How Agricultural Statistics Contribute to Food Security Decision Making

Submitted by: Nathan Associates

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Agricultural Data Collection and
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Workshop To Assess and Improve Agricultural Data Collection and Dissemination by APEC Member Economies

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How Agricultural Statistics Contribute to Food Security Decision Making

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Key Points

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- Use of statistics in food security decision making corresponds to the four dimensions of food security.

- Watching food security indicators, particularly price volatility, is important in mitigating food insecurity situations or avoiding them such as what occurred in 2008.

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Meaning of food security

- World Food Summit 1974: **food availability**

- 1980s: focus veered towards **food access**

- 1990s: **safe utilization of food**

- 2001 Food Insecurity Report
  - "all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life"

- Four dimensions: availability, access, safe use, and stability

Food Supply Use Balance

$$Q^k + BS_t + M_t = R_1^{...} + R_2^{...} + R_3^{...} + R_4^{...} + X_t + ES_t$$

where

Q is the local production of food say rice, R, in a given year:

BS is the stock at start of the year

M is imported rice

SD stands for seeds

RP is rice used as material in processing

PW is the rice used for feed and waste

FD is rice directly consumed as food

X is exported rice

ES is ending stock

- At any given period, this equation holds.

- To maintain this balance, net changes in stocks or net imports rise or fall in response to changes in local output, and prices remain stable.

- But if such adjustments are inadequate to cope with changes in output, prices of food have to change leading to food use shifts.

Food availability

- Food use at any given time period in the region is Regional production of a given food commodity
  - Plus
    - Net trade, i.e. import minus export
    - Net depletion of stock levels
  - Less
    - Allowances for seeds
    - Uses in processing and other non-human consumption, such as feed and bio-fuel storage
    - Storage and handling losses

Possible indicators of food availability: Production

- Output equals yield multiplied by the area harvested.

- Except in few cases, growth of area harvested has been flat.
  - Land frontier is reached in many cases; competing use of land due to urbanization and bio fuel use.
  - Intensification of land use for food production is possible, and may require investments in irrigation to make existing facilities more efficient; competing use of water.

- Indicators of food availability is growth in production and farm yields

## Production trends of selected food items in the APEC region

Area Harvested

Source: FAOStat

Farm Yield

— Cereals — Starchy roots — Sugar — Vegetables
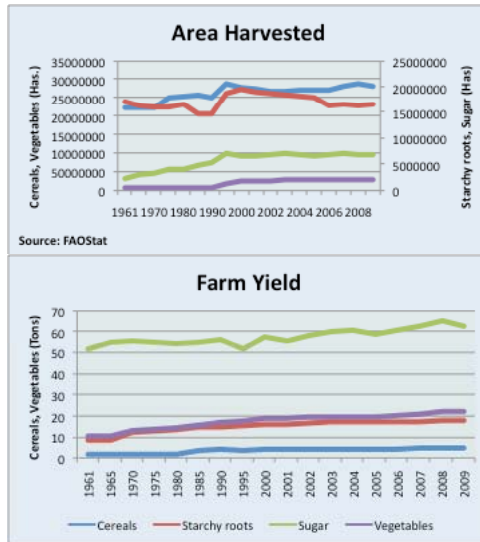
- Average growth in 2000s

	Cereals	Roots
Yield	1.97224996	1.18027591
Area	0.21007245	-1.6683642

	Sugar	Vegetables
Yield	1.04251111	1.64478589
Area	0.55211712	1.8330923

- Relatively flat growth for area

- Yield, driver of output growth

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Production trends of selected food items in the APEC region

Output

Source: FAOStat

— Cereals — Vegetables — Starchy roots — Sugar
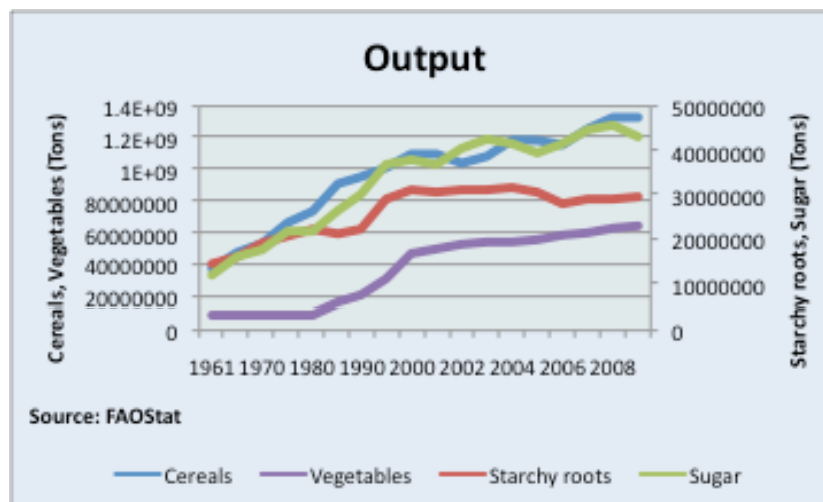
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Possible indicators of food availability: Net Imports

- Net imports of food is imports less exports of it. Imports bring food stocks into the region, while exports take food stocks out of the region.

- If, at the going world price, regional net imports is negative then this indicates the region has marketable surplus in food, e.g. case of Vietnam or Thailand for rice.

- Growth in net exports is not necessarily indicative of less food being available in the region since such growth may come from that of regional production.

- In the same vein, reduced growth in net imports is not necessarily indicative of rising food insecurity since that may be compensated with growth of regional output.

Trade trends of selected food items in the APEC region: Imports

Source: FAOStat
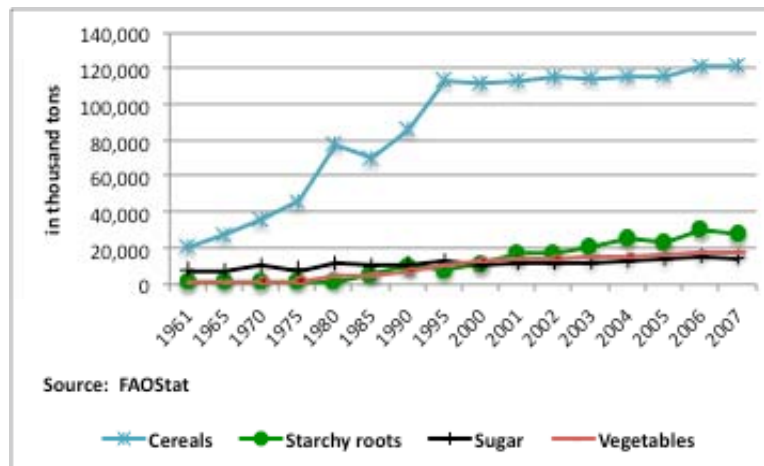
Trade trends of selected food items in the APEC region: Exports

Source: FAOStat

Cereals — Starchy roots — Sugar — Vegetables
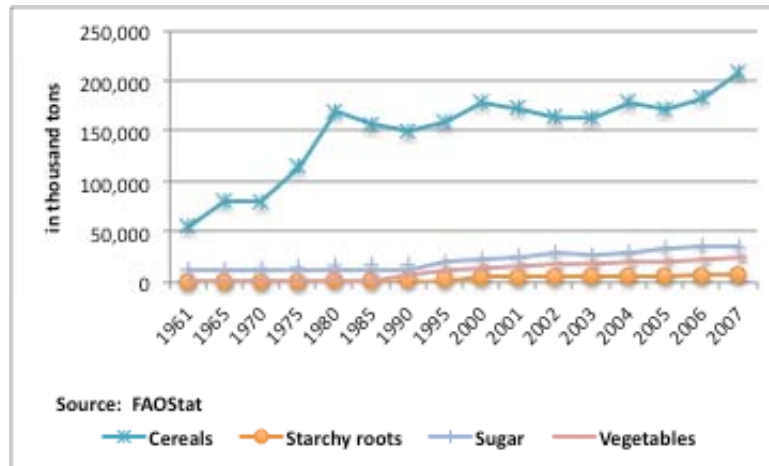
Possible indicators of food availability: Food trade integration

- Link of the region or economy to the larger world market is through its food trade.

- Integration of the regional or national food economy with the larger world market is preferable. It indicates access of food supply in the world trading system.

- Temporary shortfall of local production can be made up with foreign food stocks.

- **Trade to output ratio** measures the degree of integration. The larger this indicator, the more integrated the local food economy is to the rest of the world.

Possible indicators of food availability: net change of food stocks

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- Beginning stocks measures the food stocks available for food use in the current period.
  - These are carry over stocks or so-called "ending stocks" in the immediately preceding period.

- **Ending stocks to use ratios** indicate market prices of food.
  - The lower the ratio, the higher the price.

Trends of selected food items in the APEC region: Net change of stocks

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Source: FAOStat

Cereals — Starchy roots — Sugar — Vegetables
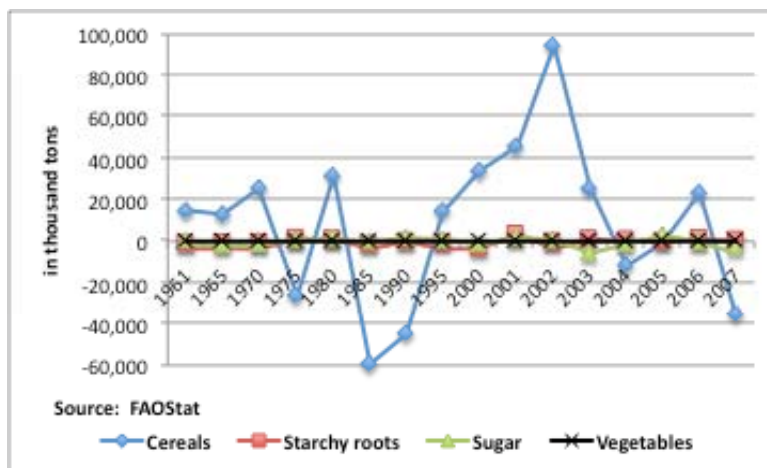
Access to Food: determining entitlement

- Food insecurity is often a problem of lack of entitlement to food rather than availability.

- Is there deprivation of food due to lack entitlement? Things to consider:
  - Per capita income across the socio-economic strata and regions (rural/urban, well connected/remote areas), the proportion of household budget spent on food, and the prevailing market price of food
  - Sources and stability of income (formal/informal sector, farm/non-farm)

- Possible indicators: GDP per capita, Gini ratio, market prices of food, food share in HH budgets

Access to Food: safety nets

- Design of appropriate safety nets for the vulnerable segments of the population.
  - Poverty-group targeted consumer food subsidy
  - Conditional cash transfers

- Create more jobs to increase per capita income of the vulnerable groups in the population.

Safe use of food: degree of ▲malnourishment

- Undernourishment means the caloric intake is below the minimum dietary energy requirement (MDER).

- MDER is the amount of energy needed for light activity and to maintain a minimum acceptable weight for attained height.
  - It varies by economy and from year to year depending on the gender and age structure of the population.

- WFS goal: reduce, between 1990–92 and 2015, the number of undernourished people by half.

- MDG 1, target 1C: halve, between 1990 and 2015, the proportion of people who suffer from hunger.

Number of undernourished in selected developing APEC member economies: ▲WFSG

	Total Population 2005–07	1990–92	1995–97	2000–02	2005–07	Progress towards WFS target = 0.5*
			Millions			
Chile	16.5	0.9	ns	ns	ns	na
Peru	28.2	6.1	5	4.7	4.3	0.7
Mexico	106.4	ns	ns	ns	ns	na
China	1,328.10	210.1	141.8	133.1	130.4	0.6
Republic of Korea	47.8	ns	ns	ns	ns	na
Indonesia	221.9	28.9	22	30.4	29.9	1
Malaysia	26.1	ns	ns	ns	ns	na
Philippines	87.1	15.2	14.1	14.5	13.2	0.9
Thailand	66.5	15	11.2	11.5	10.8	0.7
Viet Nam	85.1	21	16.7	13.3	9.6	0.5

Source: FAO

Proportion of undernourished in selected developing APEC member economies: ▲MDG

|	Total Population 2005–07	1990–92	1995–97	2000–02	2005–07	Progress towards MDG target =0.5
	Millions		Percent			
Chile	16.5	7	-	-	-	na
Peru	28.2	27	21	18	15	0.6
Mexico	106.4	–	–	–	–	na
China	1,328.10	18	12	10	10	0.5
Republic of Korea	47.8	–	–	–	–	na
Indonesia	221.9	16	11	15	13	0.8
Malaysia	26.1	–	–	–	–	na
Philippines	87.1	24	20	18	15	0.6
Thailand	66.5	26	18	18	16	0.6
Viet Nam	85.1	31	22	17	11	0.4

Source: FAO


Price stability
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- Measure of price volatility:
  - Rate of period to period change of price. Percentage change of prices through time (daily, weekly, monthly, annually) or the natural log of period to period ratio of the price
  - Summary measure, e.g. taking the average of rate of change over a year, or taking the standard deviation of the rate of change
  - Need to identify extreme rice price fluctuation or volatility.
  - Extreme rice price volatility, 5 % of the sample at the tail end of the distribution

Trends in Cereal Prices

- Price instability causes food insecurity (WB).

- Three broad swings of rice prices namely in the 1970s, 1990s, and in 2008.

Fig. 3. Export Prices of Cereals, 1961 to 2009

Source of Data: World Bank
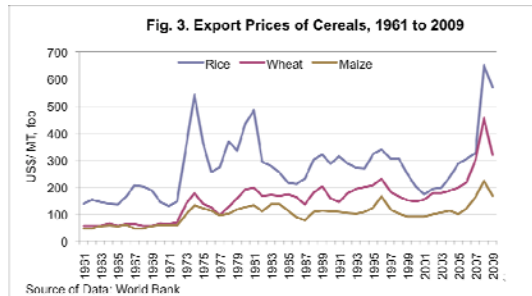
Comparative Price Volatility
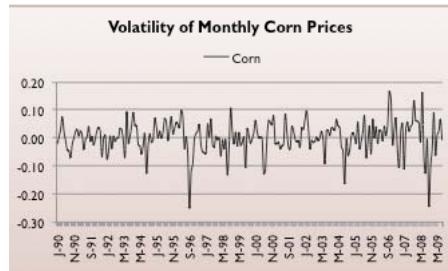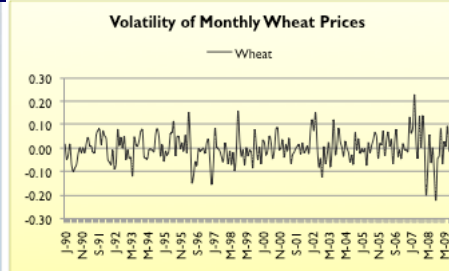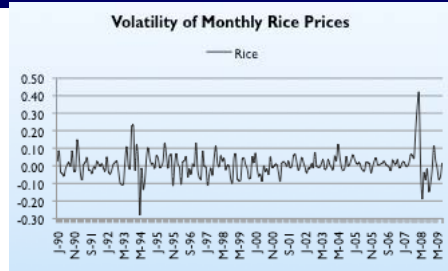
- Monthly rice prices are most volatile

- Variable plotted: natural log of monthly price changes

Average Volatility of Monthly Prices of Cereals

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- Volatility index: standard deviation

- Using monthly prices (data is from IMF), rice has the highest volatility

- Maize and wheat prices follow

Average Volatility of Monthly Prices of Cereals: 1990 to 2009

0% 20% 40% 60% 80% 100% 120%

Wheat   Corn   Rice
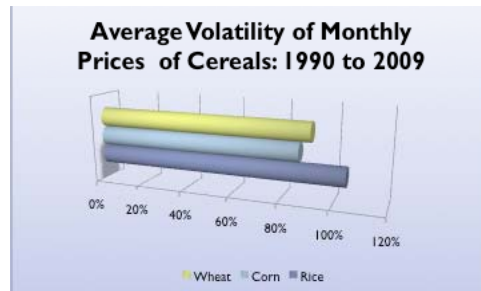
Rice Trade Shocks

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Country/region	Export/import volumes (millions mt):			Percentage change (%)
	2006/07	2007/08	Change	
Total rice trade	31.44	31.19		
Major exporters				
India	5.74	4.65	−1.09	−18.9
Vietnam[a]	4.07	3.11	−0.96	−23.6
China	1.34	0.96	−0.37	−27.7
Egypt	1.20	0.75	−0.45	−37.7
Sum: supply shocks	12.35	9.48	−2.87	−23.2
Major importers				
Energy exporters[b]	5.43	6.43	1.04	19.2
Philippines	1.82	2.57	0.77	42.8
Bangladesh	0.76	2.04	1.28	166.2
Sum: demand shocks	7.96	11.05	3.09	38.7
Sum: demand and supply side shocks				
Actual change in world rice prices: July 2007 to June 2008				

•Headey / Food Policy 36 (2011) 136–146

Uneven and Poor Quality of Market Information

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- **However, trade shocks are by themselves endogenous, i.e. part of the normal operations of the market.**

- One fundamental factor is the uneven and poor quality of market information among players.

- Importers with low information level tend to stock up to avoid future price increases. All of them doing the same shift market demand to increase, causing import shocks.

Efficient market hypothesis

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- Theory asserts that market prices are "informationally efficient".

- Market players form price expectations rationally
  - Given new information, say a drought in economy X, agents adjust price expectations.
  - Forecasts are based on new information.
  - Not all agents need to have accurate price expectations, but as a whole the market is "right".
  - Responses to the shock or new information are random, and are normally distributed.
  - Not one single agent can earn excess profits.

- Expected price movements $E[Pt_{+1}]$ are governed purely by new information.

Grossman and Stiglitz Critique

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- Paradox if market prices are informationally efficient, then why do market players invest in gathering market information.

- Grossman and Stiglitz propose in their models agents with varying information to produce "partially informationally efficient" market equilibria.

- Grossman agents invest in gathering information to profit from the information disadvantage of other agents, increasing the information content of market prices, and arrive at a rational expectations market equilibrium prices.

- Such prices aggregate disperse information, while avoiding perfect revelation due to unobservable supply shocks.

Shiller's irrational price bubble

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- Observation that volatility of market prices is extreme.

- Excess volatility is a result of psychological beliefs that exert a greater influence on the market than do economic fundamentals

- If prices of an asset begin to rise, positive returns by incumbent investors fuels the spread of over-enthusiasm in the market, attracting public attention

- New uninformed agents come in and bid up prices, feeding the expectation of future returns, and attracting more entry

Self Fulfilling Crisis

- Exporters anticipating higher prices tend to store stocks.

- Exporting economies likewise fearing shortages restrict exports.

- These actions result in export shocks.

- Combination of short run export declines, and import surges result increase market prices.

- As information is corrected and made more uniform among market players, market reverses.
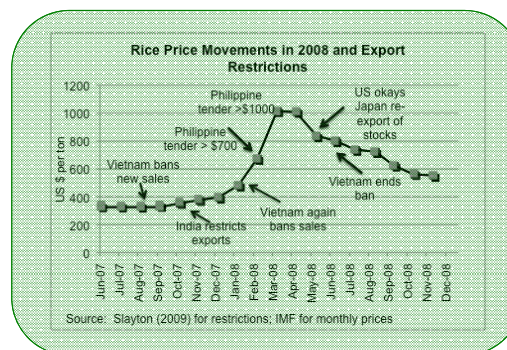

Peculiarities of the rice market

- Thin trade

- Presence of GtoG trading.

- These do not help in the Grossman-Stiglitz process of aggregating information.

- Thus, irrational price bubbles build up.

Possible intervention: rice exchange

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- Commodity exchanges have two benefits
  - Efficient price discovery
  - Risk reduction

- There are none for rice.
  - There are international exchanges for wheat, maize, and soybeans.
  - Rice exchanges are national, and none regionally.

- Rice trade is thin.

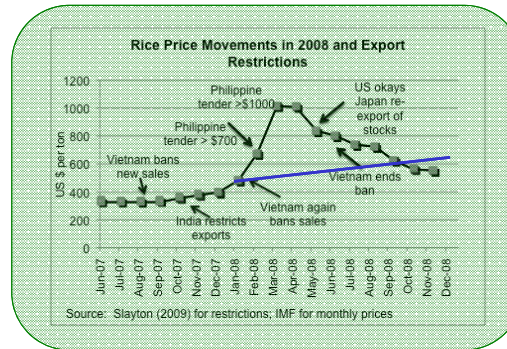- Feasibility of a rice exchange is not well established yet.

2008 was not due to market fundamentals

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- Timmer (2009) noted, the 'explosion' of rice prices in 2008 could have been avoided because the market fundamentals did not support the price surge.

Rice Price Movements in 2008 and Export Restrictions

Philippine tender >$1000
US okays Japan re-export of stocks
Philippine tender > $700
Vietnam bans new sales
Vietnam ends ban
Vietnam again bans sales
India restricts exports

US $ per ton — 1200, 1000, 800, 600, 400, 200, 0

Jun-07, Jul-07, Aug-07, Sep-07, Oct-07, Nov-07, Dec-07, Jan-08, Feb-08, Mar-08, Apr-08, May-08, Jun-08, Jul-08, Aug-08, Sep-08, Oct-08, Nov-08, Dec-08

Source: Slayton (2009) for restrictions; IMF for monthly prices

Possible Mitigating influence of Accurate Market Information

- If information was more accurate and widely disseminated, the crisis may have been mitigated.

- The rice market in 2008 could have settled at the $600 per ton level.

- There would have been adjustments but the world could have saved more resources.

Rice Price Movements in 2008 and Export Restrictions

Source: Slayton (2009) for restrictions; IMF for monthly prices

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Regional cooperation

- Intergovernmental bodies, say ASEAN, can invest in sharing and collective analysis of market information and data and serve as a focal information center.

- Credibility of the information center has the potential of harmonizing and upgrading information about the market.

- Produce a public good.

Testing the relationship using a gravity model of trade

- A gravity model of trade – econometric model that explains the bilateral trade between two trading partners in a given product, say rice, using the values of explanatory variables.

- In the gravity model of rice trade the following explanatory variables were used:
  - GDPagri of exporting economy, GDP of importing economy, Population of exporting economy, Population of importing economy, Distance between trading partners, Price volatility a year lag, Price volatility two years lag, Similarity of language, Common border, Colony dummy variable, 2008 DV, Constant

- Volatility variables
  - Average price volatility a year lag
  - Average price volatility two years lag

Testing the relationship: estimated model

Table 2. Empirical estimates of a rice trade gravity model

Explanatory variables	Model A			Model B		
	Coef.	Std. Error	z value	Coef.	Std. Error	z value
GDPagri of exporting country	0.3963	0.10	3.80	0.2952	0.11	2.81
GDP of importing country	0.1116	0.06	2.60	0.1241	0.06	2.25
Population of exporting country	0.3351	0.12	2.85	0.4276	0.12	3.62
Population of importing country	0.0023	0.10	0.02	0.0284	0.10	0.29
Distance between trading partners	-0.8510	0.14	-5.96	-0.8565	0.14	-6.01
Price volatility a year lag	-0.1118	0.04	-3.01			
Price volatility two years lag				-0.1767	0.03	-6.39
Similarity of language	-0.1719	0.30	-0.57	-0.1821	0.30	-0.60
Common border	1.5582	0.57	2.72	1.5588	0.57	2.72
Colony dummy variable	-1.0613	0.51	-2.08	-1.0491	0.51	-2.06
2008 DV	0.7508	0.08	8.98	1.0066	0.09	10.97
Constant	10.4168	1.51	6.93	9.9133	1.50	6.63

Random-effects tobit regression	Number of observation = 9693
Group variable: count	Number of groups = 757
Random effects u_i ~ Gaussian	Obs per group: min = 1

What if price volatility was zero

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- How much additional trade is induced if price volatility is eliminated?

- Using the estimated Model B, we computed the natural logarithm of the average bilateral rice trade by plugging into the estimated model the mean values of the explanatory variables. We compared the respective trade values with and without price volatility.

- The percentage change of trade was computed after the anti-logarithm of these average values of trade. The result of all of these is that trade will increase by 59 % if price volatility is zero.

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Thank You!