Trading-off Volatility and Distortions?

Economics and Politics of Food Policy During Price Spikes

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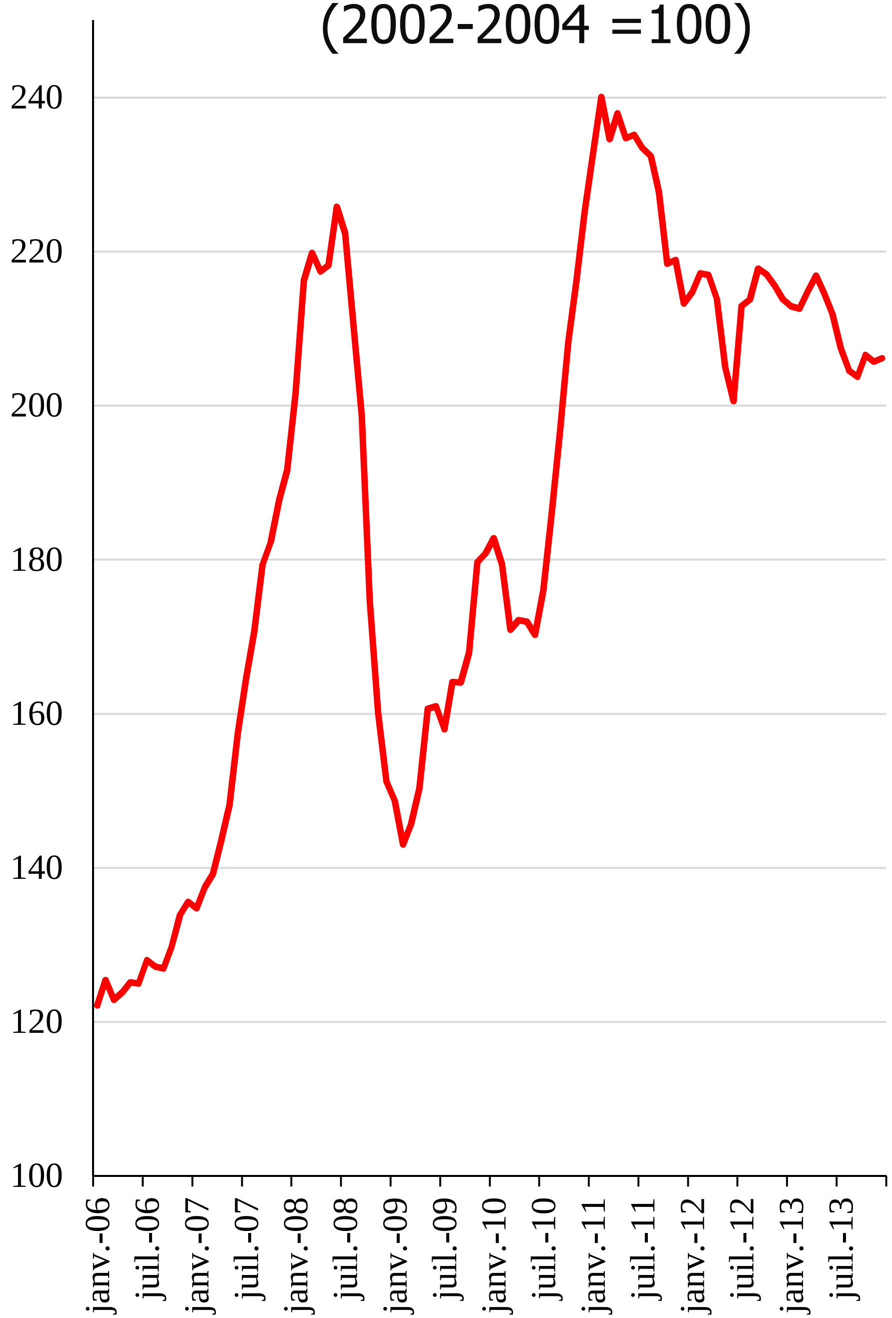
LICOS – KU Leuven

2015 – FERDI Workshop

Food Price Index

(2002-2004 =100)



Related literature includes e.g. …

- Price Volatility and Stabilization
  - Newberry and Stiglitz (1981)
  - Turnovsky et al (1980)
  - Gouel et al (2014, 2015)
  - Anderson, Ivanic and Martin (2013)
  - Barrett, Bellamare and Just (2013)
  - Minot (2014)

- Political Economy of Food Policy
  - Anderson (2009)
  - Anderson, Rausser and Swinnen (2013)
  - Rausser, Swinnen and Zusman (2011)

- Reactions to Price Spikes
  - Ivanic and Martin (2014)
  - Guariso, Squicciarini and Swinnen (2014)
  - Swinnen (1996, 2011)

- Politics and Economics of Instrument Choice
  - OECD (2011)
  - Swinnen (2009)
  - Swinnen, Olper and Vandemoortele (2011)

Everybody is concerned about price volatility (we thought …)

"The crux of the food price challenge is about price volatility, rather than high prices per se" *(*Kharas 2011)

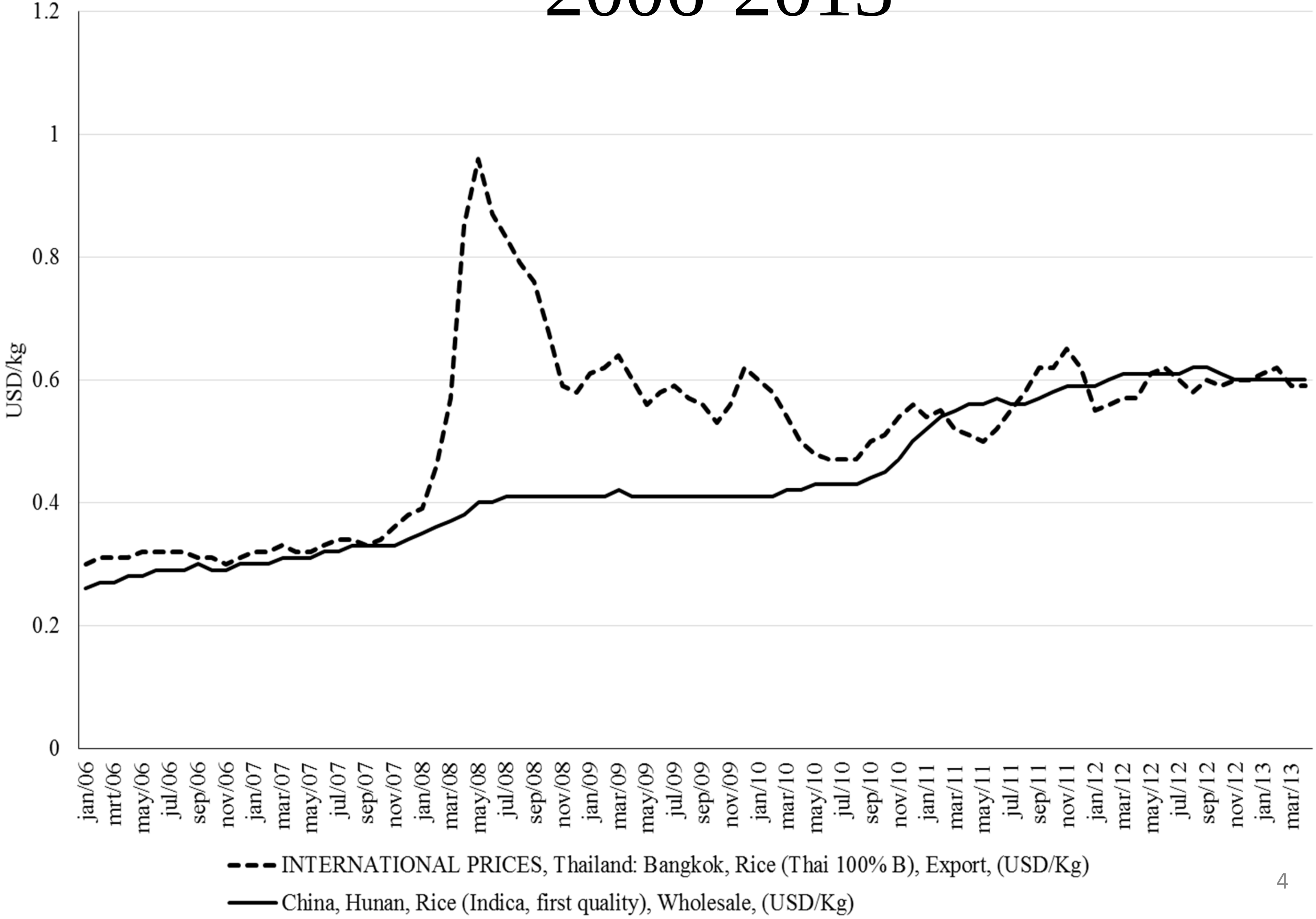
"Food price levels are important, but so too is food price volatility. … it makes planning very difficult and … can lead to hunger and malnutrition."

Senior IFPRI researcher, Nov 2014
(Wall Street

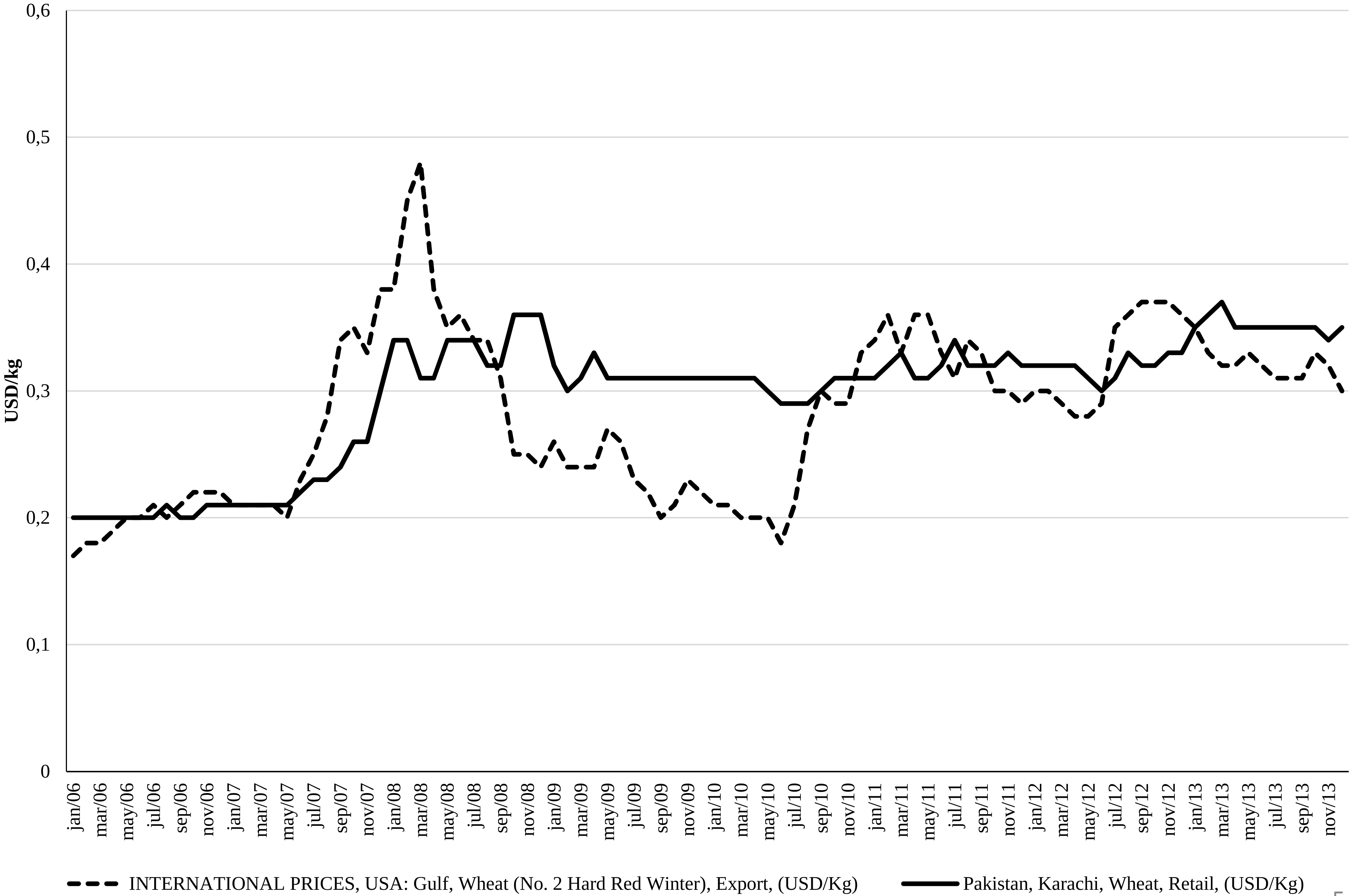
"The EU's Common Agricultural Policy [400 billion euro !] is a crucial instrument to provide a safety net for farmers in times of high price volatility"

EU Commissioner for Agriculture, 2013

Rice markets and prices in China 2006-2013



Wheat markets and prices in Pakistan 2006-2013



Trading-off Volatility and Distortions ?

Consider "**utility with adjustment costs**":

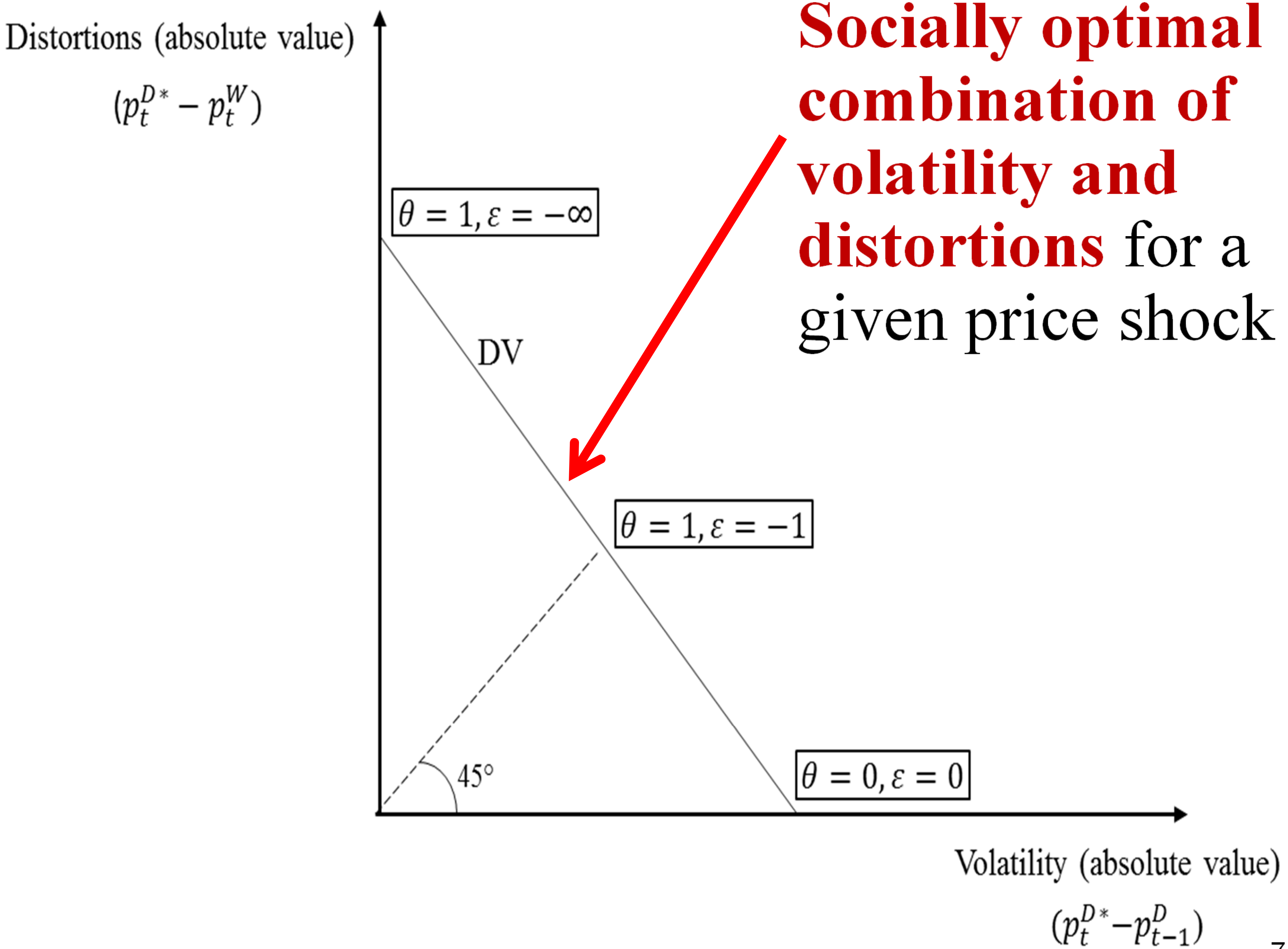
- <u>Consumer</u> utility U^C as:

$$\underbrace{v(p_t^D)}_{\text{Indirect Utility}} - \underbrace{\frac{\delta}{2}(p_t^D - p_{t-1}^D)^2}_{\text{Adjustment Costs}} + \underbrace{\gamma^C\, T}_{\text{Share in tax revenue /subsidy expenditures}}$$

- <u>Producer</u> utility U^P as:

$$\underbrace{\pi(p_t^D)}_{\text{Profits}} - \underbrace{\frac{\mu}{2}(p_t^D - p_{t-1}^D)^2}_{\text{Adjustment Costs}} + \underbrace{\gamma^P\, T}_{\text{Share in tax revenue /subsidy expenditures}}$$

with $\gamma^C + \gamma^P = 1$



Socially optimal combination of volatility and distortions for a given price shock

But ....
1: Reviewer of the paper

- “ **a long literature**, notably Newbery and Stiglitz's 1981 book etc **show that consumers may benefit from increased food price uncertainty** ”

But …
2: Not everybody is equally concerned about price volatility

- ***"Why food price volatility doesn't matter"*** (Barrett & Bellemare 2011)

- ***"Standard assessment of the welfare cost of food price volatility … suggest that … the cost to consumers is small if not negative. The only people who can expect significant gains from price stabilization are the producers – and especially affluent producers"*** (Christophe Goeul, 2013)

=> "**Price stabilization is regressive**" (i.e. benefits the rich)

Waugh (QJE 1944)

DOES THE CONSUMER BENEFIT FROM PRICE INSTABILITY?

SUMMARY

A new theorem: consumers harmed by price stability, 602. — I. Related propositions: consumer's surplus and price stability, 602. — II. The general case, 605. — III. Indifference curve analysis, 606. — IV. The theorem in its most general form, 608. — V. The meaning of the above results: "common sense," 609; offsetting price changes, 609; semi-luxuries, 610; extreme cases, 610; producers or sellers, 610; character of the demand function, 611; quantities sold, 611; adjustment of expenditures, 613; advance knowledge of prices, 613.

In preparing material for a course in Welfare Economics, in coöperation with Mr. R. O. Been, I have developed a theorem which is new, so far as I know. This theorem appears to show that, in a certain sense at least, consumers are harmed by price stability, and that they benefit from instability of prices. Such a conclusion, if correct, obviously has important policy implications, since it runs counter to the accepted doctrines upon which many national and international programs are based.

Waugh (QJE 1944)

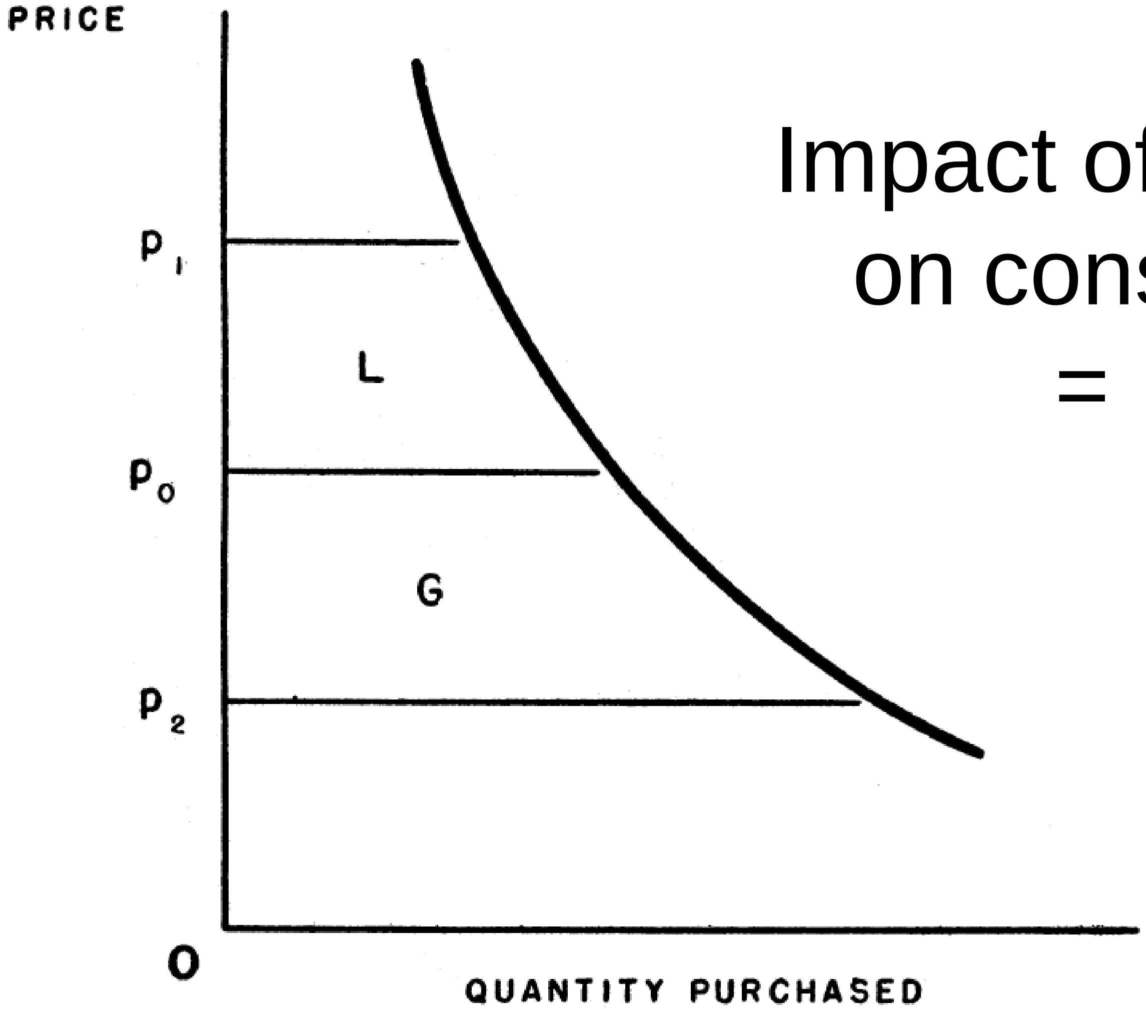


FIGURE 1

Impact of price instability on consumer surplus

= G – L > 0

Oi (1961, Econometrica)

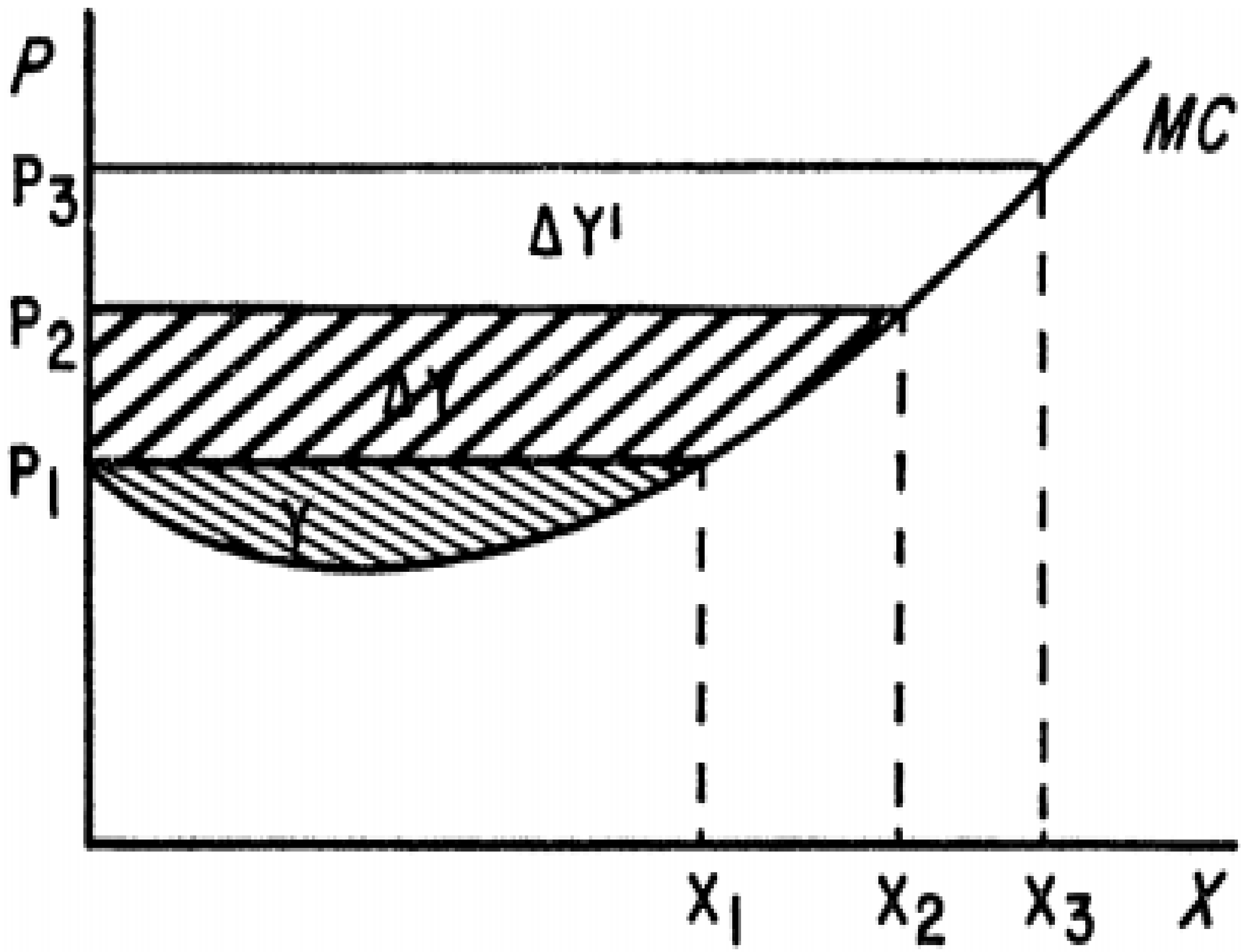


FIGURE 1

Samuelson (QJE 1972)

THE CONSUMER DOES BENEFIT FROM FEASIBLE PRICE STABILITY *

PAUL A. SAMUELSON

INAPPLICABILITY OF THE WAUGH THEOREM

Unless the system has an outside Santa Claus, we can now demonstrate that *a closed system, when it goes from stable prices to unstable prices, must necessarily have those unstable prices average out to higher than the stable prices* — so that the Waugh theorem can never feasibly apply.

Samuelson (QJE 1972)

THE CONSUMER DOES BENEFIT FROM FEASIBLE PRICE STABILITY *

PAUL A. SAMUELSON

* This answer, in reply to F. V. Waugh, "Does The Consumer Benefit From Price Instability?" this *Journal*, LVIII (1944), 602–14, was accepted for publication over a quarter of a century ago; but when the manuscript was lost in the editorial process, the exigencies of war did not seem to warrant preparing a new copy. The present reconstitution was prompted by a recent discussion with Professors Kenneth Arrow, Frank Hahn, Daniel McFadden, and Robert Bishop. My thanks go to the National Science Foundation for financial aid, and to Mrs. Jillian Pappas for editorial assistance.

So: back to the drawing board …

- A new model based on Waugh, Oi, Newbery and Stiglitz, Turnovsky et al, Barrett, Bellemare et al, Gouel et al, ….

- Following Barrett (1996):
  - a two-period model
  - product prices unknown when production decisions are made
  - post-harvest prices announced before the consumer makes its decision.

Consumer

- Maximization problem

$$\boldsymbol{max_{p^D}\, E\left[v(p^D, y)\right]}$$

- Benefit of price stabilization policy is analysed by looking at the Equivalent Variation

$$\boldsymbol{E[v(p^W, y + EV)] = E[v(p^D, y)]}$$

(Equivalent Variation measures consumer benefits of stabilization policy)

- Using Turnovsky et al. (1980) :

$$\boldsymbol{EV \cong \left[- D\left(\overline{p}^W\right) \cdot \left(\overline{p}^D - \overline{p}^W\right) + [\beta(\eta - r) - \alpha\,]D\left(\overline{p}^W\right) \frac{\Delta\sigma_p^2}{2\overline{p}^W}\right]}$$

- **$\boldsymbol{\beta}$: budget share spend on food ($\boldsymbol{0 \leq \beta \leq 1}$)**
- **$\boldsymbol{r}$: relative risk aversion of the consumer ($\boldsymbol{r \geq 0}$)**
- **$\boldsymbol{\eta}$: income elasticity of consumption ($\boldsymbol{\eta \geq 0}$)**
- **$\boldsymbol{\alpha}$: price elasticity of consumption ($\boldsymbol{\alpha \leq 0}$)**

Consumer

- Rewrite using CS as $-\int_0^{\bar{p}^W} D(p)dp$

$$\boldsymbol{EV \cong CS_p(\bar{p}^W)(\bar{p}^D - \bar{p}^W) + CS_{pp}(\bar{p}^W)\frac{\Delta\sigma_p^2}{2} - \delta \cdot \frac{\Delta\sigma_p^2}{2}}$$

$$\textbf{with } \boldsymbol{\delta = [\beta(r-\eta)]\frac{D(\bar{p}^W)}{\bar{p}^W}}$$

- $\boldsymbol{EV} > 0$ if consumers spend a large amount of their budget on food ($\boldsymbol{\beta}$)
- $\boldsymbol{EV} > 0$ if consumers are very risk averse in a context with imperfect insurance markets ($\boldsymbol{r}$)

- A more specific form of the indirect utility can be defined such that it is consistent with the equivalent variation in the above equation (Gouel et al. 2014)

$$\boxed{\begin{gathered} \boldsymbol{v(p^D, y) = CS(p^D) - \frac{\delta}{2}\left[(p^D - \bar{p}^W)^2\right]} \\ \delta = [\beta(r-\eta)]\frac{D(\bar{p}^W)}{\bar{p}^W} \end{gathered}}$$

- **$\boldsymbol{\beta}$: budget share**
- **$\boldsymbol{r}$: risk aversion**
- **$\boldsymbol{\eta}$: income elasticity**

Producer

- Equivalent Variation is approximated by:

$$\boldsymbol{EV} \cong \left(\overline{\boldsymbol{p}}^{\boldsymbol{D}} - \overline{\boldsymbol{p}}^{\boldsymbol{W}}\right) \frac{\boldsymbol{v_p}}{\boldsymbol{v_y}} - \frac{\boldsymbol{v_{pp}}}{\boldsymbol{2v_y}} \cdot \Delta\boldsymbol{\sigma_p^2}$$

- Using Barrett (1996); Bellemare et al (2013) :

$$\boldsymbol{EV} \cong \boldsymbol{S}(\overline{\boldsymbol{p}}) \left[\left(\overline{\boldsymbol{p}}^{\boldsymbol{D}} - \overline{\boldsymbol{p}}^{\boldsymbol{W}}\right) - [\boldsymbol{\lambda}(\boldsymbol{g} - \boldsymbol{r}) + \boldsymbol{\varepsilon}] \cdot \frac{\Delta\boldsymbol{\sigma_p^2}}{\boldsymbol{2}\overline{\boldsymbol{p}}^{\boldsymbol{W}}}\right]$$

  - **$\boldsymbol{\lambda}$: dominance of the food crop in the total production ($0 \leq \boldsymbol{\lambda} \leq 1$)**
  - **$\boldsymbol{r}$: relative risk aversion of the producer ($\boldsymbol{r} \geq 0$)**
  - **$\boldsymbol{g}$: income elasticity of the marketable surplus ($\boldsymbol{g} \leq 0$)**
  - **$\boldsymbol{\varepsilon}$: price elasticity of the marketable surplus ($\boldsymbol{\varepsilon} \geq 0$)**

- Rewrite:

$$\boldsymbol{EV} \cong \boldsymbol{\pi_p}\left(\overline{\boldsymbol{p}}^{\boldsymbol{W}}\right)\left(\overline{\boldsymbol{p}}^{\boldsymbol{D}} - \overline{\boldsymbol{p}}^{\boldsymbol{W}}\right) + \boldsymbol{\pi_{pp}}\left(\overline{\boldsymbol{p}}^{\boldsymbol{W}}\right) \frac{\Delta\boldsymbol{\sigma_p^2}}{\boldsymbol{2}} - \boldsymbol{\mu} \cdot \frac{\Delta\boldsymbol{\sigma_p^2}}{\boldsymbol{2}}$$

$$\textbf{with } \boldsymbol{\mu} = \boldsymbol{\lambda}(\boldsymbol{r} - \boldsymbol{g}) \frac{\boldsymbol{S}(\overline{\boldsymbol{p}}^{\boldsymbol{W}})}{\overline{\boldsymbol{p}}^{\boldsymbol{W}}}$$

Producer

$$\boldsymbol{EV} \cong \boldsymbol{\pi_p}(\overline{\boldsymbol{p}}^{W})(\overline{\boldsymbol{p}}^{D} - \overline{\boldsymbol{p}}^{W}) + \boldsymbol{\pi_{pp}}(\overline{\boldsymbol{p}}^{W})\frac{\Delta\boldsymbol{\sigma}_{\boldsymbol{p}}^{2}}{\mathbf{2}} - \boldsymbol{\mu}\cdot\frac{\Delta\boldsymbol{\sigma}_{\boldsymbol{p}}^{2}}{\mathbf{2}}$$

$$\textbf{with } \boldsymbol{\mu} = \boldsymbol{\lambda}(\boldsymbol{r} - \boldsymbol{g})\frac{\boldsymbol{S}(\overline{\boldsymbol{p}}^{W})}{\overline{\boldsymbol{p}}^{W}}$$

- $\boldsymbol{EV} > 0$ when producers are highly dependent on the production of food for their income λ
- A more specific form of the indirect utility can be defined such that it is consistent with the equivalent variation in the above equation (Gouel et al. 2014):

$$\boxed{\begin{array}{c} \boldsymbol{v}(\boldsymbol{p}^{D}, \boldsymbol{y}) = \boldsymbol{\pi}(\boldsymbol{p}^{D}) - \dfrac{\boldsymbol{\mu}}{\mathbf{2}}\left[(\boldsymbol{p}^{D} - \overline{\boldsymbol{p}}^{W})^{\mathbf{2}}\right] \\ \text{with } \mu = \lambda(r - g)\dfrac{S(\bar{p}^{W})}{\bar{p}^{W}} \end{array}}$$

- **$\boldsymbol{\lambda}$: dominance of the crop**
- **$\boldsymbol{r}$: relative risk aversion**
- **$\boldsymbol{g}$: income elasticity of the marketable surplus ($\boldsymbol{g} \leq 0$)**

The government

- **Policy intervention to stabilize prices** (with budgetary implications T):

$$T = (p^D - p^W)(D(p^D) - S(p^D))$$

- Government maximizes **social welfare**

$$max_{p^D} \left\{ \begin{aligned} & CS(p^D) - \frac{\delta}{2}(p^D - \bar{p}^W)^2 + \pi(p^D) - \frac{\tau}{2}(p^D - \bar{p}^W)^2 \\ & + (p^D - p^W)(D(p^D) - S(p^D)) \end{aligned} \right\}$$

Social Optimum with Volatility and Adjustment Costs

- The social welfare maximizing domestic price p^{D*} is determined by First order condition :

$$\begin{bmatrix} -D(p^{D*}) - \delta(p^{D*} - \bar{p}^{W}) + \gamma^{C}\left(D(p^{D*}) - S(p^{D*})\right) \\ +\gamma^{C}\,(p^{D*} - p^{W})(D'(p^{D*}) - S'(p^{D*})) \end{bmatrix} +$$

$$\begin{bmatrix} S(p^{D*}) - \mu(p^{D*} - \bar{p}^{W}) + \ \gamma^{P}\left(D(p^{D*}) - S(p^{D*})\right) \\ +\gamma^{P}\,(p^{D*} - p^{W})(D'(p^{D*}) - S'(p^{D*})) \end{bmatrix} = 0$$

Social Optimum with Volatility

- First order condition can be written as:

$$(p^{D*} - p^W)(D'(p^{D*}) - S'(p^{D*})) = (\delta + \mu)[(p^{D*} - \bar{p}^W)]$$

- Case without volatility concerns:

$$(p^{D*} - p^W)(D'(p^{D*}) - S'(p^{D*})) = 0$$

Social Optimum with Volatility

- First order condition can be written as:

$$\boldsymbol{p^{D*} = \theta\bar{p}^{W} + (1-\theta)p^{W}}$$

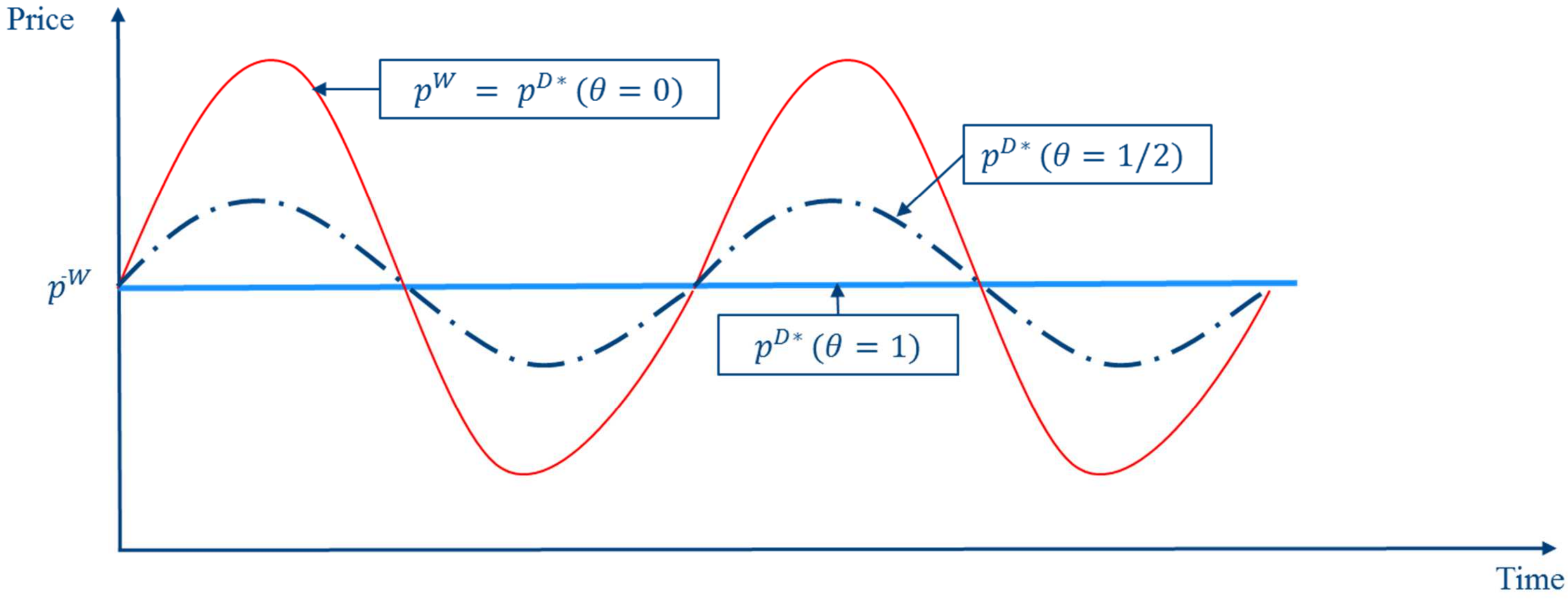
$$\textbf{with } \boldsymbol{\theta = \frac{\delta+\mu}{\delta+\mu+S\prime-D\prime} \geq 0} \textbf{ and } \boldsymbol{0 \leq \theta \leq 1}$$

or

$$(p^{D*} - p^{W}) = \varepsilon\,(p^{D*} - \bar{p}^{W})$$

$$\text{with } \varepsilon = \frac{\delta+\mu}{D'-S\prime} = \frac{\theta}{\theta-1} \leq 0$$

Social Optimum for different θ



Social Optimum with Volatility

- First order condition can be written as:

$$p^{D*} = \theta\bar{p}^{W} + (1-\theta)p^{W}$$

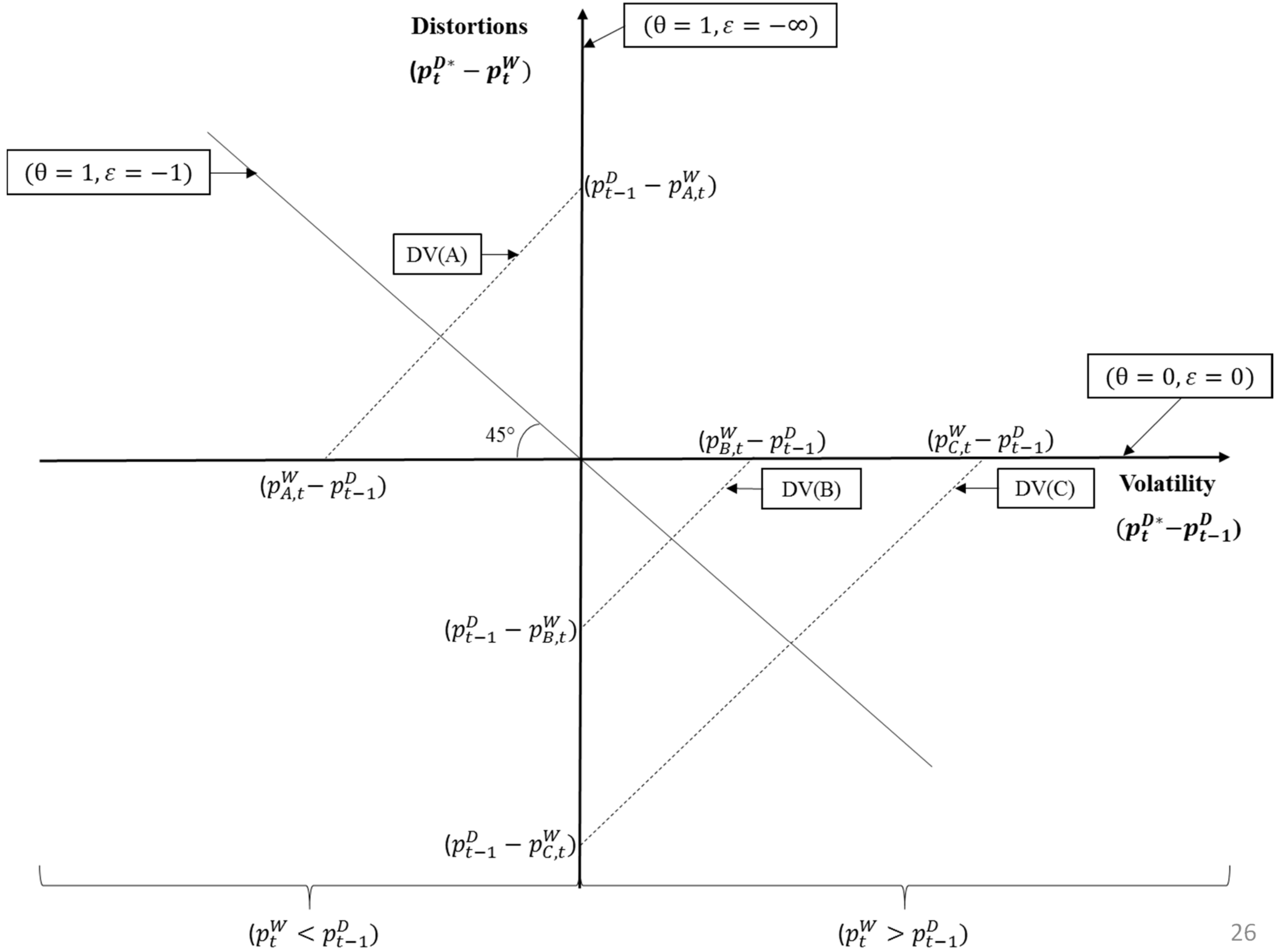
with $\theta = \frac{\delta+\mu}{\delta+\mu+S\prime-D\prime} \geq 0$ and $0 \leq \theta \leq 1$

or

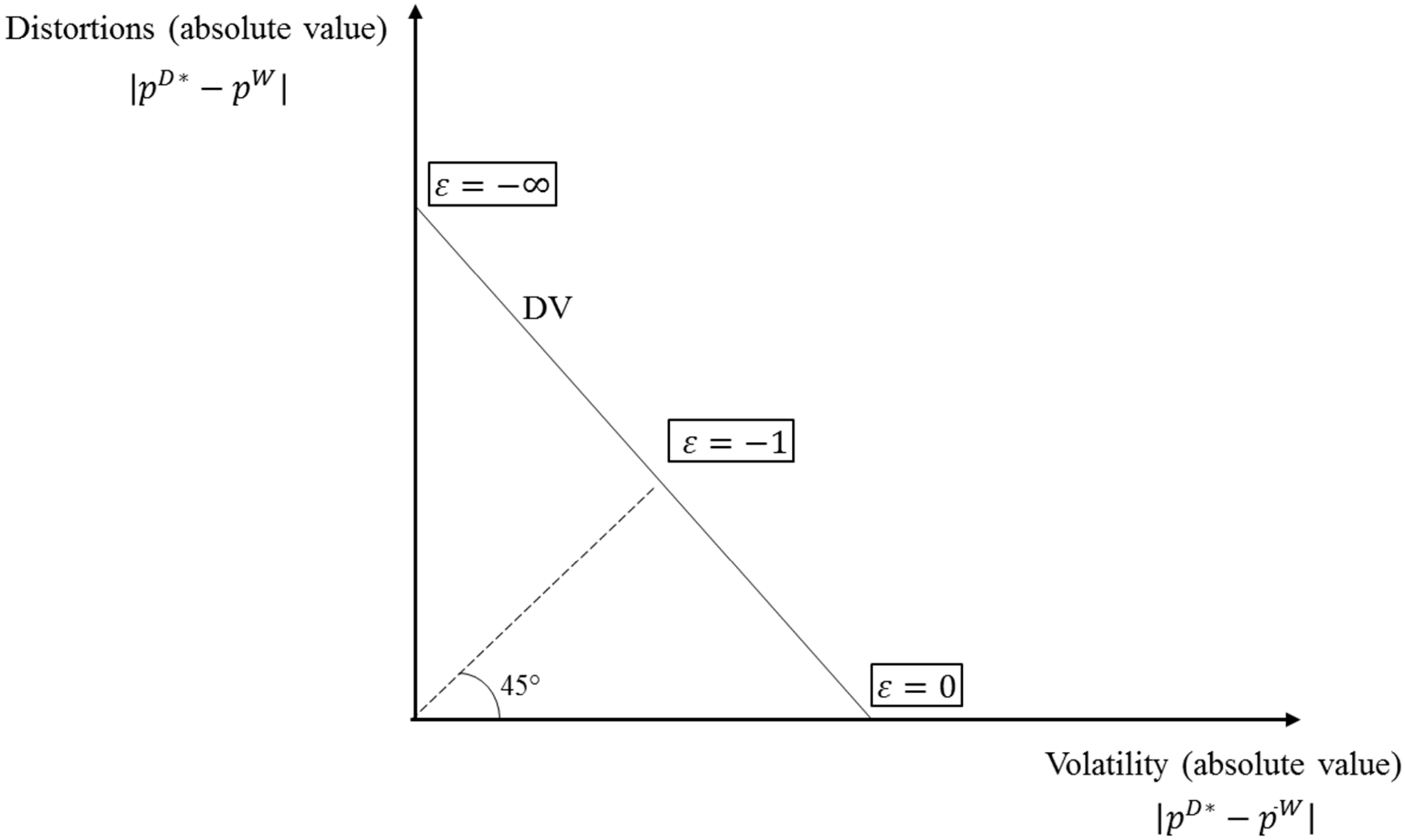
$$\boldsymbol{\left(p^{D*} - p^{W}\right) = \varepsilon\left(p^{D*} - \bar{p}^{W}\right)}$$

with $\boldsymbol{\varepsilon = \frac{\delta+\mu}{D'-S\prime} = \frac{\theta}{\theta-1} \leq 0}$

International price shocks and trade-off between distortions and volatility



Optimal combinations of observed volatility and distortions for a given price shock



Empirical Evidence
From developing countries

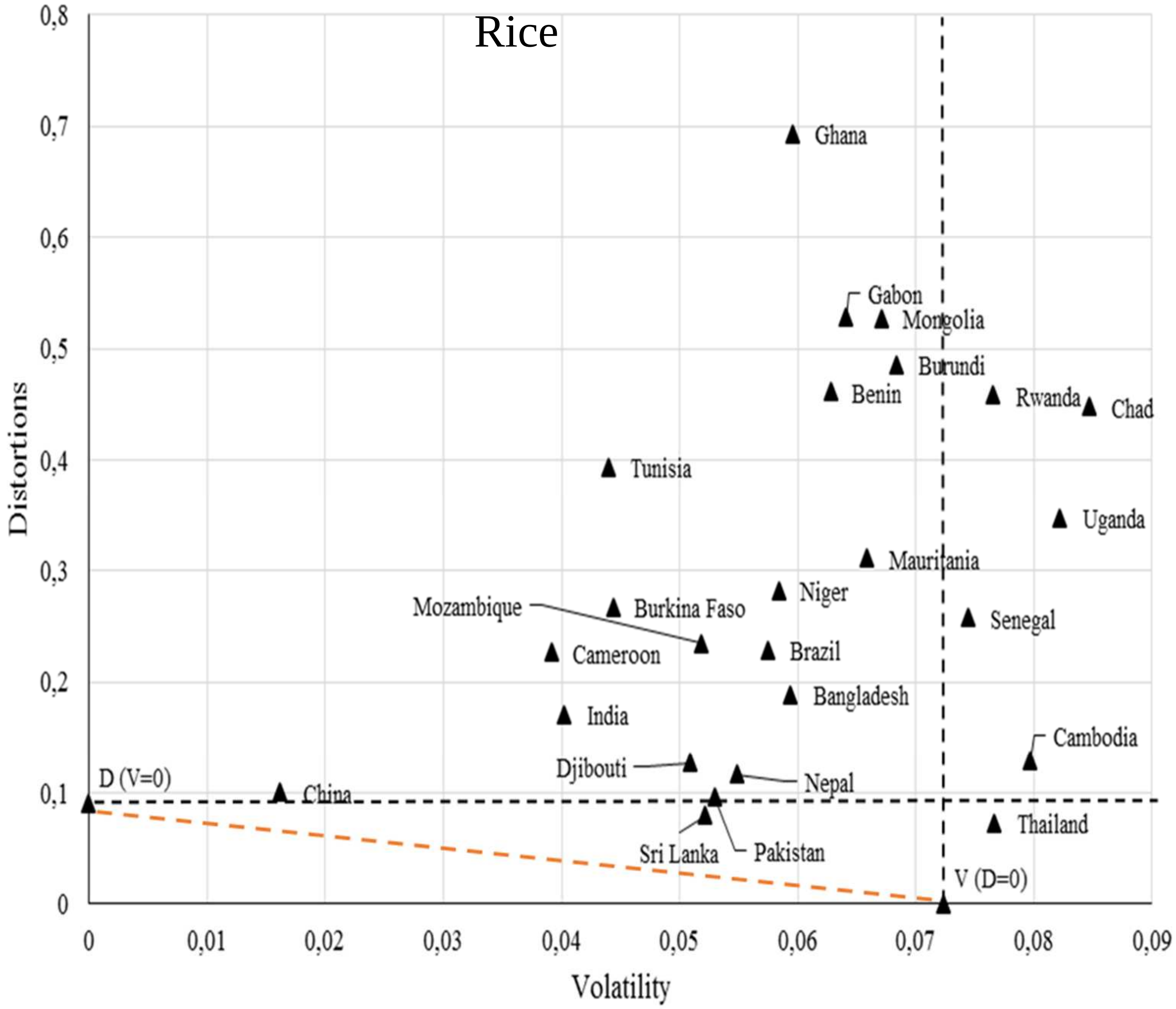
- **Volatility** (the coefficient of variation)

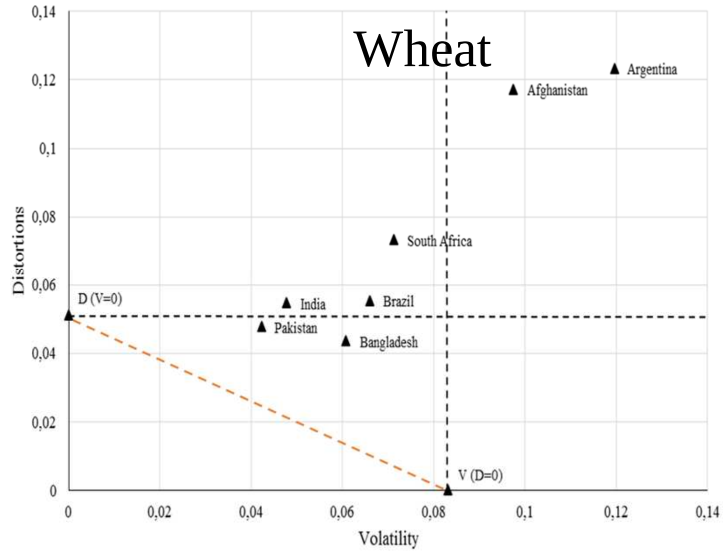
$$v = \frac{s}{\mu}$$

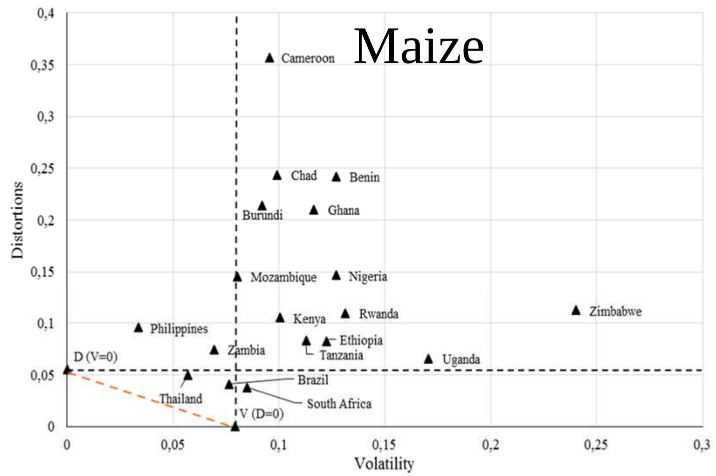
- **Distortions**:

$$d = \sum_{t=0}^{T} \frac{1}{T} |p_t^D - p_t^w|$$

Distortions and volatility (2007-2013)



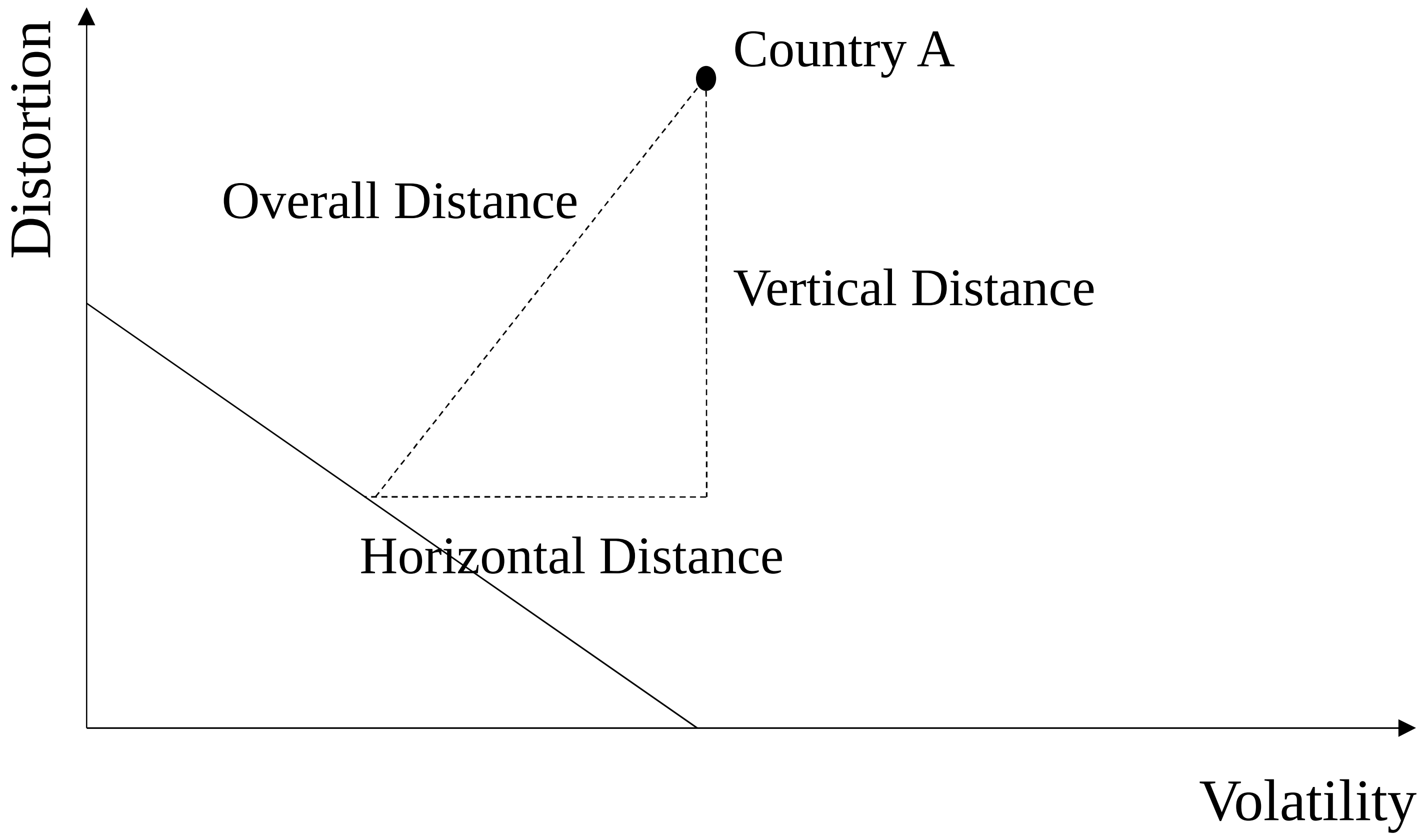




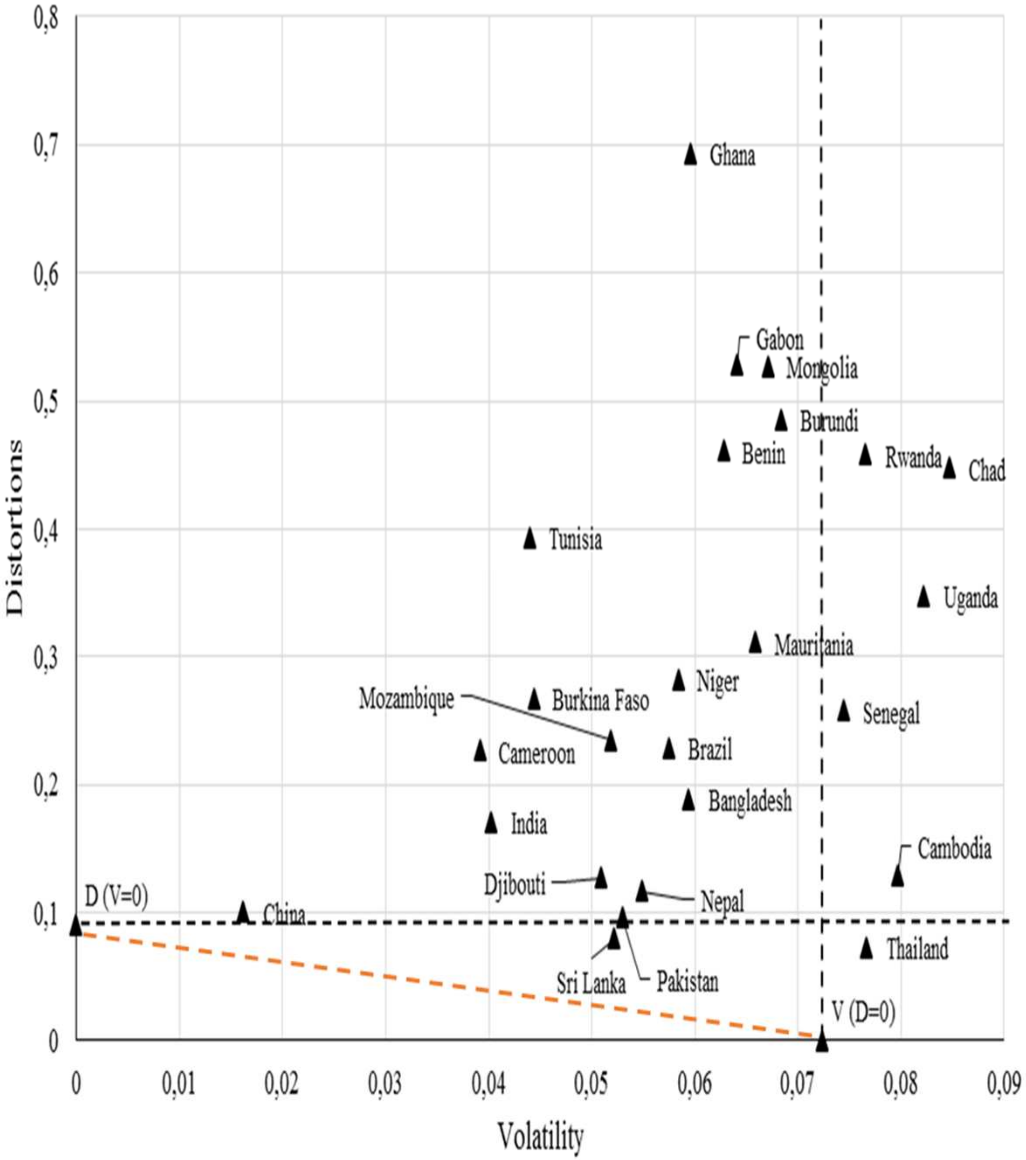
D (V=0): Minimum distortions at zero volatility
V (D=0): Volatility at zero distortions (= world market price volatility)

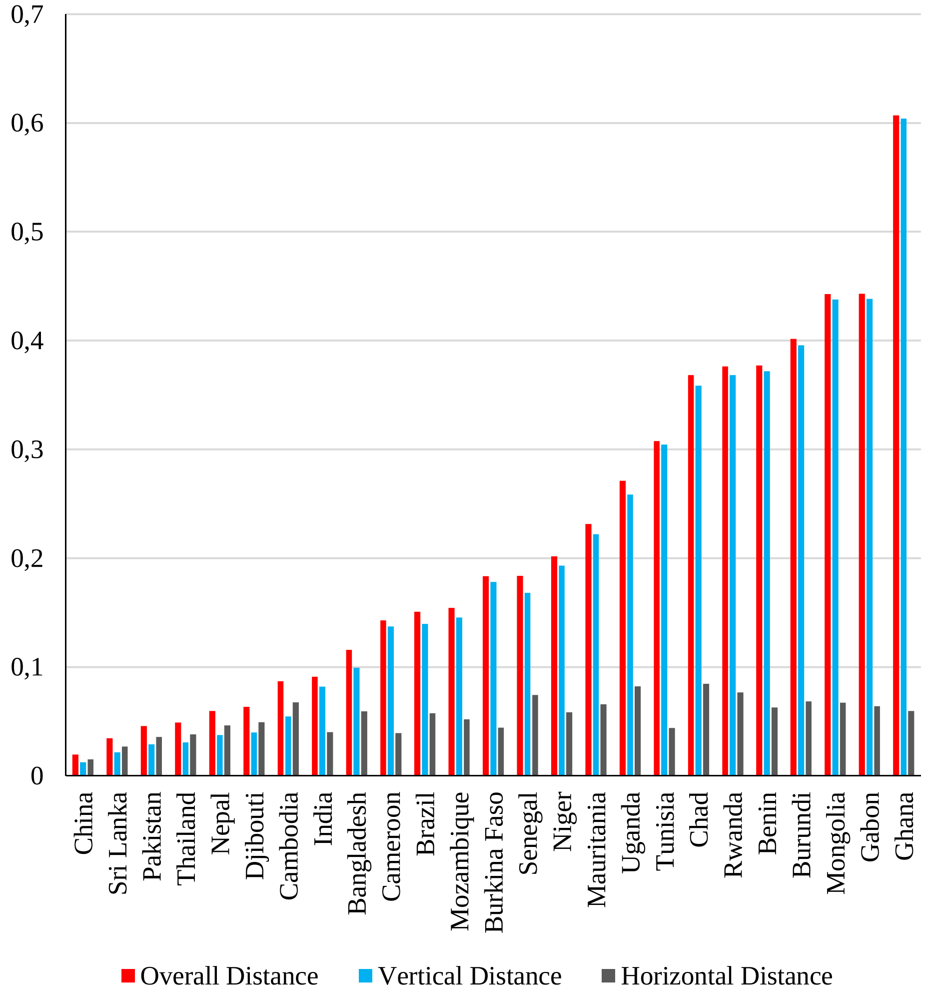
Empirical Evidence

Measuring the inefficiency of the actual policy



Rice: DV frontier & inefficiency





D (V=0): Minimum distortions at zero volatility

V (D=0): Volatility at zero distortions (= world market price volatility)

Why so much "policy inefficiency" ? (even allowing for stability objectives)

Possible explanations:

1. Political determinants

2. Measurement problems

Political Optimum with Volatility and Adjustment costs

- Adjusted Grossman and Helpman (1994) model: the government maximizes:

$$max_{p^D}\ \alpha^c C_c(p^D) + \alpha^p C_p(p^D) + W\ (p^D)$$

- α^c and α^p are relative strength of the consumer and producer lobby
- C_c is the truthful contribution schedule of consumers
- C_P is the truthful contribution schedule of producers
- $W\ (p^D)$ is social welfare

Political Optimum with Volatility

- First order condition :

$$\left(\boldsymbol{p^{DO}} - \boldsymbol{p^{W}}\right) = \frac{\boldsymbol{A}}{\boldsymbol{B}}\left(\boldsymbol{p^{DO}} - \boldsymbol{\overline{p}^{W}}\right)$$

$$- \frac{\boldsymbol{A \cdot C}}{\boldsymbol{B \cdot (B + C)}}\left(\boldsymbol{p^{DO}} - \boldsymbol{\overline{p}^{W}}\right)$$

$$+ \frac{\boldsymbol{D}}{\boldsymbol{B+C}}\left(\boldsymbol{p^{DO}} - \boldsymbol{\overline{p}^{W}}\right)$$

$$+ \frac{\boldsymbol{E - C \cdot F}}{\boldsymbol{B + C}}$$

$$A = (\delta + \mu)$$

$$B = D'(p^{DO}) - S'(p^{DO})$$

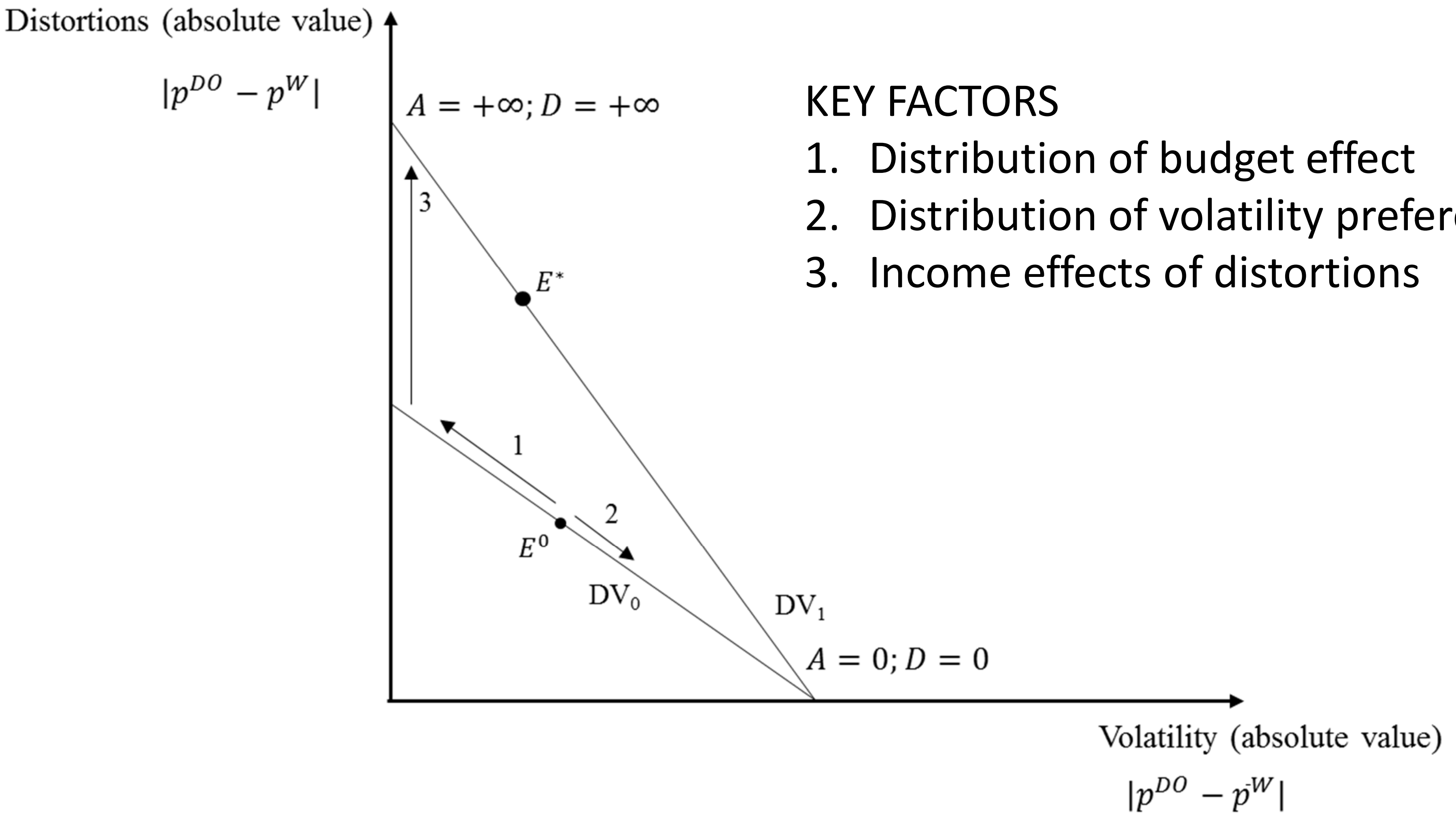
$$C = \alpha^{c}\gamma^{c} + \alpha^{p}\gamma^{p}$$

$$D = \alpha^{C}\delta + \alpha^{P}\mu$$

$$E = \alpha^{C}D(p^{DO}) - \alpha^{P}S(p^{DO})$$

$$F = D(p^{DO}) - S(p^{DO})$$

Political Optimum with Volatility



KEY FACTORS

1. Distribution of budget effect
2. Distribution of volatility preferences
3. Income effects of distortions

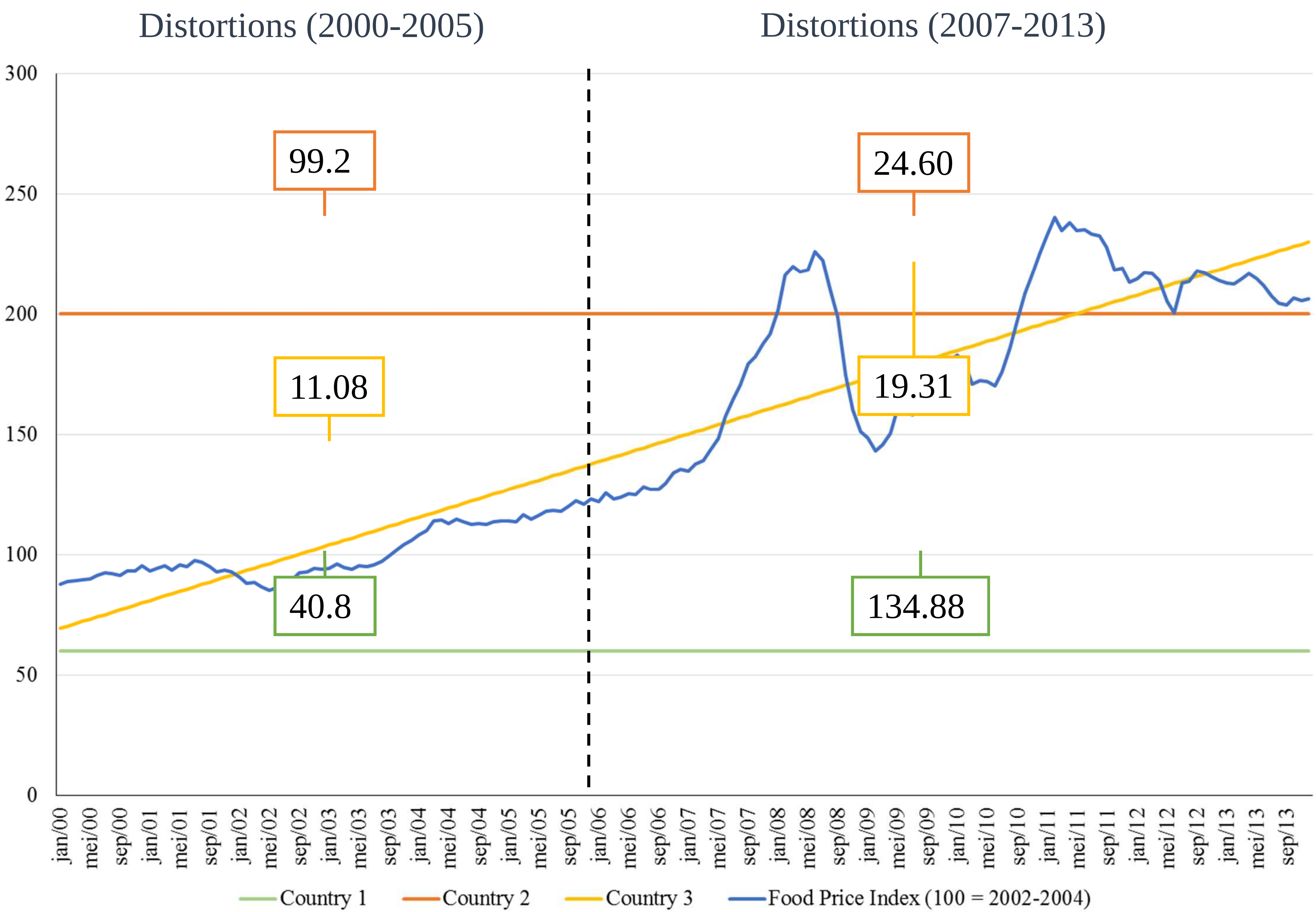
Let’s look at the correlation with some empirical factors

Note:

- Almost all empirical indicators have a “political economy” aspect and a “measurement problem” aspect

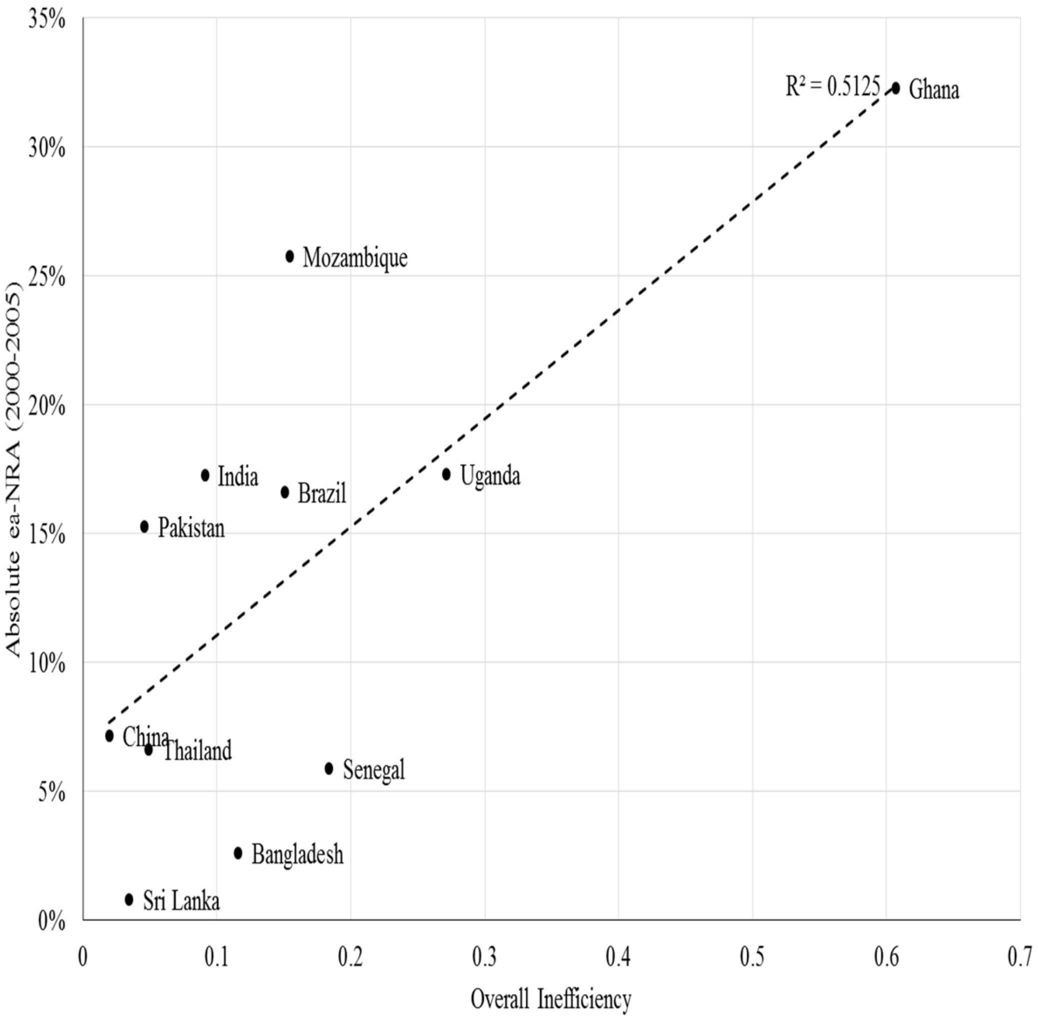
- Observed distortions will reflect <u>interaction</u> of political influence and price moment

Measured distortion, political power, and price movement

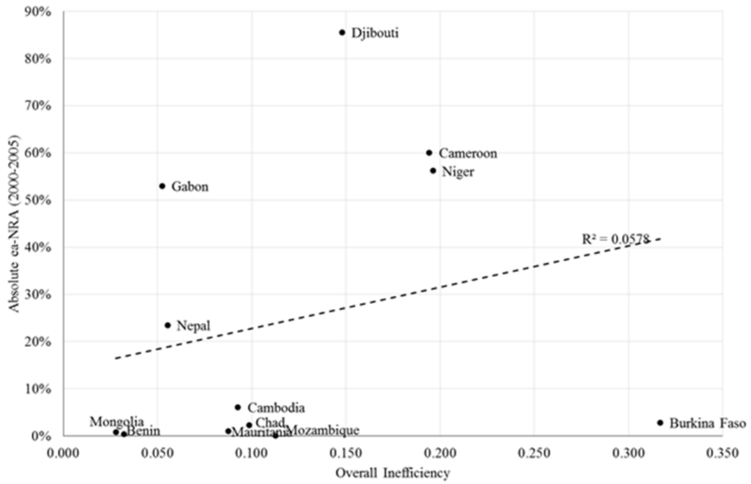


DV Inefficiency & Absolute ea-NRA

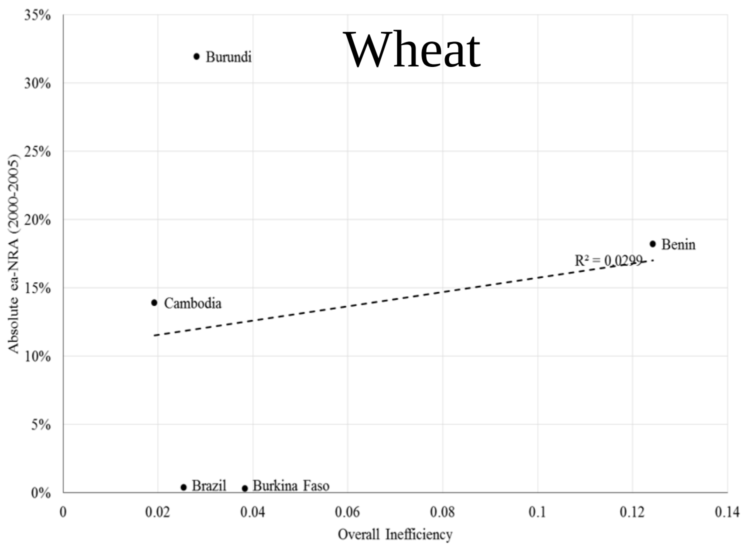
Rice



Maize



Wheat



DV Inefficiency & Tax Revenues

Rice	*Import/Export Subsidies*	*Import/Export Tariffs*
Mean Overall Inefficiency	0.106	0.274
Variance	0.014	0.024
Observations	8	13
Hypothesized Mean Difference	0	
df	18	
t Stat	-2.795	
P(T<=t) one-tail	0.006	
t Critical one-tail	1.734	
P(T<=t) two-tail	0.012	
t Critical two-tail	2.101	

Wheat	*Import/Export Subsidies*	*Import/Export Tariffs*
Mean Overall Inefficiency	0.031	0.067
Variance	0.000	0.003
Observations	3	3
Hypothesized Mean Difference	0	
df	2	
t Stat	-1.161	
P(T<=t) one-tail	0.183	
t Critical one-tail	2.920	
P(T<=t) two-tail	0.365	
t Critical two-tail	4.303	

Maize	*Import/Export Subsidies*	*Import/Export Tariffs*
Mean Overall Inefficiency	0.129	0.128
Variance	0.008	0.004
Observations	11	7
Hypothesized Mean Difference	0	
df	16	
t Stat	0.030	
P(T<=t) one-tail	0.488	
t Critical one-tail	1.746	
P(T<=t) two-tail	0.976	
t Critical two-tail	2.120	

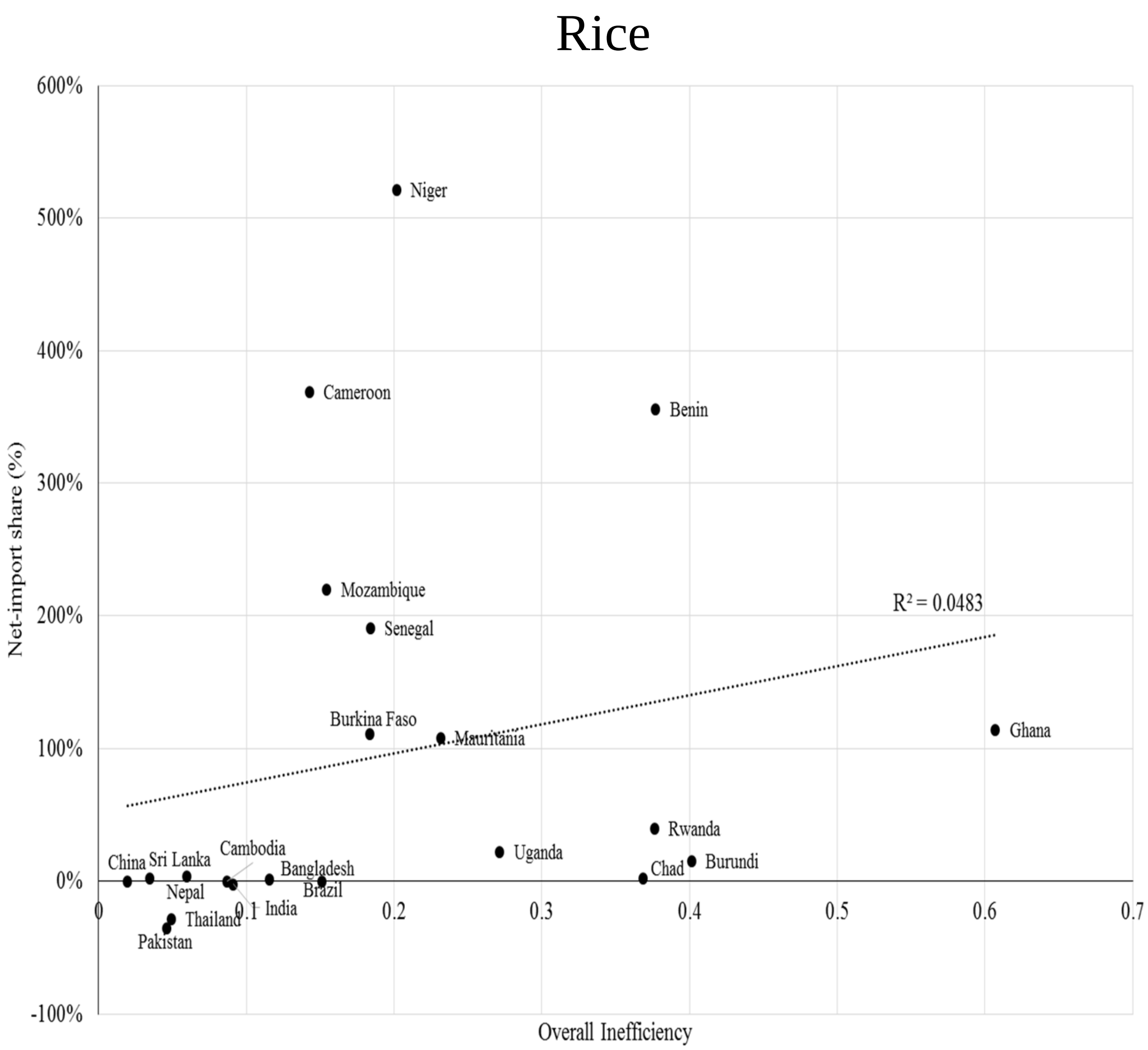
Regression

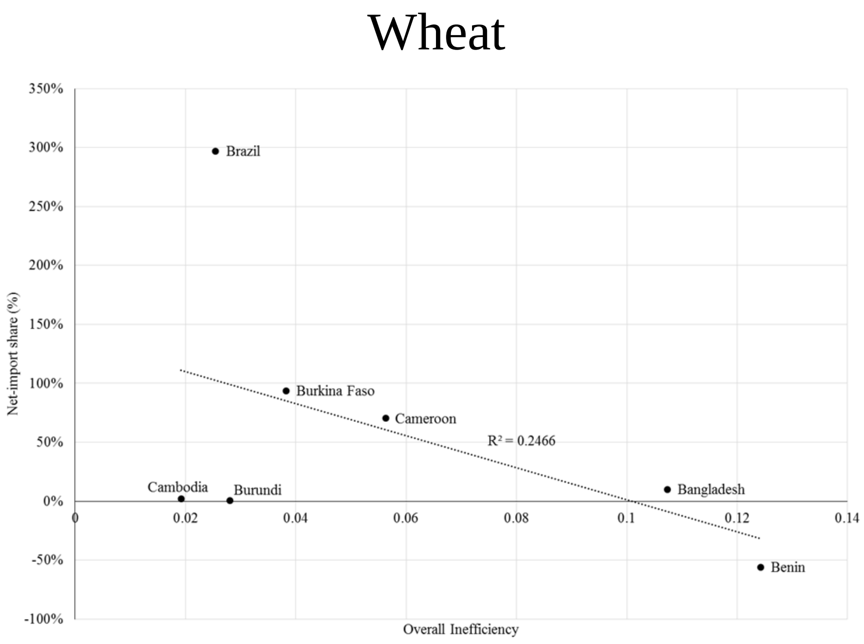
$$\boldsymbol{Inefficiency_i = \beta_1 (ea\_NRA)_i + \beta_2 Taxation_i + \varepsilon_i}$$

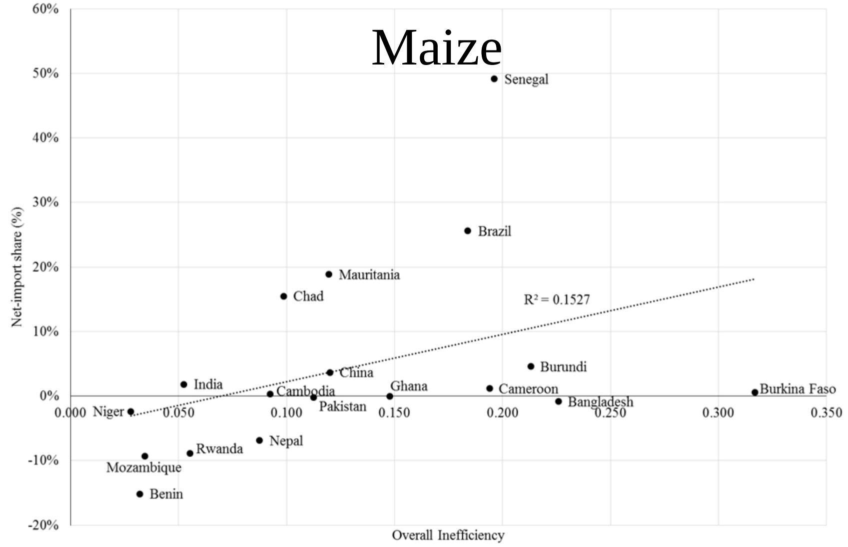
	Coefficients	*Standard Error*	*P-value*
Absolute Ex-ante NRA	0.212	0.118	0.085
Taxation indicator	-0.062	0.051	0.234
Intercept	0.113	0.033	0.002
R-Square	0.120		
Observations	28		

Taxation = 1 if the country has import or export tariffs
Absolute Ex-ante NRA is a measure for the power of lobby groups

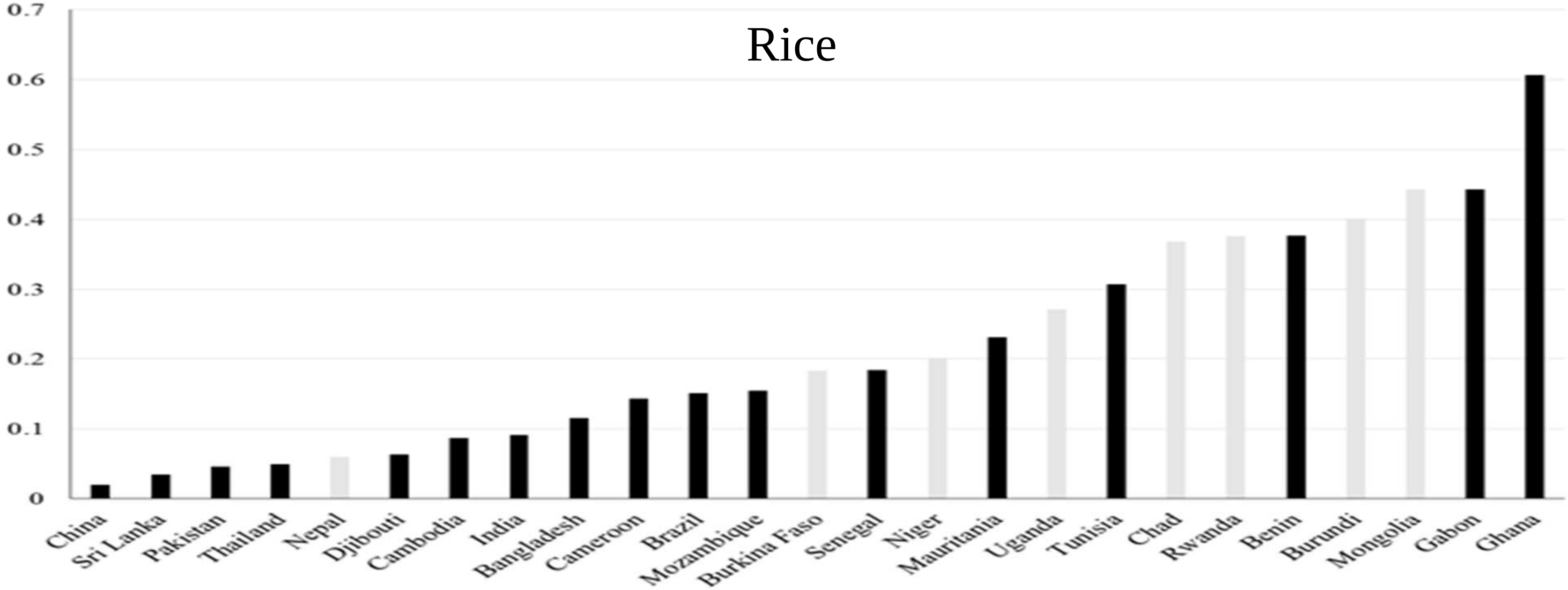
DV Inefficiency & Import Share

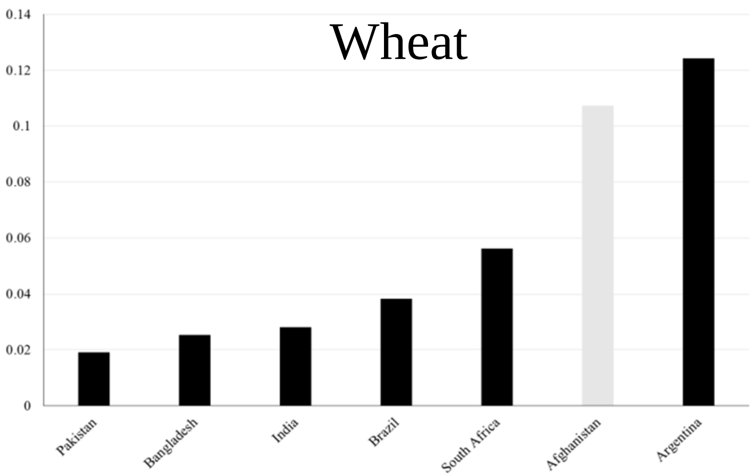


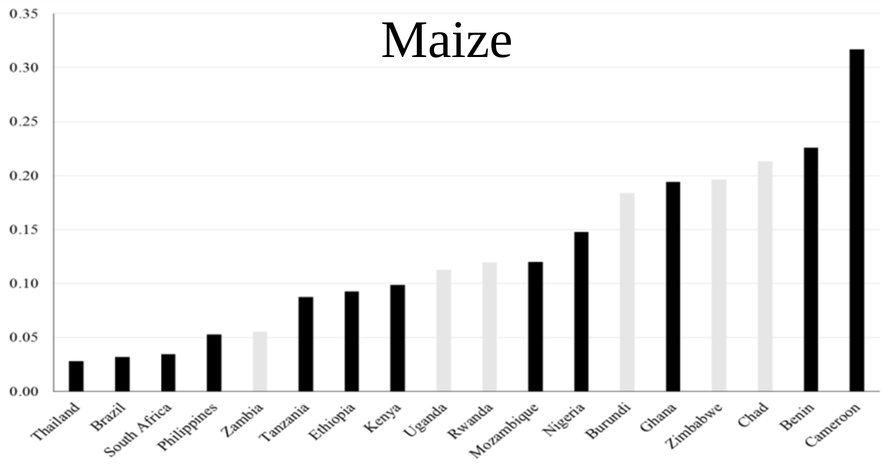




DV Inefficiency & Landlocked







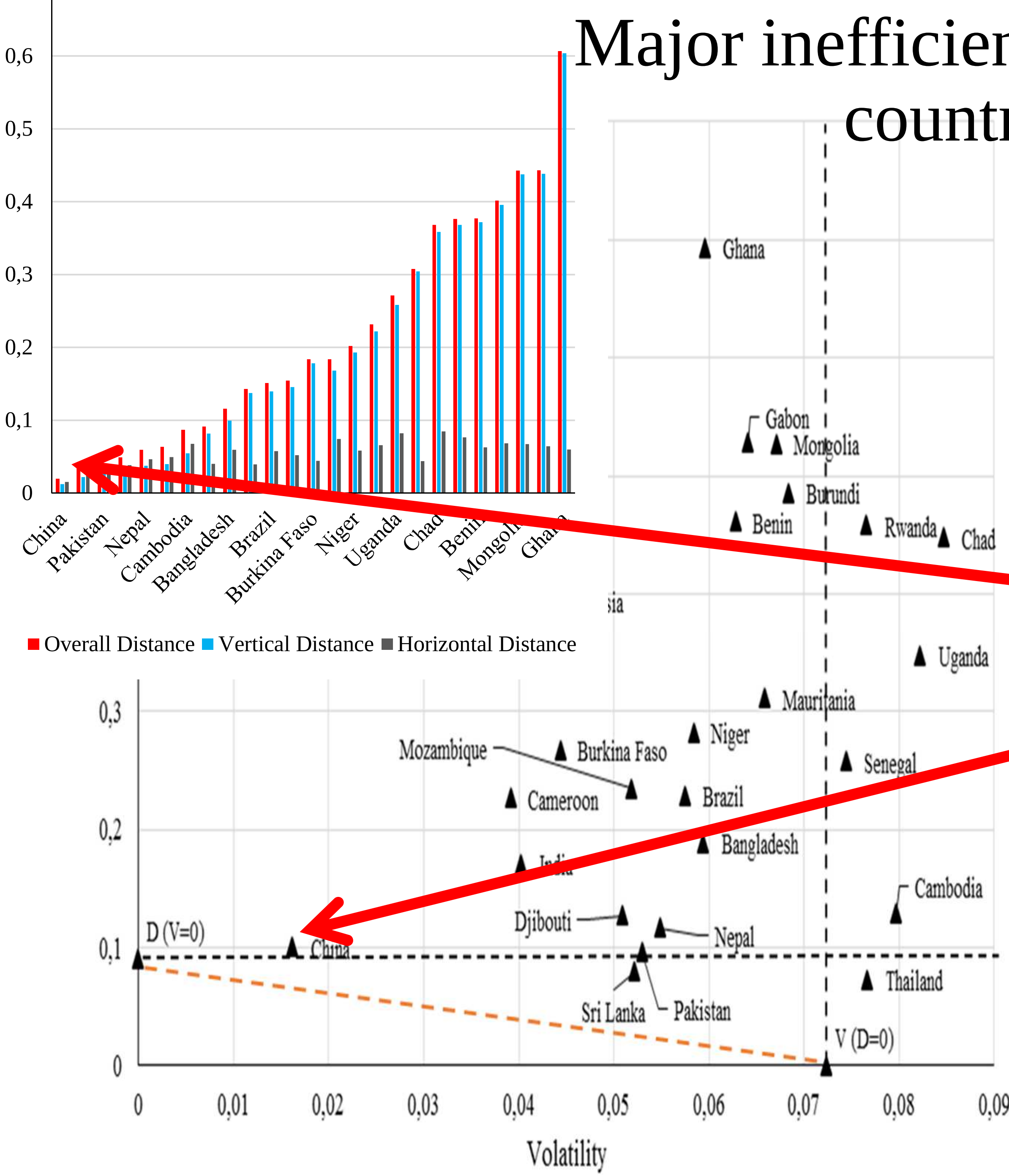
Regression

$$Inefficiency_i = \beta_1(ea\_NRA)_i + \beta_2 Taxation_i + \beta_3\ Import_i + \beta_4\ Landlocked_i + \beta_5\ Wheat_i + \beta_6 Maize_i + \varepsilon_i$$

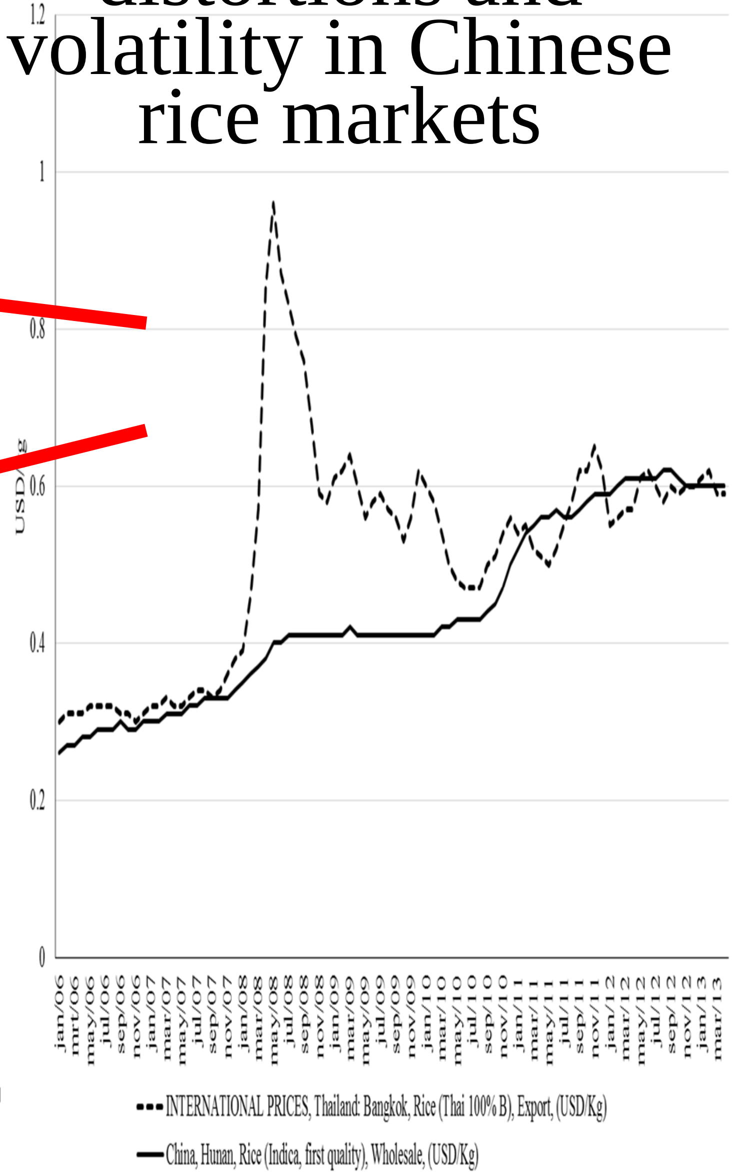
	Coefficients	*Standard Error*	*P-value*
Absolute Ex-ante NRA	0.145	0.114	0.218
Taxation indicator	0.001	0.056	0.989
Net-Import share	0.032	0.031	0.310
Landlocked	0.119	0.056	0.046
Maize dummy	-0.060	0.050	0.245
Wheat dummy	-0.095	0.061	0.132
Intercept	0.101	0.044	0.033
R-square	0.377		
Observations	28		

Taxation = 1 if the country has import or export tariffs
Absolute Ex-ante NRA is a measure for the power of lobby groups
Landlocked = 1 if country is landlocked
Net-Import share = share of net imports in total trade

Major inefficiencies in some countries



Trading off distortions and volatility in Chinese rice markets



D (V=0): Minimum distortions at zero volatility

V (D=0): Volatility at zero distortions (= world mark

Concluding comments

- Issues :
  - How much “distortions” in the “distortion measures” ?
  - Interaction of politics and price direction
  - Policy instrument choice
    - Short run : “Fire Brigade Policy-Making” (Swinnen, 1996)
    - Medium run : political economy / social optimum
    - Long run: use different instruments (development-related)
  - Overall implications ?
    - Ignoring externalities (Anderson et al argument) : how important ?

Concluding comments

Derivation of utility function

- Maximization problem

$$\boldsymbol{max_{p^D}\, E\left[v\left(p^D, y\right)\right]}$$

- Benefit of price stabilization policy is analysed by looking at the equivalent variation

$$\boldsymbol{E[v(p^W, y + EV)] = E[v(p^D, y)]}$$

- Equivalent Variation is approximated by:

$$\boldsymbol{EV \cong \left(\overline{p}^D - \overline{p}^W\right) \frac{v_p}{v_y} - \frac{v_{pp}}{2v_y} \cdot \Delta\sigma_p^2}$$

- Using Turnovsky et al. (1980) and Roy's identity:

$$\boldsymbol{EV \cong \left[- D\left(\overline{p}^W\right) \cdot \left(\overline{p}^D - \overline{p}^W\right) + [\beta(\eta - r) - \alpha\,]D\left(\overline{p}^W\right) \frac{\Delta\sigma_p^2}{2\overline{p}^W}\right]}$$

- Rewrite using CS as $-\int_0^{\bar{p}^W} D(p)dp$ with $CS_p \;=\; \partial CS/\partial p = -D(p)$ and $CS_{pp} \;= -\; D_p(p)$:

$$\boldsymbol{EV \cong CS_p\left(\overline{p}^W\right)\left(\overline{p}^D - \overline{p}^W\right) + CS_{pp}\left(\overline{p}^W\right) \frac{\Delta\sigma_p^2}{2} - \delta \cdot \frac{\Delta\sigma_p^2}{2}}$$

$$\textbf{with } \boldsymbol{\delta = [\beta(r - \eta)] \frac{D(\overline{p}^W)}{\overline{p}^W}}$$

Derivation of utility function

$$\boldsymbol{EV \cong CS_p(\bar{p}^W)(\bar{p}^D - \bar{p}^W) + CS_{pp}(\bar{p}^W)\frac{\Delta\sigma_p^2}{2} - \delta \cdot \frac{\Delta\sigma_p^2}{2}}$$

$$\textbf{with } \boldsymbol{\delta = [\beta(r-\eta)]\frac{D(\bar{p}^W)}{\bar{p}^W}}$$

- $\boldsymbol{EV} > 0$ if consumers spend a large amount of their budget on food
- $\boldsymbol{EV} > 0$ if consumers are very risk averse in a context with imperfect insurance markets

- A more specific form of the indirect utility can be defined such that it is consistent with the equivalent variation in the above equation

$$v(p^D, y) = CS(p^D) - \frac{\delta}{2}[(p^D - \bar{p}^W)^2]$$

$$\delta = [\beta(r-\eta)]\frac{D(\bar{p}^W)}{\bar{p}^W}$$

Political Optimum with Volatility

- First order condition can be written as:

$$\left(\boldsymbol{p^{DO}} - \boldsymbol{p^{W}}\right) = \frac{\boldsymbol{A}}{\boldsymbol{B}+\boldsymbol{C}}\left(\boldsymbol{p^{DO}} - \overline{\boldsymbol{p}}^{\boldsymbol{W}}\right) + \frac{\boldsymbol{D}}{\boldsymbol{B}+\boldsymbol{C}}\left(\boldsymbol{p^{DO}} - \overline{\boldsymbol{p}}^{\boldsymbol{W}}\right) + \frac{\boldsymbol{E}-\boldsymbol{C}\cdot\boldsymbol{F}}{\boldsymbol{B}+\boldsymbol{C}}$$

$$A = (\delta + \mu)$$

$$B = D'(p^{DO}) - S'(p^{DO})$$

$$C = \alpha^{c}\gamma^{c} + \alpha^{p}\gamma^{p}$$

$$D = \alpha^{C}\delta + \alpha^{P}\mu$$

$$E = \alpha^{C}D(p^{DO}) - \alpha^{P}S(p^{DO})$$

$$F = D(p^{DO}) - S(p^{DO})$$