobe region itself beyond the first couple of years. On the other side, DuPont and Noy (2012) claimed that the "evidence shows a persistent and still continuing adverse impact

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of the quake on the economy of Kobe more than 15 years after the event". There is also ample evidence that there was a fundamental structural change going on starting around mid 1990s around disaster area, the Hyogo prefecture. The port of Kobe was the sixth busiest port in the world in 1994. It was still ranked 27th in 1995 during the quake year but has fallen to the 39th in 2005. Can one attribute this dramatic decline to the Great Hanshin-Awaji earthquake or due to the competition of other lower cost ports in Asia such as Pusan, Hong Kong or Singapore, etc.? Moreover, the disaster area was heavily concentrated by traditional industries that lost competitiveness due to globalization. For instance, one of the most important local industries, the chemical shoe industry has been on the decline even before the quake and continues to decline thereafter due to the competition of the cheaper shoes from China and the expensive shoes from Italy and France (e.g. see Charts 1 and 2 of Fujiki and Hsiao (2013)).

In Section 2, we review the related studies. Section 3 discusses the data issues. Section 4 presents the estimates of combined quake and structural change effects using Hsiao et al. (2012) methodology. Section 5 proposes a method to disentangle "one treatment effects" from the other and presents the estimated net "quake" effects from the "structural change" effects. Concluding remarks are in Section 6.

2. Literature review

2.1. Definition of the losses from a natural disaster

According to Hallegatte and Przyluski (2010), researchers usually distinguish the loss of a natural disaster between direct and indirect losses depending on their purposes of estimation. Direct losses are immediate consequence of disaster, especially physical phenomenon, such as the loss of buildings or houses. Among direct losses, direct market losses are estimated by the repair or replacement cost. These estimates are essential for the payments of insurance or government subsidy to the damaged area. There are also non-market direct losses, such as loss of lives, loss of natural assets. Indirect losses include all losses that are not provoked by the disaster itself, but by its consequences.

Direct loss is a "stock" concept. They are losses of wealth and human capital. The methods to estimate the direct losses are straightforward, in contrast, there is lack of consensus on how to measure indirect losses. Indirect losses are much harder to measure. There are stimulating effects due to government recovery act. There is also the Schumpeter's creative destruction mechanism at work that a natural disaster leads to speeding up the adoption of new technologies and improvement in infrastructure (Skidmore and Toya, 2002). On the other hand, servicing the debt arising from financing the government recovery act could crowd out local consumption and investment. It could also impede government's expenditure on education and welfare in future. The loss of wealth and human capital could also affect the consumption and investment in the damaged area (e.g. Hayashi (2011)). Since the "indirect loss" is essentially a "flow" concept, most economists use the real GDP (RGDP) or real GDP per capita (RGDPPC) over time as a basis for measurement.

2.2. Estimates of economic losses due to the great Hanshin-Awaji earthquake

2.2.1. Direct market losses

The most cited official estimate of direct losses was done by Hyogo prefecture government on April 5, 1995. Their estimates of direct market losses were 9.9 trillion Japanese yen. Included in the losses are: losses for constructions for about 5.8 trillion Japanese yen, losses for ports for about 1 trillion Japanese yen, losses for expressways for about 0.56 trillion Japanese yen. The number of damaged houses was 639,686. Regarding the non-market losses, the number of casualties was 6434, and the number of injured was 43,792.

2.2.2. Direct market losses and indirect losses obtained from the firm level estimates

Toyoda and Kawauchi (1997) use a survey from the firms in the disaster area to estimate the average direct loss, and impute their estimates to the rest of firms in disaster area with some adjustment depending on how serious the firms are damaged to obtain total losses in the disaster area. According to their method, direct losses are 6 trillion yen and the indirect loss are 7.2 trillion yen. Their revised estimated losses in the manufacture and commerce sectors of the Hyogo prefecture are 13.2 trillion yen.

2.2.3. Indirect losses obtained from the econometric estimates based on national or regional data

Okuyama (2011) regresses Kobe City gross regional product per capita data on its own lagged value, Japanese GDP, lagged Japanese GDP based on pre-earthquake data to generate forecasts of gross regional product without the earthquake. He shows a small negative initial shock followed by positive impacts due to the government demand injection for a few years. His results are consistent with the observation by Horwich (2000) that the economic activity of Kobe area, manufacturers or retailers, recovered from the negative shock in about two or three years.

2.2.4. Indirect losses obtained from the input–output model at the national and regional levels

Takahashi et al. (1996) use regional input–output table to obtain an estimate of the loss in Hyogo prefecture at 2.2 trillion yen. According to this study, the disaster area experienced the decline of the output about US$73 billion (or 7.3 trillion Japanese yen if $1 = 100 yen). Ashiya and Toshiki (2001) use the input–output table to analyze the disaster area economy and conclude that the direct loss of the physical assets in the amount of 10 trillion yen were fully reconstructed from 1995 to 1997.

2.2.5. Synthetic control methods

DuPont and Noy (2012), following Abadie and Gardeazabal (2003) and Abadie et al. (2010), use a control group that consists of other untreated prefectures, optimally weighted, to construct the counterfactual for Hyogo prefecture GDP in the absence of quake. They find a significant and long-term adverse effect of the disaster: about 13% of average per capita prefecture GDP as of 2007.

3. Data

The focus of our study is to measure the "indirect loss". We use the real GDP (RGDP) or real GDP per capita (RGDPPC) over time as a basis for our measurement of indirect losses.

3.1. Data on prefecture GDP series

Japanese regional aggregate data is published by each prefecture, and the latest data is available from 1955 to fiscal year 2009. The Cabinet Office of the Government of Japan collects data from each prefecture, and publishes them altogether around February of each year.

The prefecture aggregates are revised every year, and the consistent constant price data for the period 1955–2009 do not exist because of the changes in the base years. Moreover, the estimates are compiled based on two different methods of the system of National Account; the 1968 System of National Account