Demonstrating the Benefits of Phytosanitary Regulations: The Case of ISPM 15

Eckehard Brockerhoff, James Turner, et al. (Scion / New Zealand Forest Research Institute)
Acknowledgements

- James Turner, Juliann Aukema, Kerry Britton, Joe Cavey, Lynn Garrett, Bob Haack, Mark Kimberley, Sandy Liebhold, Frank Lowenstein, Carissa Marassas, Amelia Nuding, Lars Olson, Christa Speekmann, Mike Springborn, Christina Vieglais

- UC-Santa Barbara, National Center for Ecological Analysis and Synthesis

- The Nature Conservancy

- New Zealand Foundation for Research, Science and Technology (FRST)

- MAF/BNZ (Carolyn Whyte, Alan Flynn) and USDA-APHIS for access to data
Structure / objectives of the Study

• Working Group 1
  – Temporal trends, economic impact of invaders
  – Predictive model of future impacts

• Working Group 2 (this presentation)
  – Benefits and costs of phytosanitary policy
  – ISPM 15 as a case study (retrospective analysis)

International Standards for Phytosanitary Measures, No. 15:
  “Guidelines for Regulating Wood Packaging Material in International Trade”
  – Implemented in July 2006
Wood packaging and borer invasions

ca. 21 pallets per container (average)

- 22 million containers per year into US (Richenbach et al., Jabara et al. 2008)
- 600,000 containers per year into NZ
- 1/3 to 1/2 of containers with WPM
Emerald ash borer in N. Am. (2002 - )

*Agrilus planipennis* (Buprestidae)

Photos: www.forestryimages.org; www.emerl dashboarder.info
ISPM 15: Heat treatment, fumigation

Heat treatment (HT)

56°C, 30 minutes, c. $2 per pallet (Jabara et al. 2008)

Wood packaging material should be heated in accordance with a specific time-temperature schedule that achieves a minimum wood core temperature of 56°C for a minimum of 30 minutes.
An ‘analytic framework’
- Why do we need one?

• To verify effectiveness of policy regulating pathways
• Assess benefits relative to costs
• Provide guidance to ensure efficiency in future efforts
  – “Plants for planting” (under development)
  – Domestic ISPM 15 type policy
  – etc.
Outline

• Background √

• Analytic framework:
  Policy effects on…
  1. Pest arrival rate
  2. Establishment rate
  3. Trade volume / value
  4. Costs (of policy) vs. benefits (averted pest costs)
  5. Preliminary conclusions (work in progress)
Economic theory, supply & demand model

E.g., cost of avocados

\( p(\tau_{hi}) \)
\( p(\tau) \)

Domestic production

Imports

Supply

\( \text{Gains from trade (with policy)} \)
\( \text{Gains from trade} \)

Demand

Imported good

\( \text{Damages given policy stringency } \tau \)

\( \text{Damages given policy stringency } \tau_{hi} \)

Pests established
The analytic framework

Phytosanitary policy (ISPM 15)

- Reduced approach rate (# of propagules per unit trade)
- Reduced volume of trade

Change in transport costs → Changes in production & consumption → Lost gains from trade

Lost gains from trade

- Reduced total number of pests arriving
- Reduced number of establishments

Benefits

- Reduced forest and urban tree damage
- Reduced eradication and management costs

Costs

Net benefits

$P$ establishment

Impacts (trees & forests)
1. Policy effects on arrivals

Phytosanitary policy (ISPM 15)

- Change in transport costs
  - Changes in production & consumption
  - Lost gains from trade

Costs

Net benefits

Benefits

- Reduced approaches rate (# of propagules per unit trade)
- Reduced volume of trade
- Reduced number of establishments
  - Reduced total number of pests arriving

Impacts (trees & forests)

- Reduced forest and urban tree damage
- Reduced eradication and adaptation expenditures

Net benefits
Changes in approach rate? (border)

• Treatments are effective in lab! Also at the border?
• Before–after ISPM 15 (July 2006) comparison of borer interceptions (USDA-APHIS) …

• AQIM data
  – Statistically robust, negatives recorded
  – 33 borer type records / 29945 entries.
  – 99% statistical power if ISPM effectiveness is >70%.
  – Approach rate, Pre- vs. Post-ISPM (arrivals per shipment)

• Pest ID / Most NZ interception data
  – Not random, no negatives recorded, confounding variables
  – Large number of observations.
  – Preliminary results show significant ISPM effect.

• Data from other countries (e.g., survey results)
2. Effects on establishment rate

Phytosanitary policy (ISPM 15)

- Change in transport costs
  - Reduced number of establishments
    - Reduced volume of trade
      - Reduced approach rate (# of propagules per unit trade)
  - Changes in production & consumption
  - Lost gains from trade

- Reduced total number of pests arriving
- Reduced forest and urban tree damage
- Reduced eradication and adaptation expenditures

Net benefits

Costs

Phytosanitary policy (ISPM 15) impacts (trees & forests)
Dose-response model development:
True bark beetle interceptions (105 spp.) and establishments world-wide (more data)

Response: Probability of Establishment
Dose: Relative interception rate (proxy for arrival rate)

Data from Brockerhoff et al. (2006) Canadian J. Forest Research 36
Remaining steps for dose-response analysis

• Use more sophisticated Weibull function, capable of reflecting Allee effect (Leung et al. 2004, Ecology)
• Consider size of invader species pool.
• Overall policy effect across entire species pool.
3. Policy effects on trade

Phytosanitary policy (ISPM 15)

- Change in transport costs
- Reduced approach rate (# of propagules per unit trade)

Changes in production & consumption

- Lost gains from trade
- Impacts (trees & forests)
  - Reduced forest and urban tree damage
  - Reduced eradication and adaptation expenditures

Net benefits

Benefits

Costs

- Reduced total number of pests arriving
- Reduced number of establishments
- Reduced volume of trade
Lost gains from trade
Estimating lost gains from trade

• Trade impacts of ISPM 15
  – More expensive imports
  – Changing trade partners and commodities

• Global Trade Analysis Project
  – Multiple commodities using WPM
  – Bilateral trade

• Scenarios
  – Current ISPM 15
  – Higher heat treatment
  – US domestic trade?

• New pest pathways?
4. Costs vs. benefits

Phytosanitary policy (ISPM 15)

- Reduced approach rate (# of propagules per unit trade)
- Reduced volume of trade

Change in transport costs

- Reduced number of establishments
- Reduced total number of pests arriving

Changes in production & consumption

- Lost gains from trade

Lost gains from trade

- Reduced total number of pests arriving
- Reduced number of establishments
- Reduced volume of trade

Impact (trees & forests)

- Reduced forest and urban tree damage
- Reduced eradication and adaptation expenditures

Net benefits

- Costs

Benefits
Putting it all together: Cost-Benefit Analysis

- Benefits = averted damages and response costs
  - Reduced approach rates
    - reduced expected establishments
      - expect $X of avoided damage and eradication and adaptation costs.

- Costs based on lost gains from trade
  - Some trade is eliminated
  - Remaining trade is more expensive, reducing the surplus generated
Conclusions

• Proof of ISPM 15 effects at the border more difficult than expected.
• Surprising lack of suitable interception data pre-ISPM 15 (for assessment of policy).
• Final results still useful for assessing policy effects and economics.
• Implications for other policy – ‘P4P’.
• Extension: Theoretical economics paper, several other papers on pathways, establishment rates, mitigation, etc.
Expected Timeline

• Completion of analyses in 2010 and preparation of papers for publication.

• E-mails for comments or suggestions:
  Ecki Brockerhoff – Eckehard.Brockerhoff@scionresearch.com
  James Turner (Economist) – James.Turner@scionresearch.com
  Bob Haack – rhaack@fs.fed.us
  Frank Lowenstein – flowenstein@tnc.org
  Joe Cavey – Joseph.F.Cavey@aphis.usda.gov
  Kerry Britton – kbritton01@fs.fed.us
Improved model with Allee effect capability

Weibull function in invasions: Leung et al. 2004, Ecology 85

\[ E = 1 - q^{n_c} \]
Some Notable Insect & Disease Introductions

Pre 1900: gypsy moth, beech scale, larch casebearer, white pine blister rust

0 50 100 150 200 250 300
Cumulative Alien Insect Detections

Year
1880 1900 1920 1940 1960 1980 2000 2020

butternut canker
Dutch elm disease
hemlock woolly adelgid
red pine scale
dogwood anthracnose
Sirex wood wasp
Asian longhorned beetle
emerald ash borer
sudden oak death
balsam woolly adelgid

Pre 1900: gypsy moth, beech scale, larch casebearer, white pine blister rust
Economic impacts are random variables

- Pest sp. frequency
- Probability density
- \( f_{\text{low}} \)
- \( f_{\text{poster}} \)
- Low-impact pests (most spp.)
- “Poster” pests (few, EAB, ALB)
- Economic impact ($)
Changes in Establishment

The dose-response curve of biological invasions
(Lockwood et al. 2005)

(e.g. # of accepted infested shipments)