Threshold Testing Based on Public Safety Risk: An Experimental Simulation by Support Vector Machine Method at the Regional Level, China

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Introduction

- Vulnerability-Capacity in the field of emergency management is perceived to possess the inverse effect in evolution, but it effect in public safety didnot be addressed in the disaster-based scenario.

- What is the relationship between emergency-coping capacity and vulnerability, and whether the threshold value exists in the setting of public safety? This is a critical question both theoretically and practically.

- This research conducts an exploratory research by collecting provincial data in China, and expects to uncover the likely threshold effect under the "vulnerability-capability" framework

Methodology

- The regional public safety is a complicated system subjected to multiple factors and the level of safety risk ("risk index" herein) is under the combined action of "vulnerability" and "coping capacity". When the regional public safety index goes beyond a threshold, it will entangle the public safety system in mutations (Fig 1)
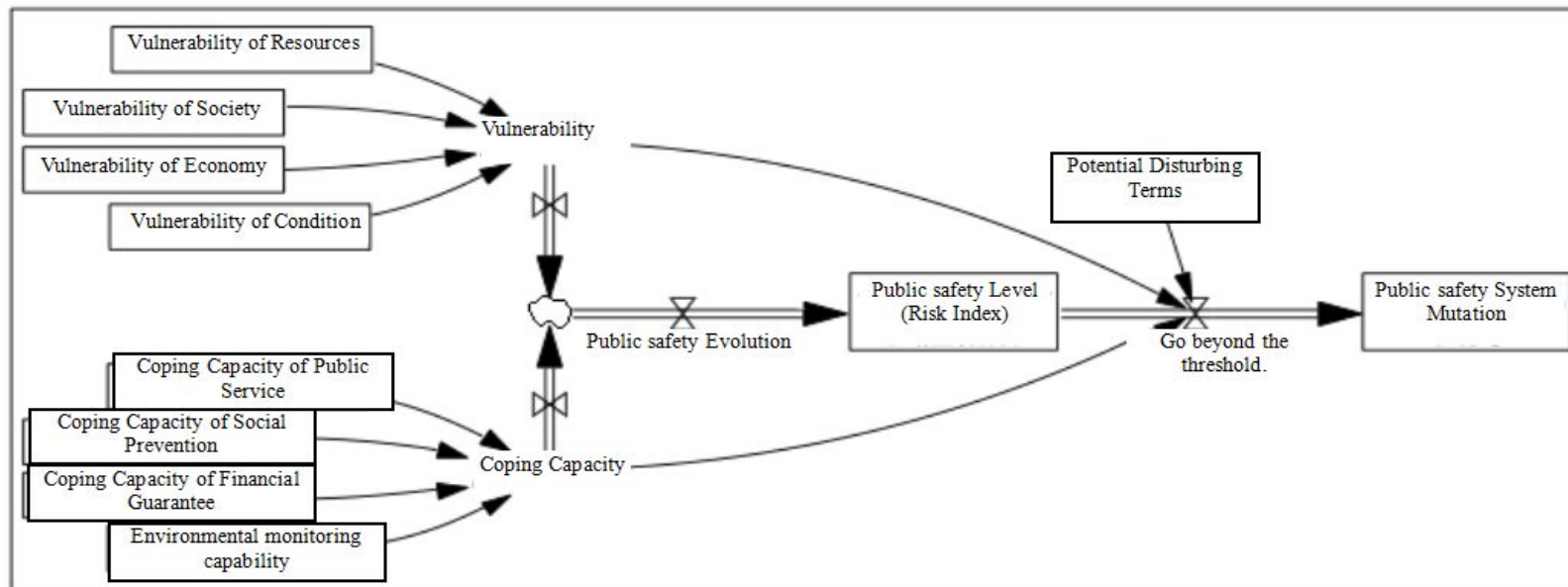

Fig. Threshold analysis framework of the regional public safety system

Methodology

- Based on the components of regional public safety system, the vulnerability factors in this paper are classified into four aspects including resources, environment, economy and society in line with the principle of comprehensiveness, measurability, effectiveness and reliability.

- The Fuzzy Evaluation and Support Vector Machine method is applied to assess the public safety status through either subjective and objective evaluation.
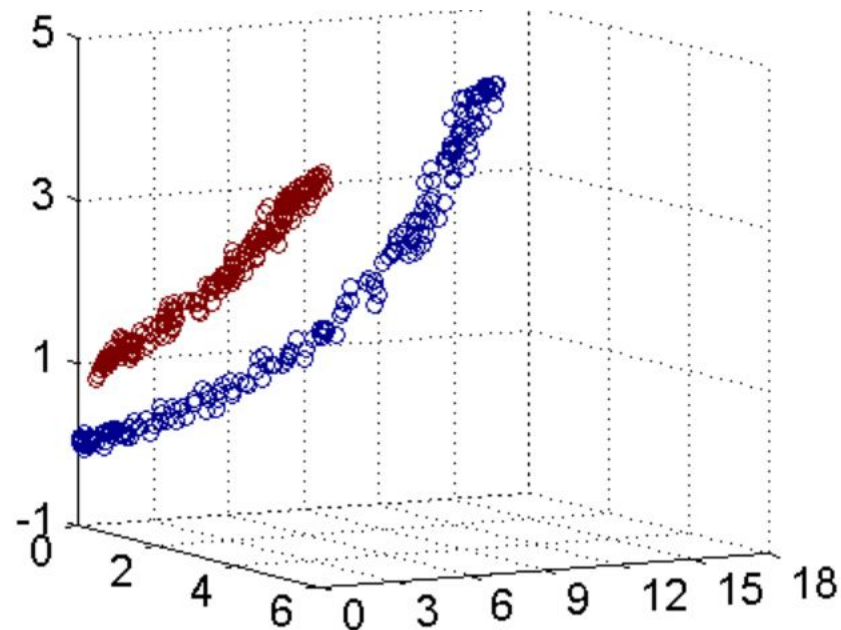
Evaluation system of regional public safety in the vulnerability-capacity framework

Level I index	Level II index	Measure index
Vulnerability（V）	Vulnerability of Resources（VR）	Arable land per capita, per capita water resource, etc.
	Vulnerability of Condition（VC）	Yield of industrial solid waste, industrial wastewater discharged, etc.
	Vulnerability of Economy（VE）	Proportion of labor remuneration in regional GDP, per capita GDP, etc.
	Vulnerability of Society（VS）	Registered urban unemployment rate, urban-rural consumption ratio, etc.
Coping Capacity（C）	Coping Capacity of Public Service (CPS)	Number of hospital beds per 1,000 people, transport line density, etc.
	Coping Capacity of Environmental Regulation（CER）	Treatment rate of industrial solid waste, compliance rate of industrial wastewater discharged, etc.
	Coping Capacity of Financial Guarantee（CF）	Proportion of public safety budget, per capita public safety budget, etc.
	Coping Capacity of Social Prevention（CSP）	Participation rate of town basic endowment insurance, proportion of illiterate population, etc.

Data and processing

- The data on the sampled regions are acquired from China Statistical Yearbook, provincial statistical yearbooks, statistical bulletins, security production incident statistics and related government reports in China
- Z-score approach was used to make the nomalization of various indicators

$$X' = (x - \bar{x}) / SD$$

- After standardization, the data conforms to the quasi Normal Distribution, that is, half of the observed values are less than 0, and the other half are greater than 0, the standard deviation value (SD) is around . The variation range among observed values is (- 1,1)
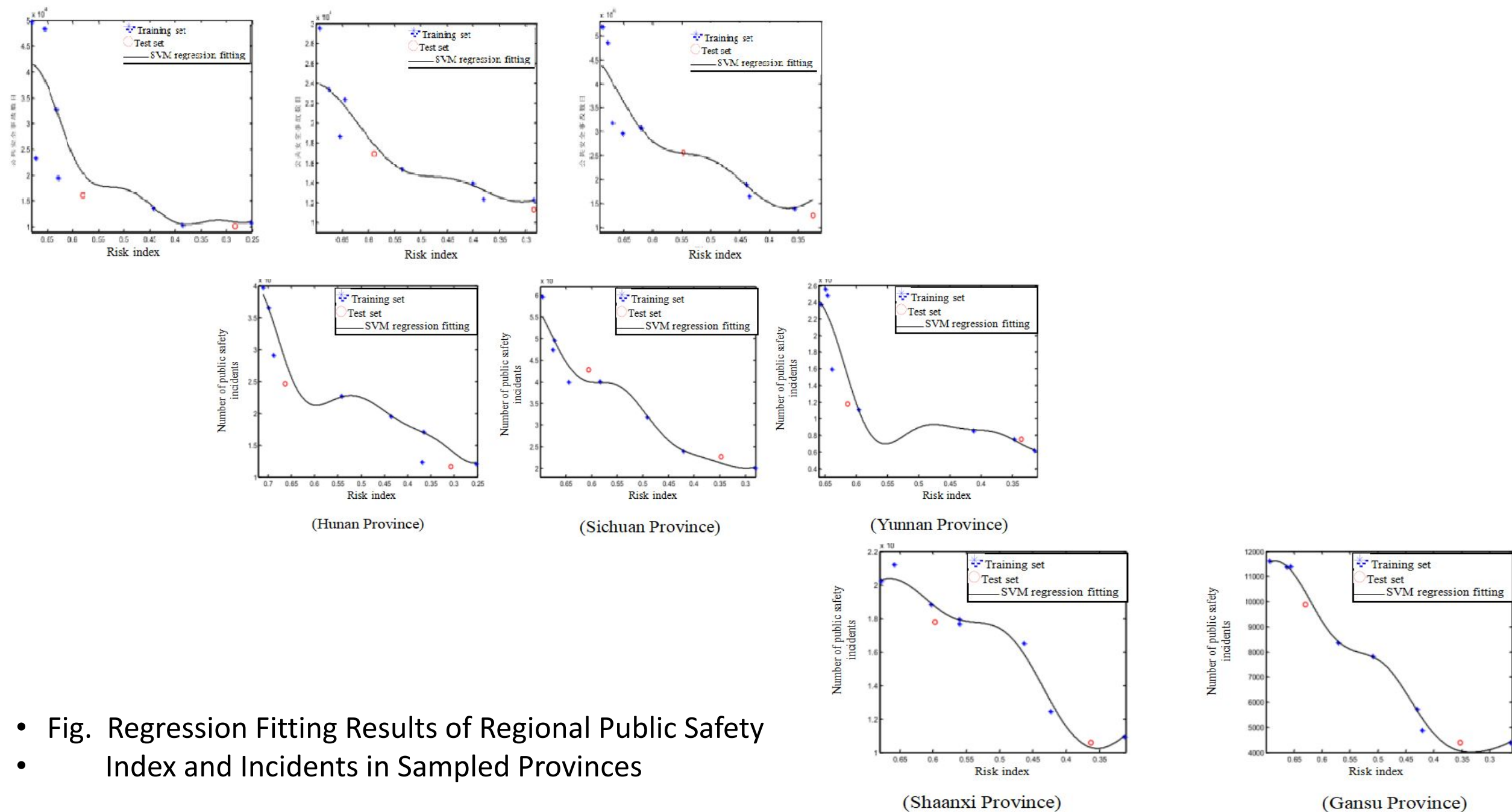
Results

- According to the "capacity-vulnerability" framework, the threshold effect in regional safety risk can be described with the number of public safety incidents as an index:
namely, the increase in the number of incidents has a significant difference below and above the threshold value. In specific, after going beyond the threshold, the increasing risk level comes with sharply increasing number of incidents. However, this upward trend remains relatively flat before going beyond the threshold.
On such a basis, this paper makes regression fitting on the level of regional public safety risk and the number of incidents by the SVM method and the trend performance is verified by the slope change of the regression curve.

(Hunan Province)　　　　(Sichuan Province)　　　　(Yunnan Province)

(Shaanxi Province)　　　　(Gansu Province)

- Fig. Regression Fitting Results of Regional Public Safety
- Index and Incidents in Sampled Provinces

Conclusion

- The threshold effect is characterized by the following. When the level of regional safety risk is below the threshold, the number of incidents increases slowly as the risk level increases; when the risk level goes above the threshold, this upward trend will suddenly speed up, imposing tremendous risk response pressure to the region.

- At the same time, the level of regional safety risk has multiple thresholds, that is, the threshold effect may be characterized by multi-stage characteristics.

- However, for a complex system, there are potential disturbing terms in the social system. Consequently, regional public safety risk cannot be precisely evaluated and threshold cannot be completely disclosed.

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