

## Factors Affecting Business Recovery After a Disaster:

Evidence from the Great East Japan Earthquake in 2011

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This research aims at empirically investigating the characteristics of businesses recovery, and evaluating the impact of lifeline disruptions on recovery by using questionnaire survey data obtained after the 2011 Great East Japan Earthquake.

The Great East Japan earthquake has caused huge impacts on Japanese economy, as well as human lives. Great importance was attached to effective relief and quick recovery immediately after the disaster, and a package of countermeasures was implemented to achieve quick post-disaster recovery. Although recovery was immediately commenced and orderly conducted under the joint efforts of business subjects, government and social assistance groups, the details of the characteristics of recovery processes and its influential factors has not been identified yet due to lack of data. Evidence-based decision making is needed, as well as the impact of multiple lifeline disruption on business recovery.

This research seeks to advance the estimation of factors affecting recovery on several fronts. Firstly, empirical analysis is implemented to estimate the coefficient of each industry. Although some empirically analysis researches have implemented on this topic, but mostly focused on the factors of business characteristics, pre-disaster preparedness or physical damage suffered, while not addressed the multiple lifeline disruptions conditions. Secondly, this research considers both individual variant effect and time-varying effect in the process of evaluating function between recovery and lifeline disruption. By implementing panel data model in factors analysis, the inefficiency of survival analysis method, in which the

business recovery is examined at a single point of time, could be avoided. Thirdly, multiple lifeline estimation is involved instead of single factor analysis, and the impacts of multiple lifeline disruption on industry recovery are evaluated. In this research, lifeline factors are including electric power supply, water supply, communicate connection, availability of facility, gasoline supply, transportation connection, employee attendance and raw materials supply.

The results of survival analysis indicated that the recovery speed in different industries show significant differences. The result in this case study illustrates that, in general, non-manufacturing sectors recover faster than manufacturing sectors. Specifically, the finance, insurance and real estate sector, service sector, and transportation sector ranked in top three in quick recovery, and all of them are non-manufacturing sectors. While the material sector, processing and assembly sector, and construction sector ranked in bottom three regarding recovery speed, and all of them are manufacturing sectors.

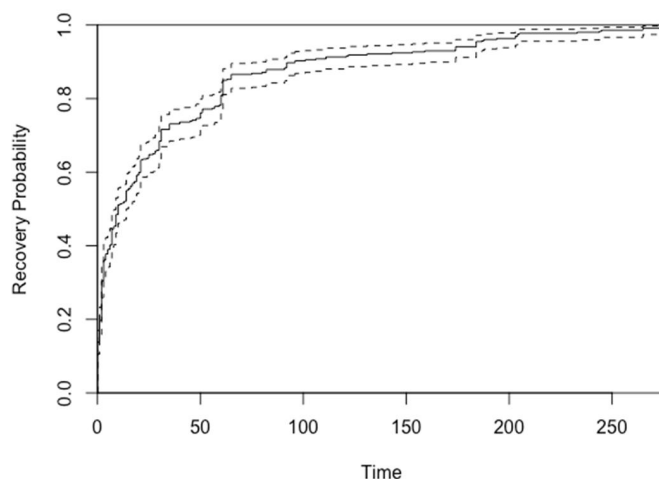


Fig.1. The survival curve for all samples (N=434)

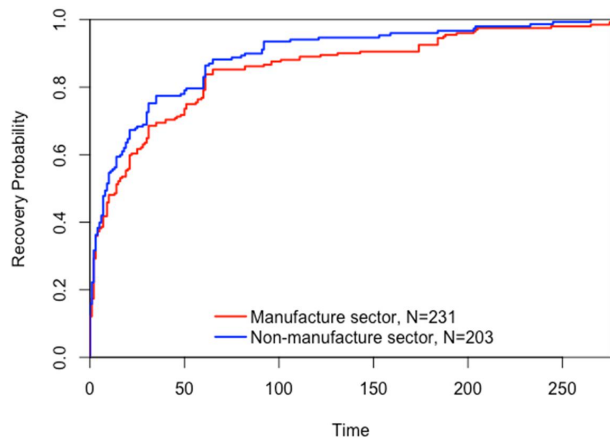


Fig.2. Survival curves between manufacturing sectors and non-manufacturing sectors

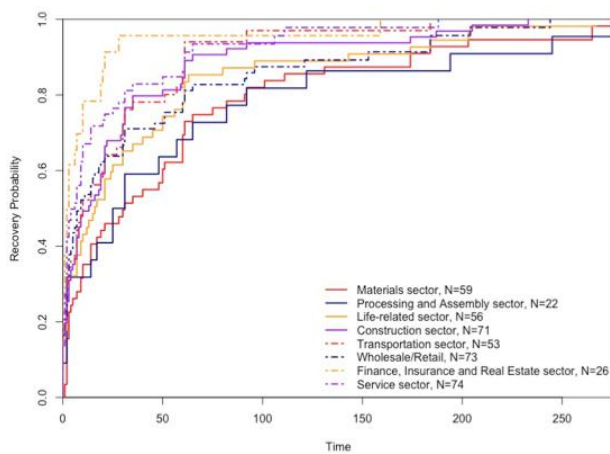


Fig.3. Survival curves of eight different sectors

Panel data regression modes are developed to evaluate the function of recovery and lifeline factors. The independent variable is production capacity level, which is varying from time and individuals, taking log transformation to achieve relatively stable variance. As for dependent variable, including the supply condition of eight lifeline factors. By using the panel data regression model, it is estimated the impacts of multiple lifeline disruptions on industries' recovery, in consideration of both individual and time-varying effects. It is observed that the disruption of lifeline factors in different industries causes a different percentage of impact on recovery, among which electric power disruption is the most crucial factor in the process of recovery, followed by water supply and

employee attendance.

The fixed effect model is selected according to the Hausman test result. The fixed effect model allows the individual-specific effect  $\alpha$  to be correlated with dependent variables, so that the intercepts will be  $\alpha_i$ , the model is developed below:

$$\ln PC_{it} = a_i + b_1 ELE_{it} + b_2 WAT_{it} + b_3 COM_{it} + b_4 FAC_{it} + b_5 GASO_{it} + b_6 TRA_{it} + b_7 EMP_{it} + b_8 RAW_{it} + e_{it}$$

Tab.1. Estimation of hazard rate for each sector

Variables	Parametric model					
	Exponential		Weibull		Loglogistic	
	Coef.	Recovery factor (%)	Coef.	Recovery Coef.(%)	Coef.	Recovery Coef.(%)
(Intercept)	5.749****		5.4371****		4.5147****	
Materials	-1.685****	81.46	-1.5813**	79.43	-1.2739*	72.03
Processing and assembly	-1.627***	80.35	-1.5600*	78.99	-1.3647*	74.45
Life-related sector	-1.976***	86.14	-1.9144**	85.26	-1.7732**	83.02
Construction	-2.322****	90.19	-2.2644**	89.61	-2.0620***	87.28
Transportation	-2.511****	91.88	-2.4073***	90.99	-2.1490***	88.34
Wholesale/retail	-2.093***	87.67	-2.0549**	87.19	-2.1368**	88.20
Finance, insurance and real estate	-3.168****	95.79	-	95.96	-	95.52
Service	-2.764****	93.70	-2.6989***	93.27	-2.6128***	92.67
scale	1		1.45		0.944	
Loglike	-1828.6		-1769.4		-1763.2	
AIC	3687.094		3557.436		3539.725	
Chisq	73.86****		36.81****		36.44****	

Tab.2. Panel data regression results in different sectors

	Manufacturing sectors		Non-manufacturing sectors	
	Coefficient	Resilience factor(%)	Coefficient	Resilience factor(%)
(Intercept)	0.266****		0.124****	
Electricity	1.956****	85.85	1.715****	81.99
Water	0.687****	49.71	1.199****	69.84
Communication	0.182****	16.60	0.184****	16.80
Gasoline	0.256****	22.55	0.305****	26.29
Transportation	0.181****	16.56	0.155****	14.36
Facility	0.306****	26.32	0.343****	29.02
Employee	0.391****	32.38	0.356****	29.98
Raw Material	0.329****	28.04	0.186****	16.96
N	37812		81972	
Adj.R2	0.438		0.401	
F-stat	3677.54****		6847.75****	

The results may contribute to giving references to the priority of the lifeline factors recovery after a disaster, an improved lifeline factors restoration pattern can be formulated to achieve a quick recovery. Additionally, knowing the predictors of disaster recovery will allow disaster managers and government decision-makers to improve recovery efficiency.

**Keywords:** Great East Japan Earthquake; recovery; sector perspective; lifeline factors; empirical analysis

**References:** Detailed in Power Point