Assessing the Economic Consequences of Removing Quarantine Restrictions under Uncertainty: the case of Australian bananas

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1. Introduction

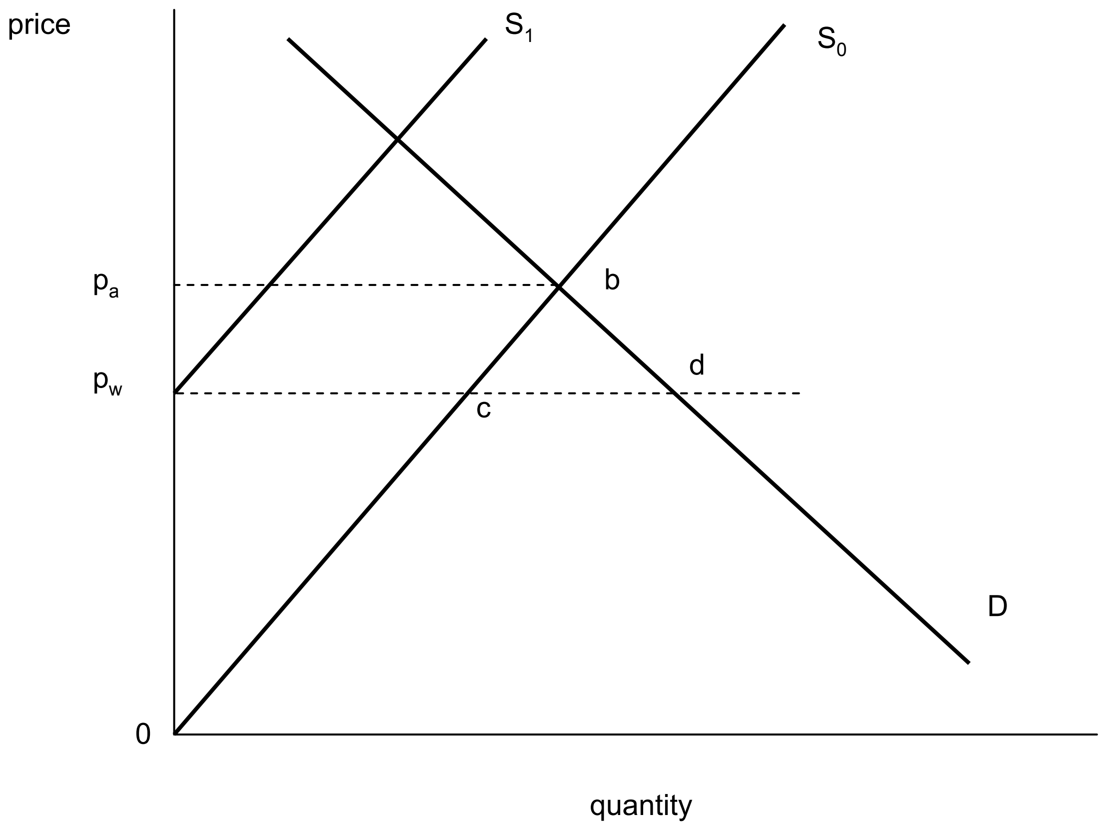
In the absence of quarantine restrictions on imports, the prices of bananas in Australia would hardly be affected by the current shortfall in domestic production

Should these restrictions be made less trade-restrictive to the benefit of domestic consumers, to the benefit of foreign suppliers and to the possible long-term detriment of domestic producers?

The SPS Agreement in the WTO allows economic considerations to play a role in this decision on the production side

What is the optimal decision when both costs to producers as well as benefits to consumers are taken into account?

2. Results from Previous Studies



2. Results from Previous Studies

James and Anderson found, using data for 1996, that lifting the import ban on bananas would increase CS by more than it would reduce PS, implying that a lifting of the ban would be beneficial nationally

Javelosa, J. and A. Schmitz, using data for 2002, extended the previous analysis and came to the same conclusion

Three weaknesses with the approach

- lacking time
- lacking uncertainty and
- lacking irreversibility of the effects of the decision

[James, S. and K. Anderson (1998) 'On the need for more economic assessment of quarantine/SPS policies', *Australian Journal of Agricultural and Resource Economics* 42: 425-444

Javelosa, J. and A. Schmitz (2006) 'Costs and Benefits of a WTO Dispute: Philippine Bananas and the Australian Market', *The Estey Centre Journal of International Law and Trade Policy* 7(1):58-83]

3. Introducing Time, Uncertainty and Irreversibility

Consider the following 'now-or-never' decision at time $t = 0$

Lifting the ban on imports will:

- increase consumer surplus for all $t \geq 0$
- decrease producer surplus at $t = 0$
- decrease producer surplus to zero for $t \geq 1$, if exotics are imported with probability π and the supply function shifts upwards to S_1 for ever

The decision rule is: lift the ban if E[NPV] >0, where

$$E[NPV] = \Delta CS - \Delta PS + \{\sum_{t=1}^{\infty} \Delta CS/(1+r)^t$$

$$-(1-\pi)\sum_{t=1}^{\infty} \Delta PS/(1+r)^t - \pi \sum_{t=1}^{\infty} PS/(1+r)^t\}$$

In the J & A and J & S approach, only $\Delta CS - \Delta PS$ is calculated

3. Introducing Time, Uncertainty and Irreversibility

Suppose now that the authority can wait for one period before making a decision.

Then:

- at time $t = 0$, changes in consumer and producer surplus are zero
- at time $t = 1$, there is an immediate gain in CS and loss in PS
- at time $t = 2$, there may be damage from imported exotics or there may not be
- between time periods 0 and 1, there is some learning which allows π to be reduced from its value at $t = 0$ to π_1

$$E[NPV] = \sum_{t=1}^{\infty} \Delta CS/(1+r)^t - \Delta PS/(1+r)$$

$$-(1-\pi_1)\sum_{t=2}^{\infty} \Delta PS/(1+r)^t - \pi_1 \sum_{t=2}^{\infty} PS/(1+r)^t \}$$

3. Introducing Time, Uncertainty and Irreversibility

Using these expressions, together with the following data (adapted from J & S),

$$\Delta CS = \$97.5m, \quad \Delta PS = -\$78.4m,$$

$$r = 0.05, \quad \pi = 0.20, \quad \pi_1 = 0.15$$

gives

E[NPV] now-or-never = $64.1m

E[NPV] wait = $141.5m

Conclusion:

- don't lift the import ban immediately
- the real option value of waiting is $77.4m

Using the static approach, $\Delta CS - \Delta PS = \$19.1\text{m} \Rightarrow$ lift ban

4. A Stochastic Economic Model in Continuous Time

Allowing for

- Multiple (infinite number of) periods
- Stochastic producer losses

- When is it optimal to irreversibly lift trade barriers?
- Effects of likelihood of an invasion on the optimal decision?
- How about the extent of and damage from an invasion?
- Is stricter import screening the solution?

4. A Stochastic Economic Model in Continuous Time

Use real option theory to develop an optimal stopping problem in continuous time (Dixit and Pindyck 1994);

- Optimal decision rule takes into account:
  - Learning about invasion risks and how to manage the risk cost-effectively
  - Variation in future producer losses, based on variation in costs of dealing with the risk: this gives rise to uncertainty
  - Risk of importing pests and pathogens with large scale effects on domestic banana production and producer surplus
  - Flexibility of timing of decision
- Focus is on economics: the decision rule is formulated in terms of optimal producer loss threshold.

Objective Function

$$F(C) = \max E\left[e^{-\rho T}\left(B\text{-}C_T\right)\right],$$

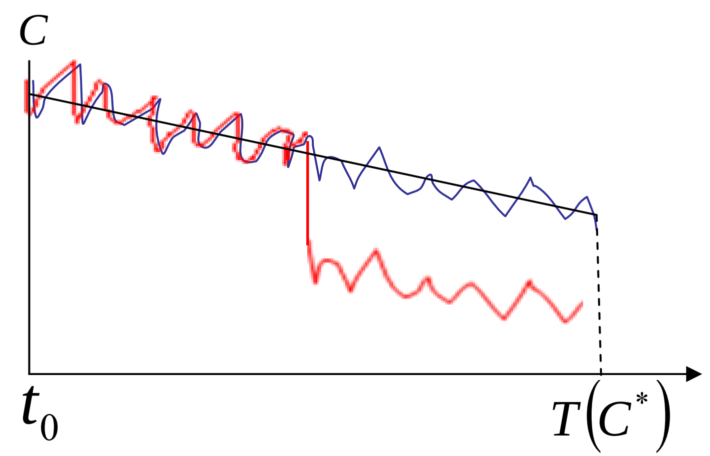
where $dC = -(\alpha+\lambda)Cdt + \sigma Cdz - Cdq,$

and $dz \sim N(0, dt),$

and $dq = 0$ with probability $1-\lambda dt,$
$dq = \phi$ with probability $\lambda dt.$

Mean: $\frac{E(dC)}{C} = -(\alpha + (1+\phi)\lambda)dt$

Variance: $Var[dC] = \sigma^2 C^2 dt + \lambda\sigma^2 C^2 dt$



Decision Rule

The optimal decision rule involves choosing between:

A) Lifting the trade ban immediately: $C_0 \leq C^*$

B) Maintaining the status quo: $C_0 > C^*$

Solution

The payoff from refraining from lifting the trade ban is:

$$\rho F dt = E\left[dF\right]$$

We apply Ito's Lemma to get

$$0 = -\left(\rho + \lambda\right) F\left(C\right) + \lambda F\left[\left(1-\phi\right)C\right] - \left(\alpha + \lambda\right) C F_C + 0.5\sigma^2 C F_{CC}$$

for which the general analytical solution is:

$$F\left(C\right) = A_1 C^{\beta_1} + A_2 C^{\beta_2}$$

The βs are the positive and negative square root of:

$$0 = -\left(\rho + \lambda\right) + \lambda\left(1-\phi\right)^{\beta} - \alpha\beta + 0.5\sigma^2 \beta\left(\beta - 1\right)$$

Decision Rule

The decision of whether or not it is optimal to lift the trade ban immediately is modelled on the following rule:

$$C^* = \frac{\beta_2}{\beta_2 - 1} B, \quad \text{where} \quad \frac{\beta_2}{\beta_2 - 1} < 1.$$

- This decision rule confirms the result from the two-period model that the there is a value to waiting which implies that we should not lift bans when B = C but rather be more prudent in the face of ecological risk and uncertainty

- The term $\frac{\beta_2}{\beta_2 - 1}$ is a 'wedge of prudence', where the size of the wedge depends on α, σ, λ and φ.

Policy Implications: 2 Scenarios

The Policy implications are shown using the two scenarios put forward by Javelosa and Schmitz (2006)

Scenario 1: No import screening.
Wholesale import price is $0.86/kg.
Gain in consumer surplus of $175m.

Scenario 2: Extensive import screening.
Wholesale import price is $1.10/kg.
Gain in consumer surplus of $39m.

Critical Producer Loss Threshold - Scenario 1

C* in $m for no import screening, B = $175m, $\alpha = 0.02$, $\sigma = 0.1$, $\rho = 0.06$.

	$\lambda = 0.00$	$\lambda = 0.01$	$\lambda = 0.10$	$\lambda = 0.25$
$\varphi = 0.25$	112	100	48	25
$\varphi = 0.50$		94	40	20
$\varphi = 0.75$		83	30	14
$\varphi = 0.99$		47	14	7

J & S estimate C = $70m*, $60m† and $38m# depending on supply elasticity assumptions

J & S recommend the immediate lifting of the import ban.

*†# based on elasticities of supply of 0.5, 1, >3.57 respectively

Critical Producer Loss Threshold - Scenario 2

C* in $m for import screening, B = $39m, $\alpha = 0.02$, $\sigma = 0.1$, $\rho = 0.06$.

	$\lambda = 0.00$	$\lambda = 0.01$	$\lambda = 0.05$	$\lambda = 0.10$
$\varphi = 0.25$	25	22	15	11
$\varphi = 0.50$		21	13	9
$\varphi = 0.75$		18	10	7
$\varphi = 0.99$		11	5	3

J & S estimates of C = $18m*, $17m† and $9m# for Scenario 2.

J & S recommend the immediate lifting of the import ban.

*†# based on elasticities of supply of 0.5, 1, >3.57 respectively

4. Conclusions (1)

The economic analysis of quarantine decisions involves time, uncertainty and (partial) irreversibility

The importance of these elements has been illustrated in a discrete time model

We developed a decision rule for the optimal lifting of trade barriers using a continuous time framework, where producer losses exhibit

- trend characteristics,
- instantaneous variation and
- are subject to discrete shocks.

4. Conclusions (2)

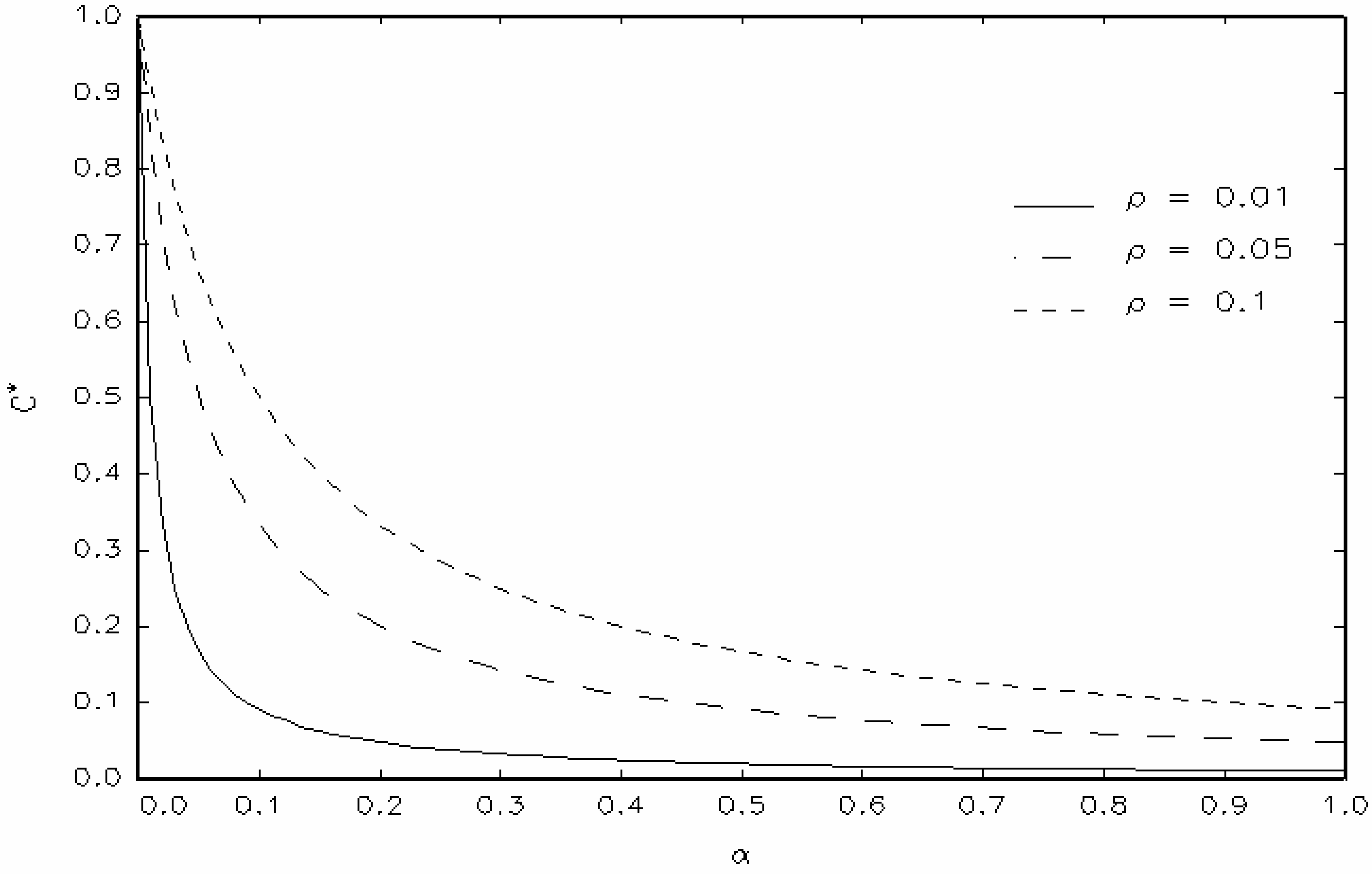
Applying that framework to the case of Australian imports of bananas, it has been found that:

- The recommendation in previous studies of lifting the import ban immediately cannot be supported unconditionally.
- Allowing for the risk of importing invasive pests and pathogens it is economically optimal to delay the decision on lifting import restrictions for a wide range of circumstances.
- The optimal policy response depends amongst other parameters on the likelihood of an invasion event and its extent.

Thank you!

Sensitivity Analysis on the Decision Rule

Deterministic Case (σ,λ = 0): various α and ρ;



Sensitivity Analysis on the Decision Rule

Diffusion Case (λ = 0): various α and σ, ρ = 0.06;