Extreme weather shocks and potentials effects on agri-food markets

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(1st day)
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Knowable but not Measurable!

28.5.2021 Global warming increases 'food shocks' threat - BBC Ne

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Science

Global warming increases 'food shock

By Matt McGrath
Environment correspondent, BBC News

14 August 2015

Climate change

Drought is one of the most significant impacts of climate change on food

Climate change is increasing the risk of severe 'food shocks' where crops fail and prices of staples rise rapidly around the world.

Federal Report Warns of Financial From Climate Change

A report commissioned by President Trump's Commodity Futures Trading Commission issued dire warnings about c change's impact on financial markets.

INDEPENDENT

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Extreme weather triggers surge in 'food shocks' over past half century

Scientists call for climate change-resistant food systems to accommodate increase in extreme weather

Josh Gabbatiss Science Correspondent | @josh_gabbatiss | Monday 28 January 2019 19:19 | comments

Around half of 'food shocks' involving crops were linked to extreme weather events *(Getty Images/iStockphoto)*

Knowable but not Measurable!

Estimates of the Welfare Impact of Climate Change
(expressed as an equivalent income gain or loss in percent GDP)

			Worst-off region		*Best-off region*	
Study	*Warming (°C)*	*Impact (% of GDP)*	*(% of GDP)*	*(Name)*	*(% of GDP)*	*(Name)*
Nordhaus (1994a)	3.0	−1.3				
Nordhaus (1994b)	3.0	−4.8 (−30.0 to 0.0)				
Fankhauser (1995)	2.5	−1.4	−4.7	China	−0.7	Eastern Europe and the former Soviet Union
Tol (1995)	2.5	−1.9	−8.7	Africa	−0.3	Eastern Europe and the former Soviet Union
Nordhaus and Yang (1996)[a]	2.5	−1.7	−2.1	Developing countries	0.9	Former Soviet Union
Plambeck and Hope (1996)[a]	2.5	2.5 (−0.5 to −11.4)	−8.6 (−0.6 to −39.5)	Asia (w/o China)	0.0 (−0.2 to 1.5)	Eastern Europe and the former Soviet Union
Mendelsohn, Schlesinger, and Williams (2000)[a,b,c]	2.5	0.0[b] 0.1[b]	−3.6[b] −0.5[b]	Africa	4.0[b] 1.7[b]	Eastern Europe and the former Soviet Union
Nordhaus and Boyer (2000)	2.5	−1.5	−3.9	Africa	0.7	Russia
Tol (2002)	1.0	2.3 (1.0)	−4.1 (2.2)	Africa	3.7 (2.2)	Western Europe
Maddison (2003)[a,d,e]	2.5	−0.1	−14.6	South America	2.5	Western Europe
Rehdanz and Maddison (2005)[a,c]	1.0	−0.4	−23.5	Sub-Saharan Africa	12.9	South Asia
Hope (2006)[a,f]	2.5	0.9 (−0.2 to 2.7)	−2.6 (−0.4 to 10.0)	Asia (w/o China)	0.3 (−2.5 to 0.5)	Eastern Europe and the former Soviet Union
Nordhaus (2006)	2.5	−0.9 (0.1)				

Tol, 2009

Financial Damage of Climate Change

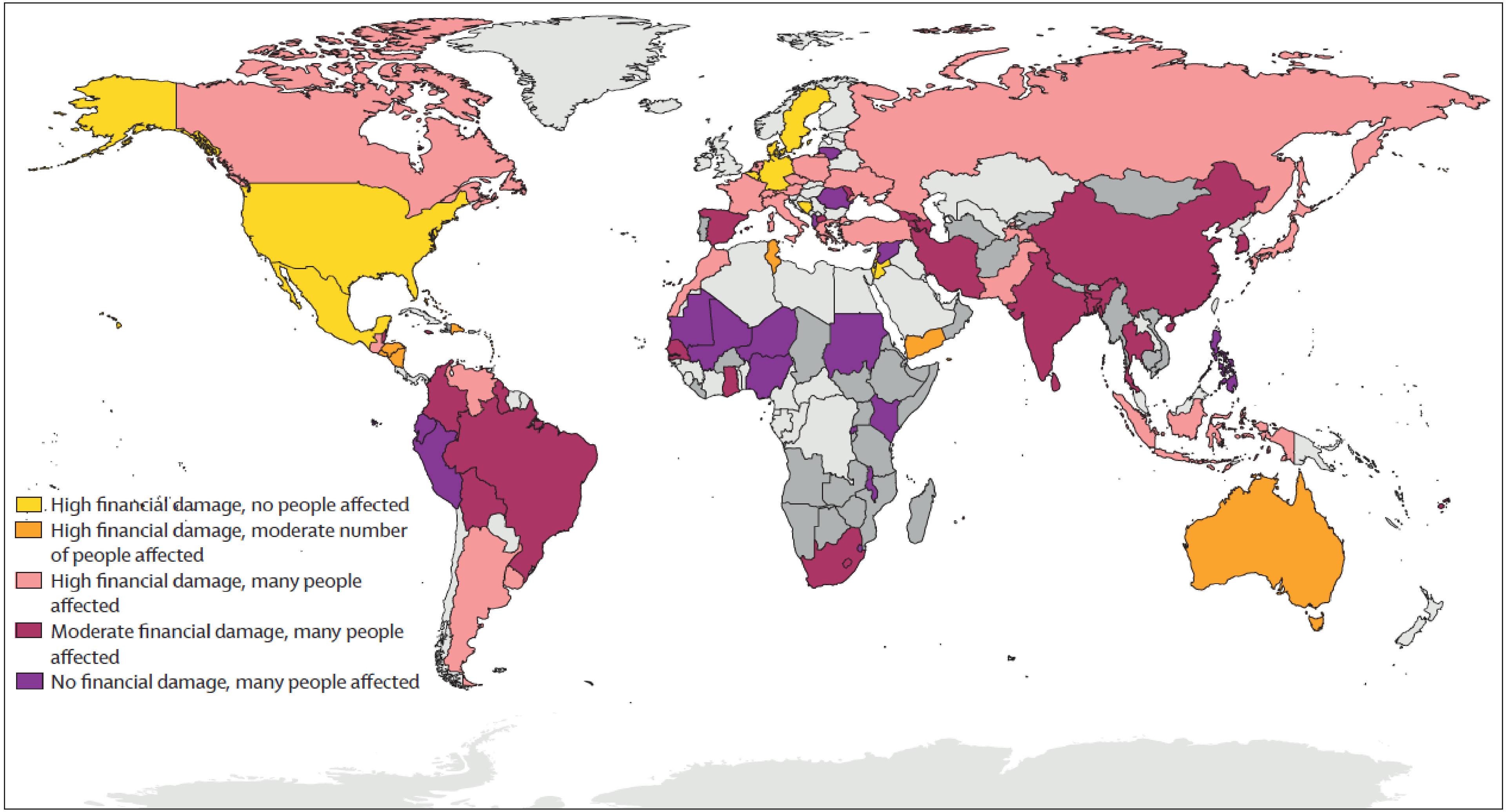


Figure 1: Map of countries with major extreme weather events included in this study, 1964–2008

Source: Park et al, 2019

Climate Change vs. Climate Anomaly

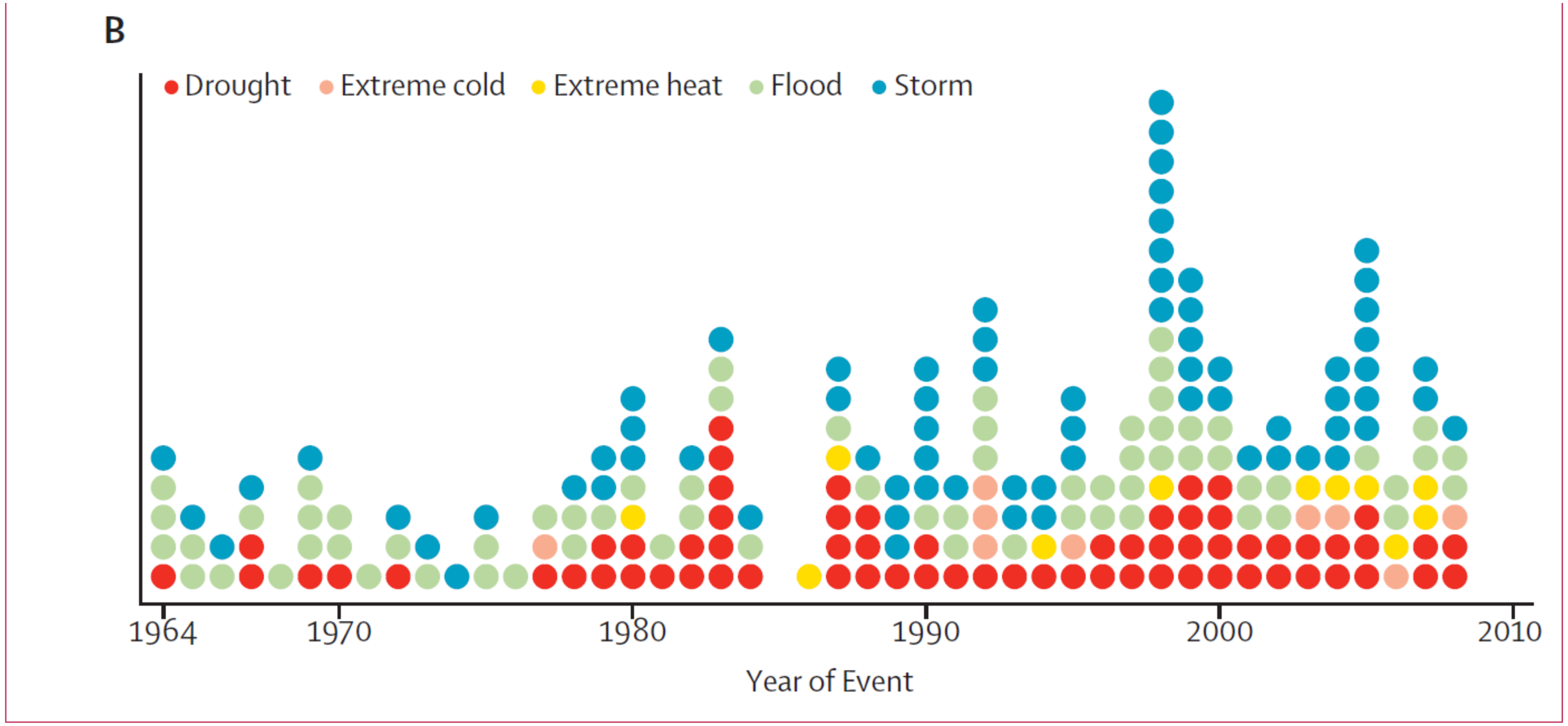
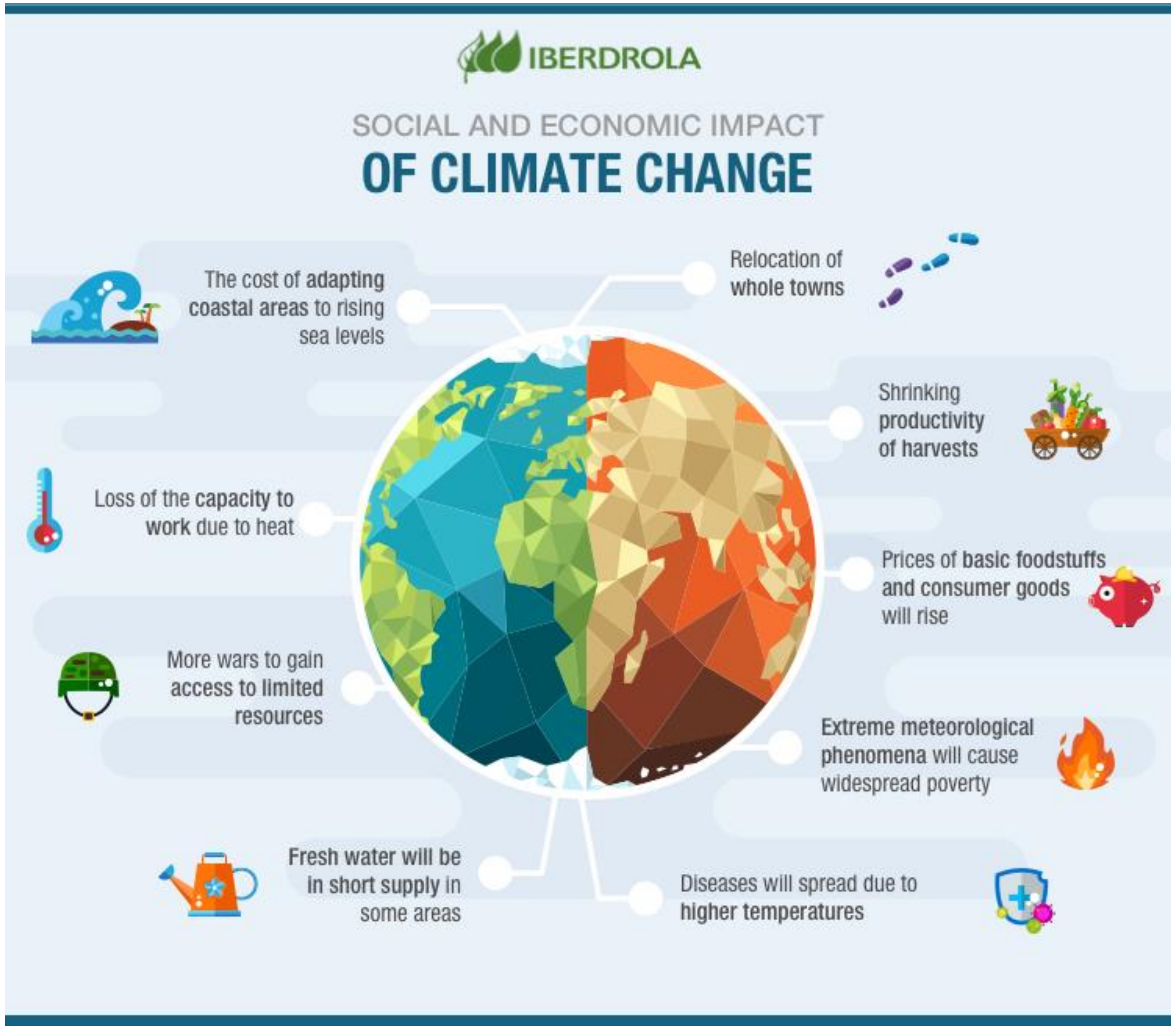


Figure 2: Stream-graph and dot-plot representations of all major extreme weather events from 1964–2008 included in this study

Source: Park et al, 2019

Potential Effects of Climate Change



https://www.iberdrola.com/

Why Agri-Food Sector!?

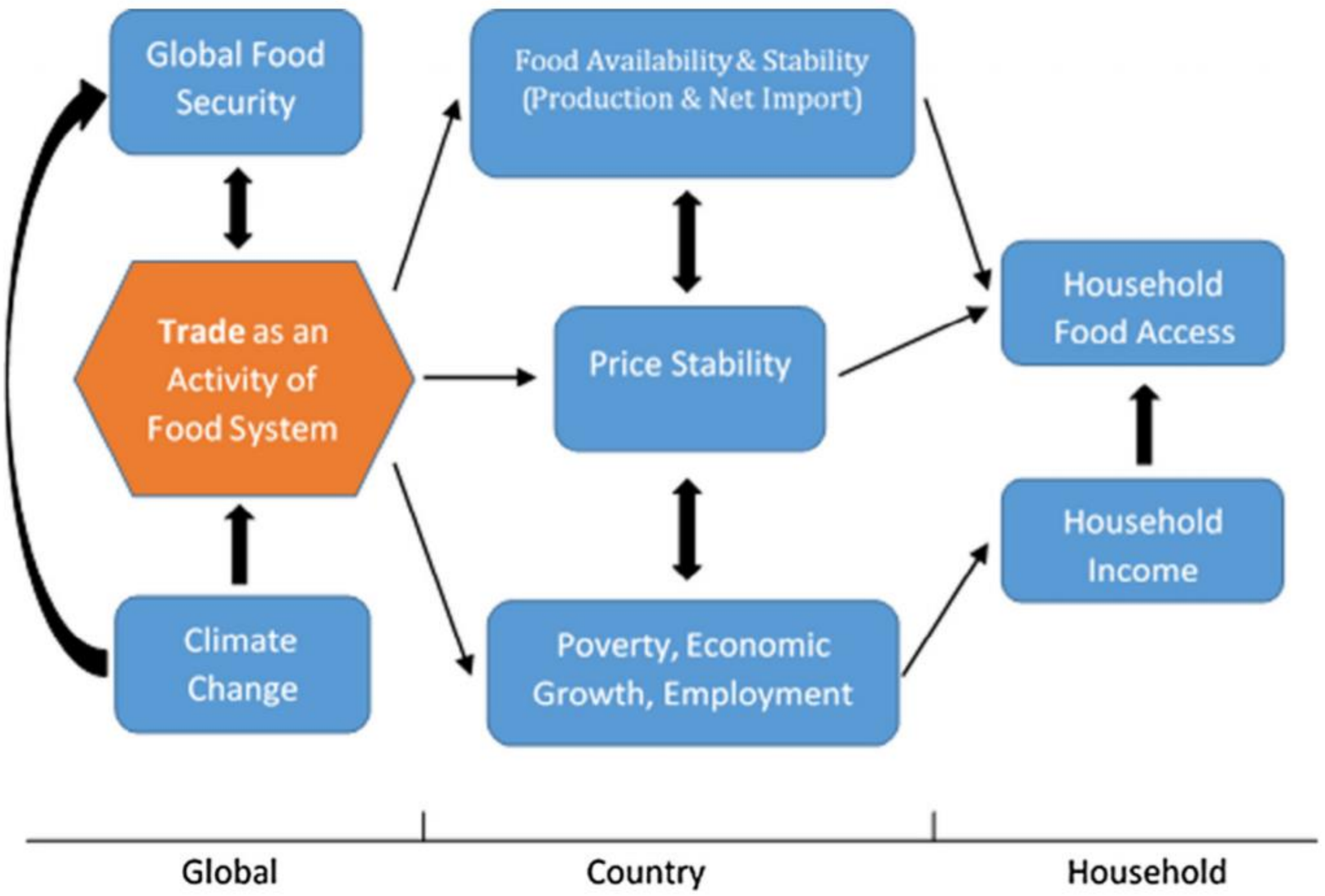
[*Almost 20% of local market prices were affected by domestic weather disturbances in the short run, 9% by international price changes and 4% by both domestic weather disturbances and international price changes*…] (Brown and Kshirsagar, 2015).

[…*a rise in temperature lowers per capita output, in both the short and medium term, through a wide array of channels: reduced agricultural output, suppressed productivity of workers exposed to heat, slower investment, and poorer health*…] (IMF, 2018).

Outline (1st session)

- Climate change, temperature variations and agricultural markets
- Price dynamics and cost pass-through
- Drivers of cost pass-through
- Different indices of weather shocks
- Weather shocks and price dynamics
- Overview of case study
- Empirical model estimate in Stata
- Seasonality and temperature
- Group work assignments

Global, Country and Household Climate Impacts



Brown et al. 2017.

Effects of Climate Change on the Agricultural Sector

Potential Effects of Temperature on the Markets

- **Seasonality**

Predictable changes over the years. Costs of production changes seasonally in some periods.

Demand is also seasonal. Any example?

- **Extreme weather events**

When temperature is above/below some thresholds

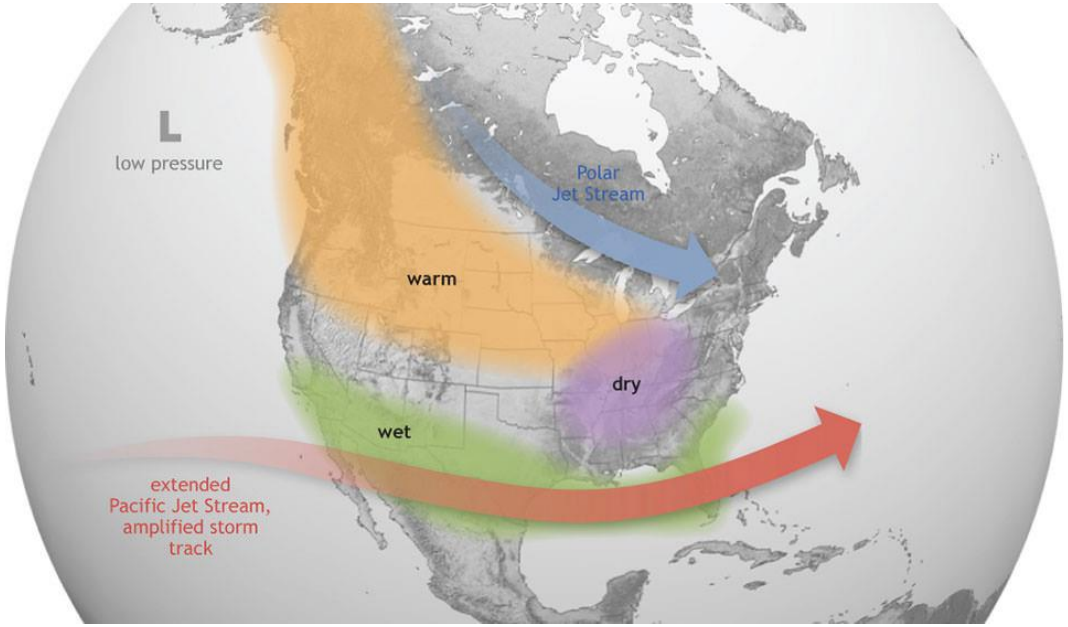
- **Weather volatilities**

Temperature volatilities is an important source of risk, which can be aggravated by climate change.

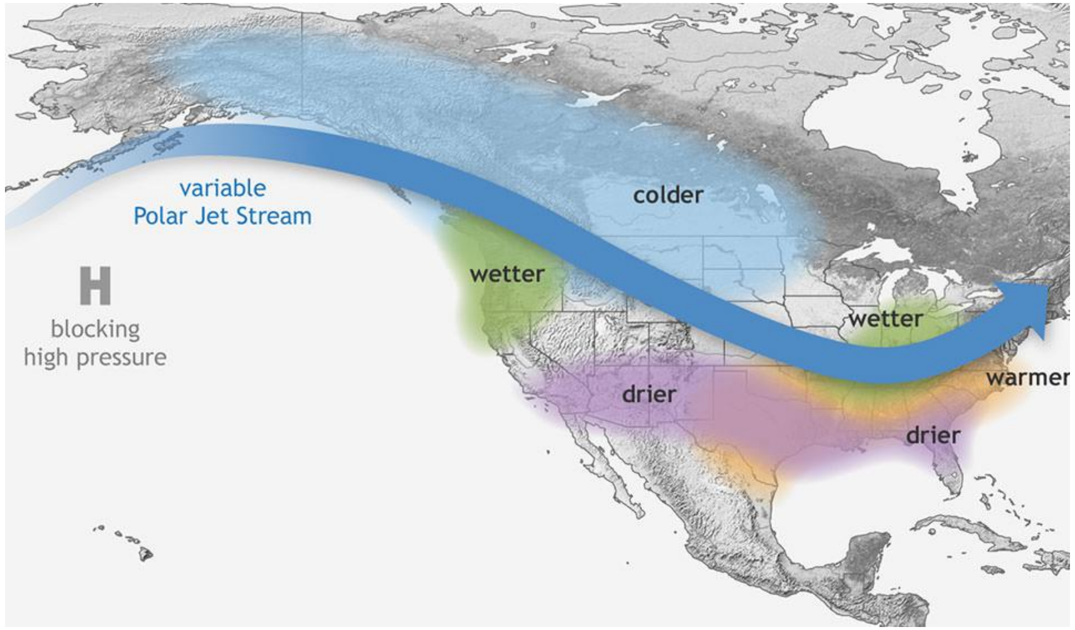
El Nino vs. La Nino

- El Nino can affect our weather significantly.

https://oceanservice.noaa.gov/facts/elninolanina/otkn_721_elninolanina_lg.mp4



El Niño, a warm event



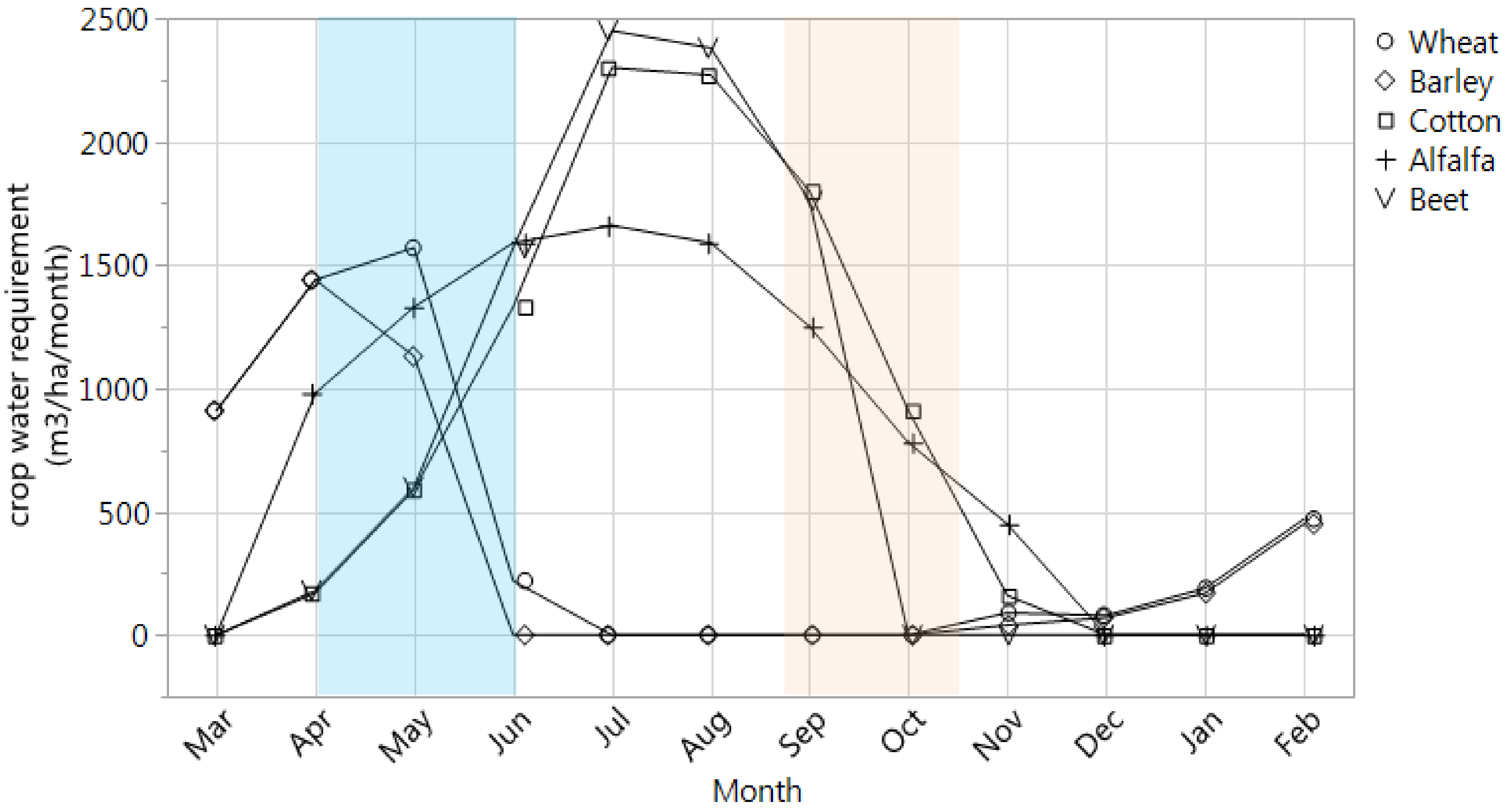
La Niña, a cold event

El Nino vs. La Nino

- Apparent consequences of an El Niño phase are increased rainfall across the west coast of Central and South America, and drought in the Western Pacific region.
- La Nina results in increased precipitation in the Oceania and ˜ droughts across the eastern Pacific region.
- During a La Nina year, winter temperatures are warmer than normal in the South and cooler than normal in the North. La Nina can also lead to a more severe hurricane season.
- ENSO has long been considered one of the driving factors of agricultural production, especially in the regions adjacent to the tropical Pacific.

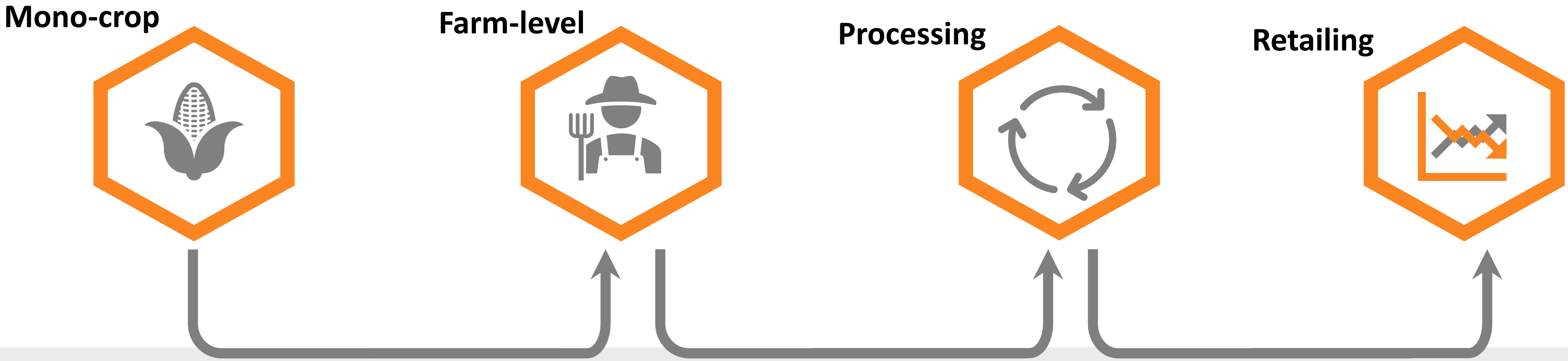
Farming seasons and water-related risks

Decision phase



yield improvement period


FEDERAL RESERVE NOTE
THE UNITED STATES OF AMERICA
ONE DOLLAR
Farm production 7.6¢
Food processing 14.7¢
Packaging 2.3¢
Transportation 3.4¢
Wholesale trade 8.4¢
Retail trade 12.1¢
Food services 38.5¢
Energy 4.1¢
Finance & Insurance 3¢
Advertising 2.6¢
Other 3.3¢
ERS, USDA


Mono-crop
Farm-level
Processing
Retailing

Ice (berg) Transport Costs and Temperature

Iceberg transport costs are one of the main ingredients of modern trade and economic geography models, introduced by Samuelson (1954).

Transport costs are modelled by assuming that in order to deliver a quantity x of a good produced in i to another destination j, one needs to ship $\rho_{ij}\mathrm{x}$ goods from i, where $\rho_{ij} > 1$.

$m_{ij} = \left(\frac{\rho_{ij}-1}{\rho_{ij}}\right)$: A constant fraction of the goods melts in transit.

$$P^r - P^f = \mathrm{f}(\rho_{ij}) \text{ where } \rho_{ij} = \mathrm{f}(\text{temperature, precipitation})$$

Weather Shocks Indicators

- Standardized precipitation-evapotranspiration index (SPEI)
- Reconnaissance drought index (RDI)
- Standardized precipitation index (SPI)
- The normalized difference vegetation index (NDVI)
- Temperature (or sea surface temperature),
- Maximum or minimum temperature shocks
- Temperature volatilities
- Dummy variables when time- (cross section) varying data isn’t available

Standardized Precipitation Index (SPI)

The SPI is a widely used index to characterize meteorological drought on a range of timescales: $SPI_{ijk} = \frac{P_{ijk} - \bar{P}_{ij}}{\sigma_{ij}}$

The precipitation value (P_{ijk}) and the standard deviation (σ_{ij}) for pixel *i* during timeframe *j* for year *k.*

SPI values	Drought class
≥ 2	Extremely wet
1.5-1.99	Very wet
1-1.49	Moderately wet
–0.99-0.99	Near-normal
–1-1.49	Moderately dry
–1.5-1.99	Severely dry
≤ 2	Extremely dry

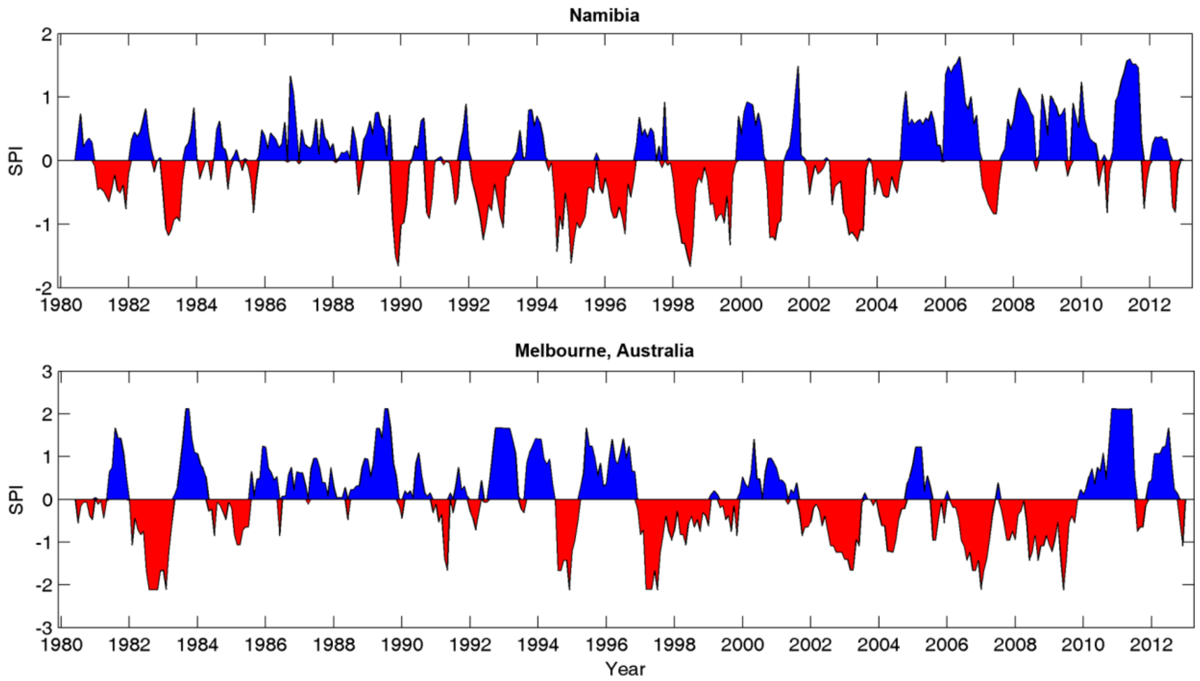
Tatli (2015)

Standardized Precipitation Index (SPI)

- **Strengths:**

– Uses precipitation only

– Less complex to calculate



- **Limitation:**

– The SPI does not account for evapotranspiration

– Sensitive to the quantity and reliability of the data used

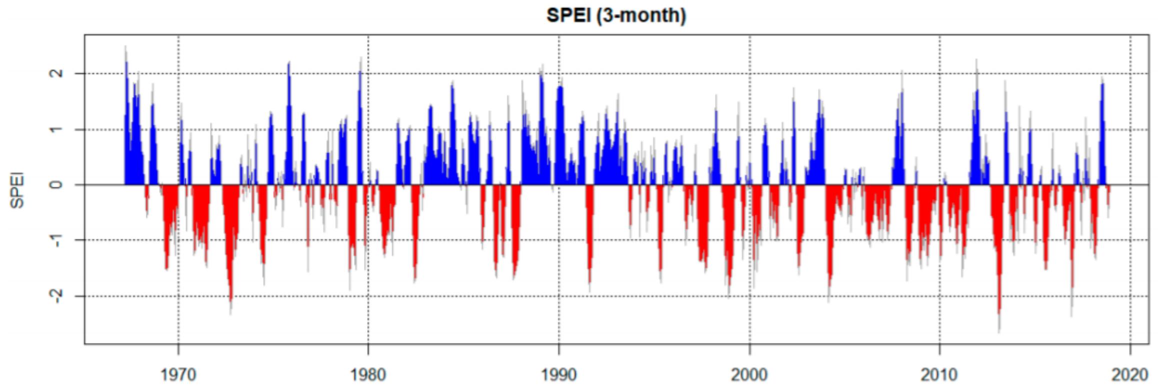
– Does not consider the intensity of precipitation and its potential impacts on runoff

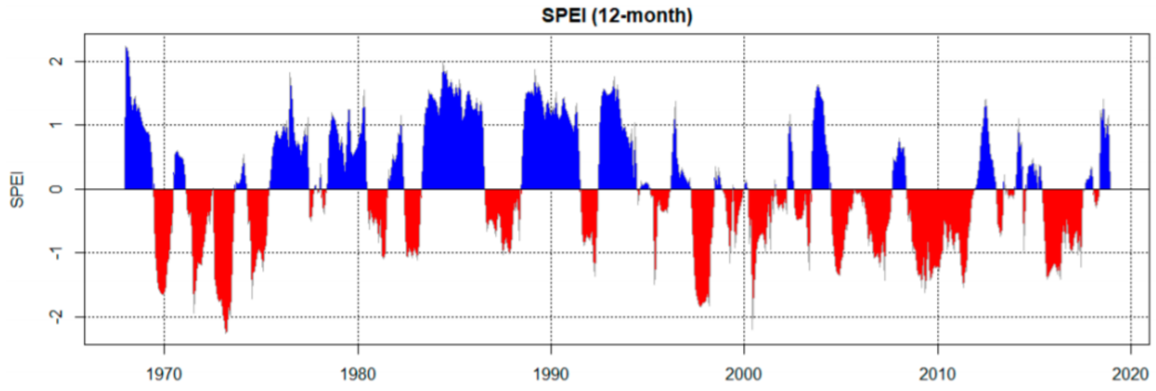
Source: Keyantash (2018), HRL (2021).

Standardized Precipitation Evapotranspiration Index (SPEI)

Considering both precipitation and potential evapotranspiration (PET) in determining drought.

Class	SPEI Value	Description	Class	SPEI value	Description
1	$\text{SPEI} \geq 2.00$	Extremely wet	5	$-1.50 \leq \text{SPEI} < -1.00$	Moderate drought
2	$1.50 \leq \text{SPEI} < 2.00$	Very wet	6	$-2.00 \leq \text{SPEI} < -1.50$	Severe drought
3	$1.00 \leq \text{SPEI} < 1.50$	Moderately wet	7	$\text{SPEI} < -2.00$	Extreme drought
4	$-1.00 \leq \text{SPEI} < 1.00$	Near normal			





Source: Fan et al. (2018), Zeng (2019).

Standardized Precipitation Evapotranspiration Index (SPEI)

- **Strengths:**
- Combines multi-timescales aspects of the SPI with information about evapotranspiration, making it more useful for climate change studies
- Statistically based index that requires only climatological information

- **Limitation:**
- More data requirements than the precipitation SPI
- Sensitive to the method to calculate potential evapotranspiration (PET)
- A long base period (30-50+ years) that samples the natural variability should be used.

Source: Vicente-Serrano (2015) and https://spei.csic.es/.

Reconnaissance Drought Index (RDI)

- RDI index is one of the meteorological drought indices used to assess the drought severity

Table 2 Classification of Reconnaissance Drought Index (RDI) and effective Reconnaissance Drought Index (eRDI)

Class	Classification	Drought index value
1	Extreme wet	≥ 2
2	Very wet	1.5 to 1.99
3	Moderate wet	1 to 1.49
4	Normal	−0.99 to 0.99
5	Moderate dry	−1.49 to −1
6	Severe dry	−1.99 to −1.5
7	Extreme dry	≤ -2

Source: Zarei et al (2019)

Summary

- Review the potential effects of temperature on value chain,
- The effects of temperature on prices,
- Different proxies of temperature variation,

Next step: We need a framework to analyze price dynamics,

How a weather shock may transmit along the value chain?

Cost pass-through: Definition and concept

- Cost pass-through arises when a business changes the prices of the products or services it supplies following a change in its own costs.

- The adjustment of prices is the principal mechanism by which information about changes in demand and costs is communicated (Lloyd, 2017, Loy and Weiss, 2019).

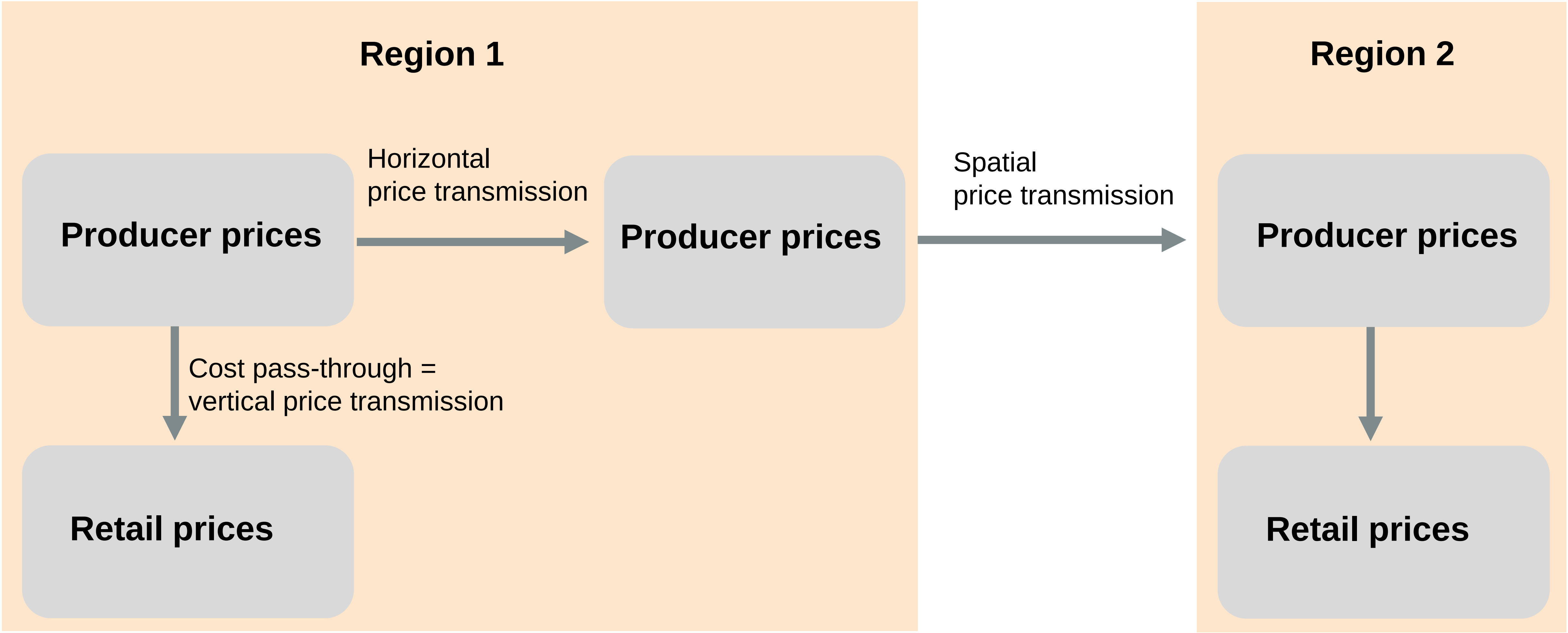
- If costs are not fully passed through, consumers may not fully benefit from declining prices in the upstream market (Loy and Weiss, 2019).

Cost pass-through: Definition and concept

- Vavra and Goodwin (2005) define price transmission as ‘How quickly and to what extent, changes in farm prices are transmitted to the retail level and vice versa’ (p. 3).

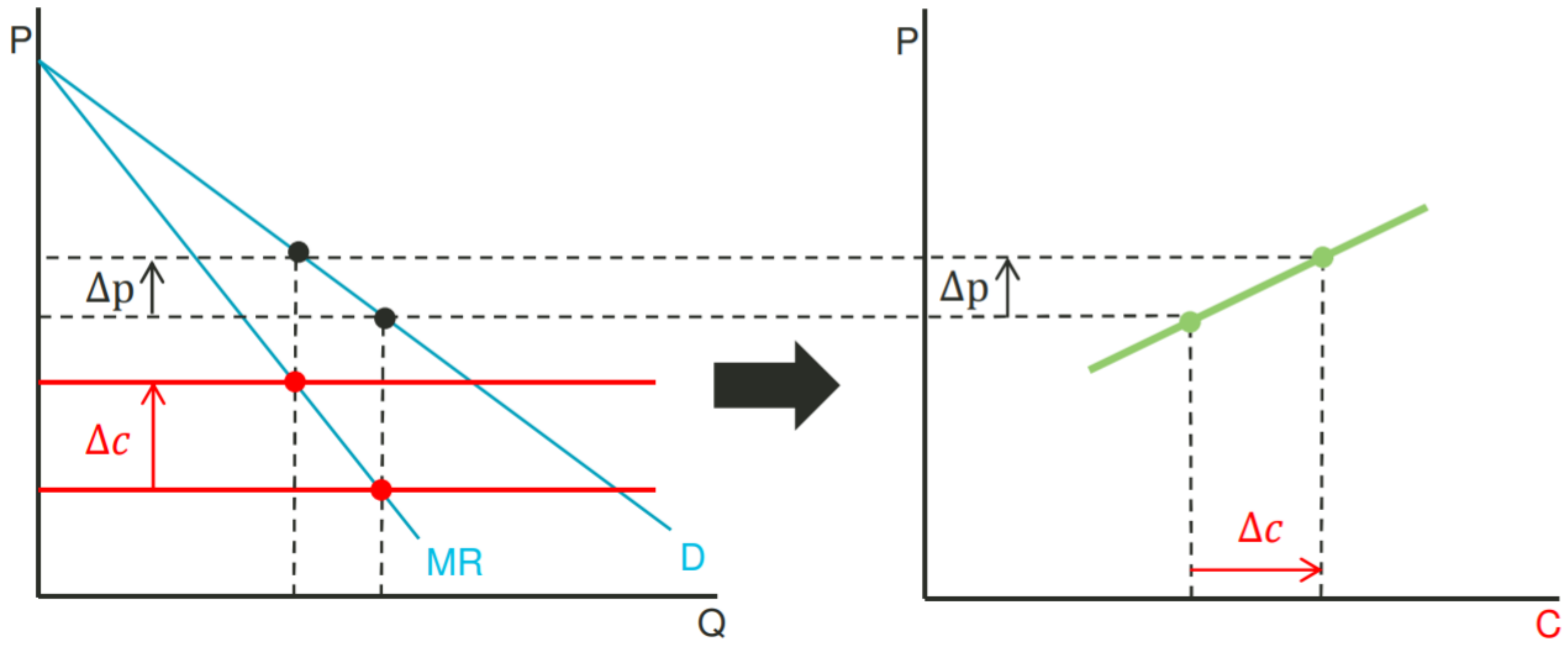
- Price transmission is an umbrella term describing two processes. The first describes how price signals emanating at the farm level move downstream to retail prices (‘pass-through’); the second how signals originating at the retail level move upstream to the farm gate (‘pass-back’).

Cost pass-through: Definition and concept



Cost pass-through: Definition and concept

- Objective: Understand (likely) price effects of a shift in firm costs
- Key challenge: What if direct measurement is not feasible?



Source: RBB Economics

Relevance of Cost pass-Through

- Likely consumer benefits from cost efficiencies
  - Mergers, agreements

- Impact of (upstream) policy interventions
  - Weather extreme events impose cost on producers

- Assessment of input foreclosure

Source: RBB Economics

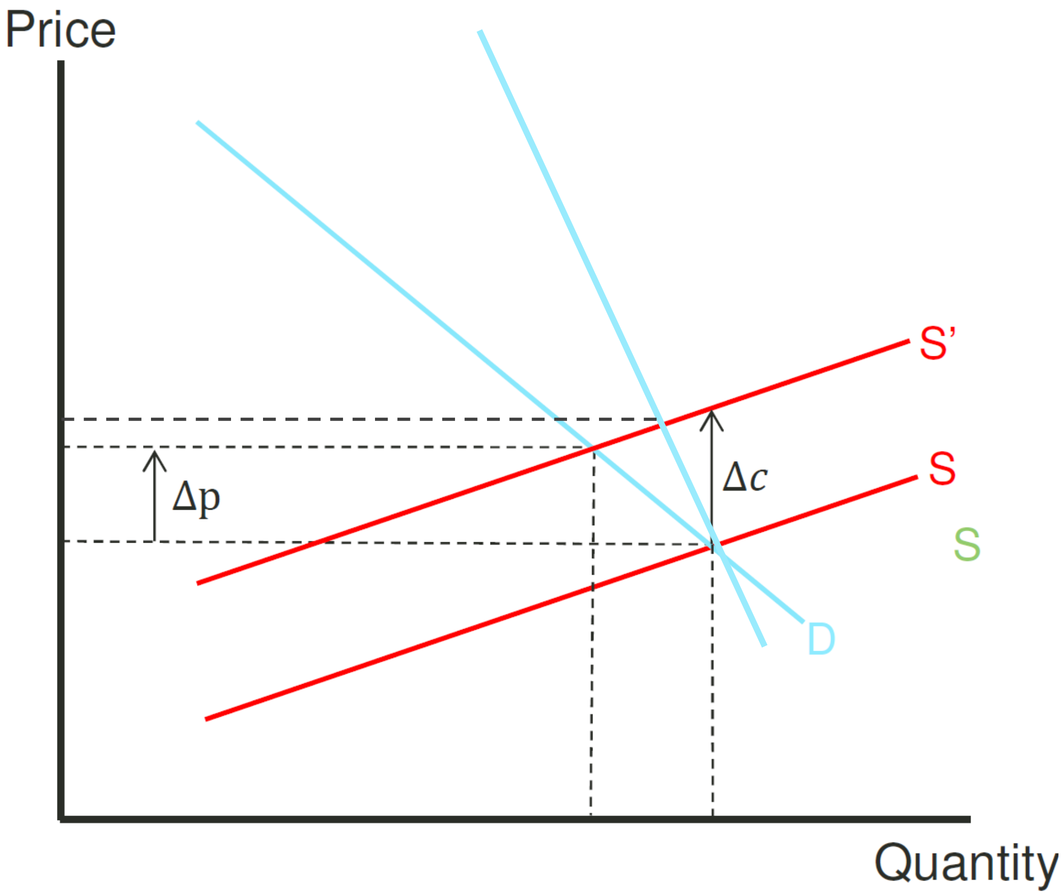
Competitive Setting

- In a competitive sitting, it is the slopes of demand and supply that are critical to pass-through of (industry-wide) cost shifts

- Slope of demand and supply

It depends on the relative slopes of demand and supply.

Demand Elas. ↑/Supply Elas.↓→ Pass-through ↓



Cost Pass-through Elasticity vs. Constant

- Law of One Price (LOP):

$$P^r - P^w = \text{average margin}$$

- Standard cost pass-through model:

$$P^r = \alpha_1 + \alpha_2 P^w + \varepsilon_t$$

α_1= absolute margin, $P^r - P^w = AM$

α_2= relative margin (long-run price elasticity), $\frac{P^r}{P^w} = RM$

ε_t= deviations from the long-run equilibrium.

Different Measure of Cost Pass-through

- **Absolute pass-through**

- **Pass-through elasticity**

E.g. unit cost increased from $5 to $6 and price increased from $10 to $11

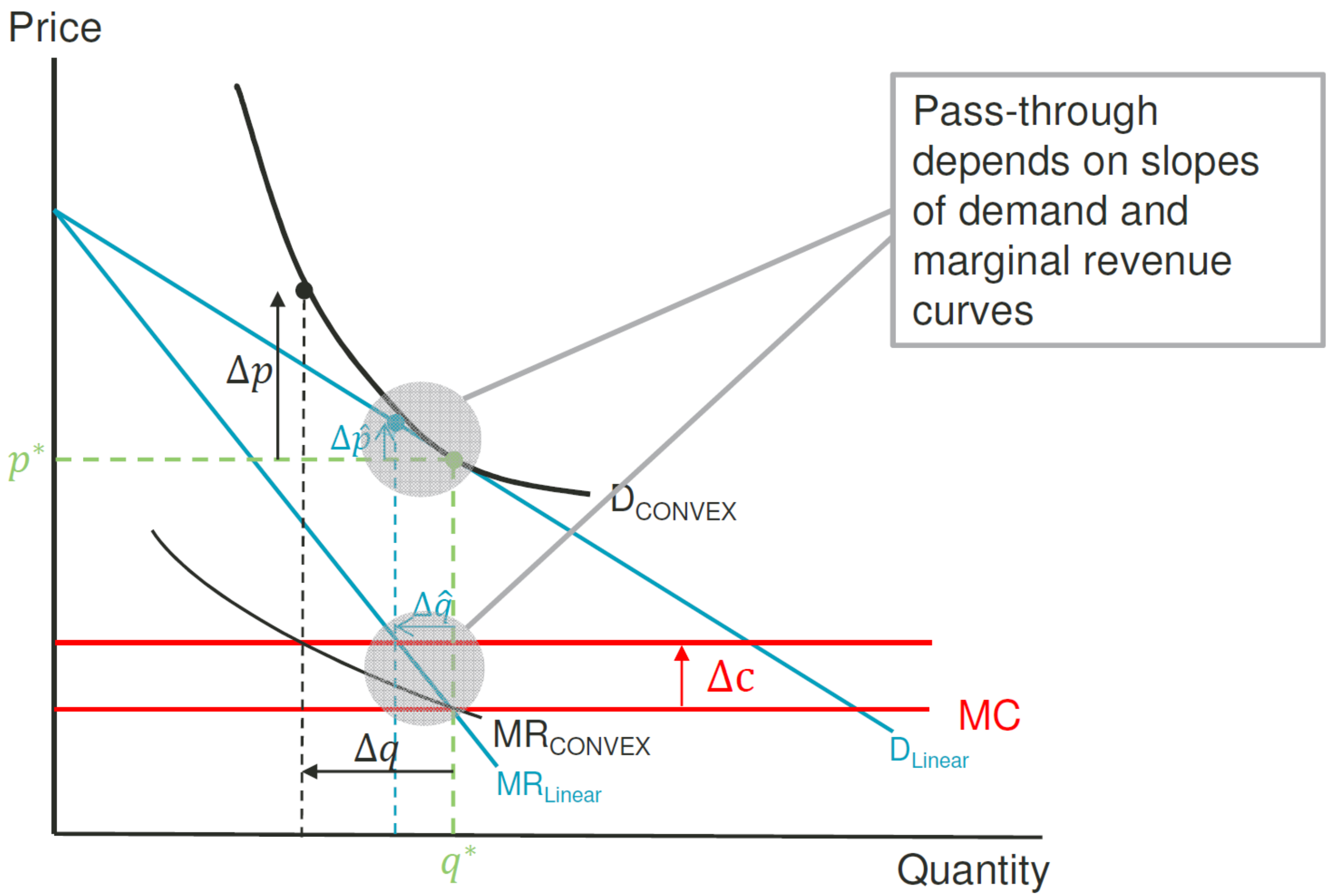
Absolute pass-through = $1 / $1 = 1

Pass-through elasticity = 10% / 20% = 0.5

Pass-through / Pass-through elasticity = 2 = Price / Unit cost = $10/$5

Source: RBB Economics, 2014

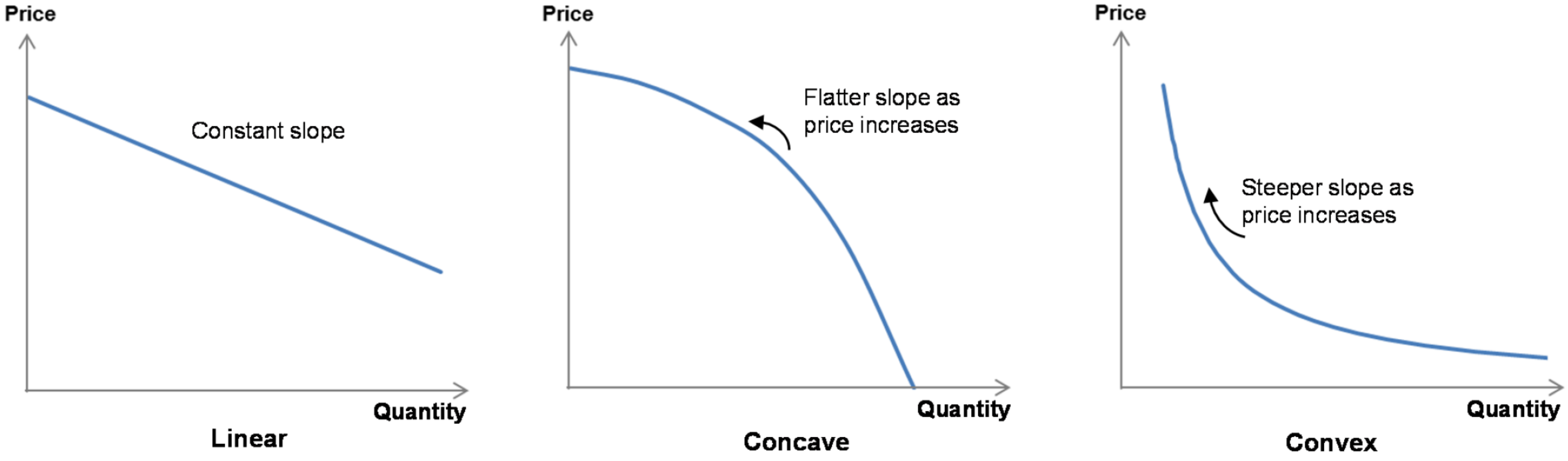
Monopoly Setting



Source: RBB Economics

Drivers of Cost Pass-through

- Demand curvature
  - Greater with convex inverse demand (the inverse demand curve becomes steeper as output decreases) and smaller with concave inverse-demand (the inverse demand curve becomes flatter as output decreases), all else being equal.



Source: RBB Economics, 2014

Drivers of Cost Pass-through

- Search costs

Tappata (2009): rational consumers will search less when prices are falling as compared to when they are rising. Therefore, prices are slower to adjust in a downward direction.

- Menu costs

Imply a lagged response to cost shocks (Ball and Mankiw, 1994), or the costs of price adjustment.

- Product differentaion

Affects the level of competition

Market Performance and Pass-through

- Market power (Bittmann, et al. 2016):

$$\frac{1}{\epsilon} = \frac{P^r - \mathrm{MC}}{P^r} = \text{Lerner's index, or}$$

$$P^r - \mathrm{MC} = \frac{\varepsilon}{1-\epsilon} = \text{Lerner's index}$$

According to FOC, marginal revenue (MR) is equal to marginal costs, i.e. producer price,

$$P^r - P^w = \mathrm{L}$$

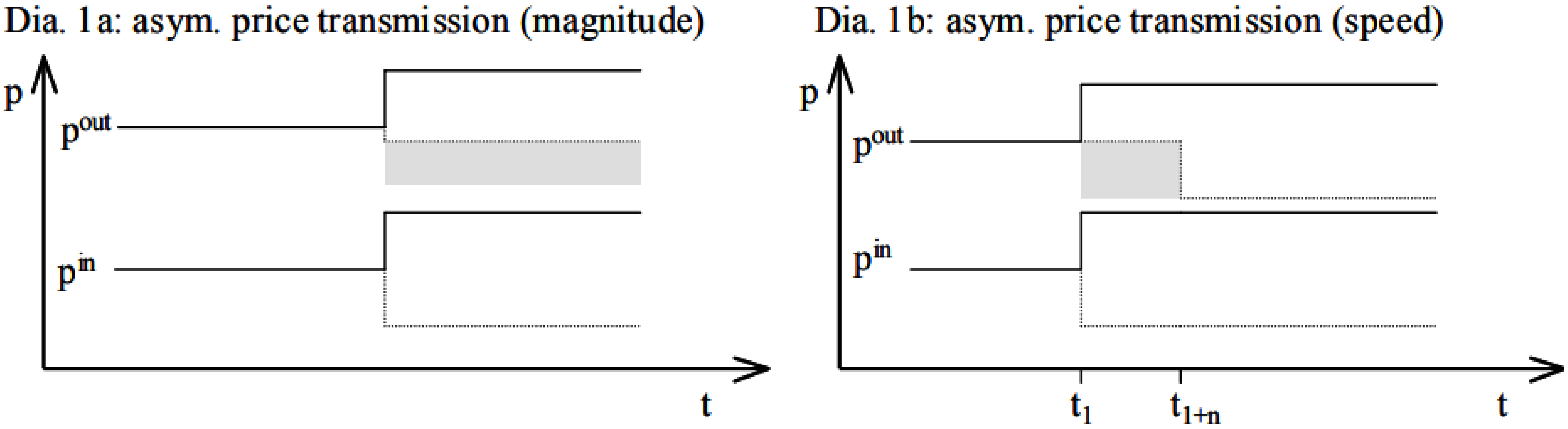
Cost pass-through: Dimensions

- Magnitude
  - Pass-through elasticity (long-run effect)

- Speed
  - How long does it take to get back long-run equilibrium?

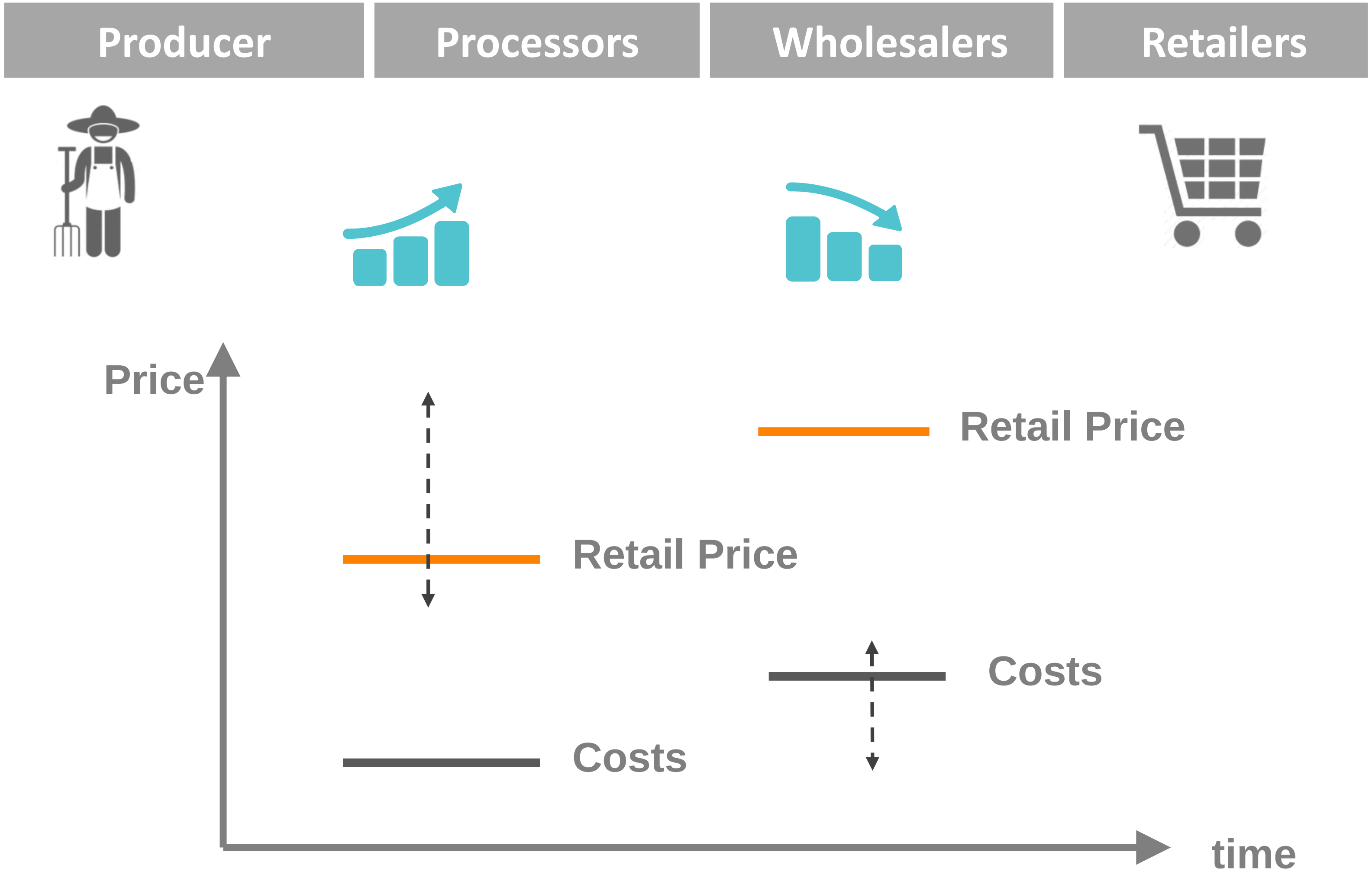
- Asymmetries
  - Whether positive costs changes have the same effect of negative ones?

Cost pass-through: Dimensions



Source: Goodwin and Varva (2006)

Asymmetric Pass-through



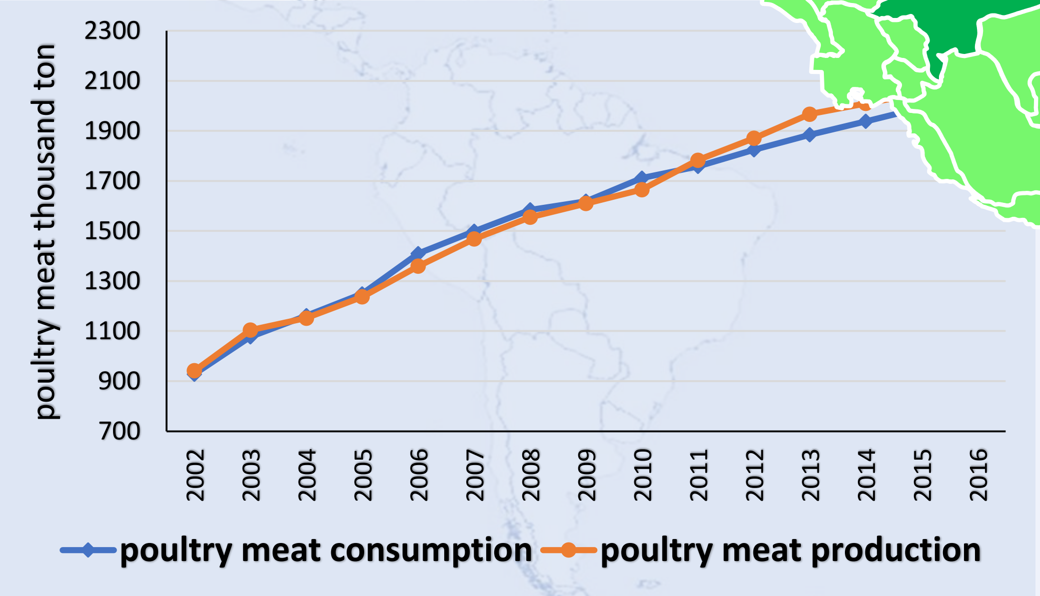
Summary

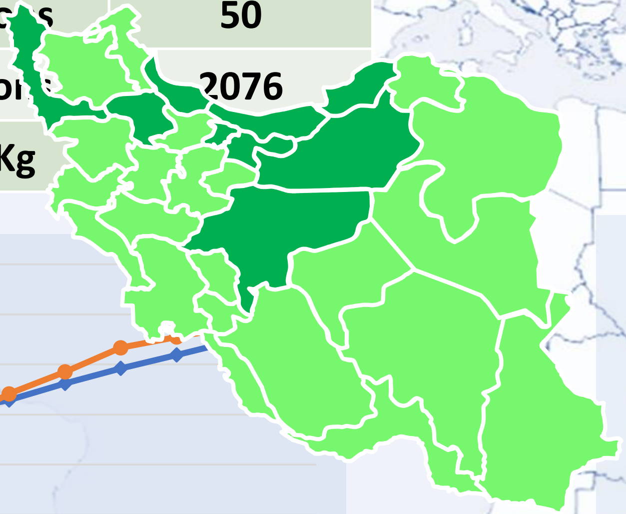
- So far, we discuss,
  - The potential effects of weather variation on the value chain/prices
  - An overview of different weather related indices
  - Cost pass-through and its drivers
  - How to link temperature shocks and price dynamics
  - The potential drivers of cost pass-through,

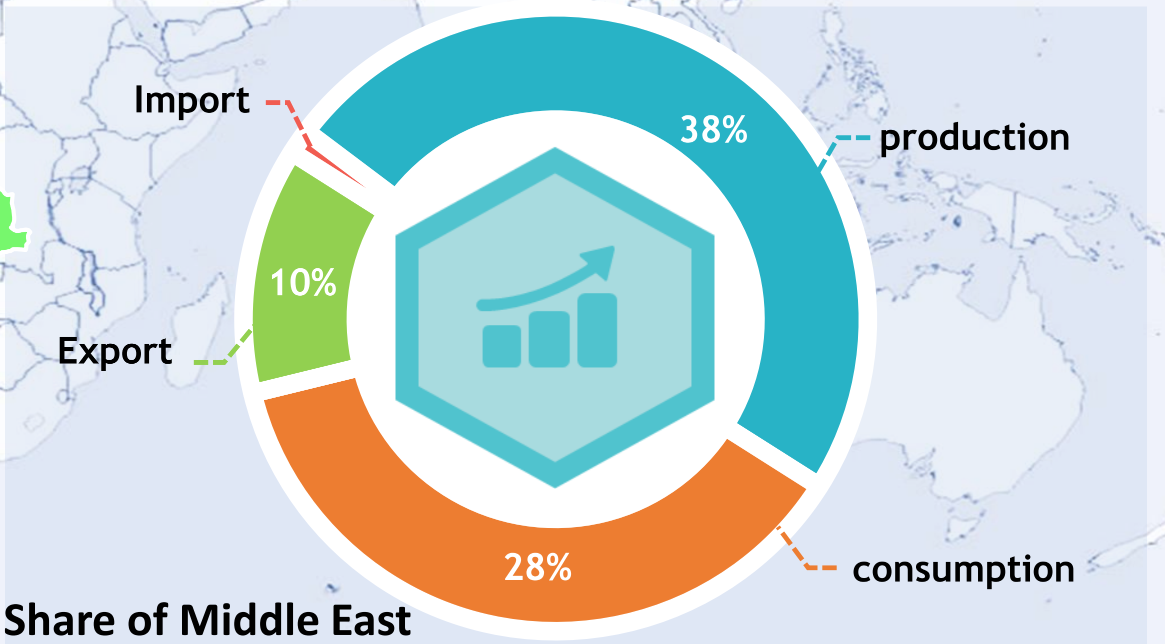
Now, we look at out case study

Iranian Poultry Sector

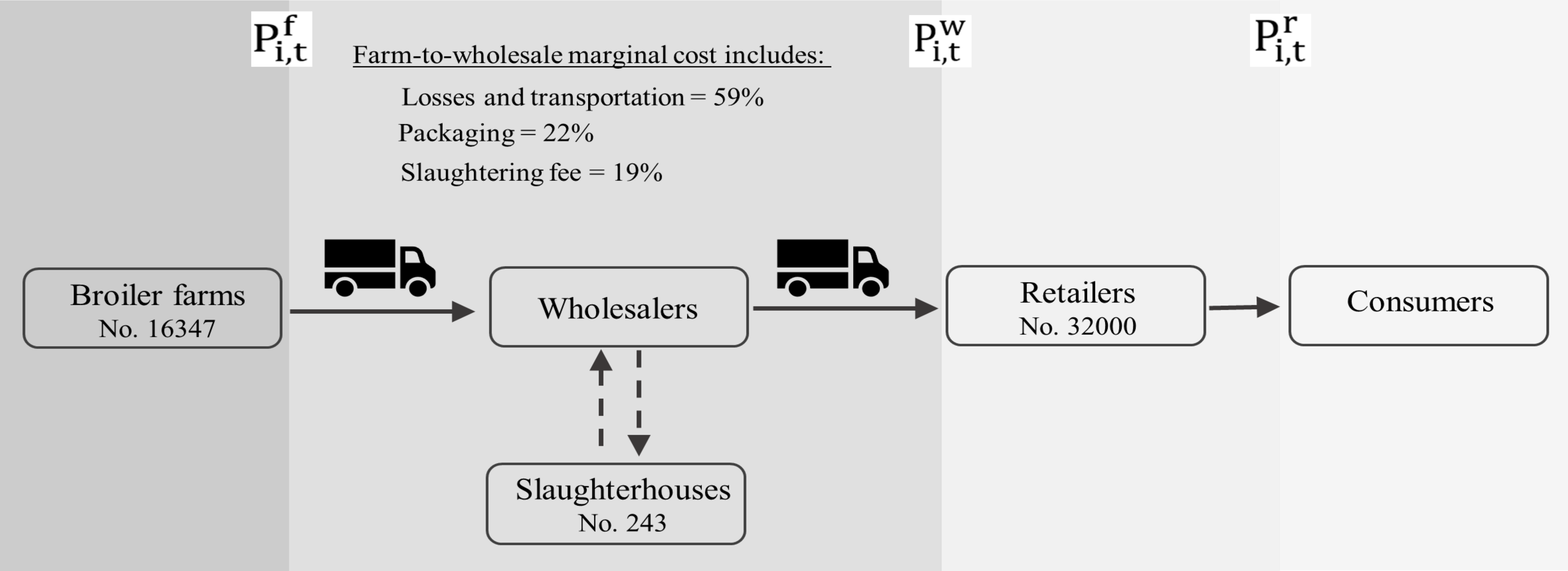
Poultry Market	Unit	Iran (2016)
Production	Tons	2103
Import	Tons	23
Export	Tons	50
Domestic Consumption	tons	2076
Consumption Per Capita	Kg	[illegible]



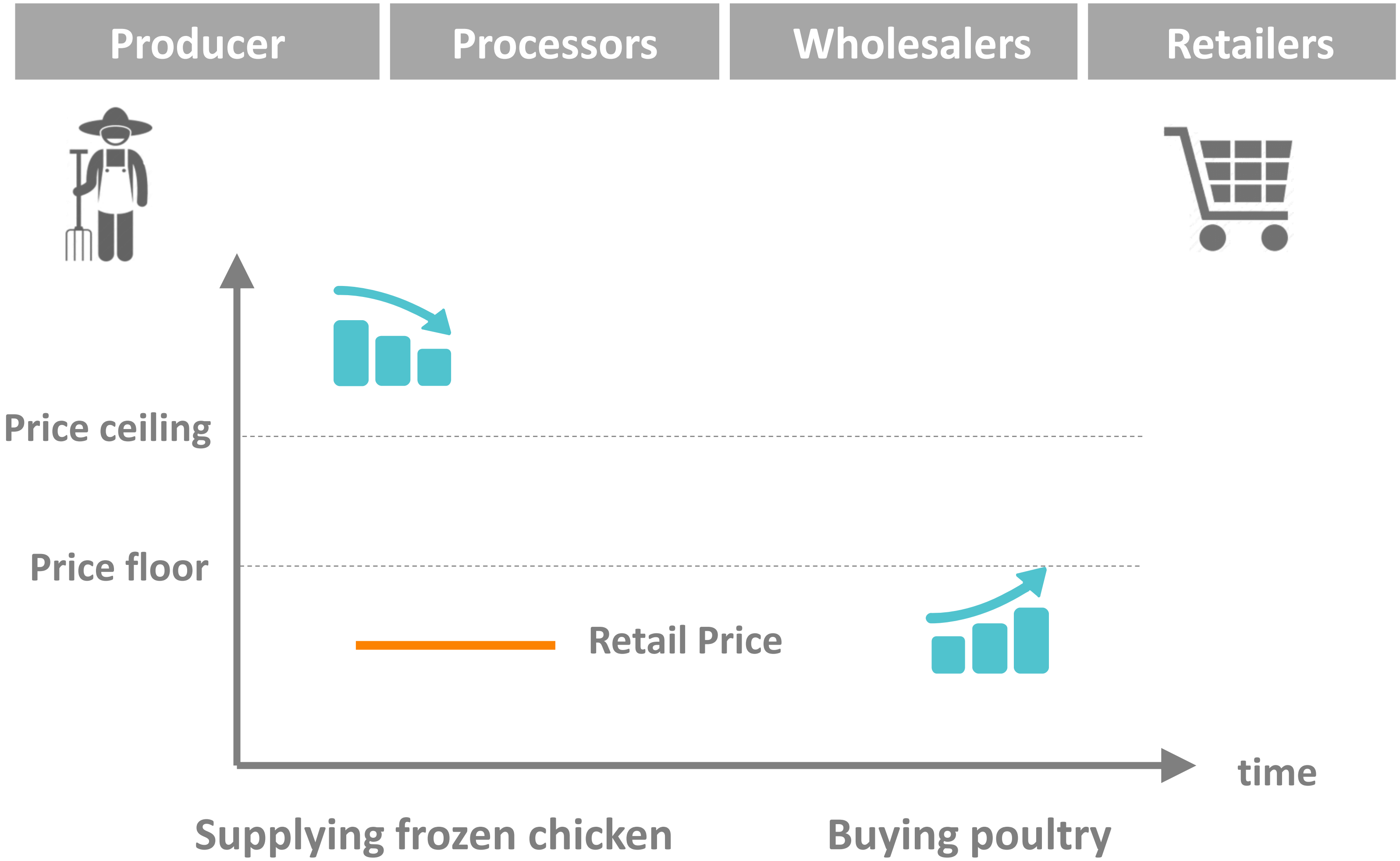




The Iranian Poultry Value Chain



Public Intervention in the Iranian Poultry Chain



Case Study and Data

- **Product:** Fresh poultry meat in farm, wholesale and retail levels.
- Prices are per kg poultry meat. Price are deflated. Why!?
- **Data type:** A weekly panel dataset
- **Source of data:** State Livestock Affairs Logistics (Affiliated by Iran’s Ministry of Agriculture)
- **Source of temperature data:**
- 9720 observations for the period of 2010-2016 (324 weeks for 30 provinces).