Upstream and downstream disruptions along the high-value foods supply chain in emerging countries

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Outline

Motivation (1)

- Emerging countries:
  - High path of economic growth. (Reinhart and Rogoff, 2010; Sheth, 2011)
  - Increasing share of middle-income population. (Ravallion, 2010)
- Increasing share of high-value food consumption:
  - Food crops that are high in value per calorie, per kilogramme or per hectare. (Skoufias et al., 2011)

Motivation (2)

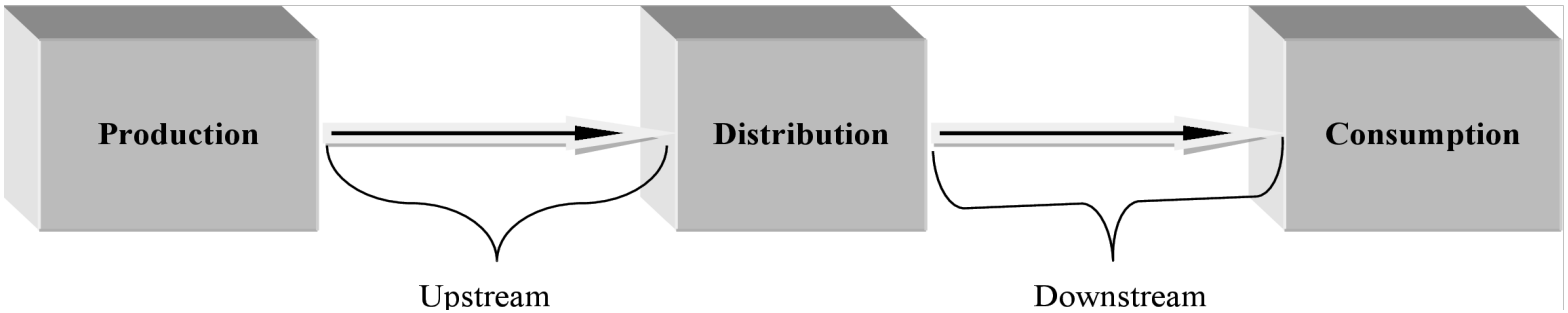
- High-value foods brought to consumers from food supply chain
- Food supply chain: Movement of food from production through sources of distribution to the final consumption (Rong et al., 2011)

Figure 1: General framework of the food value chain

Motivation (3)

- Disruption to food supply chain:
  - Event that disrupts the flow of food along the supply chain (Ambulkar et al., 2015)
  - 2 types: internal (within chain)and external (environment of operation)

Figure 2: Areas of the food value chain exposed to disruptions



Background Literature (1)

- Supply chain disruption is a multifaceted phenomenon:
  - Bode and Wagner, (2015). *Journal of Operations Management*
  - Clemons and Slotnick, (2016). *International Journal of Production Economics*
- Internal food chain disruptions:
  - Changing and volatile food prices: Bellemare, (2014). *American Journal of Agricultural Economics*
  - Production processes and turbulences experienced by suppliers: Trkman and McCormack, (2009). *International Journal of Production Economics*
  - Disparities in pricing and contracting powers: Bellemare and Novak, (2017). *American Journal of Agricultural Economics*; Wagner and Neshat, (2012). *International Journal of Production Economics*

Background literature (2)

- External food chain disruptions:
  - Natural disasters: Vlajic et al., (2012). *International Journal of Production Economics*
  - Stringent regulatory framework: Augier et al., (2005). *Economic Policy*; Maertens and Swinnen, (2009). *World Development*
  - International macroeconomic shocks: Scrimgeour, (2014). *American Journal of Agricultural Economics*; Richards and Pofahl, (2009).*American Journal of Agricultural Economics*
  - Political: Gereffi, (2014). *Review of International Political Economy*

Research question

Gaps in literature:

- Focus of current literature on upstream disruptions
- This may suggest that upstream disruptions are more important than downstream disruptions
- Lack of analysis on how upstream disruptions differ from downstream disruptions along the high-value food supply chain

Research question

Is the magnitude of disruptions along the high-value food chain in emerging countries higher upstream than downstream?

- Sources of disruption: changes in producer prices, consumer prices, produced quantity, households food consumption expenditure, political instability, regulatory framework, transport accidents and natural disasters

Hypotheses

Hypothesis 1

High-value food chain disruption caused by natural disasters upstream are higher than disruption caused downstream.

Hypothesis 2

In emerging countries, dynamics in producer prices have a bigger impact on consumer access to high-value foods from distributors than dynamics in consumer prices.

Hypothesis 3

Disruptions from institutional and political dynamics along the high-value food chain are higher upstream than downstream.

Data

- Panel of 10 emerging countries over 14 years (2000-2013)
- Data covers 6 high-value food markets: red meat, eggs, fresh fruits and vegetables, dairy and fat & oil

Data sources

Data and sources		
Variable	**Definition**	**Source**
Dependent variable		
SALE	Total quantity of high-value food sold	Euromonitor International
Independent variables		
PROD	Quantity of red high-value food produced	Food and Agriculture Organisation of the United Nations (FAO)
PPI	Producer Price Index of high-value food	Food and Agriculture Organisation of the United Nations (FAO)
CPI	Consumer Price Index of high-value food	Country statistical and agricultural departments
POL	Political stability index	World Bank Worldwide Governance Indicators (WGI)
REG	Regulatory quality index	World Bank Worldwide Governance Indicators (WGI)
TRANSPORT	Number of transport accidents	EM-DAT database Centre for Research on the Epidemiology of Disasters
NATURAL	Natural disaster ocurrences	EM-DAT database Centre for Research on the Epidemiology of Disasters
GOVT	Government expenditure on agriculture	Statistics of Public Expenditure for Economic Development (SPEED)
EXRATE	US dollar-local currency exchange rate	World Bank World Development Indicators
EXPEND	Household food consumption expenditure	United Nations Statistics Division (UNSD)
HHNUM	Number of households	Euromonitor International

Methodology (1)

Simultaneous equations modelling (SEM)

- SEM due to endogeneity between production and sales and between sales and consumption

$$\begin{cases} \ln PROD_{it} = \alpha_1 \ln SALE_{it} + \alpha_2 PPI_{it} + \alpha_3 \ln GOVT_{it} + \alpha_4 NATURAL_{it} + \alpha_5 TRANSPORT_{it} + \alpha_6 REG_{it} + \alpha_7 POL_{it} + a_{i1} + u_{1it} \\ \ln SALE_{it} = \beta_1 \ln PROD_{it} + \beta_2 PPI_{it} + \beta_3 CPI_{it} + \beta_4 POL_{it} + \beta_5 REG_{it} + \beta_6 TRANSPORT_{it} + \beta_7 NATURAL_{it} + a_{i2} + u_{2it} \end{cases}$$

$$i = 1,\ldots,N \; ; \; t = 1,\ldots,T \qquad (1)$$

$$\begin{cases} \ln EXPEND_{it} = \alpha_{11} \ln SALE_{it} + \alpha_{22} CPI_{it} + \alpha_{33} TRANSPORT_{it} + \alpha_{44} REG_{it} + \alpha_{55} POL_{it} + \alpha_{66} \ln HHNUM_{it} + a_{i3} + u_{3it} \\ \ln SALE_{it} = \beta_{11} \ln EXPEND_{it} + \beta_{22} CPI_{it} + \beta_{33} POL_{it} + \beta_{44} REG_{it} + \beta_{55} TRANSPORT_{it} + \beta_{66} NATURAL_{it} + \beta_{77} \ln EXRATE_{it} + a_{i4} + u_{4it} \end{cases}$$

$$i = 1,\ldots,N \; ; \; t = 1,\ldots,T \qquad (2)$$

- Potential instruments (Wooldridge, 2015):
  - Equation (1): Government expenditure and regulatory quality
  - Equation (2): Number of households and natural disaster occurrence

Methodology (2)

- Fist-difference form:
  - To remove individual effects (a_{i1} and a_{i2}) in (1) and (2)

$$\begin{cases} \Delta lnPROD_{it} = \alpha_1 \Delta lnSALE_{it} + \alpha_2 \Delta PPI_{it} + \alpha_3 \Delta lnGOVT_{it} + \alpha_4 \Delta NATURAL_{it} + \alpha_5 \Delta TRANSPORT_{it} + \alpha_6 \Delta REG_{it} + \alpha_7 \Delta POL_{it} + \Delta u_{1it} \\ \Delta lnSALE_{it} = \beta_1 \Delta lnPROD_{it} + \beta_2 \Delta PPI_{it} + \beta_3 \Delta CPI_{it} + \beta_4 \Delta POL_{it} + \beta_5 \Delta REG_{it} + \beta_6 \Delta TRANSPORT_{it} + \beta_7 \Delta NATURAL_{it} + \Delta u_{2it} \end{cases}$$

$$i = 1,\ldots,N \; ; \; t = 1,\ldots,T \qquad (3)$$

$$\begin{cases} \Delta lnEXPEND_{it} = \alpha_{11} \Delta lnSALE_{it} + \alpha_{22} \Delta CPI_{it} + \alpha_{33} \Delta TRANSPORT_{it} + \alpha_{44} \Delta REG_{it} + \alpha_{55} \Delta POL_{it} + \alpha_{66} \Delta lnHHNUM_{it} + \Delta u_{3it} \\ \Delta lnSALE_{it} = \beta_{11} \Delta lnEXPEND_{it} + \beta_{22} \Delta CPI_{it} + \beta_{33} \Delta POL_{it} + \beta_{44} \Delta REG_{it} + \beta_{55} \Delta TRANSPORT_{it} + \beta_{66} \Delta NATURAL_{it} + \beta_{77} \Delta lnEXRATE_{it} + \Delta u_{4it} \end{cases}$$

$$i = 1,\ldots,N \; ; \; t = 1,\ldots,T \qquad (4)$$

Results (1): Upstream

Dependent variable: ln($SALE\_MEAT$)		
Variable	Coefficient(SE)	Coefficient(SE)
ln($MEAT\_PROD$)	0.851***(0.027)	0.268***(0.073)
MEAT_PPI	0.002**(0.001)	0.001***(0.004)
POL	-0.002(0.075)	0.093*(0.073)
REG	-0.332*(0.146)	0.0001(0.064)
TRANSPORT	0.005(0.008)	-0.014***(0.004)
NATURAL	-0.01***(0.003)	0.0003(0.003)
Country dummies	No	Yes
Adjusted R-squared	0.974	0.996
F-statistic	861.52***	2137.03***
No. of observations	140	140
BPtest	26.003**	101.69***
PGtest	104.9***	81.493***

Dependent variable: ln($SALE\_EGGS$)		
Variable	Coefficient(SE)	Coefficient(SE)
ln($EGGS\_PROD$)	0.507***(0.057)	0.413***(0.093)
EGGS_PPI	0.005*(0.002)	0.002***(0.0002)
POL	-0.11(0.141)	0.053*(0.031)
REG	0.097(0.278)	-0.065(0.056)
TRANSPORT	0.039***(0.015)	-0.007**(0.003)
NATURAL	0.054***(0.010)	0.001(0.001)
Country dummies	No	Yes
Adjusted R-squared	0.915	0.998
F-statistic	249.245***	4116.72***
No. of observations	140	140
Bptest	36.833***	65.577***
Pgtest	85.158***	50.664***

Dependent variable: ln($SALE\_VEG$)		
Variable	Coefficient(SE)	Coefficient(SE)
ln($DAIRY\_PROD$)	0.660***(0.048)	-0.06(0.093)
VEG_PPI	-0.0002(0.001)	0.001**(0.0004)
POL	0.391***(0.084)	0.021(0.034)
REG	-0.871***(0.196)	-0.018(0.060)
TRANSPORT	0.018*(0.008)	-0.016***(0.003)
NATURAL	0.025**(0.007)	-0.002(0.002)
Country dummies	No	Yes
Adjusted R-squared	0.945	0.997
F-statistic	399.74	4000.71***
No. Of observations	140	140
Bptest	17.346**	77.44***
Pgtest	94.255***	87.788***

Dependent variable: ln($SALE\_DAIRY$)		
Variable	Coefficient(SE)	Coefficient(SE)
ln(VEG_PROD)	0.391***(0.015)	1.022***(0.159)
DAIRY_PPI	-0.001(0.001)	-0.001(0.001)
POL	0.376***(0.111)	0.055(0.087)
REG	-1.469***(0.203)	0.091(0.200)
TRANSPORT	-0.033***(0.009)	-0.016(0.009)
NATURAL	0.014**(0.005)	-0.003(0.003)
Country dummies	No	Yes
Adjusted R-squared	0.921	0.987
F-statistic	270.497***	685.831***
No. Of observations	140	140
Bptest	12.282	124.96***
Pgtest	51.991***	11.249

Results (2): Downstream

Dependent variable: ln($SALE\_MEAT$)			Dependent variable: ln($SALE\_EGGS$)		
Variable	Coefficient(SE)	Coefficient(SE)	Variable	Coefficient(SE)	Coefficient(SE)
ln($EXPEND$)	0.458***(0.099)	0.148*(0.056)	ln($EXPEND$)	0.623***(0.095)	0.116*(0.056)
MEAT_CPI	0.004(0.004)	0.001(0.001)	EGGS_CPI	0.004(0.002)	0.001*(0.001)
POL	1.213***(0.147)	0.083*(0.038)	POL	0.801***(0.156)	0.08*(0.036)
REG	-2.265***(0.369)	-0.034(0.057)	REG	-1.361***(0.343)	-0.198***(0.051)
TRANSPORT	-0.009(0.019)	-0.014***(0.004)	TRANSPORT	0.039*(0.023)	-0.011*(0.004)
NATURAL	0.045***(0.010)	0.0004(0.196)	NATURAL	0.061***(0.013)	-0.001(0.002)
ln($EXRATE$)	-0.083*(0.046)	0.093(0.0815)	ln($EXRATE$)	-0.013(0.037)	-0.046(0.095)
Country dummies	No	Yes	Country dummies	No	yes
Adjusted R-squared	0.821	0.995	Adjusted R-squared	0.865	0.996
F-statistic	92.588***	1859.7***	F-statistic	128.073***	2569.89***
No. of observations	140	140	No. of observations	140	140
Bptest	29.964***	104.8***	Bptest	31.551**	70.961***
Pgtest	82.354***	76.169***	Pgtest	78.371***	55.825***

Dependent variable: ln($SALE\_VEG$)			Dependent variable: ln($SALE\_DAIRY$)		
Variable	Coefficient(SE)	Coefficient(SE)	Variable	Coefficient(SE)	Coefficient(SE)
ln($EXPEND$)	0.768***(0.098)	0.104*(0.045)	ln($EXPEND$)	0.858***(0.088)	0.328**(0.101)
VEG_CPI	-0.001(0.006)	-0.0002(0.001)	DAIRY_CPI	0.008(0.006)	0.003(0.002)
POL	0.464*(0.189)	0.015(0.032)	POL	1.134***(0.131)	-0.04(0.067)
REG	-0.889*(0.386)	-0.113*(0.049)	REG	-0.992**(0.302)	0.469**(0.149)
TRANSPORT	0.062*(0.024)	-0.119**(0.004)	TRANSPORT	0.072***(0.019)	-0.028**(0.009)
NATURAL	0.072***(0.016)	-0.003(0.002)	NATURAL	-0.001(0.012)	-0.002(0.004)
ln($EXRATE$)	0.009(0.034)	-0.048(0.072)	ln($EXRATE$)	-0.027(0.031)	0.268*(0.161)
Country dummies	NO	yes	Country dummies	No	Yes
Adjusted R-squared	0.858	0.998	Adjusted R-squared	0.801	0.981
F-statistic	121.541***	4231.61	F-statistic	80.018***	422.271***
No. Of observations	140	140	No. Of observations	140	140
Bptest	9.745	74.751***	Bptest	24.001***	178.59***

Concluding comments

- Study highlights upstream and downstream food chain disruptions
- Disruptions generally larger downstream than upstream
- Natural disaster significant only without country dummies
- Producer Price Index significant in most markets. Opposite for Consumer Price Index
- Regulatory framework effect higher and more significant downstream
- Future research:
  - How food chain actors adapt to these disruptions
  - Chapter 2: Relationship between high-value food waste, producer and consumer prices
  - Chapter 3: Price volatility transmission from producer,wholesale and retail prices

Thank You

Annex 1

- **Upstream results: fruits and fat & oil**

Dependent variable: ln($SALE\_FRUITS$)		
Variable	Coefficient(SE)	Coefficient(SE)
ln($FRUITS\_PROD$)	0.648***(0.087)	0.166(0.103)
FRUITS_PPI	-0.0004(0.002)	0.002***(0.003)
POLITICAL_STAB	0.381**(0.133)	0.073(0.047)
REG_QUALITY	-1.306***(0.355)	0.005(0.092)
TRANSPORT_ACC	-0.003(0.013)	-0.015***(0.004)
NATURAL	0.029***(0.008)	-0.0001(0.002)
Country dummies	No	Yes
Adjusted R-squared	0.921	0.997
F-statistic	300.012**	2585.64***
No. Of observations	140	140
Bptest	51.778***	86.841***
Pgtest	96.022***	88.902***

Dependent variable: ln($SALE\_FAT$)		
Variable	Coefficient(SE)	Coefficient(SE)
ln(FAT_PROD)	0.564***(0.089)	0.038(0.079)
FAT_PPI	0.004*(0.002)	0.001*(0.001)
POLITICAL_STAB	0.153(0.218)	-0.013(0.086)
REG_QUALITY	-0.881*(0.448)	0.317(0.196)
TRANSPORT_ACC	0.028*(0.016)	-0.041***(0.008)
NATURAL	-0.019*(0.009)	0.006(0.005)
Country dummies	No	Yes
Adjusted R-squared	0.781	0.976
F-statistic	87.978***	347.677
No. Of observations	140	140
Bptest	6.194	78.108***
Pgtest	100.62***	45.067***

Annex 2

- **Downstream results: fruits and fat & oil**

Dependent variable: ln($FRUIT\_SALE$)			Dependent variable: ln(FAT_SALE)		
Variable	Coefficient(SE)	Coefficient(SE)	Variable	Coefficient(SE)	Coefficient(SE)
ln($EXPEND$)	0.592***(0.064)	0.192**(0.057)	ln($EXPEND$)	0.741***(0.076)	0.225**(0.075)
LFRUITS_CPI	-0.002(0.002)	0.001(0.0003)	LFAT_CPI	0.011*(0.005)	0.006*(0.003)
POLITICAL_STAB	0.391**(0.124)	0.042(0.038)	POLITICAL_STAB	0.563***(0.116)	-0.005(0.077)
REG_QUALITY	-1.853**(0.277)	-0.082(0.069)	REG_QUALITY	-1.142***(0.299)	0.254*(0.148)
TRANSPORT_ACC	0.022(0.016)	-0.009*(0.004)	TRANSPORT_ACC	0.029*(0.013)	-0.03***(0.008)
NATURAL	0.055***(0.011)	-0.001(0.002)	NATURAL	0.008(0.009)	0.006(0.004)
ln($EXRATE$)	-0.122***(0.023)	-0.036(0.077)	ln($EXRATE$)	-0.044(0.029)	0.219*(0.119)
Country dummies	no	Yes	Country dummies	No	Yes
Adjusted R-squared	0.926	0.997	Adjusted R-squared	0.879	0.981
F-statistic	248.845	3218.66***	F-statistic	145.727***	375.412***
No. Of observations	140	140	No. Of observations	140	140
Bptest	14.489	87.924***	Bptest	24.614**	76.971***
Pgtest	70.351***	66.139***	Pgtest	61.15***	37.685**