Linking Risk and Economic Assessments in the Analysis of Plant Pest Regulations: The Case of U.S. Imports of Argentine Lemons[*]

Suzanne Thornsbury and Eduardo Romano[**]

ERS project representative: Donna Roberts

December 2007

GII Working Paper No. 2007-1

[*] This report was prepared for USDA, Economics Research Service, Program of Research on the Economics of Invasive Species Management (PREISM) through a grant provided to Virginia Polytechnic Institute and State University (research grant 43-3AEM-3-80087) with subcontracts to Michigan State University and Pacific Institute for Research and Evaluation (PIRE). We thank ERS for financial support. The views expressed are those of the authors and not necessarily those of ERS or USDA. We have benefited from discussions with our ERS project collaborators and other colleagues including Mollie Woods, David Orden, Everett Peterson, Lili Gao, Claire Narrod, Joe Glauber, Trang Vo, Barry Krissoff, and Donna Roberts.

[**] Suzanne Thornsbury is Associate Professor of Agricultural Economics at Michigan State University and Eduardo Romano is Associate Research Scientist at Pacific Institute for Research and Evaluation (PIRE).

Linking Risk and Economic Assessments in the Analysis of Plant Pest Regulations: The Case of U.S. Imports of Argentine Lemons

by

Suzanne Thornsbury and Eduardo Romano*

ERS project representative: Donna Roberts

December 2007

Abstract:

This study evaluates consideration to allow shipments of Argentine fresh lemons into the United States. Besides providing analysis of an on-going and still disputed systems approach, this case was viewed as a relevant test for feasibility of a prototype analytical tool that links economic and risk assessment for SPS measures. Political economy and empirical assessment shows that despite some apparent similarities among systems approach policies, the idiosyncratic nature of SPS issues limits application of a common quantitative method for such policies. Assessment within context of the lemon case reveals important lessons with respect to economic analysis. Scientific debate is likely to be more contentious and sustained in cases where the political stakes are greater, thus *a priori* economic evaluation is likely to be the most limited in those cases where it could prove the most valuable. Results highlight transitions in the political reality of WTO SPS agreement applications. Movement away from specificity in risk assessment limits common understanding and further assessment of regulatory policies. The dynamics of the lemon case shifted attention to credibility of domestic, as well as foreign, institutions. Confidence between regulatory agencies is important, but does not compensate for public trust.

Acknowledgements:

This report was prepared for USDA, Economics Research Service, Program of Research on the Economics of Invasive Species Management (PREISM) through a grant provided to Virginia Polytechnic Institute and State University (research grant 43-3AEM-3-80087) with subcontracts to Michigan State University and Pacific Institute for Research and Evaluation (PIRE). We thank ERS for financial support. The views expressed are those of the authors and not necessarily those of ERS or USDA. We have benefited from discussions with our ERS project collaborators and other colleagues including Mollie Woods, David Orden, Everett Peterson, Lili Gao, Claire Narrod, Joe Glauber, Trang Vo, Barry Krissoff, and Donna Roberts.

* Suzanne Thornsbury is Associate Professor of Agricultural Economics at Michigan State University and Eduardo Romano is Associate Research Scientist at Pacific Institute for Research and Evaluation (PIRE)

Table of Contents

List of Tables

List of Figures

Introduction

Approximately 50,000 invasive species are estimated to be present in the United States, causing losses of almost $120 billion per year (Pimentel et al, 2005). Systems approach regulations have become a popular tool to minimize pest risks associated with imports, particularly since WTO adoption of the regionalization principle which has increased pressure to evaluate multiple regions within a country separately (Vo, 2004). These regulations are multi-step sanitary and phytosanitary policies where at least two steps are designed in such a way to have independent effects on reducing associated pest risks (USDA APHIS, 2002). It can be shown that when additional non-independent risk-reduction steps are enacted as part of the systems approach a reduction in uncertainty also takes place.

The focus of this PRESIM project is incorporating economic analysis with risk assessment by formulating and testing an analytical tool for regulations that adopt a systems approach to trade. In an earlier report, a partial equilibrium model was developed as the evaluation method and applied to the first of three systems approach policies; U.S. import of Hass avocados from Mexico (Peterson and Orden, 2006). This report focuses on the second case to be evaluated; shipment of lemons from Argentina to the United States. Besides providing analysis of an on-going and still disputed issue, this case was viewed as a relevant test for the evaluation method.

First, similar to the avocado case, the lemon case involves a commodity that is limited in geographic production area and includes relatively few trading partners for the U.S. Second, because of well-defined U.S. ports of entry and production areas, both cases include geographic restrictions as part of the systems approach. Further political economy and empirical assessment shows that despite some apparent similarities among these systems approach policies, the idiosyncratic nature of SPS issues limits the feasibility of a prototype empirical method and the partial equilibrium model is not solved for the lemon case.

Even without comparable empirical results, political economy assessment and evaluation of the model framework within context of the lemon case reveal important lessons with respect to economic analysis of invasive species policies. Scientific debate is likely to be more contentious and sustained in cases where the political stakes are greater, thus *a priori* economic evaluation is more restricted and/or uncertain in those cases where it might prove the most valuable. Case-to-case differences, even among SPS policies based on a systems approach, remain substantial and difficult to capture in a common analytical framework. The dynamic nature of invasive species spread only exacerbates these difficulties, even within the context of a specific case.

In addition to evaluation of the model framework, assessment of the lemon case highlights transitions in the political reality of WTO SPS agreement applications. The Argentine lemon case substantiates fundamental changes in how regulatory agencies approach pest risk evaluation, moving away from specificity in risk assessment. This partially reflects the difficulty of analysis and lack of consensus over scientific evidence associated with pest transmission and infestation. It also likely reflects unease over being challenged on specificity of numerical results and the political controversy surrounding many SPS issues.

The Argentine lemon case also reveals some important lessons regarding institutional uncertainty and phytosanitary policies. Dynamics of the lemon case shifted attention to credibility of domestic, as well as foreign, regulatory institutions. If the non-independent steps of a systems approach are able to decrease uncertainty of pest risk assessment, these policies may be able to facilitate increased confidence in both exporter and domestic institutions over the long-run. Still, growing confidence between regulatory agencies does not compensate for public trust.

U.S. Lemon Industry

The U.S. lemon industry is concentrated in California and Arizona, producing approximately 87 and 13 percent of the national total, respectively. Even within California, production is concentrated in six counties (USDA ERS, 2007).[1] Production levels have remained relatively constant since 1990 (table 1). Based on average production between 2002 and 2005, the U.S. ranks fifth in world output behind India, Argentina, Spain, and Iran.[2]

Table 1. U. S. lemon* production, 1990-2005

Year	**Production**
	(MT)
1990	705.80
1001	710.30
1992	758.40
1993	894.50

[1] Ventura, Riverside, Imperial, Tulare, Kern, San Diego
[2] FAO data reports production totals for lemons and limes. Mexico is the top producer in this aggregated category and Brazil is the fifth.

1994	900.80
1995	822.80
1996	912.60
1997	885.40
1998	831.00
1999	677.67
2000	762.04
2001	913.53
2002	733.00
2003	930.77
2004	723.93
2005	789.25

Source: FAO Stat http://faostat.fao.org/

* The FAO Stat data also includes values for limes, which are marginal in the U.S.

Approximately two-thirds of U.S. lemon production is marketed as fresh fruit with the rest being processed into juice and other products. Lemon peel oil is an important by-product. In terms of value, fresh market sales accounted for approximately 99 percent of the $293 million annual total between 2003/04 and 2005/06.

The marketing season runs from August to July and fresh lemons are available year-round as harvest begins in Arizona and the desert area of California and then moves into the Central Valley counties. In addition, fresh lemons can be stored to extend the harvest season.[3]

[3] Lemons can be held for 90-120 days without quality degradation (USDA APHIS, 2000)

Seasonal demand normally peaks during the summer months and domestic per capita consumption has been increasing (table 2).

Table 2. U. S. per capita consumption of fresh lemons

Years	Consumption
	(pounds per capita)
1970s	2.04
1980s	2.28
1990s	2.64
2000/01	3.05
2001/02	3.10
2002/03	3.30
2003/04	3.27
2004/05	3.25
2005/06	3.96

Sources: USDA ERS, 2004; USDA ERS, 2007

Prior to the 1990s, the U.S. fresh lemon industry was very export-oriented. Imports played almost no role in domestic markets, but exports were as high as 50 percent of production. In the 1990s that role was reversed. Spain, Chile, Mexico, and the Bahamas began exporting to the U.S. and imports were reported as approximately nine percent of domestic consumption in the early 2000s (USDA ERS, 2004). Projections are that the U.S. could account for 20 percent of world lemon imports by 2010 (Spreen, 2001). By 2001/02 only about 21 percent of the U.S. crop was exported as domestic demand increased. Major markets include Japan, Canada, Hong Kong, South Korea, Australia, and China.

Argentine Lemon Industry

Argentina is currently the second largest lemon producer in the world with more than one million metric tons a year (roughly 30 percent of global production) and a large exporter (more than 330,000 MT a year), mainly to European countries (table 3). In the 1960s Argentina was only a modest lemon producer with most production concentrated in the humid northeastern states, where citrus canker (*Xanthomonas axonopodis* pv. *Citri*) was prevalent. Production expanded rapidly, particularly during the 1990s (table 4).

Table 3. Fresh lemon exports from Argentina to all markets, 2002-2007

Year	Exports
	(MT)
2002	267,714
2003	336,815
2004	319,921
2005	370,000
2006	320,000
2007	300,000

Sources: USDA FAS, 2004; USDA FAS, 2005; USDA FAS, 2006b

Table 4. Argentine lemon* production, 1990-2005

Year	Production
	(1000 MT)
1990	534.10
1991	656.00
1992	660.70
1993	612.20
1994	681.28
1995	755.60
1996	800.65
1997	968.76
1998	1020.98
1999	1042.66
2000	1171.50
2001	1217.67
2002	1313.27
2003	1236.28
2004	1300.00
2005	1393.38

Source: FAO Stat http://faostat.fao.org/

* The FAO Stat data also includes values for limes, which are marginal in Argentina

Most of the expansion has occurred in the northwest region of Argentina (Catamarca, Jujuy, Salta, and Tucumán) with 90 percent of lemon production concentrated in Tucumán (table

5). Farms in this region tend to be larger commercial operations, included as part of vertically integrated companies (USDA FAS, 2005). The Argentine fresh lemon industry remains very export-oriented. Markets include the Russian Federation, Spain, the Netherlands, Italy, and Greece. Primary harvest occurs begins in April, peaks in June and July, and normally continues through September, although some lemons are produced year-round (USDA FAS, 2000).

Table 5. Area planted to lemons in Argentina, 2005

Region	Province	Planted Area
		(ha)
Northeast	Entre Rios	1,000
	Corrientes	2,200
	Misiones	1,300
Northwest	Tucuman	35,000
	Salta	2,000
	Jujuy	2,200
	Catamarca	50
	Chaco	50
	Formosa	200
Other	Buenos Aires	150
Total		**44,150**

Source: USDA FAS, 2005

Compared to the U.S., a larger portion of the Argentine crop is processed, approximately two-thirds of production in most years. Major products include juice, essential oils, frozen pulp, and dehydrated peel (table 6). In 2004 the state of Tucumán alone was estimated to account for 40 percent of the world's total in processed lemon products. Juice production grew at an annual rate of five percent between 1999 and 2004, much of which is exported for use in soft drink production. Primary destinations are the EU, U.S., and Israel.[4] Five companies produce

[4] In September 2006, the U.S. government initiated an antidumping investigation on imports of lemon juice from Argentina and Mexico.

approximately 90 percent of the lemon juice concentrate, with only two major companies producing approximately 60 percent of the product that is exported (Bruzone, no date).

Table 6. Argentine processed lemon products, 1997-2001

Year	Concentrated Juice	Essential Oil	Frozen Pulp	Dehydrated peel (all citrus)
	(tons)	(MT)	(MT)	(MT)
1997	33.6	2.2	522	30.2
1998	41.3	2.7	640	37.0
1999	41.8	2.7	650	35.0
2000	51.0	3.4	770	43.0
2001	50.0	3.3	750	42.0

Source: McLean, 2004

Political Economy Analysis of U.S.-Argentine Trade in Lemons

In 1967, the U.S. Department of Agriculture Animal and Plant Health Inspection Service [APHIS] banned the entry of citrus from Argentina based on concerns over the potential for infestation of citrus canker (*Xanthomonas axonopodis* pv. *citri* (Hasse)).[5] At that time, citrus grown in Argentina was concentrated in three northeast states (Misiones, Corrientes, Entre Rios) where citrus canker was present but the bacterial disease had already been eradicated in the U. S. after an earlier outbreak.[6] By the 1980s, a group of Argentine businessmen decided to buy former sugar cane farms in northwest Argentina to plant citrus, at least partially in anticipation of potential market openings under the regionalization criterion being negotiated in the Uruguay

[5] See Appendix I for a more detailed description of pests of concern.
[6] Citrus canker outbreaks occurred in the U.S. during the early-1910s and mid-1980s but were declared eradicated by 1943 and 1994, respectively.

Round at that time. Four northwest states (Catamarca, Jujuy, Salta, and Tucumán) were targeted as an area free of citrus canker. The goal was to apply modern technology to produce fruit targeted towards European and American markets.

1993 - 1994

In 1993 the Government of Argentina officially requested entry for fresh grapefruit, lemons, and oranges from this northwest region to the continental United States (Argentine Embassy, personal communication). On May 27, 1994, an APHIS memorandum recommended two actions regarding the request.[7] First that the Government of Argentina request a thorough risk assessment be completed. Second that an expert group of pathologists from APHIS and the Agricultural Research Service determine what research was needed for a regulatory decision, establish tolerances for diseased fruit in an export program, and make an assessment of Argentina's citrus canker survey.

An APHIS delegation visited the northwest growing region in September 1994. Preliminary results indicated that although the region under consideration appeared to be canker-free, it did contain citrus black spot (*Guignardia citricarpa,* Kiely) and sweet orange scab (*Elsinöe australis,* Bitancourt & Jenkins), two citrus fungal diseases not present in the United States as well as several exotic fruit flies including Medfly, mites, and other insect pests.

1995 - 1996

In 1995, APHIS prepared a preliminary qualitative pest risk assessment that denied Argentina's petition "unless pest free areas can be established or treatments can be approved" for citrus black spot and sweet orange scab (Harland Land Co. v. USDA, 2001). At the same time, APHIS personnel communicated to Argentina the areas in which additional research was needed.

[7] See Appendix II for a more detailed description of USDA APHIS process for risk analysis requests.

For a time the regulatory process stalled in a political dispute where one side asked for more data while the other claimed that further studies were costly and unnecessary. The U.S. position required scientific evidence of pest-free status through a series of experiments. The Argentine position stated that since the EU- policy under consideration at the time allowed citrus imports from pest-free orchards located in non-pest-free states, risks of transferring disease from these areas had to be negligible.[8] This political dispute illustrates how difficult it can be for regulators in a developing country to understand the importance of following established sanitary protocols and act to demonstrate phytosanitary health that is scientifically proven. To some extent, this step of the dispute also underscored differences in American and European approaches to phytosanitary prevention of citrus pests. While APHIS followed the WTO regionalization principle to allow imports from regions that were certified pest-free, exports of Argentine citrus to Europe followed sanitary protocols based only on identification of pest-free orchards, even if those orchards were located in non-pest-free areas.

Momentum to break the impasse came from the Argentine growers. First they organized an umbrella phytosanitary organization for the region (Asociación Fitosanitaria del Noroeste Argentino or AFINOA) which included several members of the Academia to provide scientific expertise needed to conduct experiments requested by potential importers. AFINOA gathered political support from the Governors in the northwest region to improve and document enactment of phytosanitary measures ensuring separation of their area from non-pest-free regions. To address concerns over institutional uncertainty at the national level, Argentina began

[8] The EU abolished protected zones for citrus in Italy and Greece in 1996, eventually opening access to all EU markets under a systems approach.

to elevate the status of its internal agency, concentrating all SPS issues under a new institutional umbrella (Servicio Nacional de Sanidad y Calidad Agroalimentaria or SENASA).[9] Such a coordinated effort to accommodate scientific requirements of potential trade partners revealed a level of organizational and scientific skills uncommon in many developing countries. During 1995 Argentina conducted the requested research and surveys. Data from this research was received by APHIS in 1996.

In the U.S., a citrus canker outbreak was detected in the Miami-Dade County, Florida area during 1995. An eradication program was undertaken that involved regional quarantines (established in January 1996) and destruction of millions of trees in an effort to contain disease spread. Under the Citrus Canker Eradication Program [CCEP] all infected trees plus any citrus trees within a 1900 ft. radius were destroyed. Decontamination procedures for grove workers, equipment, and packinghouses were also established (Zanlser et at, 2005).

1997

A U.S. Congressional delegation visited Argentina in January 1997 to discuss several trade issues with President Menem and other high ranking officials. Concern over resolution of the citrus case was raised by the Argentine government (CoA, 1997). In September 1997 APHIS prepared a Supplemental Pest Risk Assessment (PRA), which estimated the median chance of citrus canker becoming established in the U. S. as a result of imports from the northwest Argentina was 1 in 4 trillion (USDA APHIS, 1997). This Risk Assessment consisted of four basic components:

---

[9] See Appendix III for a more detailed description of the Argentine regulatory agency.

1. *Scenario Analysis*: First, APHIS conceptualized the events (probability nodes-P) that must occur before introduction of a quarantine pest. Nodes that must take place before a pest is introduced into the U.S. are that the pest has infected/infested the harvested fruit (P1), avoided detection at harvest (P2), avoided detection at the packinghouse (P3), survived treatment (P4), survived shipment (P5), been shipped to a suitable habitat (P6), found a suitable host (P7), and is able to complete the disease or life cycle (P8). Nodes P1-P4 occur in Argentina while P5-P8 happen in the United States.
2. *Mathematical Model*: Second, APHIS constructed a mathematical model to estimate the annual likelihood of pest introduction, APHIS multiplied together nine numbers – the eight probability nodes above and the estimated annual number of imported boxes of Argentine citrus (F1). To estimate the effect of mitigation, APHIS used the mathematical model separately for four pests with ("mitigated program") and without ("baseline program") specific mitigation measures anticipated to be contained in the proposed rule.[10]
3. *Input Probabilities*: Input values for F1 and P1-P8 were estimated for each pest with and without specific mitigation measures. A range of values, instead of a single value point, were used because of the uncertainty involved in risk assessment. Data was obtained from Argentine agencies, pest interception records, the known biology of the pest or related organisms, expert judgment based on field experience with the pest or related organisms, expert judgment based on experience conducting commodity inspections at ports of entry or exit, and experience working with export programs and export-quality commodities.
4. *Computer Simulations*: Finally, a quantitative analysis was conducted using randomly selected values entered into a computer program.

The Risk Assessment concludes that, without using mitigation measures, there was a high likelihood for the introduction into the U.S. of fruit flies and sweet orange scab, a medium likelihood for citrus black spot, and a low likelihood for citrus canker. However, APHIS determined that the likelihood of pest introduction would be reduced to a negligible level if a systems approach was applied (table 7).

---

[10] Fruit flies (South American, West Indian, Serpentine, and Mediterranean), sweet orange scab, citrus black spot, citrus canker

Table 7. Estimated likelihood of U.S. pest establishment

Pest		Likelihood of pest establishment			
		Mode	Median	Mean	95th percentile
Fruit Flies	Baseline	.0023	.0041	.013	.053
	Mitigation program	$1.09 * 10^{-7}$	$5.75*10^{-7}$	$2.89*10^{-6}$	$1.07*10^{-5}$
Sweet Orange Scab	Baseline	$1.73*10^{-5}$	$7.58*10^{-5}$	$5.58*10^{-4}$	$2.29*10^{-3}$
	Mitigation program	$2.45*10^{-8}$	$3.87*10^{-8}$	$5.55*10^{-7}$	$2.04*10^{-6}$
Citrus Black Spot	Baseline	$2.13*10^{-7}$	$8.75*10^{-6}$	$3.49*10^{-5}$	$1.34*10^{-4}$
	Mitigation program	$9.29*10^{-9}$	$4.77*10^{-8}$	$3.08*10^{-7}$	$1.19*10^{-6}$
Citrus Canker	Baseline	$1.58*10^{-13}$	$2.48*10^{-13}$	$2.07*10^{-12}$	$8.12*10^{-12}$
	Mitigation program	$2.29*10^{-17}$	$2.48*10^{-17}$	$2.07*10^{-16}$	$8.12*10^{-16}$

Source: USDA APHIS, 1997, p.44

1998

On August 12, 1998, APHIS published a proposed rule that allowed citrus imports using a systems approach to guard against black spot and sweet orange scab (USDA APHIS, 1998a).[11] Under this rule, citrus imports were allowed into the U.S. using a systems approach which included the following safeguards:

- *Origin requirements*. The grapefruit, lemons, or oranges must have been grown in a grove located in a region free from citrus canker (the States of Catamarca, Jujuy, Salta, and Tucumán).

[11] In 1998 the EU recognized Catamarca, Jujuy, Salta, and Tucumán as free of citrus canker and all of Argentina as free of Cercospora angolensis (citrus leaf spot). They did not recognize any states as being free from citrus black spot (McLean, 2004).

- *Grove requirements*. The grapefruit, lemons, and oranges must have been grown in a grove that meets the following conditions:

  (1) The grove must have been registered with the citrus fruit export program of SENASA.

  (2) The grove must have been surrounded by a 150-meter-wide buffer area. No citrus fruit grown in the buffer area is eligible for export to the U.S.

  (3) Any new citrus planting stock used in the grove must have met one of the following requirements:

    (i) The citrus planting stock must be obtained from within one of the four northwestern states; or

    (ii) The citrus planting stock must be obtained from a SENASA-approved citrus stock propagation center.

  (4) All fallen fruit, leaves, and branches must be removed from the ground in the grove and the buffer area before the trees in the grove blossom. The grove and buffer area must be inspected by SENASA before blossom to verify that these sanitation measures have been accomplished.

  (5) The grove and buffer area must be treated at least twice during the growing season with an oil-copper oxychloride spray. The timing of each treatment shall be determined by SENASA's expert system based on its monitoring of climatic data, fruit susceptibility, and the presence of the disease inoculum. The application of treatments shall be monitored by SENASA to verify proper application.

  (6) The grove and buffer area must be surveyed by SENASA 20 days before fruit is harvested to verify the grove's freedom from citrus black spot (*Guignardia citricarpa*) and sweet orange scab (*Elsinoe australis*) through:

    (i) Visual inspection of the grove and buffer area; and

    (ii) The sampling of 4 fruit from each of 298 randomly selected trees from each grove and buffer area covering a maximum area of 800 hectares. Sampled fruit must be selected from those portions of the trees that are most likely to have infected, symptomatic fruit (i.e., near the outer, upper part of the canopy on the sides of the tree that receives the most sunlight). The sampled fruit must be held in the laboratory for 20 days at 27° C, 80 percent relative humidity, and in permanent light to promote the expression of symptoms in any fruit infected with citrus black spot.

- *Postharvest.* After harvest, the grapefruit, oranges, or lemons must be handled in accordance with the following conditions:

(1) The fruit must be moved from the grove to the packinghouse in field boxes or containers of field boxes that are marked to show the SENASA registration number of the grove in which the fruit was grown. Identity of fruit origin must be maintained.

(2) During the time that any grapefruit, lemons, or oranges from groves meeting the proper requirements of this rule are in the packinghouse, no fruit from groves that do not meet the requirements of this rule may enter the packinghouse. A packinghouse technician registered with SENASA must verify the origin of all fruit entering the packinghouse.

(3) After arriving at the packinghouse, the fruit must be held at room temperature for 4 days to allow bruises or other fruit damages to become apparent.

(4) After the 4-day holding period, bruised or damaged fruit must be culled and the fruit must be inspected by SENASA to verify its freedom from citrus black spot and sweet orange scab. The fruit must then be chemically treated as follows:

(i) Immersion in sodium hypochloride (chlorine) at a concentration of 2000 parts per million for 2 minutes:

(ii) Immersion in orthophenilphenate of sodium;

(iii) Spraying with imidazole; and

(iv) Application of 2-4 thiazailil benzimidazole and wax.

(5) Before packing, the treated fruit must be individually labeled with a sticker that identifies the packinghouse in which they were packed and must be inspected by SENASA to verify freedom from citrus black spot and sweet orange scab and to ensure that all stems, leaves, and other portions of plants have been removed from fruit.

(6) The fruit must be packaged in clean, new boxes that are marked with the SENASA registration number of the grove in which the fruit was grown and a statement indicating that the fruit may not be distributed in Hawaii, Guam, the Northern Mariana Islands, Puerto Rico, and the U.S. Virgin Islands, or in any other state where distribution is prohibited (each of which must be individually listed).

- *Phytosanitary certificate*. Fruit to be export to the U.S. must be accompanied by a phytosanitary certificate issued by SENASA that states the grapefruit, lemons, or oranges were produced and handled in accordance with the requirements of the rule and are apparently free from citrus black spot and sweet orange scab.

- *Cold treatment*. Due to the presence in Argentina of Mediterranean fruit fly (Medfly) (C*eratitis capitata*) and fruit flies of genus Anastrepha, grapefruit, lemons (except smooth-skinned lemons), and oranges must be treated with an authorized cold treatment listed in the Plant Protection and Quarantine Treatment Manual.

- *Disease detection*. If, during the course of any inspection or testing, or at any other time, citrus black spot or sweet orange scab is detected in any grapefruit, lemons or oranges, APHIS and SENASA must be notified and the grove in which the fruit was grown or is being grown shall be removed from the SENASA citrus expert program for the remainder of that year's growing and harvest season, and no fruit harvested from that grove may be imported into the United States during the remainder of that shipping season.

- *Limitations on distribution*. Distribution of the grapefruit, lemons, and oranges is limited to the continental United States (the 48 contiguous States, Alaska, and the District of Columbia). In addition, during the 2000 through 2003 shipping seasons, the distribution of grapefruit, lemons and oranges was further limited as follows:

    (1) During the 2000 and 2001 shipping seasons, the fruit was to be distributed in all areas of the continental United States except Alabama, Arizona, Arkansas, California, Colorado, Florida, Georgia, Louisiana, Mississippi, Nevada, New Mexico, Oklahoma, Oregon, Texas, and Utah.

    (2) During the 2002 and 2003 shipping seasons, the fruit could be distributed in all areas except Arizona, California, Florida, Louisiana, and Texas.

    (3) For the 2004 shipping season and beyond, the fruit could be distributed in all areas of the continental United States

- *Port of Entry*. The grapefruit, lemons, and oranges may enter the United States only through a port of entry located in a State where the distribution of fruit is authorized.

- *Repackaging*. If any grapefruit, lemons or oranges are removed from their original shipping boxes and repackaged, the stickers required by the rule may not be removed or obscured and the new boxes must be clearly marked with all the required information.

Although the proposed rule appeared to reflect increased mutual understanding and trust between APHIS and SENASA, such confidence had not been transferred to U.S. growers and public comments revealed continued opposition.[12] Meanwhile, regulatory officials were confident in the scientific merits of the proposal and APHIS moved forward with other aspects of the process.

In 1998 an economic analysis determined that the rule "[would] not have a significant economic impact on a substantial number of small entities" (USDA APHIS, 2000 p.37667). Based on that determination, APHIS did not prepare a Regulatory Flexibility Analysis for the rule. An earlier assessment was published which concluded there was negligible environmental risk under the proposed rule, but if the system approach failed the subsequent impact associated with adverse consequences of fruit fly eradication programs on humans, non-targeted species, and the physical environment would be "considerable" (USDA APHIS, 1998b). Based on the finding, APHIS did not prepare an Environmental Impact Statement for the final rule.

This proposed rule elevated political controversy. Concerns were raised about the scientific basis and execution of the systems approach in addition to risk assessment procedures and conclusions generated by APHIS. Public comments were solicited during a 60-day period ending on October 13, 1998. U.S. constituents initially requested a one-year extension of the comment period then shortened the requested extension to six months. Finally, congresswoman Lois Capps (CA) successfully lobbied USDA/APHIS to extend the comment period by 120 days to February 11, 1999 (63 FR 55559). A public hearing was initially scheduled for December 17, 1998, in Thousand Oaks, California. At public request, the California hearing was rescheduled for February 8, 1999 and an additional hearing was held February 5 in Orlando, Florida.

---

[12] For more discussion on the role of institutional trust, see Romano and Thornsbury (2006).

Overall, APHIS received 332 comments, including 63 from the public hearings. Comments were from foreign and domestic producers, handlers, packers, and processors of citrus fruit, members of the U.S. Congress, elected representatives of state and local governments, state plant protection officials, SENASA officials, and representatives of the U.S. Citrus Science Council (USCSC), a group formed specifically to respond to the proposed rule.[13] Seventeen of the comments requested further extension to the comment period, and three comments simply stated that any decision should be based on sound science. Two hundred and fifty comments, 148 of which were form letters offering support for the position of the USCSC, raised concerns or made suggestions regarding the proposed rule. The remaining 62 comments offered support for the proposed rule as it was written.[14]

Comments in support of the proposed rule noted the mutual benefits of trade, recognized the scientific basis of the proposed rule, stated that Argentine imports would provide competition for citrus imports from other countries, saw an opportunity to increase U.S. exports to Argentina, noted that Argentine citrus has been exported to markets in other countries--including citrus-producing countries--without incident, and mentioned the positive economic effects that Argentine citrus imports would have on consumers, wholesalers, distributors, and ports of entry. Opposing comments questioned validity of the scientific basis and mitigation measures and raised doubts about execution and conclusions of the APHIS risk assessment.

1999

---

[13] For more information on origins of USCSC see the statement at http://www.cacitrusmutual.com/us_citrus_council.html.

[14] Statistics published in the final ruling (USDA APHIS, 2000).

As APHIS formulated a response to the public comments, the regulatory process slowed. In November 1999, Argentina expressed concerns regarding the delay. A representative of the United States answered that the draft measures had passed the technical level and promised to draw attention to Argentina's concerns (Magalhães, 2001).

2000

APHIS published a final ruling on June 15, 2000 which allowed Argentine citrus shipments to begin immediately (USDA APHIS, 2000). Distribution was initially permitted in 34 states, excluding five continental U.S. producing states and nine buffer states.[15] Sunkist Growers, a California based citrus marketing cooperative, was awarded the exclusive right to market Argentine lemons from SA San Miguel and Citrusuil SA, two major producers. USDA/AMS began reporting price and shipment data on August 22, 2000 and Argentina quickly became the top supplier of imported fresh lemons. Increased export rebates for fresh lemons from Argentina were established for shippers in 2000. Lemons packed in boxes up to 15 kg received a ten percent rebate while larger containers received slightly smaller rebates of 8.1 percent (USDA FAS, 2000).[16]

Opposition to the final rule continued. On July 20, 2000, Senator Boxer (CA) proposed an amendment to the Fiscal Year 2001 Agriculture Appropriations bill that would withhold funding for implementation of the Argentine citrus rule until USDA commissioned an

---

[15] Distribution was to be extended to the ten buffer states (Alabama, Arkansas, Colorado, Georgia, Mississippi, Nevada, New Mexico, Oklahoma, Oregon, and Utah) in the 02/03 season and to the continental U.s. commercial citrus producing states (Arizona, California, Florida, Louisiana, and Texas) in the 04/05 season. Only the continental U.S. was included in the final rule.

[16] Prior to 2000, all fresh citrus exports received a 5.4 percent rebate (USDA FAS, 1997).

independent peer review of the rule and its underlying risk assessment (NAWG, 2000; Costa, 2000).On August 25, 2000, 26 U.S. industry groups[17] sent a letter to Congressman Joe Skeen (NM) opposing the amendment stating

> *If enacted, the provision would seriously undermine U.S. efforts to ensure that sanitary and phytosanitary measures maintained by foreign governments are based on science, not politics, and would invite retaliation against U.S. agricultural exports because it circumvents the longstanding and scientifically-based USDA method of conducting risk assessments. We urge you to eliminate the provision during conference consideration of the Agriculture Appropriations bill*.
>
> (GMA 2000)

In a separate action, on July 26 four California Citrus Growers and the U.S. Citrus Science Council filed a lawsuit against the U.S. Department of Agriculture to overturn the decision to go forward with a final rule allowing citrus imports from Argentina (Pasco, 2000). Complainants in the lawsuit took a position that the final rule was unlawful because of inconsistency with the Plant Quarantine Act of 1912, which was intended "to exclude plants or plant products which may convey fruit diseases or insect pests new to or not theretofore widely prevalent or distributed within and throughout the U. S." (Harland Land Co. v. USDA, 2001).

2001

---

[17] The American Farm Bureau Federation, the American Feed Industry Association, the American Meat Institute, the American Soybean Association, the Biotechnology Industry Organization, Cargill, Inc., DuPont Farmland Industries, Inc. , the Grocery Manufacturers of America, the Louis Dreyfus Corporation, the National Association of Wheat Growers, the National Cattlemen's Beef Association, the National Corn Growers Association, the National Food Processors Association, the National Grain Sorghum Producers, the National Oilseed Processors Association, the National Pork Producers Council, the National Turkey Federation, the North American Export Grain Association, the Pet Food Institute, Pioneer Hi-Bred International, the Rice Millers' Association, the USA Poultry & Egg Export Council, the U.S. Dairy Export Council, the U.S. Meat Export Federation, the U.S. Rice Producers' Group, and the Wheat Export Trade Education Committee.

The following year, the U.S. and Argentina held a two-day series of bilateral trade consultations in March. During these talks, Argentina agreed to amend some long standing restrictions to entry of selected California and Florida produce. Shipments were scheduled to begin once regulations establishing sanitary and phytosanitary protocols were in place, projected to be late May 2001. On June 18, USDA announced that SENASA had signed an agreement to allow imports of Florida citrus and expand access for California citrus and stone fruit to the Argentine market and estimated the market expansion could provide a $3 million boost to the U.S. citrus industry and a $5 million boost to the U.S. stone fruit industry (USDA FAS, 2001). U.S. growers were suspicious that their own market expansion would be achieved since earlier in the year (April 10, 2001) Argentina had increased tariffs on most fruit and vegetables, including citrus, from non-Mercosur countries from 12 to 25 percent as part of an overall economic restructuring.

Opposition in the U.S. continued in the political arena. In order to address grower concerns about the ability of trade partner institutions (i.e. SENASA) to adequately monitor and carry-out the steps of the systems approach, APHIS personnel conducted an unannounced review of SENASA's citrus program in Tucumán from March 28 to March 30, 2001. They examined centralized SENASA records, and visited a laboratory to verify the presence of sufficient technical personnel, to review records and to ensure that permanent light, temperature and humidity were in the appropriate parameters. In addition, APHIS personnel reviewed citrus canker survey activities and APHIS randomly selected a citrus grove for inspection where they verified grove requirements were being met – e.g. registration, buffer zones, sanitation, oil-copper oxychloride spray, and fruit sampling. Throughout the three day review, APHIS did not discover any irregularities or violations of regulatory requirements. In addition, APHIS finalized a work plan to provide active and direct monitoring of the Argentine citrus program. Each month, APHIS would review all citrus canker surveillance program records including all phytosanitary data generated by mobile units and control checkpoints on main roadways into canker-free areas.

On March 30, 2001 the U.S. Citrus Science Council, acting on behalf of California and Arizona citrus growers, filed a rulemaking petition as part of the lawsuit against USDA requesting that the 2000 final rule be immediately suspended and ultimately amended.[18] Their position was that USDA was attempting to increase trade at the expense of caution against pest invasion. The move by Argentina to allow expanded U.S. market access was viewed as blatant tit-for-tat diplomacy.

On May 12, 2001, arguments in the federal lawsuit were heard by Judge Robert Coyle in Fresno, of the Eastern District of California (Harland Land Co. v. USDA, 2001). Institutional uncertainty surrounding both APHIS and SENASA was raised as prosecutors argued that the risk assessment was confusing and internally inconsistent. The distrust of California growers for regulatory officials had been extended to include domestic scientists and regulators. Among other reasons, the prosecution argued that

(1) the risk assessment was confusing and internally inconsistent. For example, in Node 2 (i.e., "node 2" denotes step #2 of the system approach) the baseline scenario assumes a

[18] Harlan Land Co., Limoneira Company, Pecht Ranch, R7 Enterprises and U.S. Citrus Science Council vs. U.S. Department of Agriculture, Daniel R. Glickman, Secretary of Agriculture, and Craig A. Reed, Administrator, Animal and Plant Health Inspection Service, United States District Court, Eastern District of California, Case No. CIV F00-6106 REC LIO

detection rate of 0.5 at harvest reduced to a 0.1 rate under the mitigated scenario. According to the plaintiffs, "this makes no sense because there is no mitigation for citrus black spot in Node 2 since Node 2 involves the baseline culling of blemished fruit in the field."

(2) reliance on SENASA to implement, verify and enforce part of the systems approach was misplaced. In the recent past, SENASA had for several months concealed an outbreak of foot-and-mouth disease in Argentina.
(3) the economic impact analysis was based on the false assumption that the results of the Risk Assessment were reliable, therefore, determination that there would be no economic impact on small businesses was incorrect.

The defendants' response to these three selected charges included the following:

(1) APHIS conceded they made some mistakes with their risk analysis, but considered the errors to be minor. Working with corrected assumptions, the team re-estimated input values and found the risk of citrus black spot infection increased from one chance in 3.2 million to one chance in 763,000. APHIS argued that the risk was still appreciably lower than the risk of fruit fly introduction (one chance in 350,000) which was considered acceptable and thus the new risk estimate did not warrant remand of the case
(2) APHIS agreed that SENASA's failure to report foot-and-mouth disease outbreak was of concern, but argued that while this may involve the administration of the Argentine citrus rule it did not impact efficacy of the systems approach or whether the rule was arbitrary and capricious. Further, APHIS stated that both the President of SENASA and the Argentine Minister of Agriculture had been replaced after SENASA failed to report the foot-and-mouth outbreak. In addition, "APHIS has taken several new and additional steps beyond those contemplated by the final rule to ensure that SENASA is in full compliance with its obligations under the rule."
(3) APHIS argued that the Risk Assessment was a valid basis for the subsequent economic analysis.

The court eventually ruled in favor of the prosecution, upholding grower uneasiness over the systems approach and entry of Argentine lemons was again banned. In its decision, the court made the following comments:

(1) *"Having reviewed the Risk Assessment, the court concludes that the final rule is arbitrary and capricious because it is based on a faulty risk assessment. The uncertain nature of the Risk Assessment is illustrated by the fact that the risk of citrus black spot introduction increased significantly under the revised Risk Assessment from one chance in 3.2 million to one chance in 763,000 for the mean and from one chance in 840,000 to one chance in 189,000 for the 95 percentile. Although the risk is still lower than the risk of fruit fly introduction, where there is one chance in 350,000 for the mean and one chance in 93,000 for the 95 percentile value, the fact that there was a four and a half fold increase in the risk of citrus black spot introduction at the 95 percentile because of faulty assumptions made by the APHIS scientists suggests that APHIS needs to reevaluate the Risk Assessment."*

(2) *"Although the Risk Assessment take (sic) human error into content (sic), it may have understated human error in light of SENASA's failure to report the foot-and-mouth disease. Frankly, the court is concern (sic) about whether SENASA can be entrusted to enforce the mitigation measures used by the systems approach. Although the president of SENASA and the Argentine Minister of Agriculture have been replaced, the court is not convinced that other SENASA officials who were involved in the coverup have been removed from office."*

(3) "*The court finds the Risk Assessment to be faulty. Thus, the court cannot give deference to APHIS' decision not to issue an EIS. Because APHIS' finding of no significant impact is based on its questionable conclusion that the risk of pest introduction is negligible, APHIS' decision not to issue an EIS violates NEPA and was arbitrary and capricious."*

"As discussed above, the court finds the Risk Assessment to be faulty. ACCORDINGLY, IT IS SO ORDERED that plaintiffs be granted summary judgment and defendants be denied summary judgment. IT IS FURTHER ORDERED that the Argentine citrus rule is suspended until a new rule is in place. The final rule is remanded to APHIS to address the concerns raised by the court."

2002 - 2003

While Argentine citrus imports to the U.S. remained suspended, SENASA announced in February 2002 that citrus canker had been detected in the northwest growing region of Argentina and requested a new site visit from APHIS. The goal was to demonstrate that, despite the loss of canker-free status, systems approach safeguards were rigorous enough to meet phytosanitary standards of demanding European trade partners and therefore, sufficient to satisfy APHIS requirements. This argument was not fundamentally different than that posited in 1995: there was no need for APHIS to request canker-free status since safety protocols SENASA had in place with its European partners were ultimate proof that a systems-approach worked to mitigate concerns. By 2002, however, the Argentine position included greater scientific and institutional evidence to back the claim.

On April 10, 2002 the Solicitor General's office announced they would not appeal the U.S. court ruling and a new set of risk assessment procedures began. Based on results of the requested site visit, APHIS produced a July 22, 2003 document that recognized the appropriateness of the systems approach in place, but criticized SENASA for not implementing a canker eradication program in their own northwest region (Wager-Page et al, 2003). Argentine regulators and growers rejected the need for a program and the regulatory process again stalled. Speculation was that political considerations related to the on-going Florida canker eradication program prevented APHIS acceptance of the Argentine protocol and forced the agency to request an eradication program (Argentine embassy, personal communication).

Meanwhile, on November 12, 2003 Spain issued a ban on fresh citrus imports from Argentina and Brazil in light of increased detection of the bacteria causing citrus canker in shipments. Spain requested increased stringency for phytosanitary requirements before resuming shipments.[19]

2004 - 2005

Although not directly a part of the regulatory process, a 2004 incident dubbed "lemongate" caused heightened tensions (Ramirez, 2004; Blustein and Byrnes, 2004). On July 29, an anonymous email was sent to USDA reporting unspecified hazardous material to be found in sealed containers of Argentine lemons on a ship due to dock in a N.J. port the following day.[20] In response, the Chilean-owned ship was held offshore for a week as the U.S. Coast Guard investigated. The containers were frozen and the contents, crew, and surrounding air tested for potential hazards. Although all tests were negative, the already ruined fresh lemons – with an estimated $70,000 value – were eventually destroyed. The operation was estimated to cost $1.3 million and did nothing to reduce political tensions over lemon trade. The source of the original email was never identified although later speculation centered on a business dispute between the shipper and buyer.

2006

---

[19] In April 2004, the EU resumed imports from Argentina under a series of emergency measures that increased monitoring requirements and oversight (McLean, 2004).

[20] The lemons were destined for Canada.

On January 10, 2006, USDA officials declared defeat in their own canker eradication process and announced that the recent string of hurricanes had resulted in citrus canker "so widely distributed that eradication is infeasible" (Conner, 2006 p.1). An emergency action was undertaken to extend the domestic quarantine region to the entire state of Florida and end the eradication program. U.S. policy focus shifted towards disease management and prompted a new set of scientific studies related to movement of fresh citrus from infected areas. On February 28 and March 1, 2006 a group of APHIS and SENASA officials met in Buenos Aires to discuss implications for recognition of Argentina's canker protocol (Enright, 2006).

In March 2006, APHIS released a report on the ability of asymptomatic citrus fruit to act as a conduit for citrus canker, even if the fruit originated in a region that was not designated canker-free (USDA APHIS, 2006a). Focus was movement of fruit within U.S. borders, but across canker quarantine boundaries. The report concluded that asymptomatic fruit commercially produced and treated via a systems approach did not provide a significant pathway for introduction of the disease. In addition, APHIS found that even if introduction was to occur, environmental and physiological conditions made establishment highly unlikely. The report was evaluated in an August 2006 peer review (USDA APHIS, 2006b). Although three of the four published reviews were generally supportive, some earlier concerns were raised again; notably, reliability of assumptions and uncertainty surrounding risk estimates. A fundamental assumption that all steps of the systems approach were undertaken and functioned effectively was questioned by two reviewers. Several reviewers also noted that much of the literature cited had not been peer reviewed but instead relied on government or non-scientific sources.

In July 2006 the World Bank released a report that reviewed Argentina’s regulatory structure (WB, 2006). SENASA was found to have good technical capacity but still needed improvement in planning, communication, and information management. Improving the country’s quality and safety systems was seen as critical to reaching export potential.

2007

In June 2007 APHIS released a second report that focused on movement of any commercially packed citrus (not just asymptomatic fruit) across canker quarantine boundaries within U.S. borders (USDA APHIS, 2007a). Conclusions were that the introduction of canker is unlikely when production and harvest follow a defined systems approach. However, the report notes that some risk remains and that it is not possible to design a system that halts movement of all infected fruit with certainty. The report recommends that interstate movement of fruit be allowed into non-citrus producing states but prohibited from Arizona, California, Hawaii, Louisiana, and Texas.[21] The document was subject to peer review and open for public comment until July 17, 2007. A very detailed assessment was received from one peer reviewer that raised a number of concerns with the APHIS report (USDA APHIS, 2007b). Fundamentally the assessment argues that the policy proposed by APHIS is not based on a systems approach at all since it does not include any required orchard management practices, but instead depends on inspection and treatment at the packinghouse (referred to in the comment as a control point approach). Specific concerns are again raised about the reliance on unpublished data or unreviewed publications, need for further scientific studies, and uncertainty surrounding assumptions. Further, the reviewer notes that under WTO commitments the U.S. will need to apply the same standards to imported fruit from all regions where canker is present.

On August 6, 2007 APHIS released a new PRA for import of fresh lemons from the northwest region of Argentina (USDA APHIS, 2007c). In contrast to the 1997 risk assessment, this

[21] Packinghouse inspection of fruit and treatment with approved disinfectant required before shipment to any state.

document is specific for lemons, the northwest region, qualitative (versus quantitative) in nature, and based on updated USDA risk assessment guidelines using pathway analysis.[22] Results of the new PRA identified seven quarantine pests likely to follow the identified pathway for introduction to the U.S. (table 8).[23] Each of the seven pests was then rated separately on the consequences of introduction and the likelihood of introduction. For consequences of introduction a value of 1 (low), 2 (medium) or 3 (high) was assigned in five categories (climate, host range, dispersal potential, economic impact, environmental impact) which were then summed. Similar values were assigned for six additional categories (annual quantity expected to be imported, harvested fruit is infested, pest survives packaging and post-harvest treatment, pest survives shipment, pest moves to a suitable habitat, pest finds a suitable host and establishes disease) and summed to calculate a value for likelihood of introduction. Finally totals in the two aggregated categories are summed to generate a rating for overall pest risk potential.

Table 8. Risk rating for quarantine pests likely to follow the pathway

Pest	**Consequences of Introduction Risk**	**Likelihood of Introduction Risk**	**Pest Risk Potential (total)**
Arthropod			
Anastepha fraterculus	High (14)	High (16)	High (30)
Ceratitis capitata	High (14)	High (16)	High (30)
Parlatoria cinereae	High (13)	Medium (13)	Medium (26)
Parlatoria ziziphi	High (13)	Medium (13)	Medium (26)

[22] Since 1995 the Food and Agriculture Organization (FAO) has been publishing the International Standards for Phytosanitary Measures (ISPM) to guide the enactment of SPS regulations. In April 2004, FAO published ISPM No. 11: *Pest risk analysis for quarantine pests, including analysis of environmental risks and living modified organisms* (FAO, 2004) which was used as the basis for pathway analysis. One alternative approach, based on evaluation with a Markov model, has been proposed for animal-based SPS issues (OIE, 2000).

[23] Two pests from the 1997 PRA did not appear on the list in the 2007 report (Anastrepha oblique and Anastrepha serpentine. Two additional pests were added in 2007 (Parlatoria cinereae and Parlatoria ziziphi).

Bacteria			
Zanthomonas axonopodis pv citri	Medium (11)	Medium (13)	Medium (19)
Fungi			
Elsinoe australis	Low (6)	Medium (13)	Medium (19)
Guignardia citricarpa	Medium (9)	Medium (13)	Medium (22)

Source: USDA APHIS, 2007c, p.58

The 2007 PRA concludes by interpreting total pest risk potential rated as medium (five of the seven identified pests) as areas where specific phytosanitary measures may be necessary and total pest risk potential rated as high (two of the seven identified pests) as areas where specific phytosanitary measures are strongly recommended. The document clearly states that no risk management recommendations (identification of appropriate measures to mitigate risk) are included (p.58), yet there are a number of mitigating steps mentioned throughout the document as having potential to decrease risk. These steps include: harvest fruit prior to maturity, chemical control, windbreak and/or buffer zones around groves, pruning diseased shoots and removing leaf litter from orchard floor, remove any old fruit left on the tree, culling in field and packinghouse, SOPP wash, mechanical brushing, wax, and storage temperature requirements. Presumably a defined systems approach will be developed in the next phase of the policy process. Public comments are being accepted on the current document until October 12, 2007. As of October 8, only six comments had been received[24] – four requesting an extension to the comment period, one opposed to relaxing the import ban, and one asking for more documentation of references cited in the PRA.

[24] California Citrus Mutual; Associated Citrus Packers, Inc; California Department of Food and Agriculture; California Farm Bureau Federation; Cambridge Environmental, Inc.(2 comments). Comments can be viewed online at http://www.regulations.gov/fdmspublic/component/main?main=DocketDetail&d=APHIS-2007-0112.

Empirical Analysis of U.S.-Argentine Trade in Lemons and its Limitations

Peterson and Orden developed a general framework for incorporating economic analysis of welfare with pest risk in an expectation-weighted partial equilibrium market analysis (Peterson and Orden, 2006; Peterson and Orden, 2008). The model was applied to the case of fresh Hass avocado imports to the U.S. from Mexico to evaluate net welfare changes after trade was allowed under an approved systems approach and to compare welfare tradeoffs in scenarios when some, or all, of the steps in the systems approach were removed. The discussion below explores adaptation of the Peterson/Orden model to the case of fresh lemon imports to the U.S. from Argentina. While there are some similarities between the avocado and lemon cases, a number of critical differences limit actual empirical evaluation in this second example.

Both cases use the systems approach as a basis for policy adjustments; however, in the avocado example a policy had been implemented before empirical assessment. Not just political, but also scientific, issues remain contentious in the lemon case. Further, the quantitative risk evaluation undertaken in 1997 was not substantiated in the court ruling and has been abandoned by APHIS. Therefore probabilities reported in the 1997 PRA are not suitable input for further economic analysis unless they can be upheld in the scientific community. The most critical piece of missing information for empirical analysis of the lemon case is an established pest risk assessment providing input beyond categorical rankings of pest risk.

Like the avocado case used to initially develop the model, the lemon case involves a commodity that is limited in geographic production area, includes relatively few trading partners for the U.S., and involves geographic restrictions as part of the proposed systems approach. Unlike the avocado case, the lemon case involves more widely distributed U.S. production areas and a more fragmented domestic industry (particularly when the broader category of citrus is considered).

As with any assessment of sanitary and phytosanitary policies, which are by definition unique to the conditions in defined importing and exporting regions, an economic analysis requires substantial data input. Sections below describe major components of the model and data required if the analysis were to be undertaken. Where data exists it has been incorporated into each section to better inform decisions about the Argentine lemon case and to provide input for efforts at subsequent analysis. Where current data limitations exist that prevent empirical estimation of the model, they are noted and explored.

Defining the Systems Approach

The Argentine lemon case continues to be actively debated in the policy arena. As such there is no defined systems approach policy in place. Currently imports are banned and so any analysis of existing policy options would simply compare autarky with a postulated free trade scenario. Still, the wealth of public documents generated by the on-going debate offers some insight to what a systems approach policy, once enacted, might look like. Table 9 compares steps included in the 1997 PRA with those mitigation measures mentioned in the 2007 PRA.

Table 9. Comparison of the 1997 and 2007 PRA

	1997 PRA	**2007 PRA***
Orchard design	150 meter buffer zone around grove	Buffer zone around export approved groves
	Nursery stock must originate from the canker-free zone	Windbreaks

Orchard practices	Two, or more, treatments with a copper-oil spray per year.	Copper spray
	Fallen leaves and fruit must be removed from the grove floor	Chemical control of scale insects
	Inspection prior to fungicide spray applications. Fruit with any visible symptoms to be sent for laboratory analysis.	Pruning diseased shoots and remove leaf litter from orchard floor
	Survey for disease symptoms 20 days before harvest. Sampled fruit to be held for 20 days and examined for disease symptoms.	Remove any old fruit left on the tree and cull any symptomatic fruit.
	Blemished fruit culled during harvest.	Harvest prior to maturity
Post-harvest or packinghouse practices	Packing houses in the program will be used for export to the US only.	Cull symptomatic fruit
	Harvest fruit held at room temperature for 4-5 days in the packinghouse to check for development of citrus black spot symptoms.	SOPP or chlorine wash and mechanical brushing of fruit
Table 9 (continued)		
	Fruit dipped in the packinghouse to control fungal and bacterial growth.	Treat with TBZ
	Fruit inspected and culled again after treatment and before packing	Wax fruit
	Cold treatment required for fruit flies (oranges and grapefruit only, lemons are exempt)	Storage temperature requirements
Certifications	Identity and origin of fruit maintained throughout the process	Export groves must be registered with SENASA
	Export groves must be registered with SENASA	
	Certificate from SENASA that fruit originated in a canker-free area and that it is apparently free from citrus back spot	

* The 2007 PRA does not recommend any specific mitigation measures, this listing represents only those measures mentioned in the discussion of likelihood and consequences of introduction.

Although the 1997 PRA calculated likelihood estimates of pest establishment in the U.S. from import of citrus fruit from Argentina, with and without the systems approach policy in place, the specific method of calculation and resulting specificity in estimates were among the items challenges upheld in the 2001 court ruling. The ruling against APHIS had a major impact, not just on the lemon case, but on subsequent PRAs. Like regulatory agencies in many other countries, APHIS no longer reports specific probability estimates associated with risk. This partially reflects the difficulty of analysis and lack of scientific evidence associated with pest transmission and infestation. It also likely reflects some unease over being challenged on specificity of numerical results and the political controversy surrounding many sanitary and phytosanitary issues.

While this movement away from specificity in risk assessment remains consistent with the IPPC guidelines, it does limit common understanding and further assessment of regulatory policies. The difficulties were well summarized in a recent peer review of proposed regulation

> *The qualitative nature of the analysis is consistent with both national and international standards…my concern is not, then, directed so much at this specific analysis – which is consistent with common practice – so much as it is with that common practice. A qualitative rating can be very useful, but a vague rating limits that utility. Ratings…are vague in the sense that they are neither defined nor generally subject to a common understanding. Even an informed reader is challenged to differentiate the likelihoods of unlikely, highly unlikely, and extremely low events.*
>
> *One unintended consequence is that such a scale* (vague) *can be interpreted to mean whatever the reader intends it to mean."*
>
> (USDA APHIS, 2006b, p.21-22)

From an empirical modeling standpoint, the move towards undefined categorical reporting of risk estimates (as opposed to probability estimates) creates enormous difficulty within the proposed framework. Ranking risks from 1 (low) to 3 (high) implies some level of increase from one category to the next, but does not provide any information about magnitude of the increase. For example, does a factor move from low risk (1) to high risk (3) when the probability of infestation moves from .001 to .003 or from .001 to .999, or some level in-between? The categorical rankings become even less informative once values have been summed across categories. The final ranking of consequences for introduction and likelihood of introduction depends on the number of factors considered. A low risk rating is measured as 5 to 8 for consequences of introduction and 6 to 9 for likelihood of introduction. Therefore the assigned value "9" is rated as medium in the first case and low in the second case. Comparisons can only be made between pests within the same categories.

The 2007 PRA does include an assumption of commercial production practices, culling, cleaning, and waxing at the processing plant. Still it is not clear from the current report if the risk rankings are dependent on a (as yet undefined) systems approach being enacted. These are clearly very sensitive issues and will likely take some time to resolve themselves in the policy process.[25] Probability estimates to be used in the modeling framework cannot be reliably defined from existing information.

System Compliance Costs

---

[25]The avocado ban was originally enacted in 1914 and had begun moving toward resolution in 1993 when imports were permitted entry to Alaska under a systems approach. By November 2004 all seasonal restrictions were removed and by 2006 all geographic restrictions had been removed (Peterson and Orden, 2006).

If the model were to be estimated, costs of compliance with the defined systems approach must be included. Estimates are that orchard based compliance costs for the U.S. program in place during 2000/01 averaged $0.15 to $0.25 per 18 kg box in Argentina. Certification program costs were estimated to add an additional $0.13 to $0.15 per box (Illing, 2006). Total costs are therefore estimated as $0.30 to $0.40 per 18 kg box or approximately five percent of total production costs. This is slightly less than one-half of the $0.03 to $0.05 per pound cost of compliance estimated prior to implementation of the final rule (USDA APHIS 2000).

Cost of U.S. Control Measures and Pest Damage

Since even under control of a systems approach, the risk of invasive species invasion and establishment does not go to zero, the economic framework also requires estimates for potential spread and production loss in the importing country. Ideally any pest outbreak could be contained and its negative biological and economic impacts considered negligible. At the other extreme, it might be possible that once a pest has entered the country, no countermeasure is available or feasible and the pest risk could be catastrophic to domestic production. Therefore the efficacy of control measures should be included in an evaluation (Cook and Fraser, 2002; Knowler and Barbier, 2005).

In the framework proposed, specific information is needed on the potential for spread of identified pests if they were to be introduced to the U.S. (amount of production impacted by infestation), the cost of pest control, and proportion of crop destroyed if the pest was to become established. While there is normally scientific literature available on the lifecycle and habits of particular pests, specific information on potential for spread to previously uninfested areas and crops is not readily available unless it has been specifically gathered and vetted within the context of a PRA. The difficulties in finding and/or estimating such information is illustrated below for three diseases of concern identified in the lemon case (table 10).

Table 10. U.S. costs of pest control and productivity losses due to infestation from Citrus Canker, Citrus Black Spot, and Sweet Orange Scab

Description	Mean	Minimum	Maximum
Production loss from			
Citrus Canker	2.93	0.50	7.50
Citrus Black Spot		10	
Sweet Orange Scab			
Cost per acre of lemon pest control	$293.00	$196.00	$390.00
Average yield per acre (tons)			
2000/01	15.25	9.23	17.02
2001/02	12.17	7.18	13.64
2002/03	16.60	7.71	19.42
Percentage of total production affected by infestation			
Citrus Canker			75
Citrus Black Spot	55.7	14	82
Sweet Orange Scab	50		

Sources: USDA APHIS 2003; Groenewald, 2002; O'Connell et al, 2005; USDA APHIS, 1997

Of the three diseases selected, citrus canker has been the most documented due to the U.S. outbreaks. By 2006, when the U.S. canker eradication program was abandoned in the face of widespread outbreaks, the following data was reported for spread: 75 percent of commercial groves were within five miles of an infestation and it was considered they could no longer be prevented from further disease spread. Therefore 75 percent can be taken as an upper bound on the percentage of production affected.[26] Estimated impacts on quantity of other fruit supplied ranged from a decrease of 0.50 percent for fresh grapefruit to a decrease of 7.50 percent for tangerines and tangelos (U.S. Federal Register, 2006). While not specific to lemons, these values can be used to represent the minimum and maximum impacts on production loss from citrus canker.

Relatively less information is available for citrus black spot and sweet orange scab, diseases not present in the U.S. Part of the controversy surrounding the 1997 PRA was focused on estimates of spread for citrus black spot. Information from South Africa, where citrus black spot is present, indicates fruit loss up to ten percent in orchards even where disease control is present (Groenewald, 2002). Argentine field surveys used as one data source in the PRA showed annual infection rates varied from 14 to 82 percent. Calculations of incidence of infection were 55.7 for citrus black spot and 39.7 for sweet orange scab. Eventually APHIS used a 50 percent estimate for mean incidence of sweet orange scab infection given uncertainty associated with the risk ratings (USDA APHIS, 2000).

The estimated cost of pest control for lemons is taken from a University of California enterprise budget (O'Connell et al, 2005). While only representative values are reported there, it is possible to make some slight adjustments based on the amount of control included (insect and disease spray only; addition of weed control; with or without pest scouting and/or consulting services) to calculate a small range.

Scenarios

---

[26] It should be noted that the data reported is not for lemons specifically as there is very little commercial lemon production in Florida.

The Peterson/Orden model uses a CET production possibilities frontier to capture sales shifts between seasons as U.S. producers choose to market fruit or to hold it (on the tree in the avocado case) before harvesting in order to capture positive shifts in relative prices. Since the avocado systems approach imposes seasonal restrictions on imports, the “with” and “without” import scenarios generating such price shifts could reasonably be anticipated within a calendar year. In the lemons case, it is also possible to delay harvest (hold fruit on the tree) or store fruit up to 120 days without loss of quality. Now, however, there are no seasonal restrictions on imports and the “with” and “without” scenarios take place across seasons so the storage decision is not tied to the SA. Lemon imports were allowed from August 2000 to October 2001 and banned before and after that period. Therefore if the empirical model were to be estimated, scenario 1 could reasonably be defined as 2000/01 and scenario 2 as 2002/03.[27]

Geographic Areas

The modeling framework incorporates three distinct types of geographic areas: importing country, exporting country free of the pest or pathogen of concern, and exporting country not free of the pest or pathogen of concern. In the lemon case, the U.S. is the importing country, Argentina is the exporting country with the pest of concern, and Spain is the exporting country free from the pest of concern. Spain is currently exporting fresh lemons to the U.S. and supplied about 76,000 MT in 2001.

---

[27] The important comparison is welfare impacts with and without trade, therefore two distinct periods defined by time are not strictly necessary. The scenarios could be defined in the same period under autarky and under trade with the systems approach in place.

For commodities that are more widely produced and traded, the number of countries would need to be expanded although they could still be classified into these three broad categories. This will greatly increase the complexity of applying the model framework. Like the avocado case, lemon imports to the U.S. originate in relatively few countries and so representing trade from areas without the pest of concern can be reasonably represented with one country. Multiple potential exporters and/or an aggregated rest-of-the-world would necessitate explicit modeling of cross-shipping to capture supply diversions from policy change.

Demand Regions

Consumers in the importing country are assumed to view products from each region as slightly different, although substitutable for each other. Like the avocado case, domestic demand regions are defined based on differences in susceptibility to the pest(s). In the lemons case, demand regions are citrus producing states where citrus canker is present (Florida), citrus producing states where canker is not present (Arizona, California, Hawaii, Louisiana, Texas), and non-citrus producing states. To estimate demand for fresh lemons, data is required for per capita consumption and population by region (table 11).

Table 11. Consumption of fresh lemons by demand region

	Region A (CA, AZ, TX, LA, HA)	**Region B** (FL)	**Region C** (other states)
Population (average)			
2000-2001	66,321,515	16,199,726	201,129,459
2002-2003	68,365,073	16,835,614	204,216,714
Per capita consumption (lbs)			
2000-2001	2.7	2.7	2.7

2002-2003	3.3	3.3	3.3
Consumption (mill lbs)			
2000-2001	179.07	43.74	543.05
2002-2003	184.59	45.46	551.39

Source: USDA ERS 2004

Per-capita Income

Estimates of per capita income are included in the Peterson/Orden model since they are assumed to impact consumption in the different regions. In the lemons case, per capita income is available for non-citrus producing states and separately for Florida and the five citrus producing states where citrus canker is not present (table 12).

Table 12. Average per capita income in demand regions

	Region A (CA, AZ, TX, LA, HA)	**Region B** (FL)	**Region C** (other states)
2000-2001	$24,100	$25,214	$25,855
2002-2003	$26,045	$27,066	$28,024

Source: calculated based on data from Bureau of Economic Analysis, U.S. Department of Commerce

Supply Regions

Supply in the importing country reflects domestic production (given price, frequency of pest outbreaks, and costs of controlling an outbreak) and imports (given excess supply functions in exporting countries). Excess supply is a function of export price and cost of mandatory pest control measures (zero in countries where the pest is not present). In scenario 1 (2000/01) the U.S. supplied over 95 percent of fresh lemons available to the domestic market (table 13), with the share increasing slightly in the second period when no imports from Argentina were allowed.[28] The share from Spain was relatively consistent across all four years at approximately 2.2 percent. Other imports were supplied in smaller amounts from Mexico, Chile, and the Bahamas.

Table 13. Fresh lemon availability in the U.S.

	U.S. Production	**Imports from Spain**	**Imports from Argentina**	**Other Imports**	**Total**
	----------------------------------1000 MT----------------------------------				
2000	762.04	8.9366	7.3139	10.5446	788.8351
2001	913.53	7.5965	17.5522	10.7052	949.3839
2002	733.00	8.5960	0	10.1428	751.7388
2003	930.77	7.7399	0	10.9072	949.4171
2004	723.93	9.2557	0	10.0173	743.2030

Source: calculated based on USDA FATUS data for HS 10-digit imports, http://www.fas.usda.gov/ustrdscripts

Combining information on total per capita consumption in each demand region and the share of total supplies from each source region allows calculation of relative consumption by supply region (table 14). Again, no imports were permitted in 2002/03 from Argentina. In the earlier season, distribution of Argentine lemons was geographically restricted by the systems approach to region C.

---

[28] In the avocado case, imports from Mexico rose to account for a much larger share of U.S. consumption. If trade in lemons had continued, the share supplied from Argentina may have likewise increased over time.

Table 14. Fresh lemon consumption by U.S. geographic region

	Supply Region					
	2000/01			2002/03		
	U.S.	Argentina	Spain/other	U.S.	Argentina	Spain/other
	1000 MT					
Demand Region						
Region A (CA, AZ, TX, LA, HA)						
	175.121	0	3.949	180.533	0	4.057
Region B (FL)						
	42.775	0	0.965	44.461	0	0.999
Region C (other states)						
	523.477	7.769	11.804	539.272	0	12.118

Cost of Production

In 2006 the Argentine farm gate cost of production was estimated to be $2000/ha with a yield of 50 MT/ha, 35 percent of which was suitable for export (USDA FAS, 2006a). This converts to a FOB cost of $6.90 to $7.70 per 18 kg case ($0.18 per lb on average).

In 2005, the estimated farm gate cash cost of production for lemons in San Joaquin Valley, California was $8,905 per acre. Additional non-cash overhead costs were estimated as $1,201 per acre (O'Connell et al, 2005). Without consideration of the non-cash costs, this converts to a cost of $12.05/18 kg case ($0.30 per lb).

Prices

Monthly grower FOB prices are reported for Argentina between 2002 and 2006 and for the U.S. from 2000 to 2003. Comparing to the average FOB cost of production calculated above, the annual price in Argentina has been below cost of production for three of the five years where price data is reported (table 15). Relative variability of prices within the year ranged from 15 to 26 percent.

Table 15. Fresh Argentine lemon FOB prices

	2002	**2003**	**2004**	**2005**	**2006**
			$/pound		
January	0.21	-	0.14	0.14	0.16
February	0.18	-	0.27	0.22	0.25
March	0.16	0.16	0.19	0.19	0.19
April	0.15	0.20	0.19	0.19	0.17
May	0.15	0.18	0.19	0.19	0.17
June	0.15	0.17	0.18	0.19	0.17
July	0.15	0.17	0.19	0.18	0.17
August	0.15	0.18	0.18	0.18	0.17
September	0.14	0.18	0.17	0.17	0.18
October	0.15	0.19	0.15	0.17	
November	0.13	-	0.16	0.05	
December	0.11	0.08	0.16	0.13	
Average	**0.15**	**0.17**	**0.18**	**0.17**	**0.18**
COV	**0.16**	**0.21**	**0.18**	**0.26**	**0.15**

Source: USDA FAS, 2004; USDA FAS, 2005; USDA FAS, 2006b

Dashed lines indicate data not reported

A similar comparison for U.S. prices reveals that the average price was above reported cost of production in each of the four years reported (table 16). Month-to-month volatility is of similar magnitude, ranging between 16 and 23 percent. In 2002 and 2003 when prices were reported for both Argentina and the U.S., price for U.S. fruit ranged from $0.09 to $0.36 higher per pound.[29] An earlier estimate of price differentials predicted similar patterns. Based on annual price in Argentina, differentials were estimated to be $0.01 to $0.08 per pound after transport cost and compliance cost were added to the wholesale price of Argentine lemons (USDA APHIS, 2000).

Table 16. Fresh U.S. lemon FOB prices

	2000	**2001**	**2002**	**2003**
		$/pound		
January	0.40	0.26	0.36	0.31
February	0.34	0.26	0.34	0.25
March	0.35	0.28	0.33	0.25
April	0.31	0.35	0.36	0.34
May	0.30	0.37	0.40	0.39
June	0.40	0.40	0.46	0.42
July	0.48	0.47	0.47	0.42
August	0.49	0.52	0.51	0.41
September	0.40	0.47	0.50	0.37
October	0.32	0.49	0.47	0.33
November	0.27	0.43	0.41	0.32
December	0.26	0.39	0.34	0.30
Average	**0.36**	**0.39**	**0.41**	**0.34**
COV	**0.21**	**0.23**	**0.16**	**0.18**

Source: USDA NASS, various years

[29] The comparison is for FOB price only and so does not include transportation rates or other expenses incurred.

Wholesale prices are reported by USDA AMS on a weekly basis including specific information on point of sale (terminal market location) and source (country or state of origin). These values are reported for three markets in the U.S. as well as a national average price (table 17). When available, the price for lemons from Spain and Argentina is reported separately. Between August 2000 and December 2003, the average margin between the U.S. wholesale prices reported and the FOB prices reported in table 15 above was $0.15 per pound.

Table 17. Fresh lemon wholesale prices in specified U.S. markets by supplier

		All U.S.	Atlanta	Miami	San Francisco	Imports From Spain	Imports From Argentina
		--------------------------------$/pound-------------------------------					
2000	Aug	0.60	0.62	0.69	0.61	0.46	0.55
	Sep	0.56	0.59	0.65	0.54	0.58	0.91
	Oct	0.43	0.52	0.46	0.39	0.43	0.46
	Nov	0.41	0.45	0.41	0.36	0.30	0.41
	Dec	0.38	0.39	0.39	0.36	n/a	0.14
2001	Jan	0.38	0.40	0.41	0.32	n/a	0.14
	Feb	0.39	0.40	0.42	0.34	n/a	n/a
	Mar	0.39	0.39	0.43	0.35	n/a	n/a
	Apr	0.70	0.44	0.50	0.39	n/a	n/a
	May	0.76	0.51	0.52	0.35	n/a	n/a
	Jun	0.56	0.57	0.62	0.53	0.49	0.63
	Jul	0.60	0.65	0.63	0.57	0.68	0.62
	Aug	0.63	0.60	0.64	0.65	n/a	0.53
	Sep	0.60	0.57	0.60	0.64	0.51	0.51
	Oct	0.59	0.56	0.52	0.63	n/a	0.57
	Nov	0.56	0.57	0.49	0.55	n/a	n/a
	Dec	0.51	0.49	0.50	0.48	n/a	n/a
2002	Jan	0.52	0.54	0.51	0.47	0.27	n/a
	Feb	0.49	0.50	0.51	0.45	0.39	n/a
	Mar	0.48	0.49	0.49	0.43	0.42	n/a
	Apr	0.48	0.48	0.48	0.40	0.41	n/a
	Mau	0.53	0.50	0.55	0.50	0.40	n/a
	Jun	0.57	0.56	0.57	0.59	0.40	n/a
	Jul	0.64	0.66	0.68	0.53	0.45	n/a
	Aug	0.69	0.71	0.78	0.71	0.53	n/a
	Sep	0.66	0.60	0.79	0.68	0.49	n/a
	Oct	0.62	0.53	0.57	0.59	0.43	n/a

	Nov	0.55	0.52	0.49	0.54	0.51	n/a
	Dec	0.49	0.42	0.42	0.46	0.45	n/a
2003	Jan	0.44	0.39	0.46	0.40	0.36	n/a
	Feb	0.39	0.36	0.45	0.33	0.39	n/a
	Mar	0.37	0.35	0.43	0.32	0.40	n/a
	Apr	0.42	0.43	0.50	0.41	0.45	n/a
	Mau	0.50	0.49	0.58	0.47	0.51	n/a
	Jun	0.57	0.55	0.67	0.51	0.51	n/a
	Jul	0.61	0.62	0.62	0.55	0.49	n/a
	Aug	0.60	0.64	0.58	0.58	0.47	n/a
	Sep	0.52	0.55	0.57	0.47	0.37	n/a
	Oct	0.48	0.43	0.50	0.43	0.15	n/a
	Nov	0.48	0.43	0.46	0.47	n/a	n/a
	Dec	0.46	0.42	0.38	0.40	n/a	n/a

Source: calculated from USDA AMS (various years)

Elasticities

Like most specific horticultural products, there is little empirical evidence for fresh lemon elasticities. In 1999, a UC Davis report calculated the own-price elasticity for fresh lemons as -0.34 using producer prices (Green, 1999). In the 2000 final rule a demand elasticity of -0.44 and a supply elasticity of 0.09 were used. Assuming fixed marketing margins (parallel demand curves), the demand elasticity at wholesale prices may be obtained by multiplying the producer level elasticity by the ratio of wholesale to producer prices (Figure 1). The ratio of average wholesale and producer prices for lemons from 2000 to 2003 is 2.9, which when multiplied by the producer level demand elasticity of -0.34 gives a wholesale demand elasticity of -0.986 for fresh lemons.

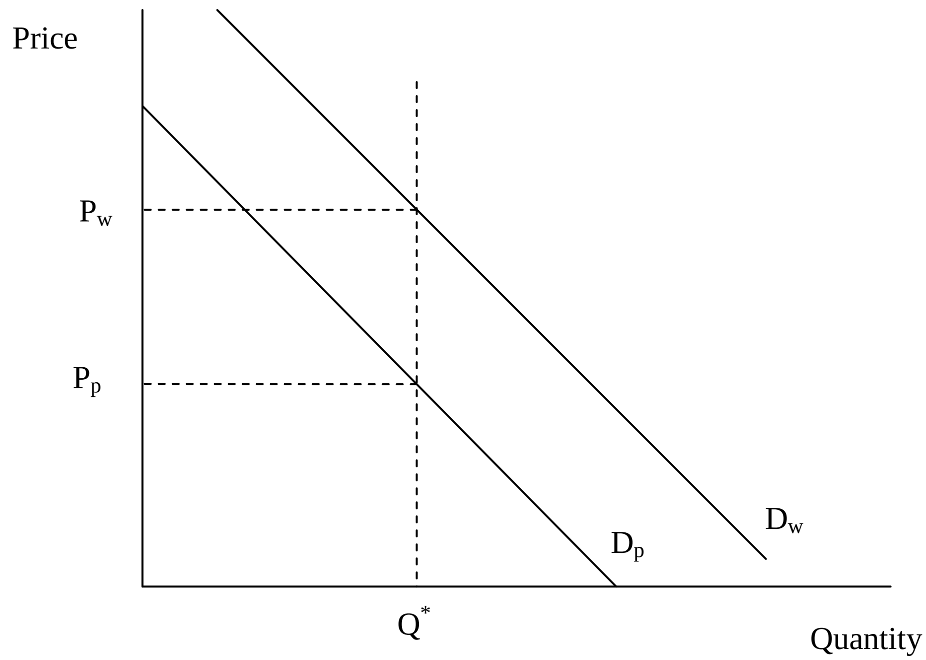

Figure 1. Relationship between Producer and Wholesale Demand with Fixed Marketing Margins

Source: Peterson (2007)

To solve the empirical model additional elasticity estimates are needed: elasticity of substitution between lemons and all other goods and between lemons from different supply regions. Assuming that the wholesale demand elasticity of -0.986 is the elasticity for domestically produced lemons it is possible to make an assumption about one of the elasticities of substitution and compute the remaining value such that the own-price elasticity is equal to -0.986.[30]

[30] This discussion is drawn from Peterson (2007).

In the elasticity form of the Slutsky decomposition ($\varepsilon_{ii} = s_i\left(\sigma_{ii} - \eta_i\right)$), ε_{ii} is the own-price elasticity of demand, s_i is the cost share for domestically produced lemons, σ_{ii} is the own-price Allen partial elasticity of substitution, and η_i is the income elasticity (which equals one for a CES utility function). For a two-level CES utility function:

$$\sigma_{ii} = -\left[\sigma_2\left(s_i^{-1} - s_A^{-1}\right) + \sigma_1\left(s_A^{-1} - 1\right)\right],$$

where s_A is the cost share for all lemons. Combining these two equations and setting η_i =1 yields:

$$\sigma_2 = \frac{-\left[\varepsilon_{ii}s_i^{-1} + \sigma_1\left(s_A^{-1} - 1\right) + 1\right]}{\left(s_i^{-1} - s_A^{-1}\right)},$$

where ε_{ii} would equal -0.986 and σ_1 would equal a pre-determined value less than one. If domestic lemons and imported lemons are substitutes, σ_1 will be less than σ_2. If σ_2 is less than σ_1 there is a complementary relationship between domestic and imported fresh lemons. Since there is overlap during the harvest seasons between competing regions and lemons harvest can easily be extended within a season, a substitute relationship is more likely.[31] Exact values of relative elasticities would be determined during the empirical calibration process.

Conclusions

Analysis of a systems approach policy is complex; the discussion above clearly documents challenges for both scientific and economic assessment. Systems approach policies

[31] Physiologically citrus fruit is non-climatic, therefore the fruit remains on the tree as it passes through the immature, mature, and over-mature stages of development and changes occur very slowly over a long period of time compared to other non-citrus fruits, such as peaches or apples (Jackson and Davies 1999).

are idiosyncratic by nature as they are predicated on unique climate and physical conditions that exist within each pair of trading countries as well as characteristics unique to each specific product. Implementation of the WTO regionalization criteria, while admirable from the standpoint of opening new areas to trade, has also increased pressure to evaluate multiple regions within a country, drawing ever-finer distinctions surrounding each policy under consideration.

The focus of this PRESIM project is incorporating economic analysis with systems approach risk assessment by formulating and testing an analytical tool that might be applied across regulations that adopt a systems approach to trade. Peterson and Orden developed a general framework for incorporating economic analysis of welfare with pest risk in an expectation-weighted partial equilibrium market analysis (Peterson and Orden, 2006; Peterson and Orden, 2008). The framework was applied to the case of fresh Hass avocado imports to the U.S. from Mexico, evaluating net welfare changes after trade was allowed under an approved systems approach and comparing welfare tradeoffs in scenarios when some, or all, of the steps in the systems approach were removed. While there are some similarities between the avocado and lemon cases, a number of critical differences currently limits empirical evaluation in this second example. Even without directly comparable quantitative results, assessment of the framework within context of the lemon case reveals important lessons learned with respect to economic analysis.

First, despite apparent similarities among systems approach policies, case-to-case differences remain substantial and limit feasibility of a prototype analytical tool. Like the avocado case used to initially develop the model, the lemon case involves a commodity that is limited in geographic production area, includes relatively few trading partners for the U.S., and involves geographic restrictions as part of the proposed systems approach. Unlike the avocado case, the lemon case involves more widely distributed U.S. production areas and a more fragmented domestic industry (particularly when the broader category of citrus is considered).

Second, on-going political and/or scientific debate over policy parameters significantly limits *a priori* analysis of impacts. Both the avocado and lemon cases involve policy adjustments towards freer trade; however, in the avocado example a policy had been established in advance of the empirical economic assessment. Not just political, but also scientific, issues continue to be debated in the lemon case. Scientific debate is likely to be more contentious and sustained in cases where the political stakes are greater, thus *a priori* economic evaluation is more restricted and/or uncertain in those cases where it might prove the most valuable. For example, the USDA APHIS quantitative risk assessment undertaken in 1997 was not substantiated by the 2000 California court ruling and has been abandoned by APHIS. Therefore probabilities estimated as part of the 1997 report would not be viewed as reliable input for further economic analysis unless they can be further validated in the scientific community. The most critical piece of missing information for empirical analysis of the lemon case is an established pest risk assessment providing input beyond categorical rankings.

Even if scientific consensus on current conditions had been reached, the dynamic nature of invasive species spread lends itself to continual updates and reassessment. The lemon case demonstrates just how rapidly and frequently conditions can change. The 1997 PRA was based on trade from a considered free of citrus canker (although not other pests of concern) to a country free from citrus canker. By 1995, a citrus canker outbreak had been detected in the United States (Florida) and an eradication program was underway. Only seven years later (2002) the previously canker-free export region (northwest Argentina) had also detected a citrus canker outbreak. By 2006 the U.S. had declared eradication of the disease infeasible in their own case and had moved to a domestic management strategy. In only eleven short years, a new policy under consideration (the 2007 PRA) was focused on trade from a region where citrus canker is present to a country where citrus canker is established within one production region.

Third, as with any assessment of sanitary and phytosanitary policies, economic analysis requires substantial data input. The empirical framework developed is data intensive and, as applied in the avocado case, relies heavily on the availability of industry specific data. In the avocado case, an intensive study undertaken by the California avocado industry provided secondary data that is not readily available for most specialty commodities. For example, assumptions about consumer response in the face of price shifts are central to the proposed framework but are very difficult to identify from secondary data, thus requiring a separate empirical estimation prior to application of the model. The political economy of the avocado case had been documented (as it developed) in a series of publications spanning more than ten years prior to the empirical model (see for example, Roberts and Orden, 1997). Critical political turning points in the lemon case are ongoing and negotiated consensus has yet to be achieved.

In addition to evaluation of the model framework, assessment of the lemon case highlights important transitions in the political reality of WTO SPS agreement applications. The Argentine lemon case has already substantiated some landmark changes in how regulatory agencies approach decisions regarding pest risk assessment and systems approach policies. The court ruling against APHIS had a major impact, not just on the lemon case, but on subsequent PRAs. Like regulatory agencies in many other countries, APHIS no longer reports specific probability estimates associated with risk. This partially reflects the difficulty of analysis and lack of scientific evidence associated with pest transmission and infestation. It also likely reflects unease over being challenged on specificity of quantitative results and the political controversy surrounding many sanitary and phytosanitary issues.

While movement away from specificity in risk assessment remains consistent with IPPC guidelines, it does limit common understanding and further assessment of regulatory policies. From an empirical modeling standpoint, the move towards loosely defined categorical reporting of risk estimates (as opposed to probability estimates) creates enormous difficulty within the proposed framework. Probability estimates critical to the modeling framework cannot be reliably defined from existing information provided by the most recent PRA. These are clearly very sensitive issues and will likely take some time to resolve themselves in the policy process.

The Argentine lemon case also reveals some important lessons regarding institutional uncertainty and phytosanitary policies. There is demonstrated need for developing countries seeking access to international markets to organize and establish strategies based on solid scientific evidence and enforcement programs. These efforts must be consistently applied over time to reduce distrust; however, the regulatory agency in the exporting country is not the sole place where such uncertainty may arise. The dynamics of the lemon case shifted attention to credibility of domestic, as well as foreign, institutions. While trust and confidence between APHIS and SENASA officials slowly increased over the last decade, the same cannot be said for the industries involved. If the non-independent steps of a systems approach are able to decrease uncertainty of pest risk assessment, these policies may be able to facilitate increased confidence in both exporter and domestic institutions over the long-run. Still, while confidence between regulatory agencies is important, it is not sufficient to compensate for public trust.

References

Berkeley University (2007). "The Arthropod Story," Understanding Evolution, http://evolution.berkeley.edu/evolibrary/article/_0_0/arthropods_02.

Blustein, P. and B. Byrnes (2004). "Producers Question Broader Implications of 'Lemongate,'" *The Washington Post*, September 10.

Bruzone, A. (no date). "Concentrated Lemon Juice: Analysis of the Alimentary Chain," National Food Administration SAGyP, Buenos Aires, Argentina, http://www.alimentosargentinos.gov.ar/0-3/revistas/r_29/Cadena_english/jugo_limon_english.htm.

CABBI and EPPO (1986). **"***Guignardia citricarpa*," Data Sheets on Quarantine Pests EU, http://www.eppo.org/QUARANTINE/fungi/Guignardia_citricarpa/GUIGCI_ds.pdf.

Chung, K.R. and L.W. Timmer (2005). "Citrus Diseases Exotic to Florida: Sweet Orange Scab (SOS)," Fact Sheet PP-224, Plant Pathology Department, Florida Cooperative Extension Service, IFAS, University of Florida, http://edis.ifas.ufl.edu/PP147.

Cook, D. and R.W. Fraser (2002). "Exploring the Regional Implications of Interstate Quarantine Policies In Western Australia," *Food Policy*, 27(2):143-157.

Committee on Agriculture [CoA] Congressional Delegation to Argentina and Chile (1997). "Summary of the Committee on Agriculture Trip to Argentina and Chile," January. http://agriculture.house.gov/105/argchile.htm.

Conner, C. (2006). Letter to Charles H. Bronson, Florida's Commissioner of Agriculture. http://www.doacs.state.fl.us/pdf/Canker%20-%20Bronson.pdf.

Costa, J. (2000). "Importation of Argentine Citrus," Bill Number: SJR 38. Adopted in Senate on August 31, http://info.sen.ca.gov/pub/99-00/bill/sen/sb_0001-0050/sjr_38_bill_20000920_chaptered.html.

Enright, C. (2006). Letter to Carlos Horacio Casamiquela, SENASA's vice-president, January 27.

Fawcett, H.S. and H.A. Lee (1926). *Citrus Diseases and their Control*. McGraw-Hill, N.Y., 1926.

Food and Agricultural Organization [FAO] (2004). Secretariat of the International Plant Protection Convention. "Pest Risk Analysis for Quarantine Pests, Including Analysis of Environmental Risks and Living Modified Organisms." ISPM No. 11, April 2004, https://www.ippc.int/servlet/CDSServlet?status=ND0xMzM5OS4zNDE2MyY2PWVuJjMzPXB1YmxpY2F0aW9ucyYzNz1pbmZv.

Global Invasive Species Database (2005). "*Xanthomonas axonopodis pv citri*." December 24. http://www.issg.org/database/species/ecology.asp?fr=1&si=219&sts=.

Gottwald, T.R. J. H. Graham, and T. S. Schubert (2002). "Citrus Canker: The Pathogen and Its Impact," *Plant Health Progress*, August/September, http://www.apsnet.org/online/feature/citruscanker.

Green, R.D. (1999). "Demand for California's Agricultural Commodities," Agricultural and Resource Economics Update, University of California Davis, 2(2): p.9. http://www.agecon.ucdavis.edu/extension/update/issues/winter99.pdf.

Grocery Manufacturers Association [GMA] (2000). Letter to Honorable Joe Skeen, August 25, http://www.gmabrands.com/publicpolicy/docs/correspondence.cfm?DocID=618.

Groenewald, S. (ed). (2002). "Diplomatic Forum Meets on Citrus Black Spot," *Agricultural News*, Department of Agriculture No. 14, July 29.

Harland Land Co. v. USDA (2001). Court Ruling. Eastern District Of California. Factual Background, http://www.thecre.com/pdf/Citrus_vs_usda.pdf.

Illing, F. (2006). AFINOA's manager, personal communication sent to the authors by e-mail on Monday, September 18.

Jackson, L.K. and F.S. Davies (1999). *Citrus Growing in Florida*, 4th Ed. University Press of Florida: Gainesville.

Knowler, D. and E. Barbier (2005). "Importing Exotic Plants and the Risk of Invasion: are Market-Based Instruments Adequate?" *Ecological Economics,* 52(3):341-354.

Magalhães, J. (2001). "Sanitary and Phytosanitary Issues and the SPS Agreement." China/FAO Citrus Symposium, Beijing, 14-17 May 2001, http://www.fao.org/DOCREP/003/X6732E/x6732e13.htm.

McLean, M. (2004). "The Impact of International Phytosanitary Requirements on the Lemon Industry in Tucuman," Report prepared for the World Bank, Annex IX, http://siteresources.worldbank.org/INTARGENTINAINSPANISH/Resources/Lemon_case_study_2.pdf.

Nader, A (1996). "Perfil de los Servicios Veterinarios en la República Argentina." II Conferencia Electrónica sobre servicios veterninarios. FAO, http://www.fao.org/WAICENT/FAOINFO/AGRICULT/AGA/AGAH/Vets-l-2/1spaArt.txt.

National Association of Wheat Growers [NAWG] (2000). "NAWG joins opposition to citrus limits," NAWG newsletter. http://www.smallgrains.org/dtnfiles/081100.htm.

O'Connell, N., C. Kallsen, M. Freeman, K.Klonsky, and R. DeMoura (2005). "Sample Costs to Establish an Orchard and Produce Lemons," University of California Cooperative Extension Report LM-VS-05, http://www.coststudies.ucdavis.edu/files/lemonvs2005.pdf.

OIE World Organization for Animal Health (2000). "Review of the consequence assessment section of the OIE Code Chapter on Risk Analysis." Third Meeting of the Working Group on Risk Analysis of the OIE Region for the Americas, Buenos Aires, Argentina, November 15-17, 2000, http://www.aphis.usda.gov/oieamericas/report3.pdf#search='forsythe%20and%20markov%20and%20aphis'.

Pasco, R. (2000). "Entry of Argentine Citrus Stirs Passion," The Agricultural Law Letter, XV(2). September-October, http://www.mwmlaw.com/sept-oct_2000.htm.

Peterson E. (2007). personal communication sent to the authors by e-mail on December 3.

Peterson, E.B. and D. Orden (2006). "Linking Risk and Economic Assessments in the Analysis of Plant Pest Regulations: The Case of U.S. Imports of Mexican Avocados," USDA ERS Contractor and Cooperator Report no. 25, Washington D.C., October.

Peterson, E.B. and D. Orden (2008). "Avocado Pests and Avocado Trade" *American Journal of Agricultural Economics*, Forthcoming.

Pimentel, D., R. Zuniga and D. Morrison (2005). "Update on the Environmental and Economic Costs Associated with Alien-Invasive Species in the United States." *Ecological Economics, 52(3)*:273-288.

Ramirez, A. (2004). "Sour Surprise for Officers who Raided Container Ship," *New York Times*, August 7.

Roberts, D. and D. Orden (1997). "Determinants of Technical Barriers to Trade: The Case of US Phytosanitary Restrictions on Mexican Avocados, 1972-1995," Ch.9 in Understanding Technical Barriers to Agricultural Trade. Eds: D. Orden and D. Roberts. St. Paul Minnesota: University of Minnesota, Department of Applied Economics, International Agricultural Trade Research Consortium.

Romano, E., and S. Thornsbury (2006). Institutional Uncertainty at Home and Away: The Case of Lemons from Argentina. *Choices.* 3rd Quarter 2006, 21(3):1-5.

Romano, E. and S. Thornsbury (2007). "Economic Evaluation of SPS Regulations: Where Can Progress by Made?" Department of Agricultural Economics Staff Paper 2007-07, Michigan State University.

Spreen, T. (2001). "Projections of World Production and Consumption of Citrus to 2010," Proceedings of the China/FAO Citrus Symposium, Beijing,14-17 May 2001, http://www.fao.org/DOCREP/003/X6732E/x6732e13.htm.

Thomas, M.C., J.B. Heppner, R.E. Woodruff, H.V. Weems, and G.J. Steck (2005). "Featured Creatures," Florida Department of Agriculture and Consumer Services, Originally published as DPI Entomology Circulars 4, 230 and 273. http://creatures.ifas.ufl.edu/fruit/Mediterranean_fruit_fly.htm.

Thornsbury, S. and E. Romano (2002). "Scientific Capacity and Institutional Adjustments for Standard Development," Free Trade of the Americas, the WTO, and New Farm Legislation, San Antonio, TX May 24, 2002.

Ulemberg, S.A. ed. (2007). "*Parlatoria ziziphi"* Arthropods of Economic Importance Visited on August 20, http://ip30.eti.uva.nl/bis/diaspididae.php?menuentry=soorten&id=161.

USDA AMS (various years). "Fruit and Vegetable Market News," Terminal Market Price Reports, http://marketnews.usda.gov/portal/fv?paf_dm=full&dr=1&paf_gear_id=1200002&repType=wiz&step2=true&run=Run&type=termPrice&locChoose=location&commodityclass=allcommodity.

USDA APHIS (1997). "Importation of Fresh Citrus Fruit (Sweet Orange, *Citrus sinensis*, Lemon, *C.limon*, and Grapefruit, *C. paradisi*) from Argentina into the Continental United States," Supplemental Plant Pest Risk Assessment, Washington D.C. September.

USDA APHIS (1998a). "Importation of Grapefruit, Lemons, and Oranges from Argentina. Proposed Rule." Federal Register, Vol. 63, No. 155, Washington D.C. August 12, 43117-43125, http://frwebgate.access.gpo.gov/cgi-bin/getpage.cgi?dbname=1998_register&position=all&page=43117.

USDA APHIS (1998b). "Proposed Rule for Importation of Grapefruit, Lemons, and Oranges from Argentina. Environmental Assessment," Washington D.C. November, http://www.aphis.usda.gov/ppd/es/pdf%20files/argentea.pdf.

USDA APHIS (2000). "Importation of Grapefruit, Lemons, and Oranges from Argentina. Final Rule." Federal Register, Vol. 65, No. 116, Washington D.C. June 15, 37608-37669, http://frwebgate.access.gpo.gov/cgi-bin/getpage.cgi?dbname=2000_register&position=all&page=37608.

USDA APHIS (2002). “The Role and Application of the Systems Approach.” A scientific review coordinated by The National Plant Board. Washington D.C. February, http://www.nationalplantboard.org/docs/sysapp.pdf.

USDA APHIS (2003). “Risk Assessment: *Guignardia citricarpa* (Citrus black spot),” Washington D.C. May 27, http://www.nappfast.org/casestudies_files/guignardia_citricapia.pdf.

USDA APHIS (2006a). “Evaluation of Asymptomatic Citrus Fruit (Citrus spp.) as a Pathway for the Introduction of Citrus Canker Disease (*Xanthomonas Axonopodis* PV.*citri*),” Washington D.C. March, http://www.aphis.usda.gov/peer_review/downloads/06-045-1_PRA_032006.pdf

USDA APHIS (2006b). “Peer Review Report for Evaluation of Asymptomatic Citrus Fruit (Citrus spp.) as a Pathway for the Introduction of Citrus Canker Disease (*Xanthomonas Axonopodis pv citri*),” Washington D.C. May 26, http://www.aphis.usda.gov/peer_review/downloads/Peer%20ReviewReportAsymptomatic083006.pdf.

USDA APHIS (2007a). “Movement of Commercially Packed Citrus Fruit

from Citrus Canker Disease Quarantine Area” APHIS-2007-0022-0003,Washington D.C. June, http://www.regulations.gov/fdmspublic/component/main.

USDA APHIS (2007b). “Comments on APHIS Risk Management Analysis” Peer review report for Movement of ‘Commercially Packed Citrus Fruit from Citrus Canker Disease Quarantine Area’ Washington D.C., July, http://www.regulations.gov/fdmspublic/component/main?main=DocketDetail&d=APHIS-2007-0022.

USDA APHIS (2007c). “Risk Assessment for the Importation of Fresh Lemon (*citrus limon* (L.) burm, F.) Fruit from Northwest Argentina into the Continental United States,” APHIS-2007-0112-0002, Washington D.C., August 6, http://www.regulations.gov/fdmspublic/component/main?main=DocketDetail&d=APHIS-2007-0112.

USDA ERS (2004). “Commodity Highlight: Lemon Production and Consumption,” Fruit and Tree Nuts Outlook, FTS-310, Washington D.C., May 26, http://www.ers.usda.gov/Briefing/FruitAndTreeNuts/fruitnutpdf/lemon.pdf.

USDA ERS (2007). “Background Information and Statistics: California’s Citrus Industry,” Washington D.C., January 19, http://www.ers.usda.gov/news/CAcitrus.htm.

USDA FAS (1997). "Argentine Lemon Production," Vol 5, Issue 1, December, reprinted at: http://ag.arizona.edu/aes/citrusnews/Economic%20aspect%20articles/Economic%201.htm#Argentine.

USDA FAS (2000). "Argentine Citrus Annual," GAIN report number AR0038, Washington D.C., June 6, http://www.fas.usda.gov/gainfiles/200006/25677812.pdf.

USDA FAS (2001). "Argentina Agrees to Expand U.S. Citrus and Stone Fruit Market Access", FASonline, March 23, http://www.fas.usda.gov/htp/News/News01/News0301/3-23-01.htm.

USDA FAS (2004). "Argentina Citrus Annual," GAIN report number AR3048, Washington D.C., January 12, http://www.fas.usda.gov/gainfiles/200401/146105159.pdf.

USDA FAS (2005). "Argentina Citrus Annual," GAIN report number AR5034, Washington D.C., November 1, http://www.fas.usda.gov/gainfiles/200511/146131424.pdf.

USDA FAS (2006a). "Argentina Citrus Semi-Annual," GAIN report number AR6017, Washington D.C., May 15, http://www.fas.usda.gov/gainfiles/200605/146187739.pdf.

USDA FAS (2006b). "Argentina Citrus Annual," GAIN report number AR6039, Washington D.C., December 6, http://www.fas.usda.gov/gainfiles/200612/146249711.pdf.

USDA NASS (various years). "Annual Price Summary," Agriculture and Statistics Board, http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1031.

U.S. Federal Register (2006). "Citrus Canker; Quarantine of the State of Florida," Docket No. APHIS–2006–0114, http://frwebgate.access.gpo.gov/cgi-bin/getpage.cgi?dbname=2006_register&position=all&page=43345.

Vo, T. (2004). Supervisory Economist, USDA Animal Plant Health Inspection Service, Washington D.C. Personal communication.

Wager-Page, S., J.M. Van Dersal, S. Robertson, Y. Demarino, and R. Gaskalla (2003). "Trip Report," Site Review of Northwest Region (NOA) Proposed for Citrus Exports from Argentina. March 9-14.

Weems, H.V. Jr. (2002). "Featured Creatures," Florida Department of Agriculture and Consumer Services Division of Plant Industry. Originally published as DPI Entomology Circular 217, http://creatures.ifas.ufl.edu/fruit/tropical/south_american_fruit_fly.htm.

World Bank [WB] (2006). “Argentina Agriculture and Rural Development: Selected Issues,” Report no. 32763-AR, July 31.

Zansler, M., T. Spreen, and R. Muraro (2005). “Florida’s Citrus Canker Eradication Program (CCEP) Summary of Annual Costs and Benefits,” University of Florida EDIS report FE532, March, http://edis.ifas.ufl.edu/FE532.

Appendix I: Quarantine Pests Likely to Follow the Pathway[32]

Anastrepha fraterculus (Insecta: Diptera: Tephritidae)

This species was described in the genus Dacus by Weiderman in 1830 based on samples collected in Brazil. The common name is South American fruit fly but they can be found from Argentina up to southern Texas, though there are differences between the flies from different countries (Weems, 2002). This species attacks a very large variety of plants and has an extensive distribution. This species can be found in different hosts like chirimolla, citrus, Ceylon gooseberry, loquat, mangoes, zopotas, guava, rose apple, tropical almonds and some wine grapes. In South America, it is the most important specie of the *anastrepas*. Anastrepha *fraterculus* is a very complex species that has not yet been completely studied (Berkeley University, 2007)

Tephriitis mellea Walker
Trypeta unicolor Loew
Trypeta fraterculus (Wiedemann)
Dacus fraterculus Wiedemann
Anthomyia frutalis Weyenbergh
Anastrepha soluta Bezzi (as *fraterculus* var.)
Anastrepha peruviana Townsend
Anastrepha brasiliensis Greene
Anastrepha pseudofraterculus Capoor
Anastrepha costarukmanii Capoor
Anastrepha scholae Capoor
Acrotoxa fraterculus (Wiedemann)

Ceratitis capitata: (Insecta: Diptera: Tephritidae)

The common name is Mediterranean fruit fly and it is one of the most destructive pests. It originated in sub-Saharan Africa. Occurences of infestation by the Mediterranean fruit fly in the

[32] As identified in USDA APHIS, 2007c

United States include: 1910 in Hawaii, 1929-1930, 1956-1957, 1962-1963, 1981-1998 in Florida; 1966 in Texas and 1975 and after 1980 in California. The pest has never become established in the United States. This species has a large distribution around the world, tolerates different kinds of climates, and is hosted in a wide range of fruits and vegetables.[33] This specie attacks various species of plants in different regions including more than 260 different fruits, vegetables, flowers and nuts. The Medfly prefers ripe succulent and juicy fruits. Cucurbits are not good hosts for Medfly (Thomas et al, 2005).

Medfly is a citrus pest but is more serious in deciduous trees like apples and pears. The eggs are laid in the fruit and the larvae feed from the fruit pulp that becomes a juicy inedible mass. In the Mediterranean region, only early citrus varieties are grown due to the rapid fly infestation, and common practice is to harvest before full fruit maturity for fly infested fruits. This species spreads rapidly and easily. The Medfly has the synonyms:

Ceratitis citriperda MacLeay
Ceratitis hispanica De Brême
Paradalaspis asparagi Bezzi
Tephritis capitata Wiedemann
Ceratitis capitata (Wiedemann)

[33] Countries with medfly infestations include Albania, Algeria, Angola, Argentina, Australia, Austria, Azores, Balearic Islands, Belgium, Bolivia, Botswana, Brazil, Burkina Faso, Burundi, Cameroon, Canary Islands, Cape Verde Islands, Colombia, Costa Rica, Crete, Cyprus, Dahomey, Ecuador, Egypt, El Salvador, Ethiopia, France, Germany, Ghana, Greece, Guatemala, Guinea, Honduras, Hungary, Israel, Italy, Ivory Coast, Jordan, Kenya, Lebanon, Liberia, Libya, Madagascar, Madeira Islands, Malagasy Republic, Malawi, Mali, Malta, Mauritius, Mexico (chronic) (near Guatemalan border), Morocco, Mozambique, Netherlands, Nicaragua, Niger, Nigeria, Panama, Paraguay, Peru, Portugal, Reunion, Rhodesia, Rwanda, Saint Helena, San Miguel (Azores), Sardinia, Saudi Arabia, Senegal, Seychelles, Sicily, Sierra Leone, South Africa, Southern Rhodesia, Spain, Sudan, Switzerland, Syria, Tanzania, Tasmania, Togo, Tunisia, Turkey, Uganda, Uruguay, Venezuela, Yugoslavia, Zaire, and Zambia.

Parlatoria Cinereae (Tropical gray chaff scale or chaff scale or tropical chaff scale)

Parlatoria cinerea is a tropical species that attacks hosts in 14 plant families, but its prefered hosts are *Citrus* spp. It affects plant leaves, fruit, roots, and stems and can cause yield and quality reductions.

Parlatoria ziziphi

The common name is black paralatoria. It probably originated in Southern China and therefore is mostly found in the tropics with some extension into the temperate regions (Ulemberg, 2007). Black parlatoria is mostly hosted by five plant families: *Citrus* spp.,*Codiaeum, Cymbidium, Damnacanthus, Ligustrum, Murrayapaniculata, Poncirus, Severinia buxifolia* and *zizphus.* They attack the vegetative, growing, flowering, fruiting and post-harvest stages, and they attack all the aerial parts of the plant (especially the upper part of the leaves). Black parlatoria can be diagnosed by observing black subrectangle scales on shoots, leaves and fruit, especially on the upper leaf surface. Foliage and fruit will have discolorations, yellow streaking and spotting due to saliva toxicity.

Xanthomonas axonopodis* pv *citri

Citrus canker is a highly contagious bacterial disease that causes leaf loss, premature fruit drop, and lesions on leaves, stems, and fruit. It is endemic in some major citrus-producing regions of the world (i.e., Brazil) but generally considered manageable for fruit that will be further-processed. The main impact of canker on production is damage to the exterior appearance of the fruit which can have a potentially devastating impact on fresh fruit markets.

In the United States, citrus canker was first introduced in 1912 and identified as a new disease in 1913 (Fawcett and Lee, 1926). The disease is more prevalent in tropical and subtropical climates and thus Florida has been a particularly susceptible region of the U.S. Still there is the potential for establishment in temperate and arid regions under conditions of highly susceptible hosts, lack of control measures, and frequent irrigation (USDA APHIS, 1997). Lemons (*c. limon*) are considered to be moderately (Fawcett and Lee, 1926; USDA APHIS, 1997) to highly (Gottwald et al, 2002) susceptible to citrus canker.

This specie is a bacterium that affects citrus trees in areas with high temperatures, high rainfall and strong winds. It spreads by translocation of infected fruits and seedlings and with the help of the Asian citrus leaf miner which spreads the bacteria through wind and rain fall. Fruits and leaves of infected plants will show brown raised lesions with oily, water-soaked yellow rings. When lesions are old, leaves will fall, creating a shot-hole effect on the plant. In the microscope, tiny rods can be observed in leave sectionals. Hosts for this specie are all type of citrus and will only be present in regions with high temperatures and high levels of rainfall. *X. axonopodis pv.citri* has a large geographical range and can be found in Asia, Japan, Middle East, Africa, and South and North America.

If unchecked, the bacterium damages the tree and slows fruit production until the tree is killed. (Global Invasive Species Database 2007). Management practices include planting resistant varieties, local or regional removal of infected trees, windbreaks, pruning and removal of debris from the orchard, and a copper spray program.

Elsinoë australis

Sweet orange scab (SOS) is a fungal pathogen that forms lesions on leaves, twigs, and fruit. The pathogen overwinters in the tree canopy on limbs and any remaining fruit infected from the previous year. It can be found in tangerine and tangerine hybrids, grapefruits, sweet oranges and lemons. Lemons are rated as highly susceptible. The pathogen requires a warm humid climate to become established and can be found in Europe, United States, Argentina, Bolivia, Brazil, Ecuador, Paraguay and Uruguay. SOS has asexual spores that increase the chances of reproduction. The spores do not infect leaves, only fruit and therefore the damage is only at the skin level and attacks are only on young fruit (more susceptible between 6 to 8 weeks after flower petal fall). SOS does not damage the internal fruit. The symptoms are tan to gray wart-like and cork-like pustules which reduce fresh market value (Chung and Timmer, 2005). The disease is spread by wind and rain splash.

Guignardia citricarpa

This pest from the fungi family has several common names including black spot, hard spot, shot-hole, freckle spot, virulent spot, and speckled blotch of citrus. *Guignardia citricarpa* Kiely has two synonyms: *Phoma citricarpa* McAlpine and *Phyllostictina citricarpa* (McAlpine) Petrak and an asexual reproductive system. The fungus is mostly hosted by citrus species (*C. limonia*, *C. nobilis*, *C. poonensis*, *C. tankan)*, grapefruits (*C. paradisi*), lemons (*C. limon*), limes (*C. aurantifolia*), mandarins (*C. reticulata*), oranges (*C. sinensis*) excepting sour orange which is not susceptible. Lemons are viewed as highly susceptible. Other hosts have been reported like almonds, avocados, eucalyptus, guavas, mangoes, passion fruit, cardamom, sugarcane and some ornamental plants like camellias, magnolias and holly.

This fungus has a broad geographical distribution. It originated in southeast Asia and spread to Australia, South Africa and China. The first lesions appear as circular brown dots with slight depressions that will grow into crater-shaped lesions, gray in the center and black in the rim (CABBI and EPPO 1986). Spores can be spread short distances by air or rain if mature and/or diseased fruit is left on the tree. Evidence is the disease could overwinter successfully in the U.S. and is likely to be spread through human activity (USDA APHIS, 2003).

Appendix II. USDA APHIS

In the U.S., the Animal and Plant Health Inspection Service (APHIS) is the government agency in charge of protecting the country against the entry of exotic pests while maintaining its goal of maximizing the economic benefits of trade. Figure 2 depicts a broadly defined schematic for consideration of a policy change to allow product entry from the perspective of the U.S. regulatory agency. APHIS has a legal mandate to protect U.S. agriculture and natural resources including prevention of invasive species infestation. The decision-making process starts with a request for regulatory change by a candidate exporter (top of Figure 2). Regulatory agencies in the exporting country will normally submit their own Pest Risk Assessment [PRA] to support the application for policy change under consideration. For APHIS, the PRA presented by its foreign counterpart conveys two sources of uncertainty. On one hand, there is uncertainty related to the biology of the invasive species in their new environment (biological uncertainty). On the other hand, there is uncertainty linked to the scientific capability of the candidate exporter and the level of trust and confidence achieved by inter-agency relationships (regulatory uncertainty) (Thornsbury and Romano, 2002).

APHIS' initial assessment addresses what, if anything, has changed to warrant consideration of a policy adjustment. After initial consideration, there are two possible immediate outcomes for the request. APHIS may reject the importer's petition for further consideration and keep the ban in place. Another possibility is for APHIS to consider product entry under a safety protocol. The continued process to implement this second alternative (the one relevant to this paper) is shown in detail in Figure 2. At this stage it is customary for APHIS officials to evaluate foreign PRA results against the scientific literature. Once the process of identification is complete, APHIS undertakes its own PRA.

In principle, three distinct targets of invasion risk are investigated as part of the PRA: the risk to domestic production, the risk to natural ecosystems (environment), and the risk to public health. The risk to domestic production (e.g., the risk exotic pests may pose to domestic food) is the most common source of dispute among interest groups, and hence often the analytical focus. Many of these risks are complex in nature and therefore difficult to evaluate by economists. Exotic pests may pose a risk to one or more domestic products and enter the importing country through multiple pathways, each with different biological and market conditions. Some negative consequences from phytosanitary problems are realized not in biological destruction of the host, but in damage to the quality of product available for sale. Figure 2 also acknowledges the possibility that the pest infestation may have an impact not only on supply, but also on demand. For instance, labeling and other additional information may create demand shifts attributable to SPS regulation that should be included in an assessment.

Although less frequently debated in public, the other two sources of risk (environment and public health) should not be dismissed. As directed by the U.S. National Environmental Policy Act (42 USC, 4321-4347) the risk that exotic pests may impose to the environment is never overlooked by APHIS. In some cases the environmental concern alone has motivated the enactment of regulations to stop the entry of foreign commodities. The potential risk invasive species may pose to human health may also be critical. In general, only extreme, controversial cases such as those involving arsenic in Chilean grapes or the Mad Cow disease controversies have explicitly included public health risk in economic analyses.

Figure 1 shows three factors with direct impact on the risk and uncertainty of pest invasion: spatial dispersion, mechanism of spread, and control methods. A critical consideration should be the spatial distribution of both the host target(s) and existing invasive species. Among the common policy measures applied to reduce this source of risk is the imposition of designated ports of entry for the exporter, and regional restrictions on where imports can be shipped once they enter the country. The efficacy of these restrictions is moderated in part by mechanisms of dispersion the invasive species may adopt. Invasive species with greater capacity for movement and dispersion pose a higher risk to domestic products against which more stringent policy restrictions may be enacted. The availability and efficacy of control mechanisms once a pest outbreak has occurred may also influence the design and adoption of the SPS regulation. Ideally, any pest outbreak would able to be contained and its negative biological and economic impact would be considered negligible. It could be argued that, under such ideal conditions, there would be no need for any SPS measure at all, since the cost of enacting and enforcing such regulations would be greater than the efficient and inexpensive measures of control. On the other hand, it might be possible that once a pest is established, no countermeasure is available or feasible. For these cases pest risk would be catastrophic to domestic production. In reality, most cases tend to fall between these extremes, allowing for measures of both pre- and post-infestation control to be implemented.

After taking into account all sources of risk and uncertainty (biological and regulatory uncertainty), APHIS will draft a PRA. It is usually here where economists enter the regulatory process. Figure 2 lists important attributes used by economists in their evaluation of SPS regulations: market conditions for the domestic crops under consideration and the legal framework associated with the pest risk. These factors do not have a direct influence on reducing either biological risk or uncertainty; however, they are crucial to economic analysis and risk management.

The outcome of the economic evaluations, together with comments received by biologists and interest parties on the proposed draft, should help produce a revised, improved PRA. A final PRA is published and a risk management scheme is set in place.

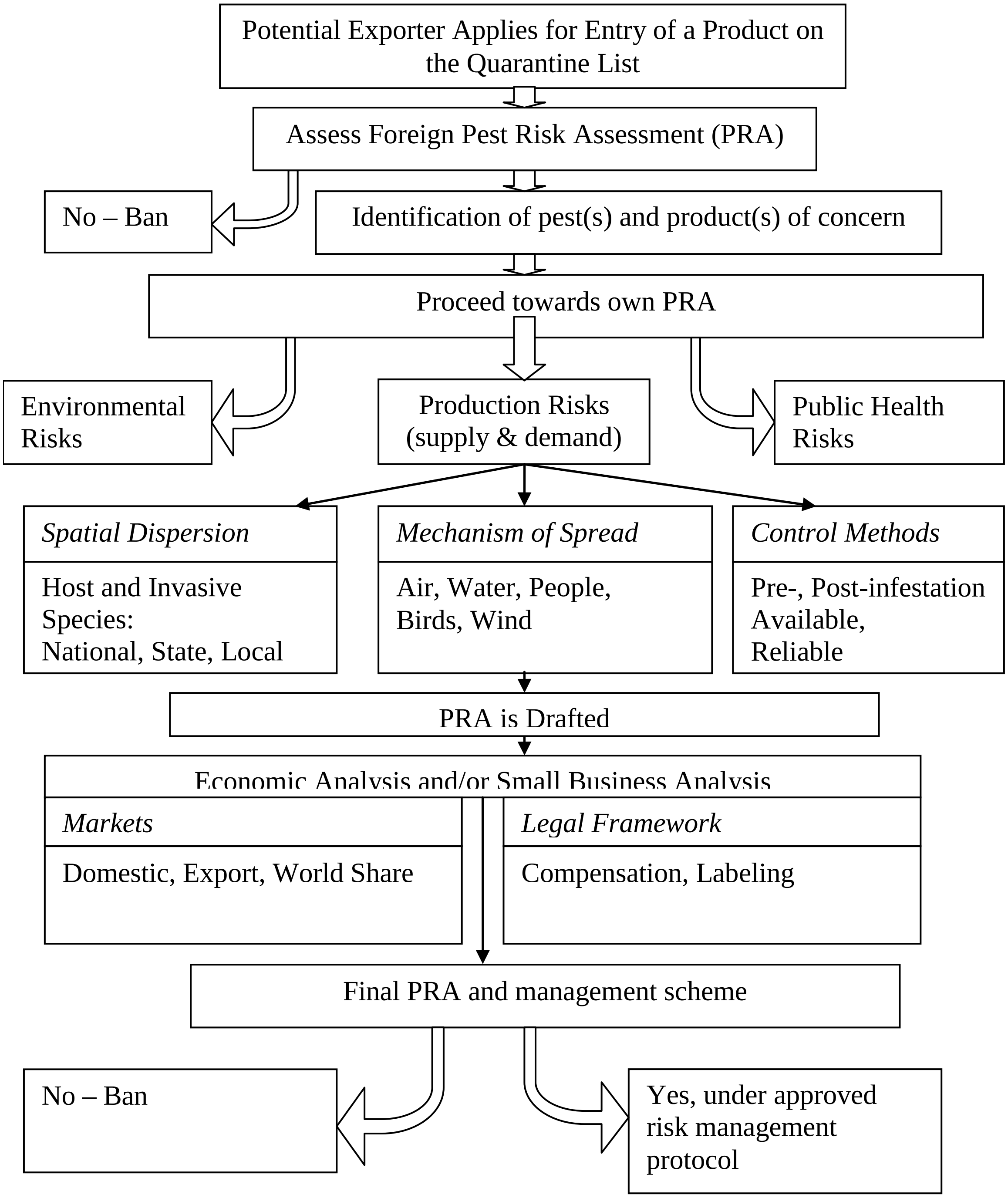
Potential Exporter Applies for Entry of a Product on the Quarantine List
Assess Foreign Pest Risk Assessment (PRA)
No – Ban
Identification of pest(s) and product(s) of concern
Proceed towards own PRA
Environmental Risks
Production Risks (supply & demand)
Public Health Risks
Spatial Dispersion
Host and Invasive Species: National, State, Local
Mechanism of Spread
Air, Water, People, Birds, Wind
Control Methods
Pre-, Post-infestation Available, Reliable
PRA is Drafted
Economic Analysis and/or Small Business Analysis
Markets
Domestic, Export, World Share
Legal Framework
Compensation, Labeling
Final PRA and management scheme
No – Ban
Yes, under approved risk management protocol

Figure 2. Schematic for Consideration of an Invasive Species Policy Change

Source: Romano and Thornsbury, 2007

Appendix III. Argentine SPS Institutions and Regulatory Process

The enactment of most SPS regulations in Argentina is a responsibility of the *Servicio Nacional de Sanidad y Calidad Agroalimentaria* (National Agro- and Food-Aimed Health and Quality Service or SENASA). SENASA is an agency dependent on the *Secretaría de Agricultura, Ganadería, Pesca y Alimentación* (Agriculture, Livestock, Fishery, and Food Secretariat or SAGYP); which also depends on the Ministry of Economy and Public Services. Two sub-agencies within the Secretariat, the *Dirección de Cuarentena Vegetal* or DCV (Plant Quarantine) and the *Dirección de Cuarentena Animal* or DCA (Animal Quarantine) are directly responsible for the enactment of SPS regulations. The roles of SENASA, DCV, and DCA are broadly paralleled in the U.S. to that of the Animal and Plant Health and Inspection Service (APHIS), and within APHIS, the Plant Protection and Quarantine (PPQ), and Veterinary Services (VS). Besides DCV and DCA, there are about 10 other sub-agencies within SENASA. Some of these agencies focus on issues other than SPS, such as legal issues (i.e., *Dirección Nacional de Coordinación Técnica, Legal, y Administrativa*), or food quality (i.e., *Dirección Nacional de Fiscalización Agroalimentaria*). Thus, differently from APHIS, SENASA is also charged with monitoring food quality in Argentina**.**

Border control of plant and animal imports is also a responsibility of SENASA. The *Dirección de Fronteras y Barreras Sanitarias* (Border and Sanitary Barriers Directorate, or DFBS) is the sub-agency in charge of this issue. The remaining SENASA sub-agencies have been charged with roles that to some extent overlap with those imposed to DCV, DCA, and DFBS. For instance, the *Dirección de Sanidad Vegetal, Dirección Nacional de Sanidad Animal,* and the *Dirección de Vigilancia y Monitoreo* (Plant Health Directorate, Animal Health Directorate, and Monitoring Directorate) are structures parallel to DGV, DGA, and DFSB with apparently similar roles. Such an organizational overlapping could have been the result of the 1997 restructure of SENASA. Before 1997, there were two SPS-related agencies in Argentina: the *Servicio Nacional de Sanidad Animal* or SENASA, which was responsible for animal health issues, and the *Instituto Argentino de Sanidad y Calidad Vegetal* (IASCAV) which was in charge of plant health protection since the early 1990s, when phytosanitary and quality control issues previously dispersed in several official organizations such as the former *Junta Nacional de Granos* were collapsed into IASCAV. The Presidential Executive Order (*Decreto Oficial*) 1.585/96. published in the Boletín Oficial (the Argentinean Federal Register) on January 10, 1997, merges both agencies into SENASA. It is interesting to notice that the new agency kept the acronym SENASA, which was the same one originally applied to the animal health protection agency. In other words, although the new agency was baptized with a new name, this new name was designed to keep the acronym by which the animal health agency was formerly known. Such a naming is quite revealing in the sense it exemplifies the relatively larger political power that the animal industry enjoys in Argentina.

SENASA's resources are quite limited, in particular when compared against that of APHIS. In 1999, there were a total 2,615 permanent and 915 temporary employees in SENASA. Approximately 30% were college graduates (veterinary and agriculture) including primarily veterinarians, agricultural engineers, and biologists. This relatively large presence of livestock experts in SENASA is not surprising given the traditional political power this group has enjoyed in Argentina.

SENASA's budget for the year 1995 was about $88 million. This figure represented about 37% of SAGYP's budget for that year. The Argentinean government was responsible for 26% ($23m) of SENASA's budget. The remaining 74% was earned by SENASA as fees for services the agency provided to the public and private sector (Nader, 1996). The limited participation by the government in SENASA's budget was a novelty to Argentinean bureaucracy, since before the '90s Federal agencies were almost exclusively federally funded. SENASA's budget increased 9-14 percent annually between 1992 and 1995 due to the agency's efforts to eradicate several trade-restrictive diseases from Argentina, particularly foot and mouth disease (Nader, 1996). Further, despite SAGYP's reduced budget for 1996, SENASA's budget received a $60 million increase due to renewed concerns about the success of the foot and mouth campaign.