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Partial Equilibrium Trade Models: Arkansas Global Rice Model and RICEFLOW Model

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Presentation Outline

- Explanations based on Questions made by Prof. Gemma
- Arkansas Global Rice Model (AGRM)
- RICEFLOW Model: analytical framework
- A Result of Impact Assessment: TPP negotiations on Rice

Analysis of TPP without Japan/Analysis of TPP with Japan/Low Substitution of Imported Rice for Domestic Rice/High Substitution of Imported Rice for Domestic Rice/Updated analysis/Conclusions

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Evolution of Arkansas rice model, initial and current objectives and structure of the model?

RICEFLOW started as a spatial optimization model of the Takayama-Judge type, and then evolved into a spatial accounting model with first-order solutions as equations defining the behavior of consumers, producers, and traders. Most of the evolution in later years has been on the database. The latest version of the RICEFLOW database depicts the market situation as of 2013, includes 73 countries/regions, 9 rice commodities, and incorporates numerous policy variables to account for public intervention on production, consumption, and trade

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What are comparative advantages of Arkansas rice model in examining TPP impacts compared to the USDA-ERS study of last year using GTAP model?

ERS-USDA used the GTAP CGE model for this assessment. CGE modeling has the advantage of endogenously accounting for the economy-wide spillover effects of a policy change such as TPP on the rice sector. In RICEFLOW we can introduce the economy-wide effects of TPP on the rice sector by incorporating CGE findings (e.g., GDP, factor prices, price of substitutes in final consumption) through exogenous shocks only since they are not endogenously estimated in a partial equilibrium setting.

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What are comparative advantages of Arkansas rice model in examining TPP impacts compared to the USDA-ERS study of last year using GTAP model?

For an assessment of the impact of TPP on rice, RICEFLOW has the advantage of a much more detailed specification of the rice sector. For instance, rice in GTAP is represented by two commodities, paddy and milled rice. This means that differences in policies between medium/short grain and long grain rice cannot be disentangled in GTAP while they can be specifically modelled in RICEFLOW. This is a major advantage given the heterogeneity of these rice subsectors in terms of public intervention, production costs and returns, and consumer preferences.

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What is benefit of the use of Leontief technologies for production functions?

The Leontief assumption is easy to implement (elasticities of substitution equal zero) and can be appropriate for short-term analysis. The main disadvantage is its inflexibility, which makes it a poor choice for long-term analysis. But the main reason we assume Leontief technology at the highest level of the production function is for simplicity and lack of estimates. If we were to have a set of elasticity estimates we would rather use them.

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You assumed that imported rice and domestic rice were inputs to the production of a composite commodity subject to milling. How does this work in terms of the structure of the model?

Basically this is part of the Armington specification, where imports and domestic goods are inputs in the production of a composite according to a CES production function. This substitution between imports and domestic goods happens at each level in the supply chain (paddy, brown, and milled). So take for instance Mexico. They import roughly 80% of their total paddy demand, which gets comingled with domestically-produced paddy rice and enters the milling sector as an intermediate input. imported and domestically-produced paddy rice lose their identity and are treated as a composite paddy. The same logic applies at higher levels in the supply chain.

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How did you estimate Armington elasticity of substitution of 4.98 for Philippines? You estimated the same elasticity for Indonesia as 4.13.

These were estimated using a very simple time-series model of volume of imports as a function of total demand (imports + domestic production), and average price of imports and domestic rice.

What is the source of information for Armington elasticity of substitution of 0.25 for Japan and South Korea?

There is no source, this value was selected ad-hoc to represent the strong consumer preference for domestic rice relative to imports.

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For policy simulations, you have a scenario with a one-time removal of import barriers among TPP countries and a long-run assumption about the substitution of domestic for imported rice in Japan, namely that the Armington elasticity in Japan reaches the levels observed in the reference country Philippines.

In the 2012 paper, we have not assessed the scenario of a dynamic increase in the Armington elasticities, what we have done is to run two scenarios with different Armington elasticities. We can expect that consumers in Japan might start changing their preferences towards imported rice as this becomes available to consumers. Right now only a small portion of imports gets to the final consumer.

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Do you think that Armington elasticity of substitution becomes larger even in Japan and South Korea once consumers start seeing imported products as a result of trade liberalization?

YES. This is a plausible hypothesis.

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Have you seen any papers looking into the changes in consumer preferences on domestic and imported agricultural products?

No. This is a good topic for graduate research.

Do your think institutions to promote/differentiate domestic agricultural products from imported products with the geographical indication (GI) and country of origin labels slow the process of increase in Armington elasticity of substitution for rice or other agricultural products?

Yes, at least Europeans think so. Much depends on how exporter promotes imports and the intrinsic & perceived quality differences of domestic and imports.

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How were own price demand elasticity and income demand elasticity estimated for TPP countries?

These are taken from AGRM, and countries not listed in AGRM we make assumptions, applying elasticities from countries with similar profiles.

In Japan, there exists clear preference on short grain rice to medium grain rice. Is it feasible for the RICEFLOW model to consider medium grain and short grain separately?

Yes. The only limitation to modeling this is data availability. We can collaborate on the database and model to achieve that relatively easily. This goes back to the earlier part of the discussion on the importance of the data availability.

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The Arkansas Global Rice Model (AGRM)

The Arkansas Global Rice Model (AGRM) is a nonspatial, multicountry statistical simulation and econometric analytical framework developed and maintained for 20 years by the University of Arkansas Global Rice Economics Program (AGREP) in Fayetteville, USA. The model is disaggregated into five world regions: Africa, the Americas, Asia, Europe, and Oceania.

There are 43 key countries, areas, or regions explicitly included in the model, and all other countries or areas not individually modeled are included in one of the five rest-of-region (ROR) models.

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- The AGRM can be used to generate annual projections of the world rice economy for a 10-year period and up to 2035. Simulation is conducted for the purpose of the baseline projection, scenarios on technology, trade, production shocks, consumption shocks, and policy analyses.
- The model can be used to generate both deterministic average outcomes and stochastic distribution of outcomes.

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- The major components of a country or regional model in AGRM include a supply sector, a demand sector, trade, stocks, and price linkage equations. As a system of equations, the model links countries through prices and trade to obtain global and national estimates that add up consistently using data from the United States Department of Agriculture.
- The model makes assumptions about key macroeconomic variables and links to other crop and livestock models.
- A key component is government-determined policy variables that reflect the various mechanisms by which countries intervene in their rice sector economy.

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RICEFLOW Model: analytical framework

- Riceflow is a spatial partial equilibrium model of the global rice sector, with detailed specification of the basic components of the rice supply chain:

(i) Factors of production (land, labor, and capital) and intermediate inputs (fertilizer, pest control, fuel, etc.)

(ii) Paddy production, area harvested, and yield per hectare

(iii) Rice storage and drying costs and quantities

(iv) Rice milling, costs of milling, and degree of milling

(v) Rice wholesale and import/export shipments by country source or destination

(vi) Rice consumption

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- The model builds from national or subnational models to generate disaggregated bilateral trade flow volumes subject to trade policies and import/export fees. It disaggregates rice by type depending on availability of data (long grain, medium grain, fragrant, percent brokens, and degree of milling (white, brown, and paddy).
- By treating sectors and products separately, the model allows for a detailed disaggregation by production systems and rice types, and household types, conditional on the existence of reliable data.

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- Rice production in Riceflow is disaggregated into primary production, primary milling (paddy to brown), and secondary milling (brown to milled). The model is flexible to allow alternative production systems. Furthermore, a number of technology-related variables are defined to deal with technological changes affecting production at any stage.
- The latest Riceflow database corresponds to calendar year 2009, and is disaggregated into 60 regions (including all ASEAN countries), three rice types (long grain, medium and short grain, and fragrant rice), and three milling degrees (paddy, brown, and milled), for a total of nine rice commodities.

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- Riceflow has been used extensively to assess different rice market scenarios:

(i) Technological changes (e.g., adoption of hybrid rice, etc.)

(ii) Policy changes (e.g., impact of trade integration in Asia, the Western Hemisphere, changes in domestic support policies, etc.)

(iii) Consumption changes (e.g., impact of changes in population growth and income)

(iv) Weather-related events (e.g., impact of calamities and other weather events, etc.)

- Riceflow can complement the Arkansas Global Rice Model and can be used for forecasting purposes, thus generating baseline projections against which the medium-term and long-term impacts of alternative scenarios can be assessed.

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RICEFLOW© Model

Salient Features

- Spatial Partial Equilibrium Model with Bilateral Trade Flows
- Supply Chain Framework – Production, Processing, Transportation, Trade, and Final Consumption
- Product Distinction: (Type & Degree of Milling)

Type	Degree of Milling
Long	Paddy
Medium	Brown
Aromatic	Milled

Analytical Applications

- Trade Policy
  - Multilateral
  - Bilateral
  - Regional Trade Agreements
- Food Security
- Impacts of Technology Innovation, Adoption and Dissemination

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A Result of Impact Assessment: TPP negotiations on Rice

- Analysis of TPP without Japan
- Analysis of TPP with Japan

  Low Substitution of Imported Rice for Domestic Rice

  High Substitution of Imported Rice for Domestic Rice
- Updated analysis
- Conclusions

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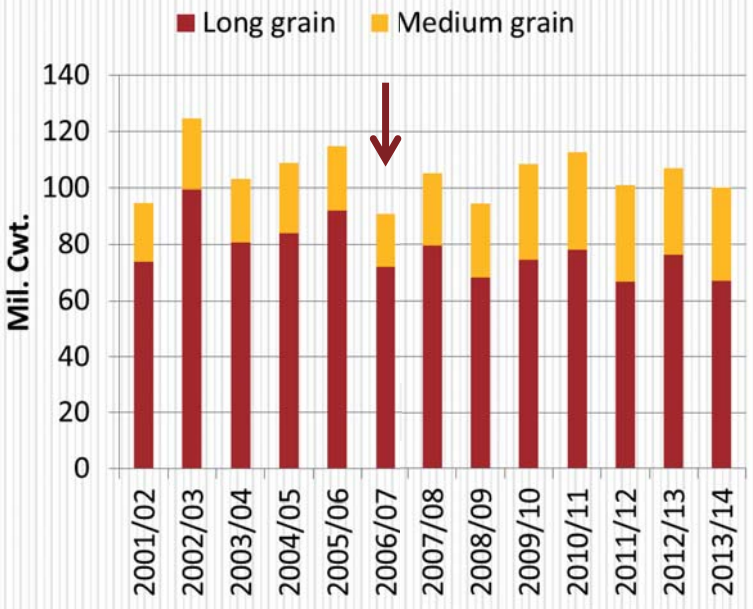
U.S. Rice Exports, 2001/02 -2013/14

World's 5th largest exporter

Export value in 2013 – $2.05 Billion

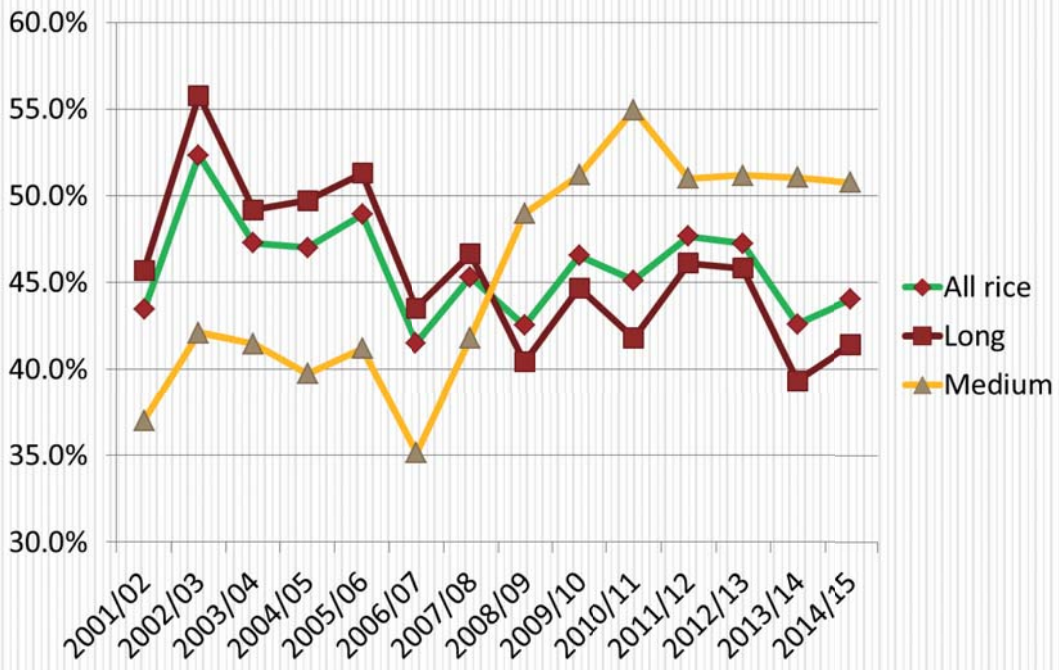
Rice ranks 13th among top 25 farm commodities exported

GMO contamination in 2006 resulted in complete loss of the EU long grain market, which has only partially recovered since.



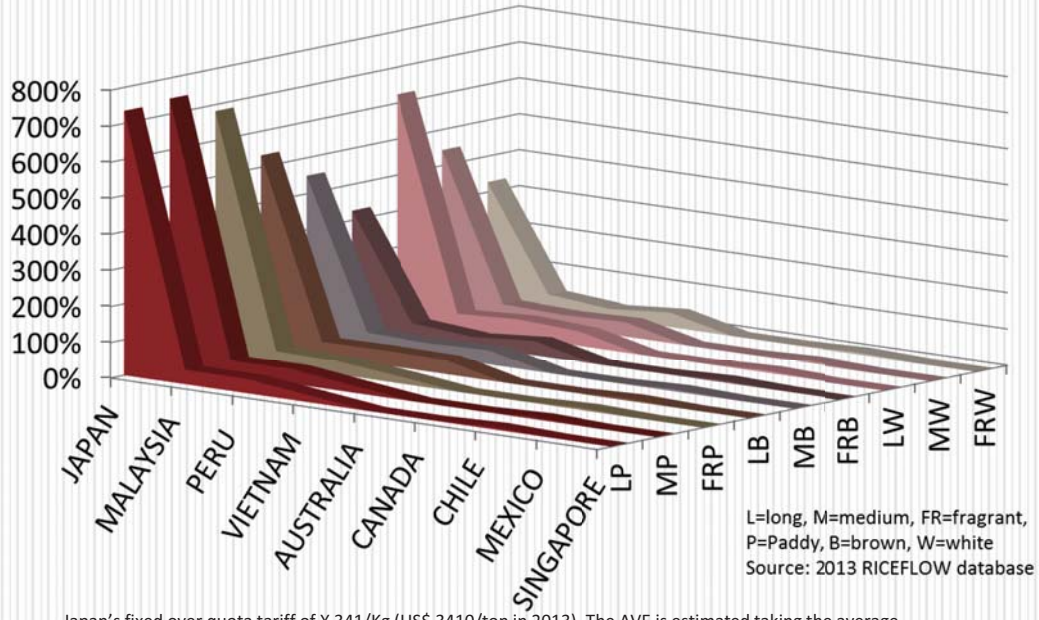
Source: USDA, ERS, *Rice Yearbook*

U.S. Rice Export Share to Total Use



Source: USDA, ERS, *Rice Yearbooks and Rice Outlooks*

MFN AVE Tariffs by Rice Type For Selected TPP Countries



Japan's fixed over quota tariff of ¥ 341/Kg (US$ 3410/ton in 2013). The AVE is estimated taking the average global cif price for each rice type and milling degree. Mexico currently bans rice imports from Pakistan due to phytosanitary reasons (presence of Khapra beetle). Peru administers a price band system taking Thai price as reference. The AVE is estimated using the average global cif price for each rice type and milling degree.

TPP Rice Trade, 2013

2013 volume of rice trade by TPP partners (metric tons milled equivalent)

	EXPORTS		IMPORTS	
	TOTAL	INTRA-TPP	TOTAL	INTRA-TPP
AUSTRALIA	96	56	172	58
BRUNEI	-	-	24	1
CANADA	-	-	366	243
CHILE	-	-	103	6
JAPAN	-	-	639	339
MALAYSIA	-	-	828	496
MEXICO	-	-	954	870
NEW ZEALAND	-	-	42	22
PERU	-	-	177	1
SINGAPORE	-	-	387	107
USA	3,732	1,416	610	48
VIETNAM	6,757	697	100	-
TOTAL	10,585	2,168	4,404	2,191

*. Conversion factor brown to paddy: 1.25; milled to paddy: 1.725.

Source: 2013 RICEFLOW database; COMTRADE for Brunei and New Zealand

Three Scenarios Analyzed in 2011

1. TPP with full market access without Japan as a member
2. TPP with full market access with Japan as a member, but assume Japanese consumers strongly prefer Japanese domestic rice compared to imported rice.
3. TPP with full market access with Japan as a member, but assume Japanese consumers will substitute imported rice for Japanese domestic rice.

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TPP rice trade without Japan

				BASELINE	TPP-JAPAN	
Type	Milling	Exporter	Importer	Initial	% Change	Final
LG	white	USA	Australia	19,392	0.0%	19,392
MG	white	USA	Australia	9,128	0.0%	9,128
LG	white	Vietnam	Australia	8,252	0.0%	8,252
LG	white	Vietnam	Brunei	5,880	0.0%	5,880
MG	white	USA	Chile	442	0.0%	442
LG	white	USA	Japan	142,260	0.0%	142,260
MG	brown	USA	Japan	12,543	0.0%	12,543
MG	white	USA	Japan	246,082	0.0%	246,082
LG	white	Vietnam	Japan	4,166	0.0%	4,166
LG	white	Vietnam	Malaysia	633,505	119.9%	1,393,077
MG	brown	Australia	New Zealand	813	0.0%	813
MG	white	Australia	New Zealand	6,661	0.0%	6,661
LG	white	USA	New Zealand	5,126	0.0%	5,126
MG	white	USA	New Zealand	1,757	0.0%	1,757
LG	white	Vietnam	Peru	7,496	0.0%	7,496
MG	white	Australia	Singapore	2,253	0.0%	2,253
LG	white	USA	Singapore	2,099	0.0%	2,099
MG	white	USA	Singapore	1,648	0.0%	1,648
LG	white	Vietnam	Singapore	334,935	0.0%	334,935
LG	white	Vietnam	USA	41,278	0.0%	41,278
Total				**1,485,715**	**51.1%**	**2,245,288**

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TPP with Japan, low substitution

				BASELINE	TPP+JAPAN	
Type	Milling	Exporter	Importer	Initial	% Change	Final
LG	white	USA	Australia	19,392	0.0%	19,392
MG	white	USA	Australia	9,128	0.0%	9,128
LG	white	Vietnam	Australia	8,252	0.0%	8,252
LG	white	Vietnam	Brunei	5,880	0.0%	5,880
MG	white	USA	Chile	442	0.0%	442
LG	white	USA	Japan	142,260	95.7%	278,403
MG	brown	USA	Japan	12,543	134.8%	29,451
MG	white	USA	Japan	246,082	71.2%	421,292
LG	white	Vietnam	Japan	4,166	13273.0%	557,119
LG	white	Vietnam	Malaysia	633,505	119.9%	1,393,077
MG	brown	Australia	New Zealand	813	0.0%	813
MG	white	Australia	New Zealand	6,661	0.0%	6,661
LG	white	USA	New Zealand	5,126	0.0%	5,126
MG	white	USA	New Zealand	1,757	0.0%	1,757
LG	white	Vietnam	Peru	7,496	0.0%	7,496
MG	white	Australia	Singapore	2,253	0.0%	2,253
LG	white	USA	Singapore	2,099	0.0%	2,099
MG	white	USA	Singapore	1,648	0.0%	1,648
LG	white	Vietnam	Singapore	334,935	0.0%	334,935
LG	white	Vietnam	USA	41,278	0.0%	41,278
Total				**1,485,715**	**110.4%**	**3,126,502**

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TPP with Japan, high substitution

				BASELINE	TPP+JAPAN High	
Type	Milling	Exporter	Importer	Initial	% Change	Final
LG	white	USA	Australia	19,392	0.0%	19,392
MG	white	USA	Australia	9,128	0.0%	9,128
LG	white	Vietnam	Australia	8,252	0.0%	8,252
LG	white	Vietnam	Brunei	5,880	0.0%	5,880
MG	white	USA	Chile	442	0.0%	442
LG	white	USA	Japan	142,260	90.4%	270,863
MG	brown	USA	Japan	12,543	2674.0%	347,943
MG	white	USA	Japan	246,082	2207.0%	5,677,112
LG	white	Vietnam	Japan	4,166	12913.0%	542,122
LG	white	Vietnam	Malaysia	633,505	119.9%	1,393,077
MG	brown	Australia	New Zealand	813	0.0%	813
MG	white	Australia	New Zealand	6,661	0.0%	6,661
LG	white	USA	New Zealand	5,126	0.0%	5,126
MG	white	USA	New Zealand	1,757	0.0%	1,757
LG	white	Vietnam	Peru	7,496	0.0%	7,496
MG	white	Australia	Singapore	2,253	0.0%	2,253
LG	white	USA	Singapore	2,099	0.0%	2,099
MG	white	USA	Singapore	1,648	0.0%	1,648
LG	white	Vietnam	Singapore	334,935	0.0%	334,935
LG	white	Vietnam	USA	41,278	0.0%	41,278
Total				**1,485,715**	**286.5%**	**8,678,276**

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Key results of the analysis

Scenario	Change in global trade	Percent change
No Japan	0.5 million mt	1.7%
Japan, low substitution	1.2 million mt	4.0%
Japan, high substitution	7.7 million mt	22.0%

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Key results of the analysis

Scenario	Trade creation	Trade diversion
No Japan	Vietnam, Malaysia	India, Pakistan
Japan, low substitution	Japan, US and Vietnam	China and Thailand
Japan, high substitution	Japan, Australia, US and Vietnam	China and Thailand

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Key results of the analysis

Scenario	Change in Japan imports	Percent change
No Japan	0 million mt	0.0%
Japan, low substitution	1.3 million mt	70.1%
Japan, high substitution	6.8 million mt	802.1%

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Key results – Impact on Production

		BASELINE	TPP-JAPAN		TPP+JAPAN Low		TPP+JAPANHigh	
		Volume of Production (mt)						
Type	Country	Initial	% Change	Final	% Change	Final	% Change	Final
MG	Japan	10,592,500	0.00%	10,592,500	-6.90%	9,861,618	-93.80%	656,735
LG	Malaysia	2,510,000	-59.40%	1,019,060	-59.40%	1,019,060	-59.40%	1,019,060
LG	USA	7,550,973	0.00%	7,550,973	2.50%	7,739,747	2.40%	7,732,196
MG	USA	2,421,257	0.00%	2,421,257	11.00%	2,687,595	331.00%	10,435,618
LG	Vietnam	38,895,500	3.00%	40,062,365	5.20%	40,918,066	5.10%	40,879,171

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Key results – Impact on Consumption

		BASELINE	TPP+JAPAN Low		TPP+JAPAN High	
		Volume of Consumption (mt)				
Type	Country	Initial	% Change	Final	% Change	Final
LG	Japan	413,849	12.7%	466,408	12.7%	466,408
MG	Japan	7,977,251	-5.2%	7,562,434	0.1%	7,985,228
FR	Japan	3,933	-6.4%	3,681	-8.9%	3,583
LG	Malaysia	2,411,214	5.9%	2,553,476	5.9%	2,553,476

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Key Assumptions for TPP analysis 2013

1. Rice production, consumption and trade are differentiated by type and degree of milling.
2. Assumed Armington elasticities allow for high levels of substitution by origin.
3. Land is sluggish but not limited, water for irrigation is not constrained.

These assumptions imply long-run adjustments where substantial long grain production areas in the southern US are able to convert to medium japonica production.

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TPP Impact on US 2013

	LP	MP	LB	MB	LW	MW	FRW
Production							
Benchmark volume TMT	6245	2806	3862	2281	3344	1803	5
% Change	-60.7%	247.9%	-57.1%	244.8%	-54.7%	280.3%	1.5%
Price % Change	63.9%	112.3%	61.5%	110.7%	47.7%	106.8%	1.5%
Benchmark value M$	2,073	1,049	1,626	1,080	1,672	1,006	7
Change M%	-738	6,702	-489	6,770	-464	6,935	0
Demand[1]							
Benchmark volume TMT	4827	2851	3822	2061	2192	1101	511
% Change	-57.1%	244.8%	-54.7%	280.3%	-0.2%	-0.6%	0.3%
Price % Change	61.5%	110.7%	47.7%	106.8%	47.7%	106.8%	1.5%
Benchmark value M$	1,603	1,066	1,616	976	4,604	2,908	1,462
Change M$	-478	6,722	-435	6,838	2,183	3,068	25
Trade							
Benchmark exports TMT	1520	0	51	220	1239	703	0
% Change	-67.9%	0.0%	-84.1%	-83.6%	-93.4%	723.1%	0.0%
Post exports TMT	488	0	8	36	82	5,786	0
Benchmark exports to Japan	0	0	0	1	3	278	0
% Change	0.0%	0.0%	0.0%	-11.6%	-90.9%	1937.8%	0.0%
Post exports to Japan TMT	0	0	0	1	0	5,665	0
Benchmark Imports TMT	0	0	11	0	87	1	507
% Change	0.0%	0.0%	315.6%	0.0%	547.2%	3084.6%	0.2%
Post imports TMT	0	0	46	0	563	32	508

1 Intermediate demand for paddy and brown rice, final demand for milled rice.
LP=Long paddy, MP=Med. Paddy, LB=Long Brown, LW=Long white, MW=Med. White, FRW=Fragrant White

TPP results for USA 2013

- Rice production increases by 35%,
  - medium grain increases by 248% long grain decreases by 61%
- Paddy price increases by 79%.
  - Medium grain price increases almost twice as much as long grain price.
- Farm production value increases by US$ 5,964 million (91%).
- Processing activity increases
  - de-husking activity by 55%, milling by 63%.
- Total exports (milled basis)increase by 104%. Composition of exports favor more value-added rice. Milled exports increase by 202% ; brown and paddy exports decrease by 84% and 68%, respectively.
- Total exports (on a milled basis) to JAPAN increase from 282 tmt to 5,666 tmt. TPP
- USA final consumption decreases marginally.
- The value of final consumption increases by US$ 5,276 million due to much higher consumer prices.

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TPP results for JAPAN 2013

- Rice production decreases by 47.5%. (other estimates MAFF 32%; USDA 3%)
- Producer paddy price decreases by 27%.
- Value of paddy production decreases by ¥ 1,403 billion (62%).
- Milling activity decreases by 46%.
- Total rice imports (on a milled basis) increase from 635 TMT to 7,072 TMT.
- Final consumption increases marginally by 1.8%.
- The value of final consumption of rice in Japan decreases by ¥ 925 billion or 37% due to lower consumer prices.

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Results for TPP Partners 2013

- Total exports by TPP partners increase by 51%, total imports by TPP partners increase by 178%, while intra-TPP trade increase by 363%.
- In relative terms, Australia has the largest percent expansion of total and intra-TPP exports, 827% and 764%, respectively.
- In nominal terms, the USA captures the largest increase in total and intra-TPP exports, 3.2 million tons and 4.9 million tons, respectively.
- Japan imports increase substantially by 6.4 million tons.
- After Japan, the USA has the largest expansion in total imports by 518 tmt or 85%, followed by Malaysia with 280 tmt or 34%.

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Summary and conclusions

- Analyses based on complete liberalization of US into TPP and EU markets which are currently subject to significant protection.
- Gains from TPP are potentially large for the US rice sector – 35% increase in output vs 2.5% with TTIP.
- Total US rice exports double with TPP, favoring large expansion in medium japonica rice.
- Both TPP and TTIP results expand US value added through milling.
- Results contingent on ability of US to surmount resource constraints and substitute into Japan and EU markets.

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Key results of the analysis

- Japan membership in TPP has a significant impact on global rice trade
- The extent of the impact depends primarily upon the Japanese consumers.
- Will they readily substitute imported rice for domestic Japanese rice?

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Key Questions on the Analysis in the paper:

The Trans-Pacific Partnership and Its Potential Impact on the Rice Market:
Implications for Japan and the Partners,
http://worldfood.apionet.or.jp/2_wailes.pdf

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