

Analysis and management of agricultural risk in China

中国农业风险分析和管理

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农业风险分析

1.1 Agricultural risk classification

农业风险分类

- **Agricultural risk (概念)**

The degree that individual's actual revenue lower than expected revenue, for uncertainty and bounded rationality, during agricultural production and operation activities

风险是指在一定时期和一定客观环境下，由于不确定性的存在和人的有限理性，致使经济行为主体的实际收益低于预期收益的程度。

- **Agricultural risk classification (农业风险分类)**

- | | | |
|--------------------------|------------------------------|-------------------------------|
| — natural risk
(自然风险) | — Independent Risk
(独立风险) | — Normal Risk
(一般风险) |
| — market risk
(市场风险) | — Systemic Risk
(系统风险) | — Catastrophic Risk
(巨灾风险) |

- **Agricultural yield risk (农业产量风险)**
- **Price risk of agricultural commodity (农产品市场风险)**
- **Agricultural catastrophic risk (农业巨灾风险)**

1.2 Agricultural risk feature

农业风险特征

- **Yield Risk**（生产风险）
Relative independent , stochastic
相对独立性、随机性.
- **Price Risk**（市场风险）
Systemic, conjunctive
系统性、关联性.
- **Catastrophic Risk**（巨灾风险）
Low probability , high Loss, strong impactive
发生概率低、损失程度大、破坏性强

1.3 Agricultural risk analysis

农业风险分析

An Example: Corn yield risk analysis and evaluation in China (中国玉米生产风险分析和评估)

- Background (背景)
- Analysis objective (分析目标)
- Analysis approach (分析方法)
- Analysis results (分析结果)

Background (背景)

Corn is one of the main crop in China ,and the Corn Belt in China is from Northeast to Southwest.

玉米是中国主要粮食作物之一，我国玉米生产分布大致呈现一个从东北到西南的斜长带。

The acreage and production in Corn Belt and whole country

主产区玉米播种面积和产量占全国的比重

	Corn Belt	Whole country	Percent
Acreage (10 ⁴ Ha)	2213. 43	2464. 0779	89. 8%
Output (10 ⁴ t)	10826. 44	12114. 725	89. 4%

Average of 2000-2005



Background (背景)

We had selected eight province as the sample of Chinese Crop Belt, there are *Heilongjiang, Jilin, Liaoning, Shandong, Henan, Sichuan, Guizhou and Guangxi*)

我们选取了八个省份作为我国玉米主产区的样本代表，分别为：黑龙江、吉林、辽宁、山东、河南、四川、贵州和广西

The percent of Sample acreage & production to Corn Belt
八省份玉米播种面积和产量占主产区的比重

	HLJ	JL	LN	HN	SD	SC	GX	GZ	Sum
Acreage	9.5%	11.8%	7.0%	10.6%	11.3%	5.4%	2.5%	3.2%	61.4%
Output	8.5%	14.0%	8.2%	10.1%	13.8%	4.9%	1.6%	3.1%	64.1%

Average of 2000-2005

Analysis objective (分析目标)

- **Analysis and compare the yield risk (CV, Mean, Variation) between different regions**
分析和比较不同地区的产量风险（均值、标准差和变异系数等）
- **Establish the risk distribution models for different regions**
建立各个地区生产风险分布模型（单产分布模型）
- **Estimate and rank yield risk in different regions**
估算和比较不同地区的生产风险大小

Analysis approach (分析方法)

- Step 1: Collect yield data and got the relative stochastic variation (RSV)

第一步：收集单产数据，计算相对随机波动（RSV）

a: Detrend (去除趋势)

$$y_{actual} = y_{trend} + u$$

$$\Rightarrow u = y_{actual} - y_{trend}$$

And:

$$RSV = \frac{u}{y_{trend}}$$

Analysis approach (分析方法)

b: We use the linear movement average (LMA) to simulate the yield trend

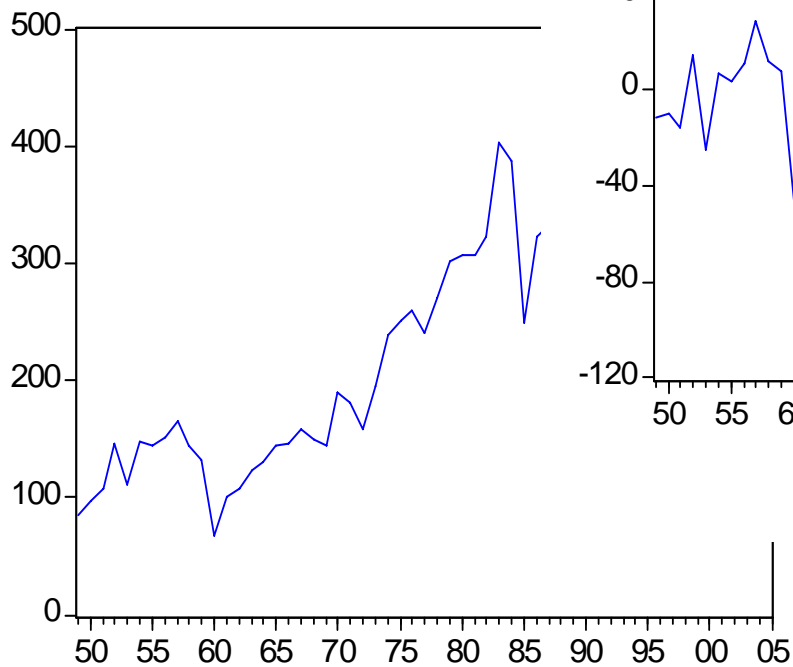
我们用线性移动平均法（LMA）计算单产趋势

(Why? Cause this methods have the advanced of objectively & didn't lose sample data)

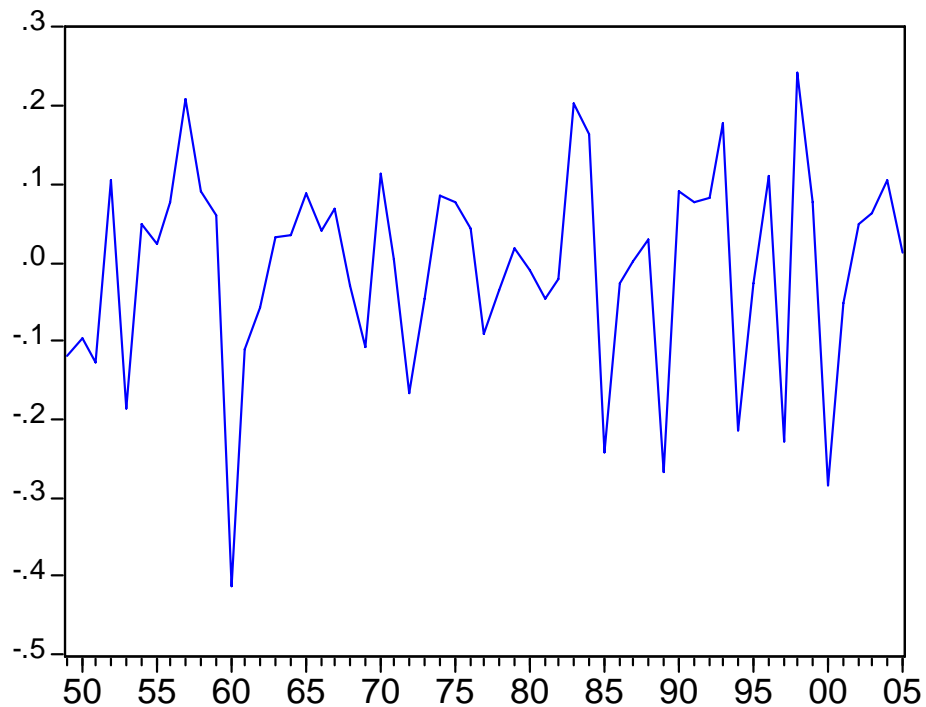
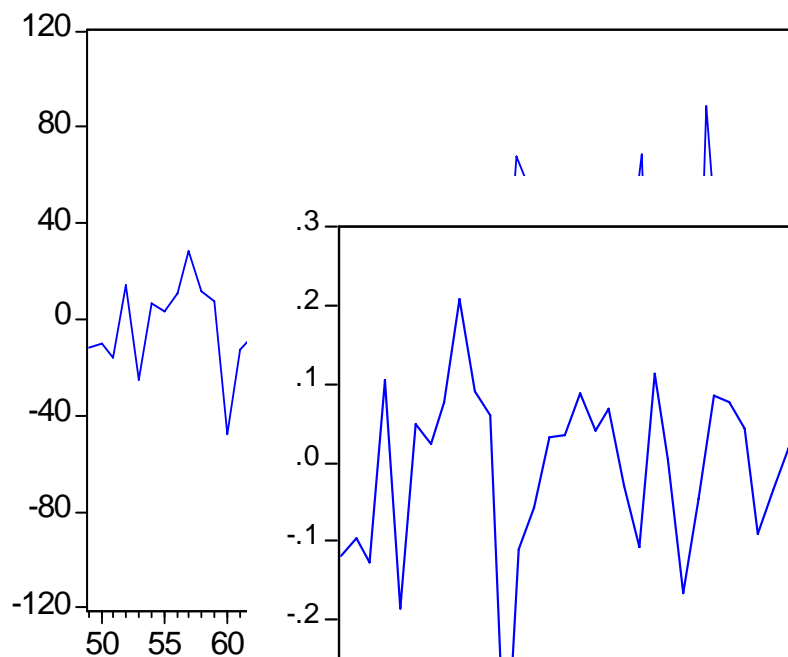
为什么？因为该方法具有既不必主观假定产量历史演变的曲线类型，同时又不损失样本量的优点

Analysis approach

- A demo



— yield



— RSV

Analysis approach (分析方法)

- Step 2: Select candidate parameterization of yield distribution for different regions

第二步：采用参数方法，为不同地区选定合适的单产分布形式

a: AD test

AD检验

b: Compare the skewness and kurtosis of samples with the moment ratio diagrams

将各样本的偏度、峰度值与距比率图进行比较

Analysis approach (分析方法)

- Step 3: Using MLE to estimate the parameters of yield distributions ,then got the PDF & CDF for different regions

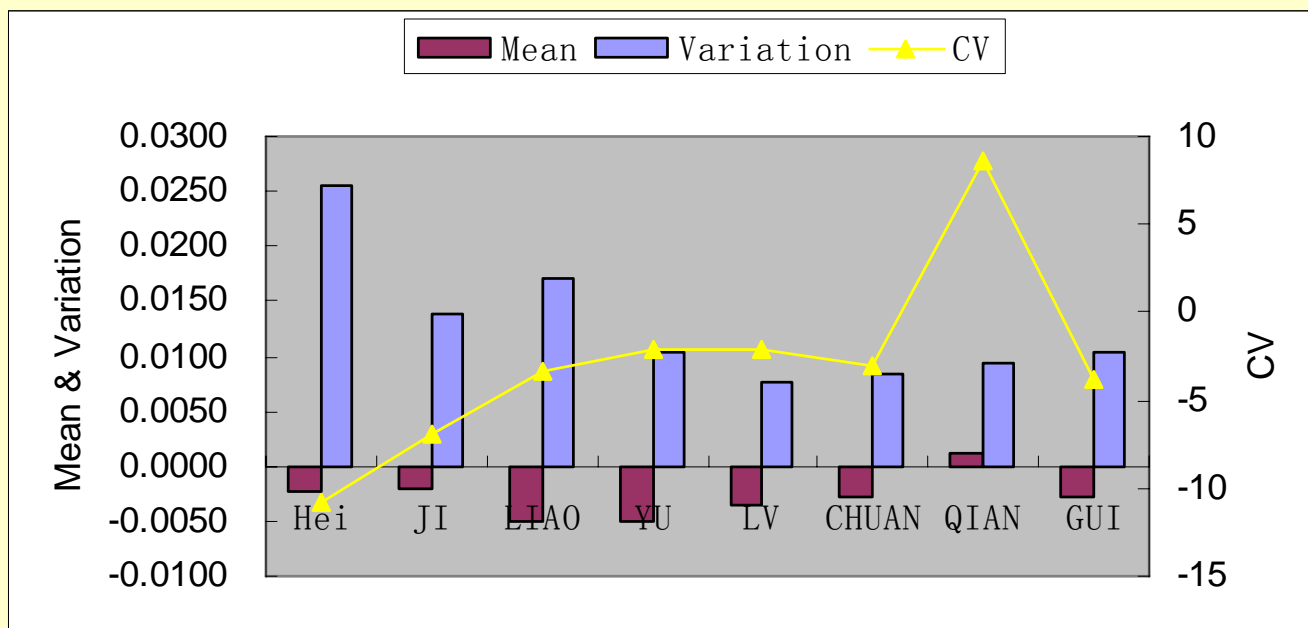
第三步：利用极大似然估计法估计各单产分布的参数，得到各样本的概率密度函数和累积概率密度函数

Analysis results(分析结果)

- RESULT (1)

The yield risk (CV, Mean, Variation) between different regions

不同地区生产风险（均值、方差和变异系数）图示



Analysis results (分析结果)

- RESULTS (2)

The histogram, PDF and yield distribution of these sample is:

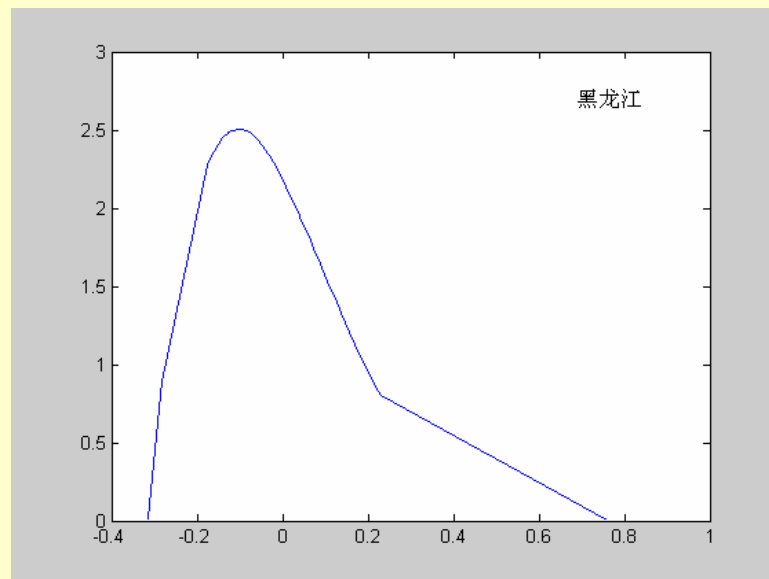
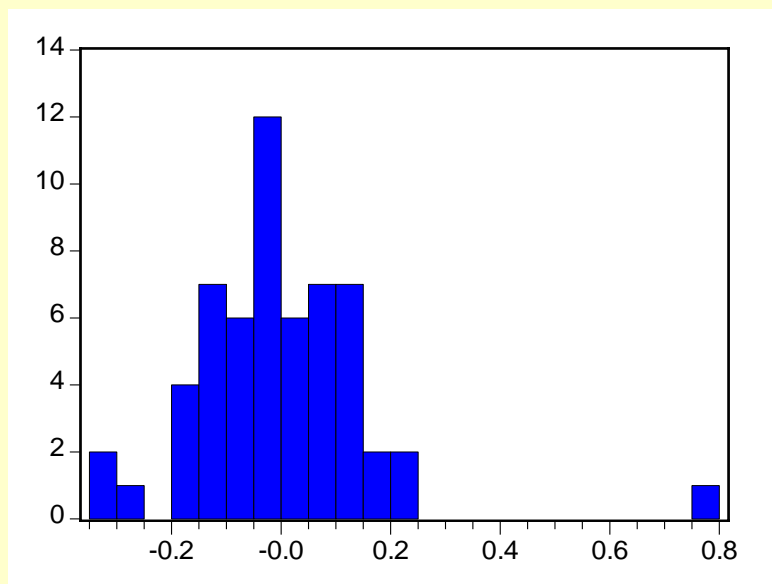
各样本省的单产分布直方图、概率密度函数和单产分布模拟图:

Analysis results(分析结果)

➤ Heilongjiang (Weibull distribution)

黑龙江 (服从Weibull分布)

$$f(x) = 4.2873 \times \left(\frac{x}{1.7575}\right)^{6.5350} \times \exp\left[-\left(\frac{x}{1.7575}\right)^{7.5350}\right]$$

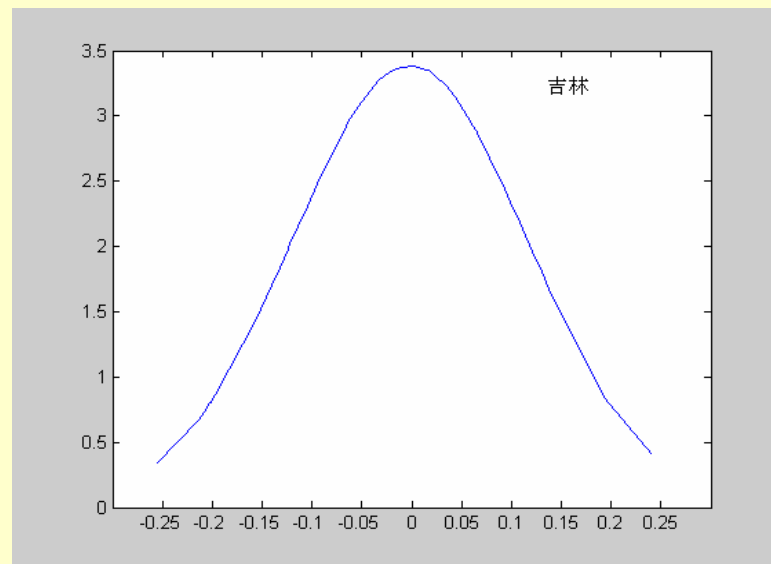
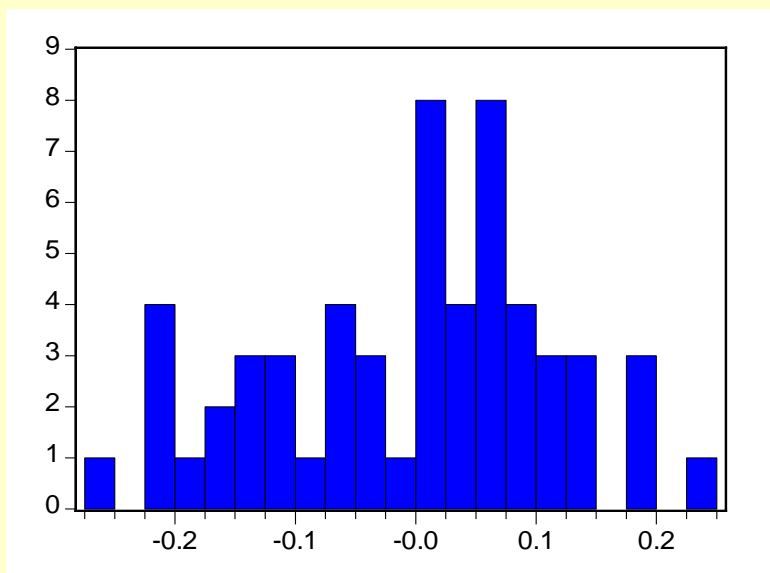


Analysis results (研究结果)

➤ Jilin (Normal distribution)

吉林 (服从正态分布)

$$f(x) = \frac{1}{0.2952} \exp\left[-\frac{(x + 0.002014)^2}{0.0277}\right]$$

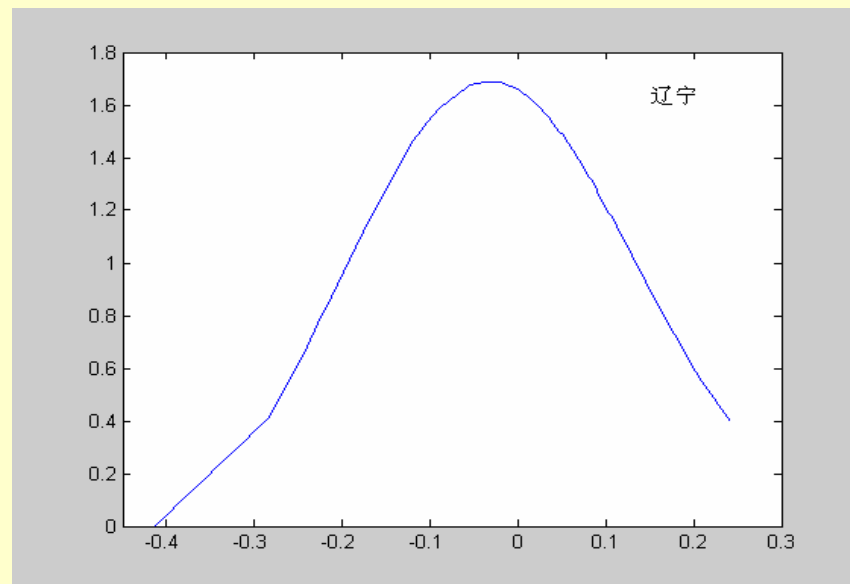
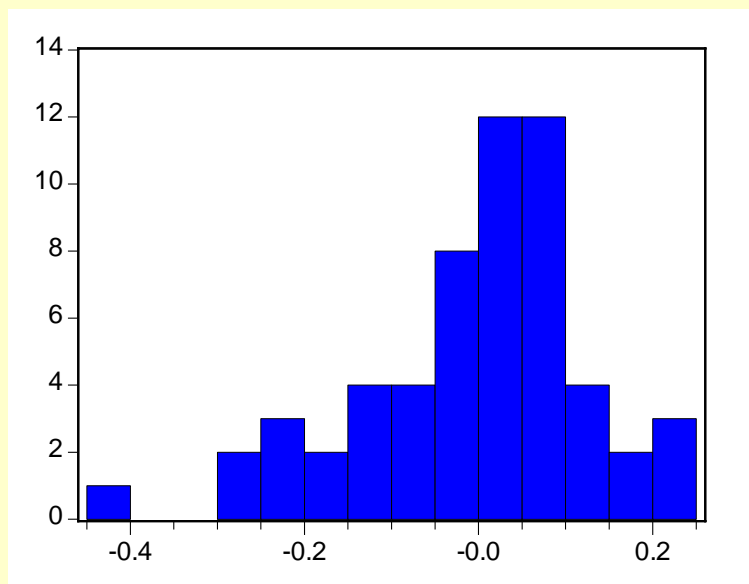


Analysis results (研究结果)

➤ Liaoning (Weibull distribution)

辽宁 (服从Weibull分布)

$$f(x) = 1.0836 \times \left(\frac{x}{2.89}\right)^{2.1316} \times \exp\left[-\left(\frac{x}{2.89}\right)^{3.1316}\right]$$

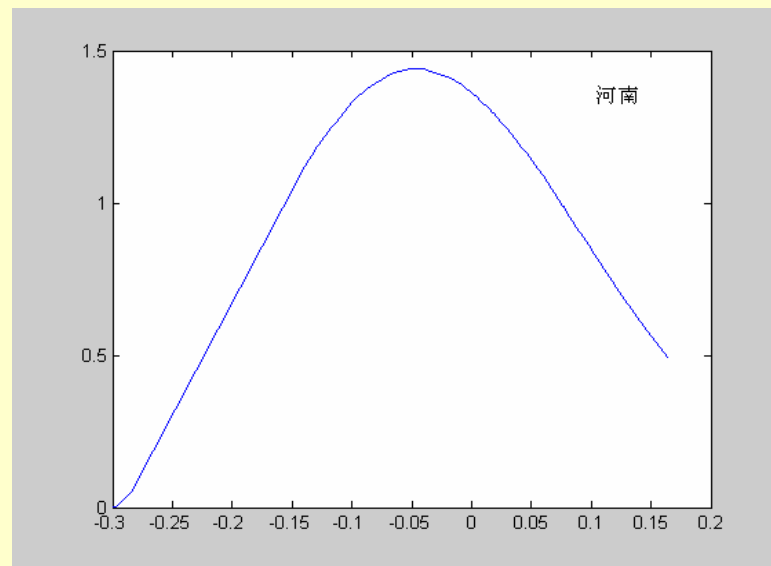
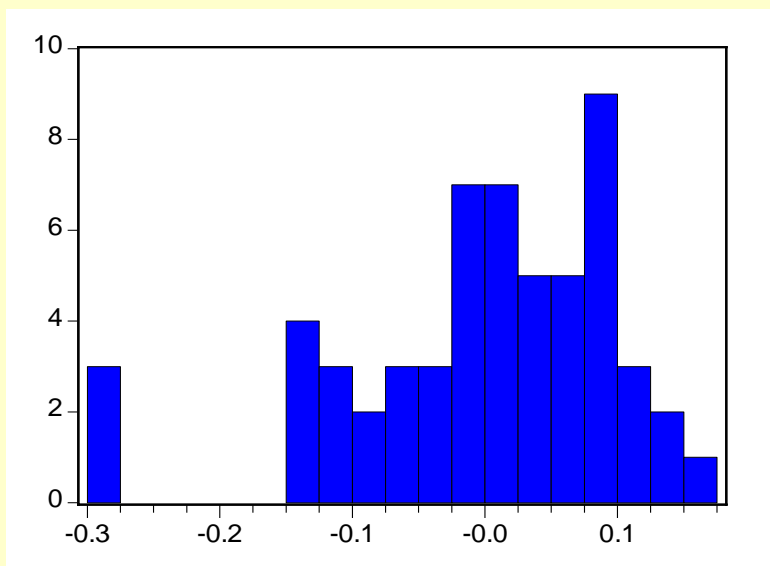


Analysis results (研究结果)

➤ Henan (Weibull distribution)

河南 (服从Weibull分布)

$$f(x) = 1.0455 \times \left(\frac{x}{2.4114}\right)^{1.5212} \times \exp\left[-\left(\frac{x}{2.4114}\right)^{2.5212}\right]$$

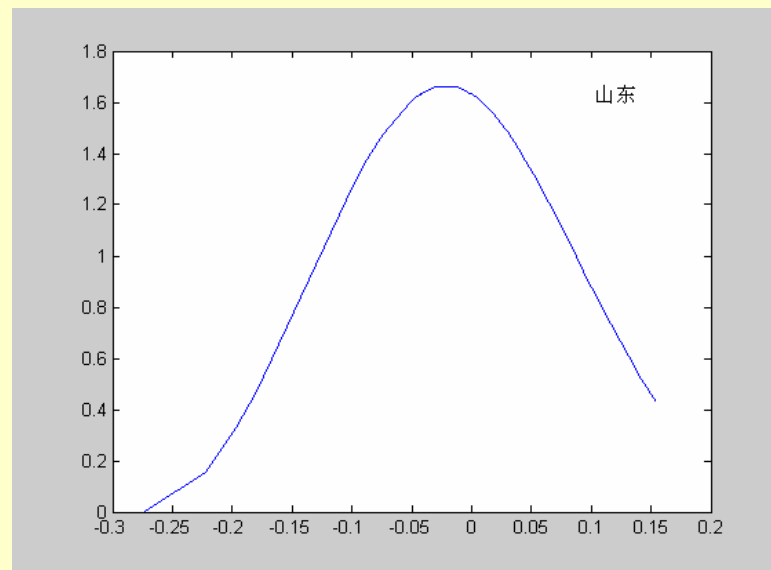
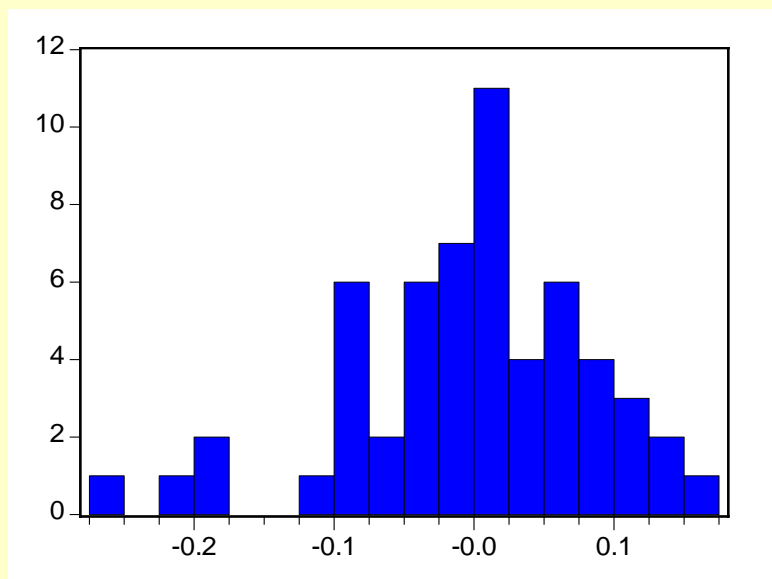


Analysis results (研究结果)

➤ Shandong (Weibull distribution)

山东 (服从Weibull分布)

$$f(x) = 1.0428 \times \left(\frac{x}{2.8814}\right)^{2.0047} \times \exp\left[-\left(\frac{x}{2.8814}\right)^{3.0047}\right]$$

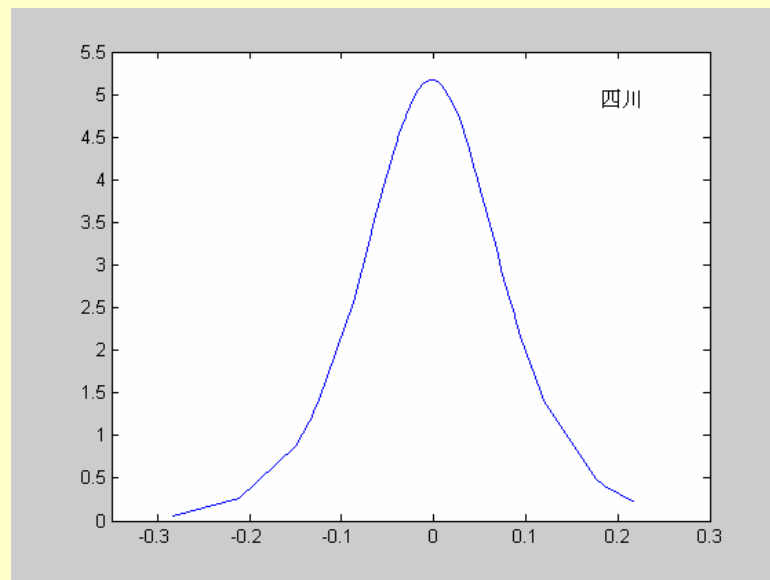
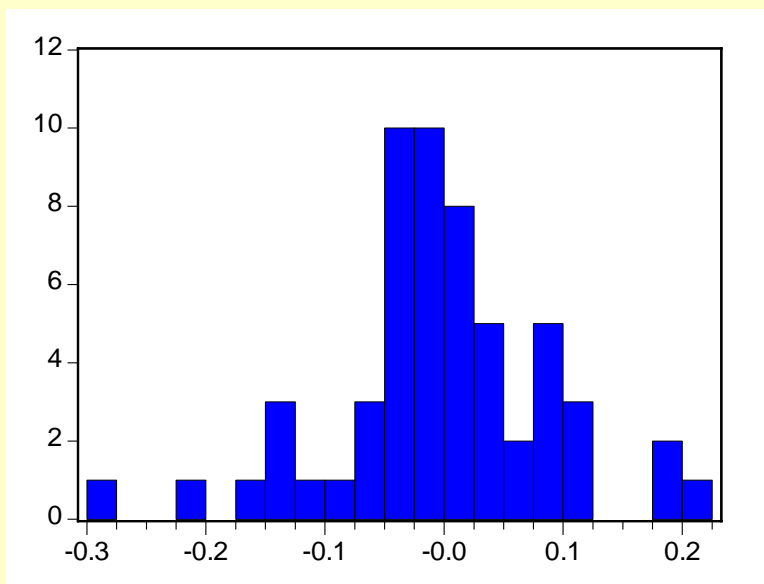


Analysis results (研究结果)

➤ Sichuan (Logistic distribution)

四川 (服从Logistic分布)

$$f(x) = 0.048335 \times e^{-\frac{x+0.002068}{0.048335}} \times \left(1 + e^{-\frac{x+0.002068}{0.048335}}\right)^{-2}$$

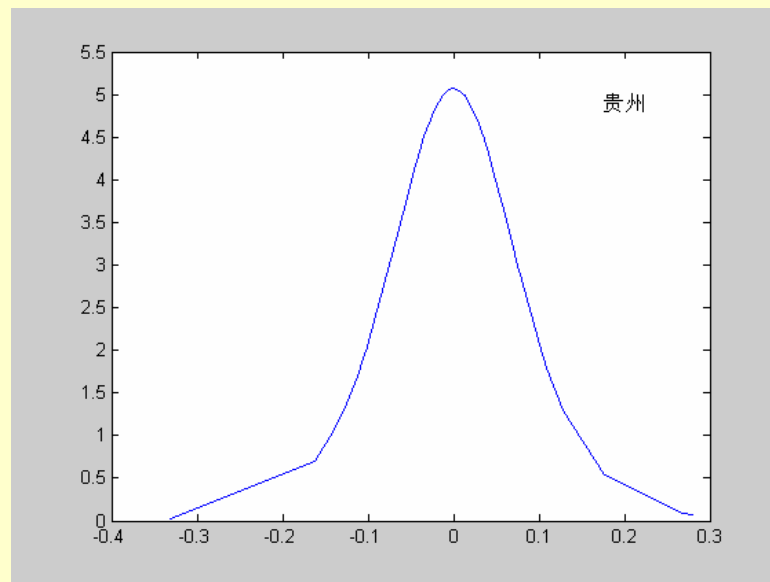
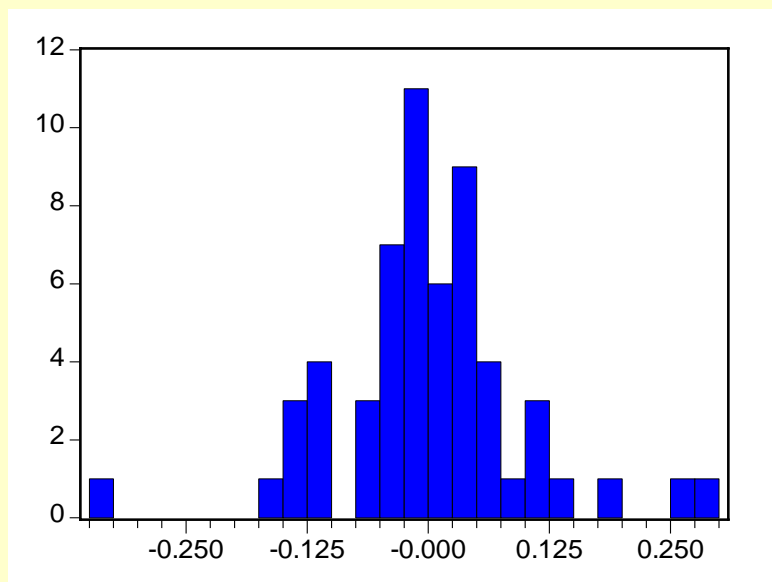


Analysis results (研究结果)

➤ Guizhou (Logistic distribution)

贵州 (服从Logistic分布)

$$f(x) = \frac{1}{0.049286} \times e^{-\frac{x-0.000298}{0.049286}} \times \left(1 + e^{-\frac{x-0.000298}{0.049286}}\right)^{-2}$$

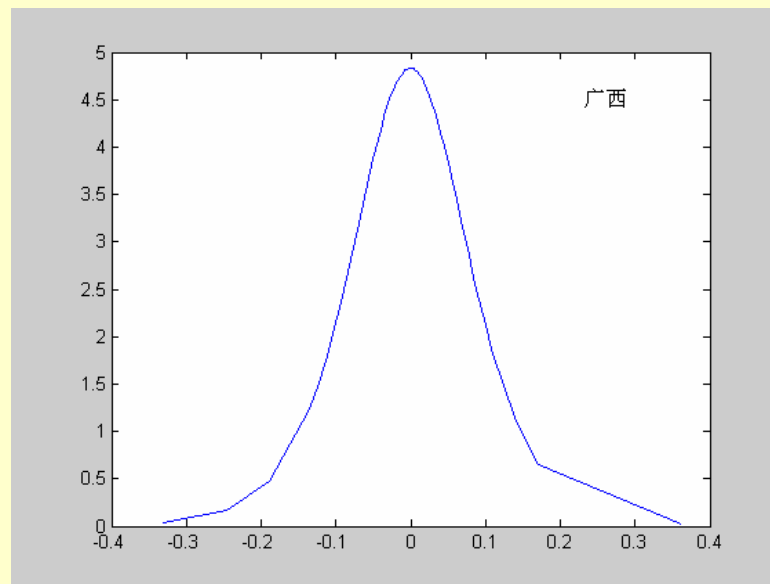
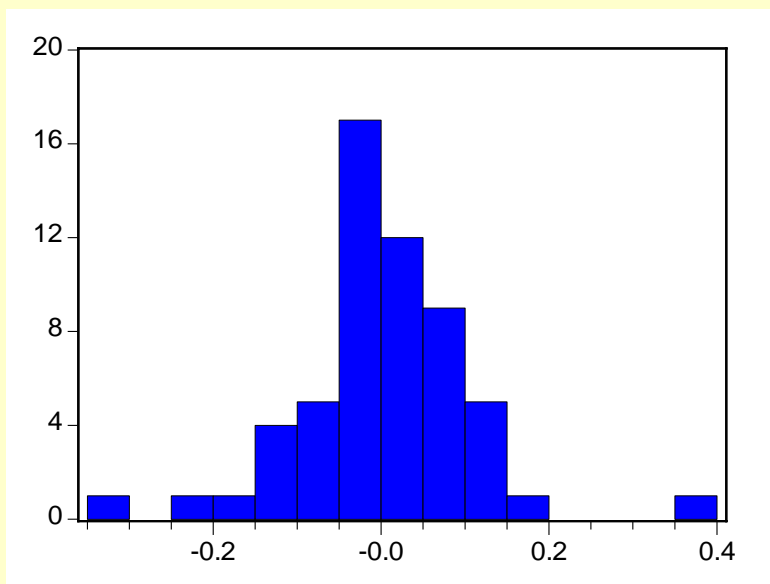


Analysis results (研究结果)

➤ Guangxi (Logistic distribution)

广西 (服从Logistic分布)

$$f(x) = \frac{1}{0.051701} \times e^{-\frac{x+0.000622}{0.051701}} \times \left(1 + e^{\frac{x+0.000622}{0.051701}}\right)^{-2}$$



2. Agricultural risk management

农业风险管理

2.1 Agricultural risk management

农业风险管理

2.2 Agriculture risk management tools

农业风险管理工具

2.3 Framework system of integrated risk management

农业风险管理系统框架设计

2.1 Agricultural risk management

农业风险管理

- **Not eliminate or avoid agricultural risk**
并不是消灭或消除农业风险
- **tradeoffs between changes in risk, expected returns, entrepreneurial freedom, and other variables**
需要在风险、预期回报、经营自主权等因素之间进行权衡
- **Select proper risk management tools for different types of risk**
针对不同的风险类型，要设计不同的风险管理工具
- **Portfolio management**
风险组合管理

2.2 Agriculture risk management tools

农业风险管理工具

- **Agricultural insurance** (农业保险)

- used to disperse the independent risks.

用于分散独立风险

- effective management tool for yield risk in developed countries

发达国家经验已证明，农业保险是生产风险管理的有效工具

- decentralize natural risks suffered by some farmers to a multitude of insurance participators.

将单个农户的灾害转移给众多参保农户承担

- government will offer appropriate subsidiary in finance to advocate the farmers to participate into crop insurance.

政府需要提供合理的费用补贴，以鼓励农户参加农业保险

- **Future market (期货市场)**

- used to transfer and disperse the systemic risks.

- 用于分散和转移系统风险

- effective management tool for price risk in developed countries

- 发达国家经验已证明，期货市场是市场风险的有效管理工具

- Provide Hedge mechanism transfer and decentralize various market risks from numerous producers and operators of agricultural products to speculators in futures market.

- 通过对冲机制，将众多农民的风险转嫁给期货市场投机者

- has the function of price discovery, and can offer scientific and rational price directions to agricultural products' production, processing and circulation.

- 具有发现价格功能，可为农业生产者、加工者和贸易商提供科学合理的价格指导。

- **Contract farming** (订单农业)

- used to transfer and disperse the systemic risks.

- 用于转移和分散系统风险

- effective management tool for market risk in developed countries

- 发达国家经验已证明，订单农业是市场风险管理的有效工具

- Provide Hedge mechanism transfer and decentralize various market risks from numerous farmers to ordering enterprises.

- 通过对冲机制，分散广大农户市场风险给订单企业

- Ordering enterprises also reduce the risk by gaining stable price and supply of agricultural raw materials.

- 通过订单，订单企业也获得稳定的原材料及价格，同样降低了市场风险

- **Catastrophic risk securities** (巨灾风险证券化)

---- used to transfer and disperse the systemic and independent risks .

用于转移和分散系统、独立的风险

---- effective management tool for catastrophic risk in developed countries

发达国家经验证明，发行巨灾证券是巨灾风险的有效管理工具

---- transfer and decentralize the huge risk in capital market by catastrophe securities to people of whole country and world.

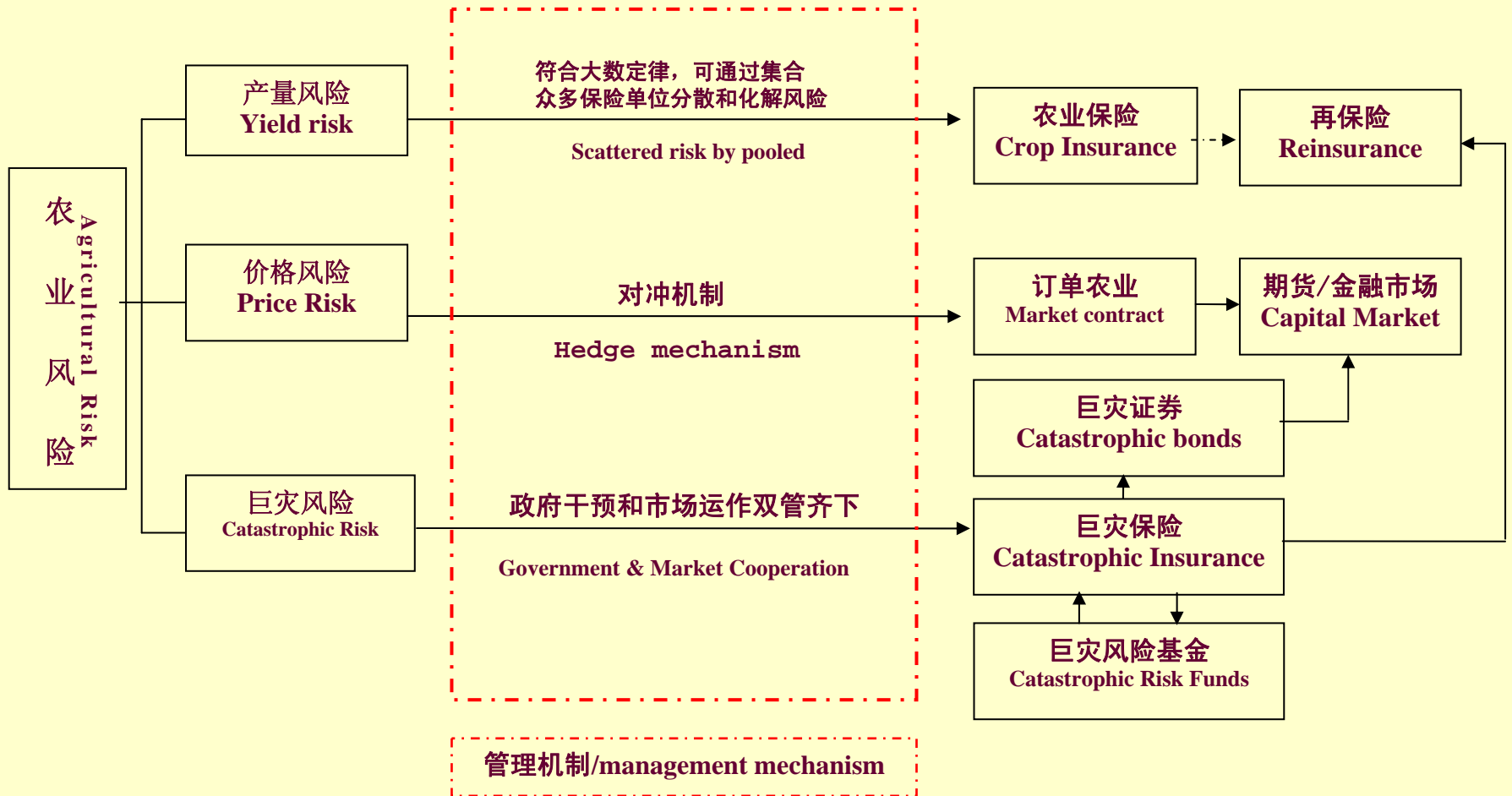
通过资本市场，可将巨灾的风险转移给全国或全球的投机者

---- need to organized by government.

需要政府的组织和参与

2.3 System of integrated Agricultural risk management

农业风险管理系统框架



3. Effectiveness of crop insurance

农业保险效果研究

3.1 Insurance products classification

农业保险产品分类

3.2 Criterion & Approaches

指标和研究方法

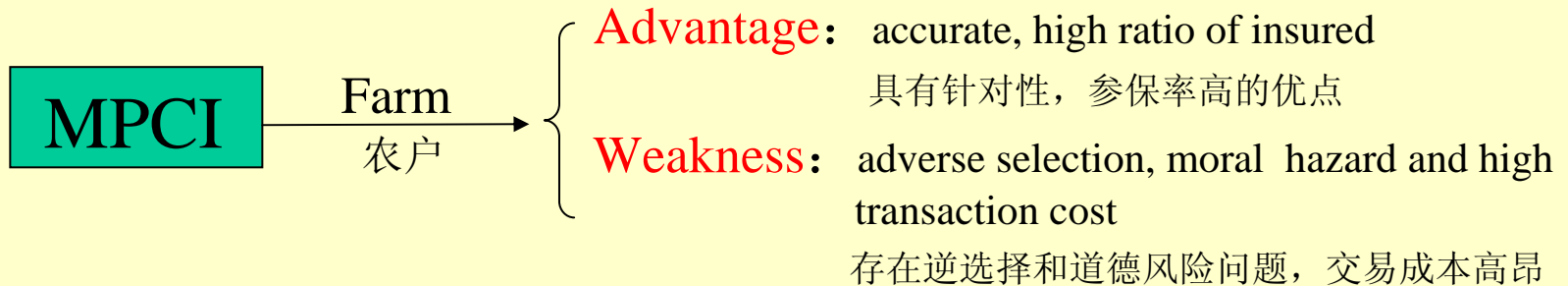
3.3 Empirical study: An example

实证研究的一个案例

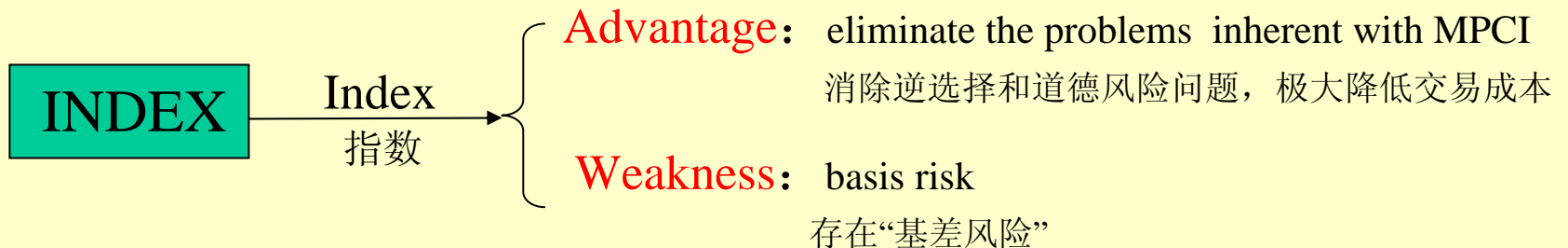
3.1 Insurance products classification

农业保险产品分类

- Traditional insurance, such as MPCICI



- Innovation, such as index insurance



3.2 Criterion & Approaches

指标和研究方法

- Criterion (指标)

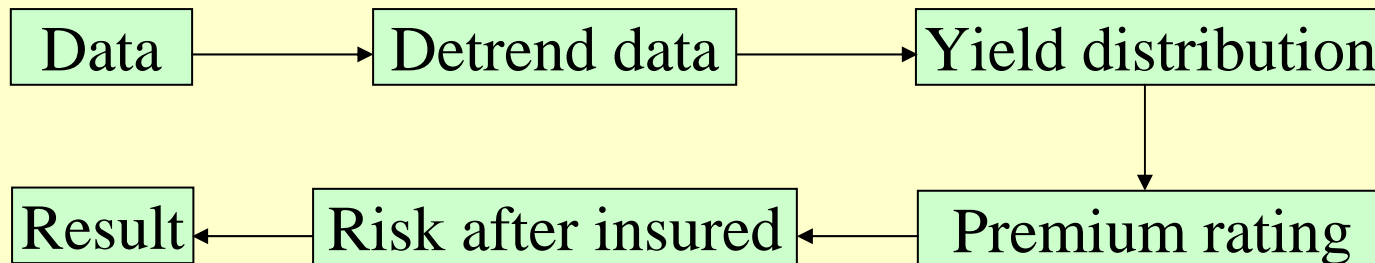
Estimate the insurance effectiveness by their **risk reduction percentage** (Δ_i) and **risk reduction percentage per premium** (U_i).

通过保险产品的风险降低比率和单位保费风险降低比率来衡量其效果

$$\Delta_i = \frac{\text{var}(\tilde{y}_i) - \text{var}(\tilde{y}_i^{net})}{\text{var}(\tilde{y}_i)}$$

$$U_i = \Delta_i / P$$

- Approaches(研究方法)



3.3 Empirical study: An example

实证研究：一个案例

“The Effectiveness Study of Area-based Yield Crop Insurance Application in China”, accepted paper by CES2008 annual conference 。

This paper compared the effectiveness of area-based yield insurance and traditional APH-based yield insurance using the survey data for 97 wheat farmers in Xingtai county and Zaoqiang county of Hebei province in China

《区域指数保险在中国应用的效果研究》，留美经济学会08年年会论文稿
本文利用河北省邢台和枣强县97个小麦生产农户的调查数据对区域指数保险和传统农业保险（MPCI）的效果进行了比较。

3.3 Empirical study: An example

实证研究：一个案例

Results, partly. (部分结果)

Table 1 Effectiveness of MPCl and area-based yield insurance for farmers in Xingtai County

Farm	β_i	Premium		Effectiveness (Δ_i)		Effectiveness (U_i)	
		AYI	MPCI	AYI	MPCI	AYI	MPCI
No.1	1.32	14.8	93.7	10.2%	79.82%	0.68%	0.85%
No.2	1.30	14.8	99.4	7.7%	73.75%	0.52%	0.74%
No.3	1.25	14.8	82.9	24.0%	77.32%	1.62%	0.93%
No.4	0.91	14.8	84.7	6.3%	81.46%	0.43%	0.96%
No.5	0.91	14.8	55.1	27.1%	80.66%	1.83%	1.46%
No.6	0.84	14.8	62.0	30.8%	48.47%	2.08%	0.78%
No.7	0.79	14.8	50.1	43.6%	63.64%	2.93%	1.27%
No.8	0.78	14.8	46.2	16.8%	62.66%	1.13%	1.35%
No.9	0.75	14.8	62.9	15.2%	80.06%	1.02%	1.27%
No.10	0.75	14.8	47.7	33.7%	77.88%	2.27%	1.63%

3.3 Empirical study: An example

实证研究：一个案例

Conclusion

1. Although traditional farm-yield insurance such as MPCl is complex, it seems to be more effectiveness than area-based yield insurance
2. The area-based yield insurance should to be an alternative for policymakers, for it is more competitive if estimated by risk reduction percentage pre premium(17 farmers in Xingtai county and 12 farmers in Zaoqiang county will be more favor with area-based yield insurance)

研究结论

1. 虽然传统多种灾害作物保险（MPCI）有许多问题，但其风险规避效果要好于指数保险
2. 如果从单位保费的风险规避效果看，区域指数保险竞争力增强，邢台和枣强县分别有17个和12个农户的区域指数保险效果要好于传统保险。故，区域指数保险应该成为我国农业保险体系的一员。

