



Natural disasters, natural selection, and firm exit: Lessons from the Tohoku earthquake

Hirofumi Uchida, Arito Ono 11 February 2015

It seems like natural disasters should harm the economy by destroying lives and capital. This column investigates the extent to which disasters can lead to creative destruction through 'natural selection' of the fittest firms. Surprisingly, the rate of closure due to bankruptcy decreases – perhaps due to aid. Firm exits following the Tohoku earthquake were predominantly voluntary closures, with firms seizing the moment in order to leave an ageing market.



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Economic impact of natural disasters

Natural disasters such as earthquakes, floods, typhoons, and hurricanes inflict serious damage and so seem to be bad for the economy. For firms, natural disasters destroy tangible assets such as buildings and equipment – as well as human capital – and thereby deteriorate their production capacity. These adverse impacts may sometimes be fatal to the firms and result in them being forced to close down.

But the academic evidence on the economic impact of natural disasters is mixed. As reviewed in surveys such as Noy and Vu (2010) and Loayza et al. (2012), the existing studies report that natural disasters may even promote growth. One possible mechanism behind this positive impact is the enhancement of the productivity of the economy's corporate sector – as reported in Skidmore and Toya (2002) and Crespo-Cuaresma et al (2008). But because these studies use aggregate data, they cannot answer why and how corporate productivity improves due to natural disasters. We thus need analyses that use micro-data to clarify the mechanisms through which natural disasters affect the productivity of an economy's corporate sector.

Natural disasters and corporate productivity: (1) Creative destruction

A channel through which natural disasters may enhance corporate productivity is the improvement in the productivity of firms that survive the disasters, which is due to the update of their capital stock and the adoption of new technologies. This mechanism is often called creative destruction.

There is some evidence for this hypothesis, although mixed. De Mel et al (2011) find that the firms that suffered more damage to their assets because of the devastating tsunami in Sri Lanka in 2004 exhibited smaller profits, sales, and capital stock.¹ Cole et al. (2013) and Tanaka (2015) find that the plants located in the most devastated districts during the 1995 Kobe Earthquake exhibited smaller employment and value-added growth. These findings are inconsistent with creative destruction.

On the other hand, Hosono et al. (2012) – who also focus on the Kobe Earthquake – find more investment by the firms located inside the affected area than those located outside, supporting the creative destruction hypothesis. Also consistent with this hypothesis, Leiter et al (2009) find that – an firms located in regions affected by a major flood in 2000 had higher asset and nent growth as compared with non-affected firms, although they also find that the firms in cted regions exhibited smaller value-added.² Finally, Cole et al (2013) find some evidence

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for a short-run increase in the productivity of damaged plants after the Kobe Earthquake, although they also report that this effect disappeared over time.

Natural disasters and corporate productivity: (2) Firm selection

Aside from the channel through survived firms, there is another potentially important channel through which natural disasters may affect the corporate sector: the selection, or exit, of firms due to the disasters.³ If natural disasters expel inefficient firms, or if natural selection is at work, then the average corporate productivity will increase. However, to the extent that efficient firms are also forced to exit, or an unnatural selection is at work, then the overall impact is unclear.

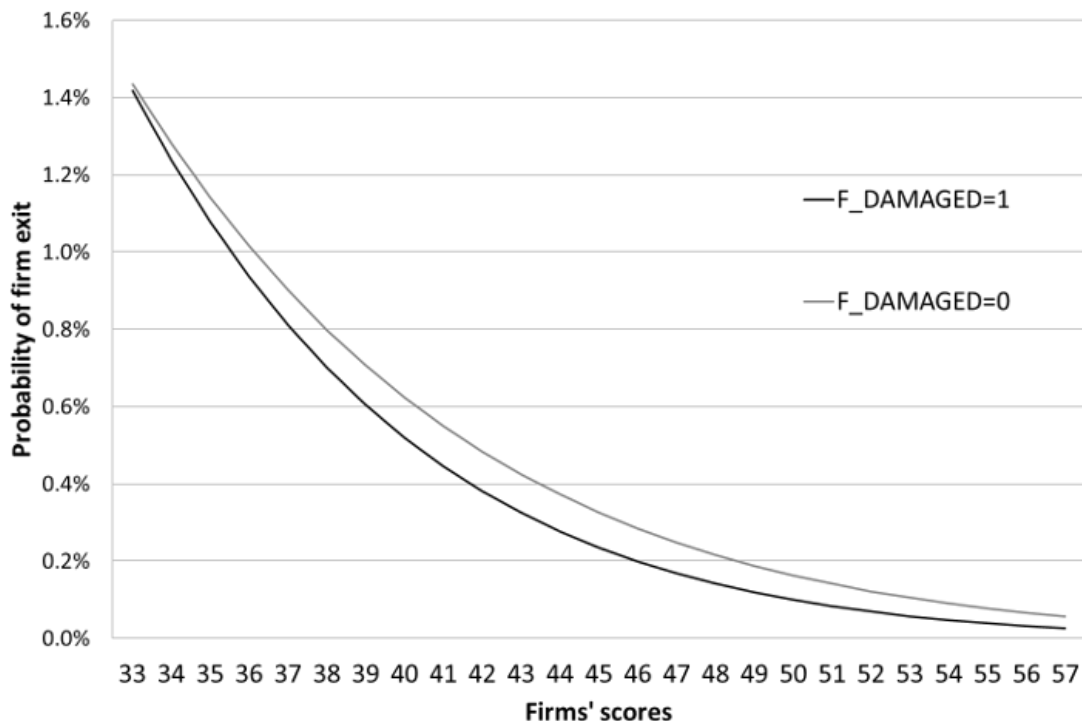
Compared to the effect of natural disasters on surviving firms, the empirical evidence on the firms' post-disaster exits is scant.⁴ To fill this gap, a team of researchers including these authors examined the selection of firms in the form of bankruptcy after the Tohoku Earthquake in Japan that occurred on March 11, 2011 (Uchida et al 2014a). In the subsequent sections, we report our findings from this study.

Empirical approach on firm bankruptcy after the Tohoku Earthquake

In Uchida et al (2014a) we use a sample of firms located in the Tohoku area of Japan that we obtain from the database of Teikoku Databank Ltd. (TDB). The TDB is a leading private credit bureau in Japan that covers a sufficient fraction of the firms in Japan. Our data contain rich information on the firms' attributes, financial statements, and exits after the earthquake. We focus on bankruptcy as the type of firm exit, which is one of the most commonly observed types. To proxy for the firms' efficiency, we use their 'scores' in the TDB. The TDB calculates these scores to evaluate the firms' soundness of management, repayment ability, and creditworthiness as a safe trade counterpart from a third-party's viewpoint.⁵ We also identify the firms whose headquarters were located inside the areas severely affected by the earthquake and create a dummy variable for such firms to represent damaged firms. Using these variables, we run probit model regressions for the firms' bankruptcies and examine whether and how the working of the firms' selection (i.e., the impact of their scores) differs depending on the firms' damage (represented by their location).

Evidence for natural selection

Table 1. Bankruptcy probability and firm score: Regression results (Excerpt)



DAMAGED is a dummy variable indicating that the firms are located in the area severely by the earthquake. *** indicates statistical significance at the 1% level.

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Source: Uchida et al (2014a)

Figure 1. Bankruptcy probability and firm score: Damaged versus undamaged firms

	(A) Firms with F_DAMAGED=1		(B) Firms with F_DAMAGED=0		(C) Whole sample, using F_DAMAGED	
	dF/dx	p-value	dF/dx	p-value	dF/dx	p-value
Firms' score	-0.00039	0.00 ***	-0.00040	0.00 ***	-0.00043	0.00 ***
F_DAMAGED					-0.00104	0.00 ***
Obs	28306		53904		84012	

Source: Uchida et al (2014a)

Table 1 is an excerpt from our probit regression results, where we report the marginal effect of the firms' scores on the probability of bankruptcy for those located in the affected (F_DAMAGED=1: Column A) and unaffected areas (F_DAMAGED=0: Column B). We also illustrate in Figure 1 how the probability of bankruptcy (Y-axis) predicted from the regression results differs depending on the value of the firms' scores (X-axis) when keeping the value of the other control variables fixed at their means. The black and the gray lines respectively indicate the results for firms inside and outside the affected areas.

From these results, we first find that the marginal effects of the firms' scores on the probability of bankruptcy is negative both inside and outside the affected areas (Table 1, Columns A and B), and the probability is smaller for more efficient firms (Figure 1). These findings suggest that natural selection is at work both inside and outside the affected areas. Second, the estimated marginal effects in Table 1 are comparable between the firms in damaged (Column A) and undamaged (Column B) areas, and the curvatures of the two lines in Figure 1 are comparable (although the levels of the two lines differ, which will be discussed below). We thus find no quantitative difference in the effect of the firms' scores on the probability of bankruptcy in damaged and undamaged areas. This finding means that the Tohoku Earthquake neither promotes nor demotes the natural selection of firms. On balance, our findings lend no support to the positive or negative impact of the earthquake on corporate productivity through the firms' exits.

Different impact on bankruptcy and voluntary closures

Although not directly related to the disaster's impact on corporate productivity, it is worthwhile to add that we report another intriguing finding. In Figure 1, the gray line is located above the black line irrespective of the firms' scores. Consistent with this finding, in Panel C of Table 1 where we pool the samples with F_DAMAGED=1 and 0 and add F_DAMAGED as an additional independent variable, it has a negative and significant impact.⁶ Thus, the probability of bankruptcy is lower (not higher) in the affected area.

In reality, it is evident that the firms in the affected area do suffer substantial damage, especially from tsunamis or the serious accident at the nuclear plant in Fukushima. Hence, the finding of a smaller probability of bankruptcy in the affected area is seemingly counterintuitive. However, there is one potential reason for the lower probability in the affected area – the enormous amount of public aid to firms.⁷ This aid may have financially supported the damaged firms and contributed to keeping them from going into bankruptcy (see Uchida et al 2014a for more discussion).⁸

Relatedly, the descriptive statistics show another intriguing finding. If we focus on voluntary closures, a type of 'unforced' exit, then they significantly increase in the severely damaged areas (Uchida 2014).⁹ This finding, together with the former finding of a lower probability of bankruptcy in the affected area, suggests that even if the policy intervention reduced the firms' defaults and thereby bankruptcies, many firms may still have found it difficult to remain in business in the post-earthquake environment. These firms may have voluntarily closed down. This story is convincing because the Tohoku area is the epitome of a shrinking Japan due to its aging population. Therefore, the firms in this area would have sooner or later faced long-run problems such as difficulty in business succession and a decline in the local economy.

... we have little evidence to support these conjectures, and there remain many empirical issues to resolve. As the above discussion suggests, the exit of firms – or more generally their exits and the recovery of the local economy after natural disasters – is closely intertwined with

the policy measures taken and the underlying economic conditions. Thus we should have a broader and long-run perspective in examining their economic impact and the policy measures needed to deal with them – beyond just focusing on the direct and devastating damage that attracts much of our attention.

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Footnotes

1 They also report the results of an experiment that randomly allocated grants to the firms, where they find that the grants contributed to the firms' faster recovery

2 Note however that elsewhere in this same study, the authors find that the flood increases the firms' value-added. The authors' explanation for this mutual inconsistency is not clear.

3 The selection of firms is also important in ordinary (non-disaster) environments. For the mechanism through which the market eliminates inefficient firms during the recession period, see e.g., Bertin et al. (1996), Bresnahan and Raff (1991), and Caballero and Hammour (1994). Relatedly, many studies conclude that in the so-called 'lost decade' in Japan, the unnatural selection promoted by 'evergreening' loans from financially impaired banks helped inefficient zombie firms to survive (see, e.g., Ahearne and Shinada 2005, Peek and Rosengren 2005, Caballero et al 2008, and Fukuda and Nakamura 2011).

4 To the best of our knowledge, the only exception is the study by Cole et al (2013) mentioned above. Using very detailed plant-level information for the amount of damage, this study finds that plants with more damage are more likely to exit. However, they do not put much emphasis on how the exit of the plants differs depending on their efficiency, and they do not distinguish the plant's exit due to its firm's exit and the plant's exit due to relocation of the plant. Ono et al (2014) examine the relocations of firms after the Tohoku Earthquake and find that damage by the earthquake increased the likelihood of relocations.

5 The TDB's scores are used as a useful and reliable metric, for example, when firms evaluate a potential transaction partner.

6 The marginal effect in the table indicates that the probability of bankruptcy is on average lower by 0.1 percentage point in the affected area, which is economically significant because the average bankruptcy rate in our sample is 0.48%.

7 In June 2011, the government of Japan allocated \19 trillion of its budget for aid in the rehabilitation from the earthquake, which was later increased to \25 trillion in fiscal 2013. Using this budget, the government has implemented a variety of measures, such as different forms of subsidies, public credit guarantees by credit guarantee corporations, and loans by public financial institutions. Saito et al (2014) inspect from an economics viewpoint the policy-making process behind this huge budget and conclude that the budget was excessive.

8 Consistent with this view, a related study (Uchida et al 2014b) reports some evidence suggesting that the capital injections to damaged banks may have contributed to the lower probability of bankruptcy for their borrowers.

9 Using a data set similar to that used in Uchida et al (2014a), Uchida (2014, Table 6) reports that the annual rates of voluntary closures in the affected area around the earthquake (March 11, 2011) were 1.31% (March 2010-February 2011), 1.43% (March 2011-February 2012), and 2.03% (March 2012-February 2013); while the rates of bankruptcy in the same periods are respectively 0.47%, 0.21%, and 0.16%.

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