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## **Impact of SPS Regulations on International Trade of Fruits**

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# Impact of SPS Regulations on International trade of Fruits

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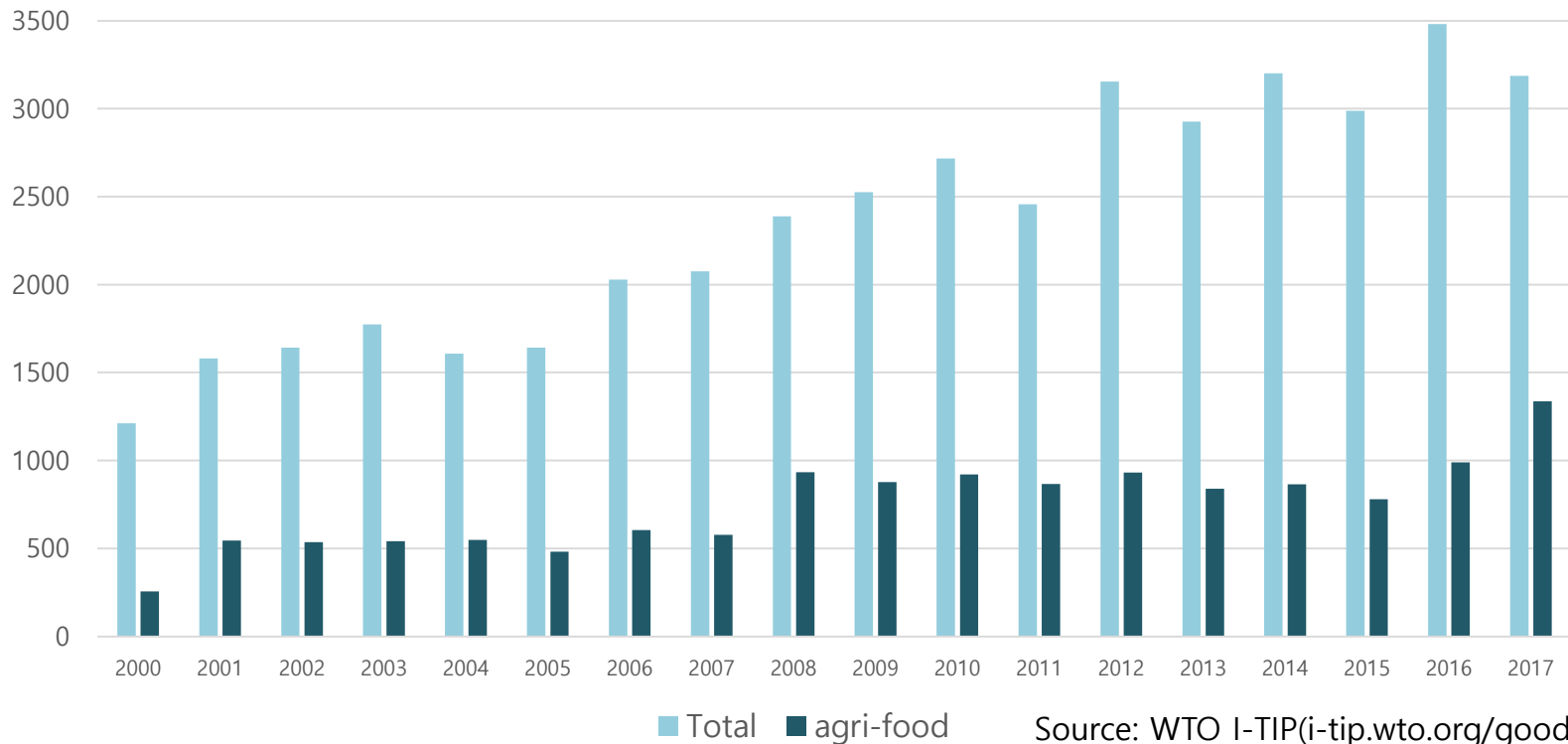
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# Background

- NTMs (Non-Tariff Measures) imposed on overall commodity trade have been increasing since 2000
- On average NTMs applied to agri-food trade take 31.3% out of total NTMs imposed in overall trade

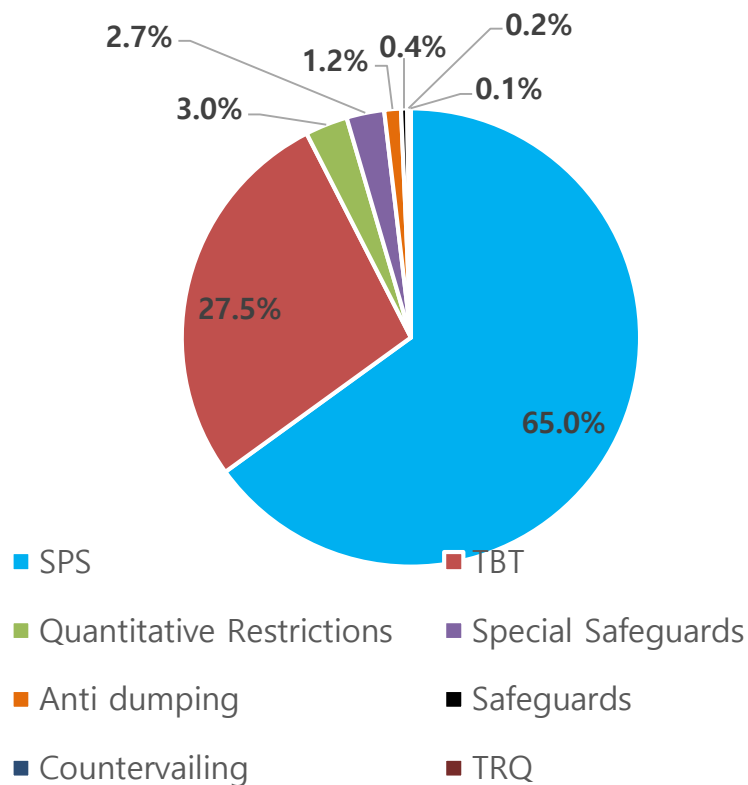
<Trends of NTMs imposed on overall and agri-food trade>



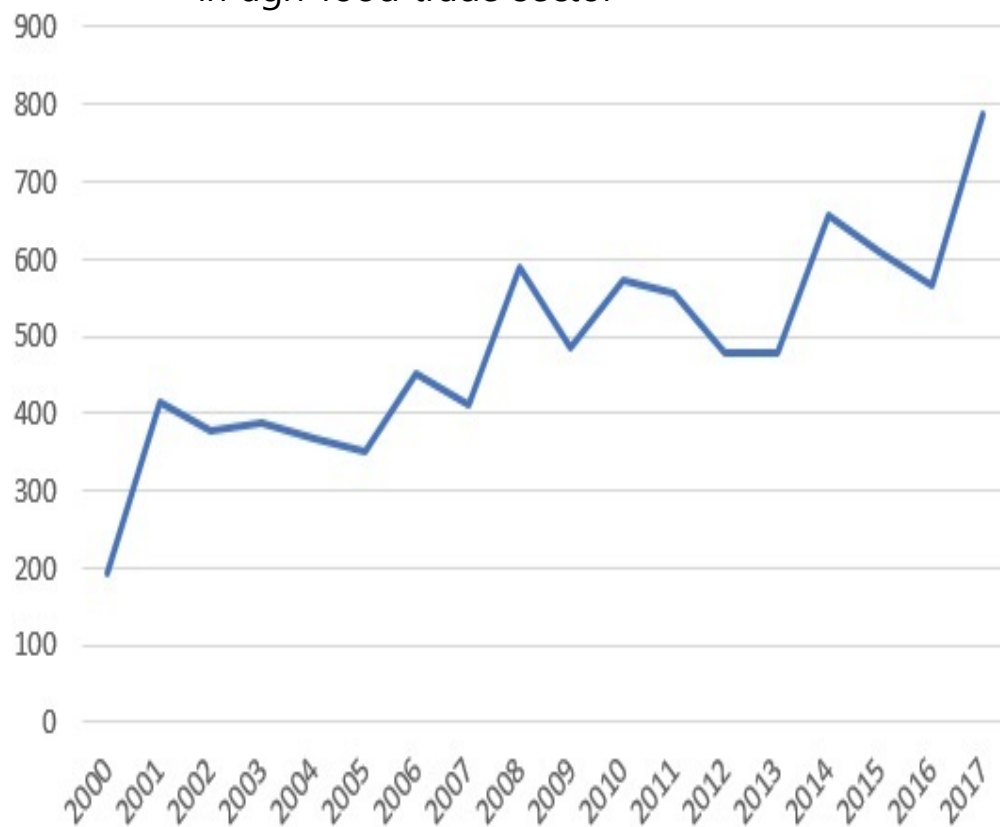
# Background

- SPS (Sanitary and Phytosanitary) consists of 65% out of all cumulative NTMs in the agri-food trade sector from 2000~2017
- The number of SPS notified to WTO is continually increasing

<Types of NTMs in agri-food trade sector  
On cumulative base during 2000~2017>



<Cases of SPS notified to WTO  
in agri-food trade sector>



Source: WTO I-TIP([i-tip.wto.org/goods](http://i-tip.wto.org/goods))

# Literature Review

Author (year)	Subjects	Results
Hoeckman & Nicita (2008)	-Global trade overview -Tariffs, NTMs	-Significant impact
Disdier, Fontagné & Mimouni (2008)	-International agricultural trade -SPS/TBT	-Not significant (OECD) -Negative (non OECD)
Crivelli & Groschl (2012)	-International agricultural trade -SPS/TBT	-Negative (Conformity assessment) -Positive (Product characteristics)
Schlueter, Wieck & Heckelei (2009)	-Meat product trade -Analysis of different SPS requirements	-Negative (Production process, Handling) -Positive (Disease, MRL, Conformity assessment)
Meneguelli Pinto de Souza & Lee (2011)	-Brazilian poultry exports -SPS/TBT	-Negative (Conformity assessment) -Positive (Labeling, Prohibitions/restrictions)
Melo et. al. (2012)	-Chilean fruit exports -SPS	-Negative (according to perceived stringency) -Positive (GAP)
Peterson et. al. (2013)	-U.S. Fresh Fruit & Vegetable imports -phytosanitary treatments	-Negative
Wang and Choi (2013)	-Chinese agricultural exports to Korea -TBT	-Negative

# Literature Review

Author (Year)	Types	Results
Disdier & Marette (2010)	-Crustacean trade -Chloramphenicol MRL standards	-Negative
Xiong & Beghin (2012)	-African nut exports to the EU -EU standard on aflatoxins MRL	-Not significant
Wei, Huang & Yang (2012)	-Chinese tea exports -Pesticides MRLs	-Negative
Wieck, Schlueter & Britz (2012)	-Poultry meat trade -Quarantine measures – Avian Flu	-Negative (raw) -Positive (cooked)
Beghin & Melatos (2012)	-Pork meat trade -Australian quarantine regime	-Negative
Disdier & Fontagné (2010)	-Exports from USA, Canada and Argentina -EU moratorium on GMO	-Negative
Lee and Yoon (2012)	-Garlic, Onion, Spinach trade -MRL	-Negative



# Literature Review

- Previous literature review shows that NTMs or SPS measure may have trade-restricting effects by, for instance, imposing compliance costs on firms or may have trade-facilitating effects by, for instance, reducing information asymmetry
- Some limitations to the database which has been most frequently used in the previous literature
  - ✓ UNCTAD NTMs database: not time series data, lots of omitted values in individual country's list
    - ➔ panel analysis is impossible
  - ✓ WTO SPS IMS (Information Management System) database: difficult to identify the instrumental category and policy goal of individual SPS measure
  - ✓ uses 'WTO I-TIP' (Integrated Trade Intelligence Portal) database which enables us to construct a panel data set and to classify individual SPS measure into instrumental categories and policy goals

# Research Objective

- What are effects of SPS measures by instrumental categories and policy goals in the world fresh fruit trade
  - Are they trade restricting or trade facilitating?

# Analytical Model

- 1) Panel data gravity model is used to estimate the effects of SPS measures by **categories** and their **policy goals** in the world fresh fruit trade
- 2) Considerations in the Gravity Model Estimation
  - (1) Multilateral Resistance (MR) :
    - Need to control the trade impacts from third party trading partners
    - ➔ following Baldwin(2006), Baldwin and Taglioni(2006), exporter and importer fixed effects included in the model
  - (2) Zero trade :
    - Log-linearized gravity Model excludes zero trade data, which cause selection bias as well as heteroscedasticity bias
    - ➔ adopt Poisson Pseudo-Maximum Likelihood(PPML) estimation method proposed by Silva and Tenreyro (2006)
    - ➔ Panel data Gravity Model with exporter and importer fixed effects based on PPML method

# Analytical Model

## 3) Estimation Model

**Time-varying Fixed effect Panel Gravity Model to be estimated by PPML method**

$$(1) M_{ijts} = PROD_{it}^{\beta_1} GDP_{jt}^{\beta_2} Dist_{ij}^{\beta_3} \exp[\alpha_i + \alpha_j + \beta_4 z_t + \beta_5 t_{ijts} + \sum_k \beta_k r_{ijts}^k] \epsilon_{ijts}$$

$M_{ijts}$  = Imports from exporter  $i$  to importer  $j$  in year  $t$  per HS 4 digit ( $s$ )

$PROD_{it}$  = Fruit production of exporter  $i$  in year  $t$

$GDP_{jt}$  = GDP of importer  $j$  in year  $t$

$Dist_{ij}$  = bilateral distance between exporter  $i$  and importer  $j$

$\alpha_i, \alpha_j$  = country-specific exporter and importer fixed effects

$z_t$  = yearly dummy variable

$t_{ijts}$  = tariff rate applied by importer  $j$  to exporter  $i$  in year  $t$  per HS 4 digit ( $s$ )

$\sum_k r_{ijts}^k$  = number of SPS instrument ( $k$ ) applied by importer  $j$  to exporter  $i$  in year  $t$  per HS 4 digit ( $s$ )

**Transform (1) into exponential function (2), and estimate using PPML method**

$$(2) M_{ijts} = \exp[\beta_1 \ln(PROD_{it}) + \beta_2 \ln(GDP_{jt}) + \beta_3 \ln Dist_{ij} + \alpha_i + \alpha_j + \beta_4 z_t + \beta_5 t_{ijts} + \sum_k \beta_k r_{ijts}^k] \epsilon_{ijts}$$

# Data

## 1) SPS measures from WTO I-TIP Database

- All measures are classified into 4 categories, 11 sub-categories (instruments), and 5 policy goals
- Total 648 SPS measures applied to fresh fruit trade during 2001~15 are used for the analysis

<Categories, instruments and their trade policy goals of SPS measures>

categories \ goals	Food safety	Animal health	Plant protection	Human protection	Territory protection
<b>Pests, diseases and related</b>					
Diseases	√		√	√	√
Pests	√	√	√	√	√
Bacteria	√			√	
<b>Tolerance limits and restricted use of substances</b>					
Contaminants	√			√	
MRLs	√		√	√	
restricted use of substances	√		√	√	
<b>Labelling and packaging requirements</b>					
Labelling	√				
packaging	√				
<b>Conformity assessment and Quality requirements</b>					
Certification/control/inspection	√		√		
Traceability	√		√	√	
Quality requirements	√				

# Data

## 2) Product and Country Coverage

- Fresh Fruits: HS 0803 ~ 0810
- Top 10 exporters and importers on average during 2001~2015
  - EU members are aggregated into EU-15 because all apply same SPS
  - 96 trading-country-pairs: 10 (exporters) X 10 (importers) – 4 same country pairs

<Top 10 exporters and importers, average values during 2001~2015>

Exporters	Avg. Exports(US 1000\$)	Importers	Avg. Imports(US 1000\$)
EU-15	18,047,113	EU-15	24,492,394
USA	3,829,049	USA	6,961,010
Chile	2,990,683	Canada	2,528,386
Mexico	1,891,183	Japan	1,859,630
Ecuador	1,744,314	China	1,661,460
China	1,719,462	Arab Emirate	754,442
South Africa	1,573,239	Swiss	672,844
Turkey	1,533,222	Saudi Arabia	656,742
Costa Rica	1,257,038	Korea	586,827
New Zealand	973,957	Mexico	547,817

Note: Average exports and imports of all products under HS 0803~0810 during 2001~2015

Source: WITS(<https://wits.worldbank.org>: 2018. 5. 30.).

# Data

## 3) Uniform and Bilateral SPS measures

- uniform measure : measures applied to all exporter's and domestic producers
- bilateral measure : measures applied to bilateral trading partner

-> 91% (591/648) SPS measures applied in fruit trade during 2001~15 are uniform

-> 69.8% (452/648) are applied to all fresh fruits

<SPS measures, by category>

	Pests, diseases and related measure	Tolerance limits and restricted use of substances	Labelling and packaging requirements	Conformity assessment and Quality requirements
Uniform	99	407	66	19
Bilateral	34	18	4	1
Total	133	425	70	20

< SPS measures, by HS 4 digit product>

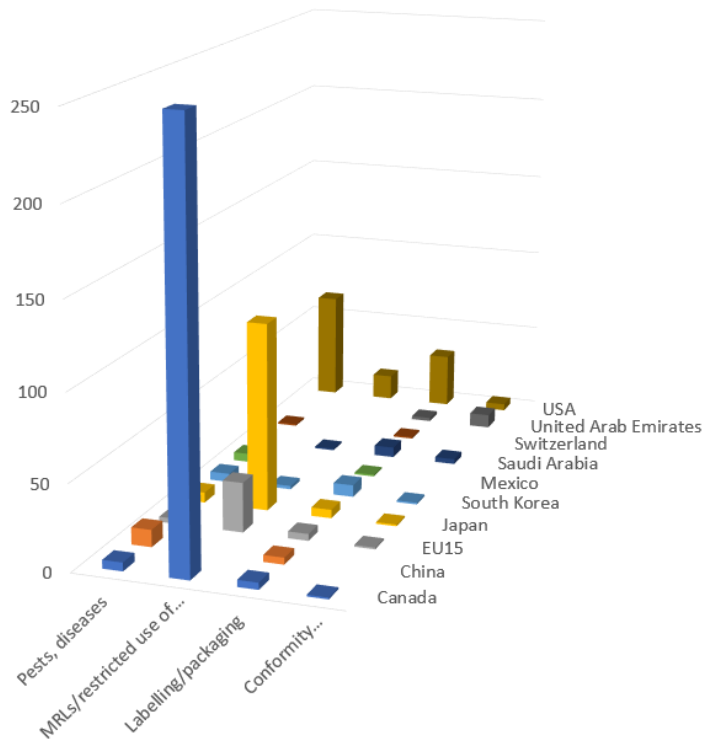
	Bananas	Dates, Figs, Avocados, Guavas, Mangoes	Citrus	Grapes	Melons/ Papayas	Apples, pears	Apricots, cherries, peaches, plums	Other (raspberries, etc)
Uniform	468	494	501	482	482	493	488	511
Bilateral	0	8	31	24	25	5	2	32
Total	468	502	532	506	507	498	490	543

# Data

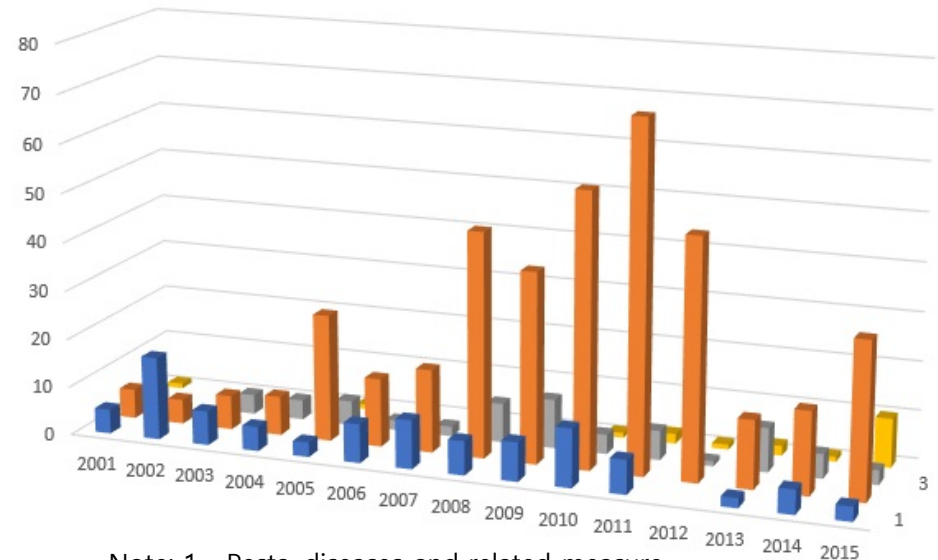
## 4) Uniform measures

- Major uniform measures applicators include Canada, Japan, USA
- Big increase in uniform measures during 2008~2011 were due to sudden jump in MRLs and restricted use of substances

< uniform measures, by country and type >



< uniform measures, by year and type >



Note: 1= Pests, diseases and related measure,  
2= MRLs and restricted use of substances,  
3= Labelling and packaging,  
4= Conformity assessment and Quality requirements



# Data

## 5) Bilateral measure

- Only 4 importers (EU15, Korea, Mexico, USA) apply bilateral measures
- Mostly related with Pests, diseases and related measure

< Bilateral measures, by importer and category >

Country \ Categories	EU15	South Korea	Mexico	USA
Pests, diseases and related measure	12	3	1	18
Tolerance limits & restricted use of substances	18			
Labelling & packaging requirements				4
Conformity assessment & Quality requirements				1
<b>Total</b>	<b>30</b>	<b>3</b>	<b>1</b>	<b>23</b>

< Bilateral measures, by importer and exporter >

Export \ Importer	EU15	South Korea	Mexico	USA
Chile				4
China	12	1	1	7
Costa Rica		1		
Ecuador				1
Mexico				5
South Africa	3	1		4
EU15				2
Turkey	12			
USA	3			
<b>Total</b>	<b>30</b>	<b>3</b>	<b>1</b>	<b>23</b>

# Estimation

## Estimation 1: impacts of SPS measures on total fresh fruit imports

- LHS variable : All Fruit imports of top 10 importer  $j$  from the other top 10 exporter  $i$  in year  $t$  ( $M_{ijt}$ )
- RHS variable : the number of SPS measures are considered at three different levels (aggregate level, category level, sub-category (instrument) level) and five different goals (Food safety, Animal health, Plant protection, Human protection, Territory protection)
- Obs.=11,520 (96 country pairs  $\times$  15 years  $\times$  8 products in HS 4 digit)

$$M_{ijt} = \exp[\beta_1 \ln(\text{PROD}_{it}) + \beta_2 \ln(\text{GDP}_{jt}) + \beta_3 \ln \text{Dist}_{ij} + \alpha_i + \alpha_j + \beta_4 z_t + \beta_5 \tau_{ijt} + \sum_k \beta_k r_{ijt}^k] \epsilon_{ijt}$$

# Estimation

## Estimation 2: impacts of SPS measures on 8 individual fresh fruit products

- LHS variable: Fruit imports of top 10 importer  $j$  from the rest of the world ( $M_{wjt}$ ) for each fruit variety  $s$
- RHS variable: the number of uniform measures are considered at three different levels (aggregate level, category level, type level) and five different goals (Food safety, Animal health, Plant protection, Protect humans, Protect territory)
- Obs.=1.440 (96 country pairs × 15 years) for each 8 products in HS 4 digit

$$M_{ijts} = \exp[\beta_1 \ln(\text{PROD}_{its}) + \beta_2 \ln(\text{GDP}_{jts}) + \beta_3 \ln \text{Dist}_{ijs} + \alpha_i + \alpha_j + \beta_4 z_t + \beta_5 \tau_{ijts} + \sum_k \beta_k r_{ijts}^k] \epsilon_{ijts}$$

# Estimation

<Variables in Gravity Model and Data Sources>

Variable	Description	Source
$M_{ijts}$	value of imports(\$1000)	UN COMTRADE
$GDP_{jt}$	GDP (\$)	World Bank WDI database
$Prod_{it}$	Fruit production (tones)	FAOSTAT
Dist	bilateral distance(km)	Geographical database of CEPII
$t_{ijts}$	bilateral applied tariff rate	UN COMTRADE
$\sum_k r_{ijts}^k$	bilateral number of SPS measures under type k	WTO I-TIP

# Estimation

## Statistics for Variables

Variable	Mean	Standard deviation	Minimum value	Maximum value
Import values (1000\$)	23,015	91,894	0	1,902,022
ln ( $GDP_{jt}$ )	28.13	1.41	25.36	30.52
ln ( $Prod_{it}$ )	16.50	1.40	13.80	19.51
ln (1+tariff)	9.02	0.67	0	5.47
ln (distance)	1.6	1.46	6.3	9.85
Total SPS measures	21.71	45.61	0	248
<b>Pests, diseases and related</b>	2.04	3.87	0	33
Diseases	0.11	0.36	0	4
Pests	1.77	3.64	0	30
Bacteria	0.16	0.4	0	5
<b>MRLs &amp; restricted use of substances</b>	16.42	44.64	0	242
Contaminants	0.42	1.03	0	10
MRLs	15.32	44.79	0	242
restricted use of substances	0.68	1.43	0	10
<b>Labelling &amp; packaging requirements</b>	2.68	4.96	0	31
Labelling	2.53	4.66	0	28
packaging	0.14	0.45	0	3
<b>Conformity assessment &amp; Quality requirements</b>	0.57	1.33	0	8
Certification/control/ inspection	0.12	0.48	0	3
Traceability	0.18	0.4	0	2
Quality requirements	0.27	1.07	0	7
Food safety	17.47	46.37	0	253
Animal health	0.47	0.73	0	4
Plant protection	0.78	1.65	0	16
Protect humans	11.41	38.22	0	213
Protect territory	0.07	0.28	0	3

# Results: Estimation 1

	Aggregate	By Category	By Instrument	By Goal
-		Labelling & packaging requirements Conformity assessment & Quality requirements	<b>disease</b> , Bacteria, Labelling, packaging, <b>certification/control/inspection</b> , quality requirements	food safety, territory and human protection
+	Aggregated SPS measures	<b>Pests, diseases and related</b> , MRLs & restricted use of substances	<b>pest</b> , Contaminants, MRLs, restricted use of substances, traceability	<b>animal health</b> , plant protection

		Total	Categories	Instruments	Goals
ln ( $Prod_{it}$ )		0.394* (0.23)	0.287 (0.23)	0.230 (0.22)	0.163 (0.24)
ln ( $GDP_{jt}$ )		1.277*** (0.18)	1.404*** (0.17)	1.669*** (0.22)	1.391*** (0.19)
ln (distance)		-1.586*** (0.17)	-1.582*** (0.17)	-1.583*** (0.17)	-1.584*** (0.17)
ln (1+tariff)		-0.111(0.10)	-0.119(0.10)	-0.110 (0.10)	-0.123 (0.10)
Total SPS measures		0.0006 (0.0006)			
CATEGORIES and INSTRUMENTS	<b>Pests, diseases and related</b>		0.048** (0.02)		
	Diseases			-0.448*** (0.17)	
	Pests			0.079* (0.04)	
	Bacteria			-0.111 (0.18)	
	<b>MRLs &amp; restricted use of substances</b>		0.0001 (0.0006)		
	Contaminants			0.050 (0.14)	
	MRLs			0.001 (0.0001)	
	restricted use of substances			0.057 (0.10)	
	<b>Labelling &amp; packaging requirements</b>		-0.020 (0.01)		
	Labelling			-0.013 (0.02)	
	packaging			-0.060 (0.12)	
	<b>Conformity assessment &amp; Quality requirements</b>		-0.029 (0.07)		
	Certification/control/ inspection			-0.242*** (0.07)	
	Traceability			0.253 (0.22)	
Quality requirements			-0.006 (0.03)		
GOALS	Food safety				-0.001 (0.01)
	Animal health				0.179* (0.10)
	Plant protection				0.058 (0.05)
	Protect humans				-0.0003 (0.01)
	Protect territory				-0.166 (0.19)

## Results: Estimation 2

	Total	0803	0804	0805	0806	0807	0808	0809	0810
<b>Total SPS measures</b>	0.000	0.0001	0.001	0.001	-0.001**	0.0001	0.001	-0.001	0.003
<b>Pests, diseases and related</b>	0.048**	0.048	0.048***	0.014	0.016	-0.001	0.026	0.018	0.094***
Diseases	-0.448***	-0.248***	0.021	-0.020	0.602***	0.126	-0.436***	-0.089	-0.008
Pests	0.079*	0.013	0.061***	-0.005	-0.003	-0.035**	-0.005	0.006	0.086***
Bacteria	-0.111	-0.111	-0.119	0.076	0.085	0.002	0.522**	-0.035	-0.071
<b>MRLs &amp; restricted use of substances</b>	0.0001	0.00003	0.001	0.001	-0.001***	0.001*	0.000	-0.001	0.001
Contaminants	0.050	0.028	0.090	-0.088	-0.091	0.031	0.006	-0.064*	-0.059
MRLs	0.001	0.001	0.002	0.000	-0.002**	0.001	-0.003**	-0.001	0.001
restricted use of substances	0.057	0.171***	-0.049	0.091*	0.046*	0.069***	0.014	0.011	0.061
<b>Labelling &amp; packaging requirements</b>	-0.020	-0.011	-0.001	0.003	-0.020***	-0.016	-0.009	-0.015	-0.024*
Labelling	-0.013	0.024	-0.022	0.024	-0.016	-0.006	0.006	0.018	-0.003
packaging	-0.060	-0.260	0.244***	-0.206*	-0.090	-0.099	-0.218*	-0.030	-0.060
<b>Conformity assessment &amp; Quality requirements</b>	-0.029	-0.040	-0.002	-0.012	0.040**	0.057*	0.007	-0.044	-0.015
Certification/control/inspection	-0.242***	-0.160**	-0.084	0.029	0.093	0.004	-0.055	-0.229***	-0.061
Traceability	0.253	-0.071	0.064	-0.199***	0.039	0.222**	0.025	0.141	-0.026
Quality requirements	-0.006	0.085	0.031	0.031	0.049*	0.085*	-0.0003	0.032	0.017

Note: 0803=Bananas, 0804=Dates, figs, pineapples, avocados, guavas, mangoes and mangosteens, 0805=Citrus fruit, 0806=Grapes, 0807=Melons (including watermelons) and papaws (papayas), 0808=Apples, pears and quinces, 0809=Apricots, cherries, peaches (including nectarines), plums and sloes, 0810=Other fruit

## Results: Estimation 2

	Total	0803	0804	0805	0806	0807	0808	0809	0810
<b>Food safety</b>	-0.001	0.003	0.001	-0.001	-0.002	0.001	-0.0005	0.002	0.001
<b>Animal health</b>	0.179*	0.002	0.029	0.369***	-0.009	0.036	0.091**	0.165**	0.024
<b>Plant protection</b>	0.058	0.065	0.074**	-0.018	-0.045	-0.025	-0.019	-0.077**	0.078***
<b>Protect humans</b>	-0.0003	-0.002	0.0001	-0.001	0.001	0.000	0.0001	-0.005	0.0002
<b>Protect territory</b>	-0.166	0.100	-0.172***	-0.008	0.035	0.043	0.080	-0.486***	-0.062

Note: 0803=Bananas, 0804=Dates, figs, pineapples, avocados, guavas, mangoes and mangosteens,  
 0805=Citrus fruit, 0806=Grapes, 0807=Melons (including watermelons) and papaws (papayas),  
 0808=Apples, pears and quinces, 0809=Apricots, cherries, peaches (including nectarines), plums and sloes,  
 0810=Other fruit



# Implications

- Used the accumulated number of SPS measures based on the assumption that regulatory SPS measure produces restricting or facilitating effects on the trade flows permanently unless it is removed (Schlueter, Wieck & Heckelei, 2009)
- Results vary seriously depending on aggregation level of SPS measures and by products, which make it difficult to make consistent interpretations
- Some limitations in WTO I-TIP Database
  - Possibility for double counting due to multiple data sources
  - Possibility for deleting some measures in case of the SPS notification to WTO without identifying HS code, instrumental category, and policy goals
  - Many countries do not notify
  - But, the most comprehensive database