

Mitigating Public Health Risks From Food Supply Chains

Retsef Levi

**J. Spencer Standish (1945) Professor of Operations Management
MIT Sloan School of Management**

**IDEAS MADE TO MATTER – SUMMER SERIES, MIT
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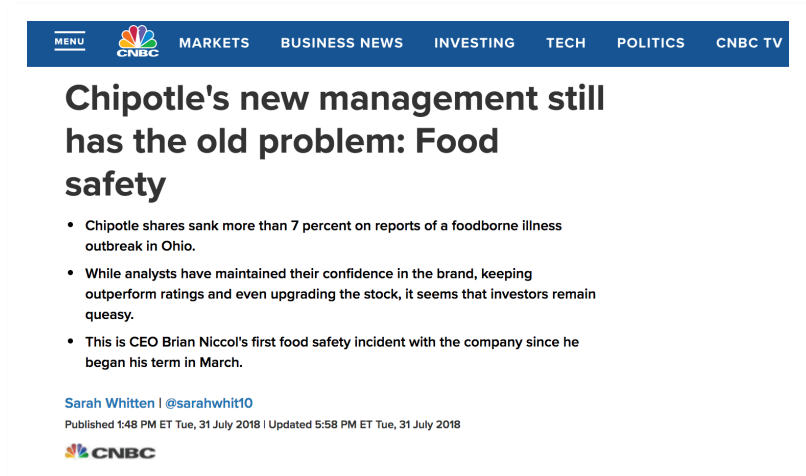
Impact of Food SCs on Human Health

- Food security (~ 700M people worldwide live in hunger)
- Food safety and adulteration (600M illnesses and 420K deaths per year)
- Major two-sided environmental impact (26% of greenhouse emission)
- Source of zoonotic diseases (e.g., COVID-19, SARS, Avian & Swine Flu)

Leveraging SC Analytics and multidisciplinary field research to inform global and local policy in China



Global Challenge of Food Adulteration



Regulatory Perspective:

- Over 40M annual unique food lines imported into United States
- Over 227K food safety incidents in China between 2005 - 2014



Types of Food Adulteration

**Unintentional
Negligence**



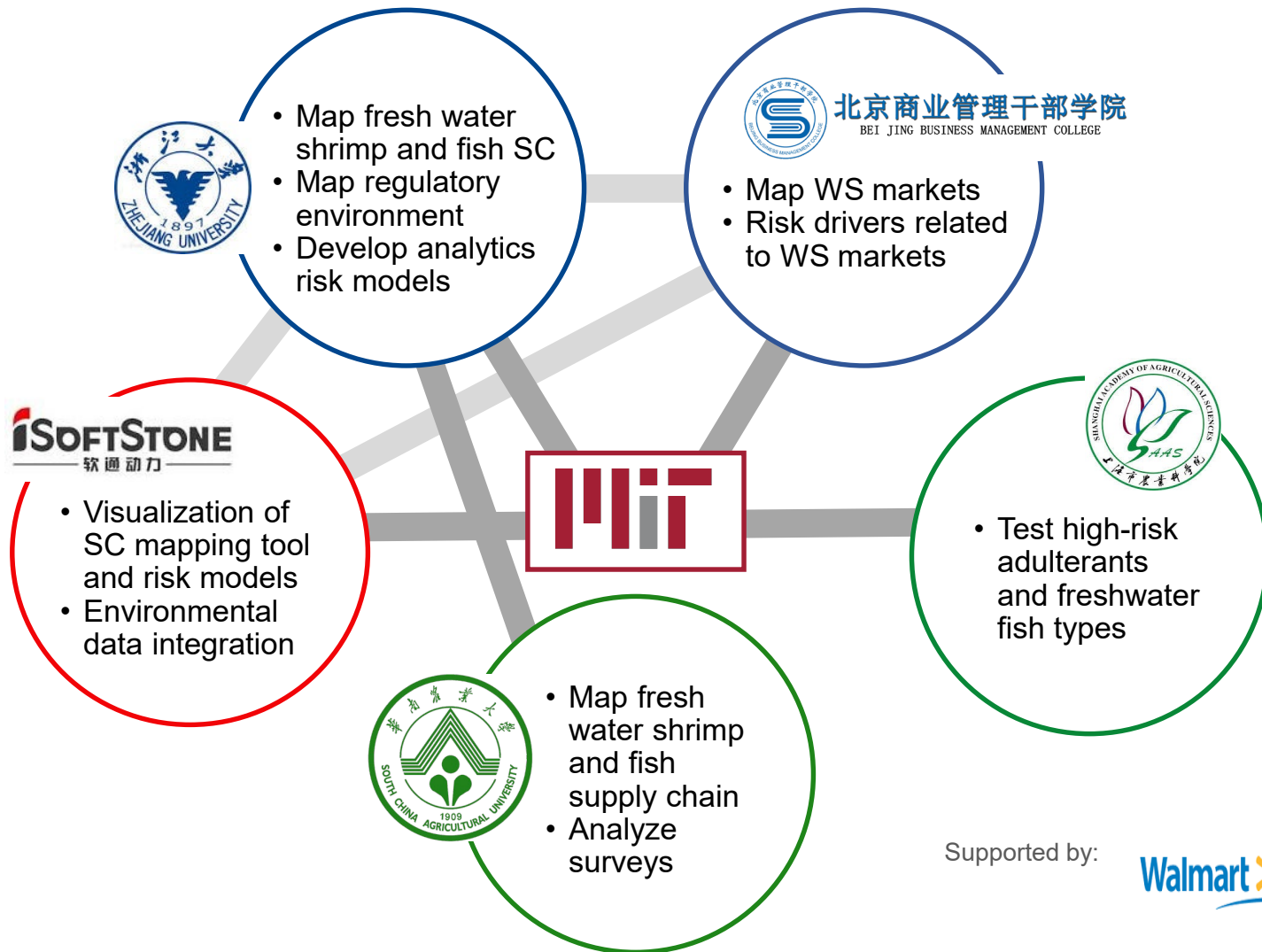
**Economically Motivated
Adulteration (EMA)**



**Terror
motives**



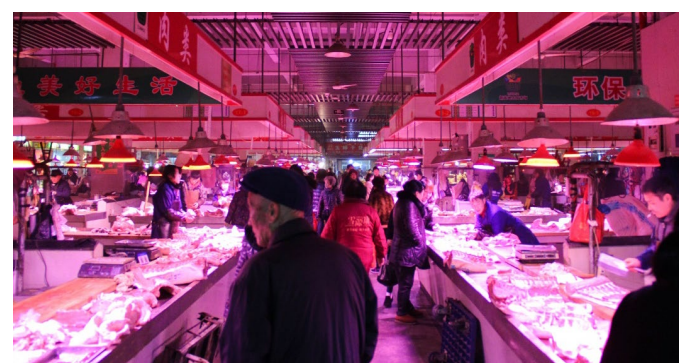
Food Safety Effort in China



Supported by:



On the Ground



CFDA Data Integration



CFDA Interface

Search fields

快速查询

产品抽检
国家食品安全监督抽检 (合格产品)
全部

高级查询

标称生产企业名称
食品名称
分类
公告号

国家食品安全监督抽检 (合格产品)

标称生产企业名称	
标称生产企业地址	
被抽样单位名称	陕西文昌物流有限公司
被抽样单位所在省份	陕西省西安市新城区西一路鑫鑫水产付食综合市场一层4区01号
食品名称	多宝鱼
规格型号	
生产日期/批号	
分类	食用农产品
公告号	2017年第34号
备注	
抽检项目	包括有关公告中规定禁止使用、且在动物性食品中不得检出的禁用药物孔雀石绿、硝基呋喃代谢物、氯霉素。
注	说明：此数据仅指本次抽检标称的生产企业相关产品的生产日期/批号和所检项目

Example Notice

浙江省食品药品监督管理局食品安全监督抽检信息公告 (2017年第4期)



2017年04月17日 发布

根据《中华人民共和国食品安全法》及其实施条例等规定，现将2017年第4期食品安全监督抽检信息公布如下：本次监督抽检涉及3大类食品，包括：水产制品、糕点和糖果制品，抽检样品共计31批次，其中合格26批次，不合格5批次，样品信息详见附件。针对食品安全监督抽检中发现的不合格食品，浙江省食品药品监督管理局已要求有关单位对不合格食品及其生产经营企业进行依法处置。特别提醒消费者，如在本省购买或在市场上发现被通报的不合格产品时，请拨打96317、12315投诉举报电话，或直接到当地市场监管部门投诉、举报。特此公告。

发布部门：浙江省食品药品监督管理局

发布时间：2017年04月12日

[食品抽检合格-20170412](#)

[食品抽检不合格-20170412](#)

Extensive text analytics needed!

- Automated processing (in legal accordance with *robots.txt*)
- Integrated central data, all provinces & 215/334 prefectures
- 4M tests, 60K files (PDF/HTML/Excel/Word), 15k unique data table structures



Structuring the Data

Raw Data

<u>Sampled Location Name</u>	<u>被抽检单位名称</u>
Wenling Songmen Deqing Century Hualian Optional Store	温岭市松门德清世纪华联 自选店

<u>Sampled Location Address</u>	<u>被抽检单位地址</u>
No.261-283 Tianzhu Middle Road, Songmen Town, Wenling City, Taizhou City	台州市温岭市松门镇天竺 中路261-283号

<u>Food Name</u>	<u>食品名称</u>
Small Yellow Croaker	小黄鱼片

<u>Adulterant Free Text</u>	<u>不合格项目 检验结果 标 准值</u>
The total number of colonies 50000CFU/g ≤30000CFU /g; coliform 230MPN/100g ≤30MPN/ 100g	菌落总数 50000CFU/g ≤ 30000CFU/g; 大肠菌群 23 0MPN/100g ≤30MPN/100 g

Processed Data

<u>Sampled Location Type</u>	<u>业务类型</u>
Supermarket	超级市场

<u>Sampled Location Prefecture (City)</u>	<u>州</u>
Taizhou City	台州市

<u>Product Category</u>	<u>分类</u>
Aquatic Products	水产制品

<u>Test Result</u>	<u>测试结果</u>
Failure	失败

<u>Adulterant #1</u>	<u>大肠菌群1</u>
The total number of colonies	菌落总数

<u>Adulterant #2</u>	<u>大肠菌群2</u>
Coliforms	大肠菌群

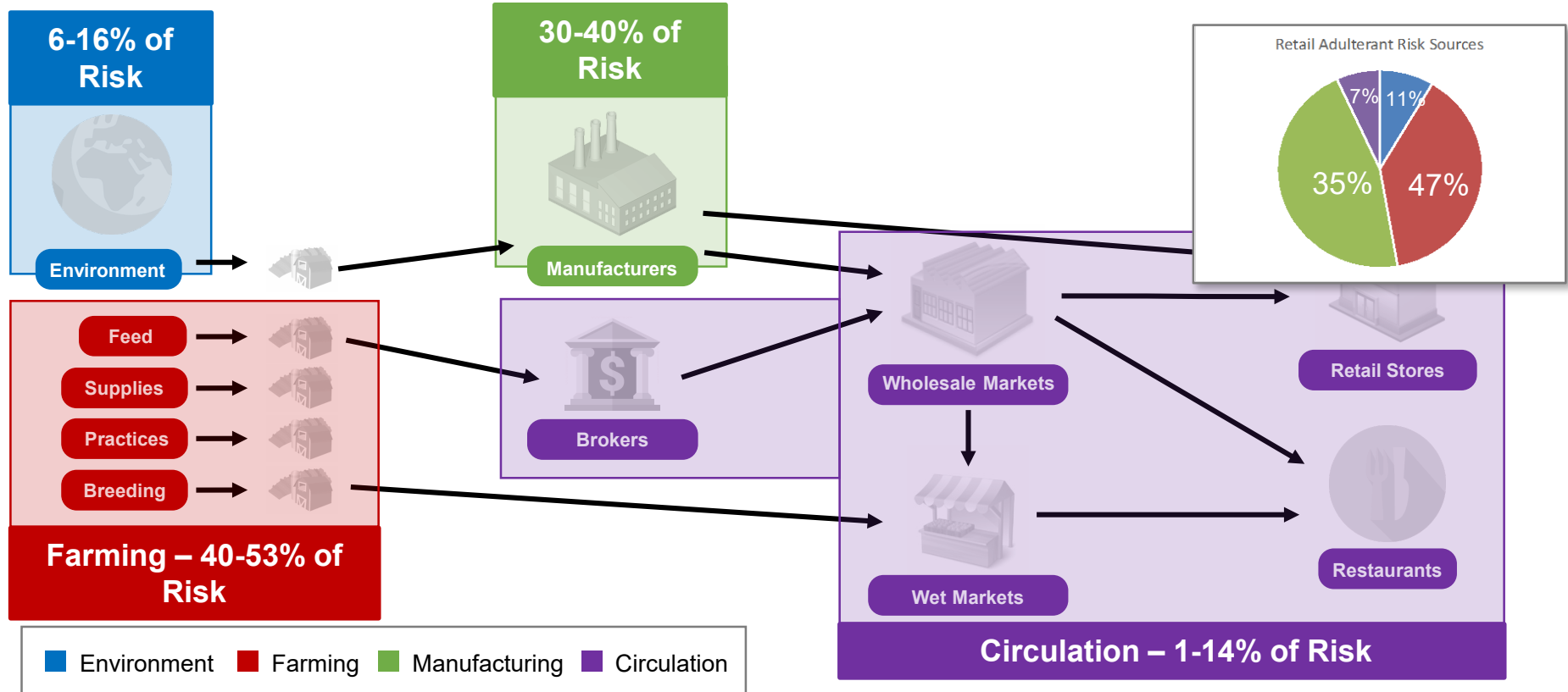
Where was
the test
conducted?

What was
tested?

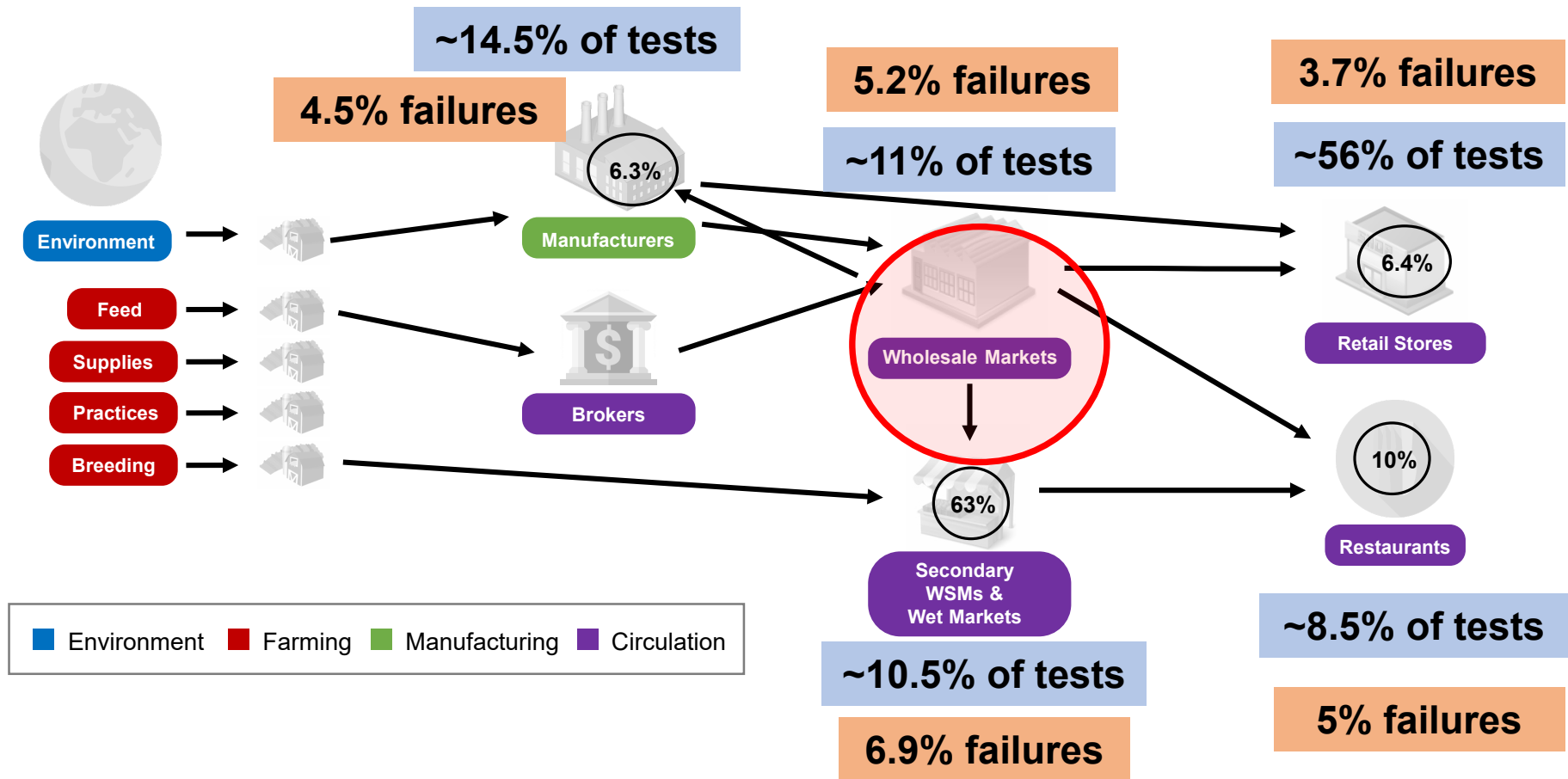
What were
the test
results?



SC Risk-Source Analysis of Aquatic Products



Wholesale Markets

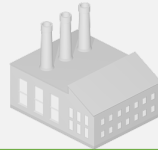


- Wholesales markets are a consolidation point of the SC (70-80% of supply through 4,500 large markets)



SC Risk-Source Analysis of Aquatic

More CFDA Regulatory Testing, Lower Failure Rates, Less Sales Volume
More Adulterant Risk from Manufacturers



Manufacturers
14.5% of Tests
4.5% Failure Rate



Retail Stores
56% of Tests
3.7% Failure Rate



Environment

Feed

Supplies

Practices

Breeding



Brokers



Wholesale Markets
11% of Tests
5.2% Failure Rate



Wet Markets
10.5% of Tests
6.9% Failure Rate



Restaurants
8.5% of Tests
5.0% Failure Rate

Less CFDA Regulatory Testing, Higher Failure Rates,
More Sales Volume
More Adulterant Risk from Farms

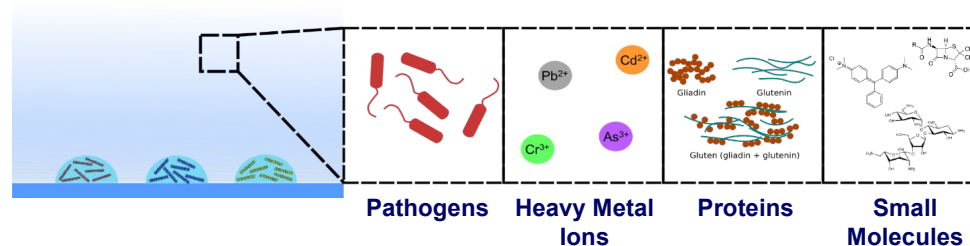


Wholesale Market Monitoring

- Opportunity to monitor supply and create SC transparency
- Challenging logistics and high volume, fast transactions (overnight)



Develop and pilot wholesale market transparency, testing & monitoring (analytics & technology)



Largest WSM Field Survey

Province	#WSM	#Vendors	Freshwater	Marine & processed	Freshwater & Marine
Zhejiang	38	463	289	174	NA
Hunan	39	289	284	4	NA
Guangdong	41	407	188	172	47

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Alignment with Government Policy in China

- Attitude of Chinese Government on Food Safety:
 - President Xi (2014): “food safety issues must be one of the most important priorities of our government.”
- Food Safety Policy (Chinese Central Government, released May 2019):
 - **By 2020**, Establish a risk analysis and supply chain management based food safety regulatory system.
 - **By 2035**, Modernize the national governance system and capacity in the field of food safety.
- Food Regulatory Policy (SAMR, Feb 2019)
 - Strengthen random inspections in key areas such as wholesale markets and campus to increase the problem discovery rate.



Zoonotic Diseases in Wholesale/Wet Markets in China



New coronavirus outbreak in Beijing linked to market



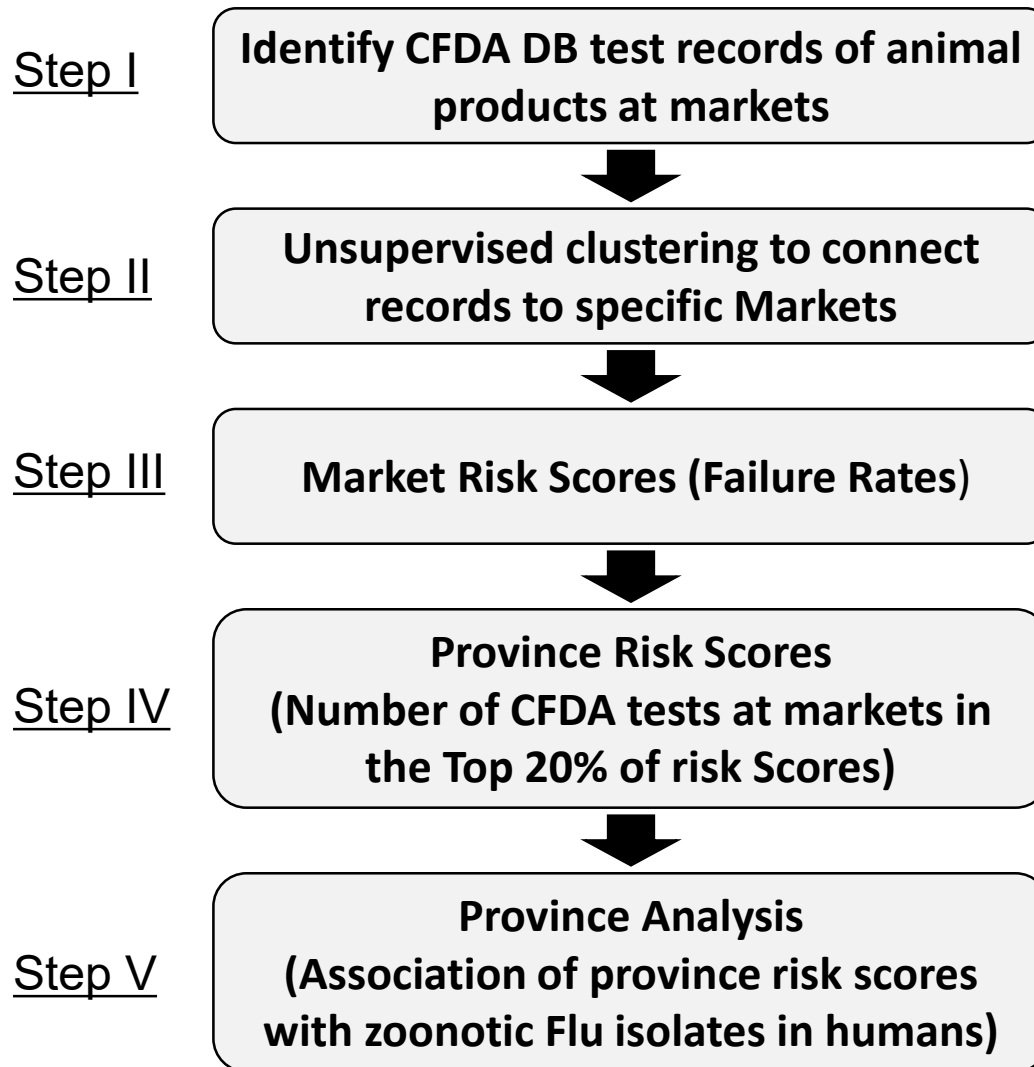
- Wholesale and wet markets in China are a common source of zoonotic diseases outbreaks (COVID-19, SARS, Avian/Swine Flu)
- Correlation between zoonotic disease risks to food safety & adulteration?

Common system-level environmental & management deficiencies

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Analysis Roadmap



Associating CFDA Tests with Markets

Step 0.

Location Name

武汉华南海鲜高氏水产批发部

Wuhan Huanan Seafood Gaoshi Aquatic Wholesale Department

Step 1.

Identify Constituent
Parts (Geographic
and Market
Keywords)

武汉
Wuhan

*Geographic
Keyword*

华南海鲜高氏
Huanan Seafood Gaoshi

水产批发
Aquatic Wholesale

*Market
Keyword*

部
Department

Step 2.

Identify 'Potential Proper
Name' (Between
Geographic and Market
Keywords)

华南海鲜高氏
Huanan Seafood Gaoshi

Step 3.

Tokenization of 'Potential
Proper Name' for Jaccard
Similarity Score

华南海鲜
Huanan Seafood

高氏
Gaoshi

- Accuracy: 90-93%, manually evaluated across three provinces



Association with Zoonotic Disease

- Is volume of animals passing through high-risk markets associated with zoonotic disease outbreaks by province?

Regression Variables
<u>Dependent Variable:</u> Zoonotic Isolates in Humans per Province
<u>Independent Variable:</u> CFDA Tests at High-Risk Markets
<u>Control Variables:</u> CFDA Tests at All Markets CFDA Failures at All Markets CFDA Failure Rate at All Markets Production & Slaughter Statistics Average Daily High Temperature

- Best Model (AIC improvement vs benchmark $p < 1 * 10^{-3}$)

Coefficient	Estimate	P-value
<u>CFDA Tests at High-Risk Markets</u>	0.0435	$2.22 * 10^{-6}$
Total Meat Production	-0.0278	0.114



Concluding Comments

- Analytics & AI based decision support tools to guide risk-based sampling at the SC source:
 - High risk SC locations
 - High-risk Companies/markets
- Leveraging technology (IT-platforms) to create transparency in the supply chain (Focus on WSMs)
- Association between food safety & adulteration and zoonotic diseases suggests that there are potential important synergies in aligning risk management and policy interventions in the two domains



Food SC Analytics & Sensing Initiative

Analytics & Technology to Optimize and Improve Global and Local Food Supply Chains

Supply chain & market design and optimization

Management of food safety and adulteration risks

Access to healthy food

Farmers & consumers welfare

Agriculture Practices

Predictive risk models & tools

Testing technologies

Food deserts

Food waste

<https://mitsloan.mit.edu/centers-initiatives/food-supply-chain-analytics-and-sensing-initiative/about>

