



Australian Government
Australian Bureau of Agricultural and
Resource Economics and Sciences



**The use of an integrated model of pest spread
and commodity markets to estimate the cost of
pest outbreak**

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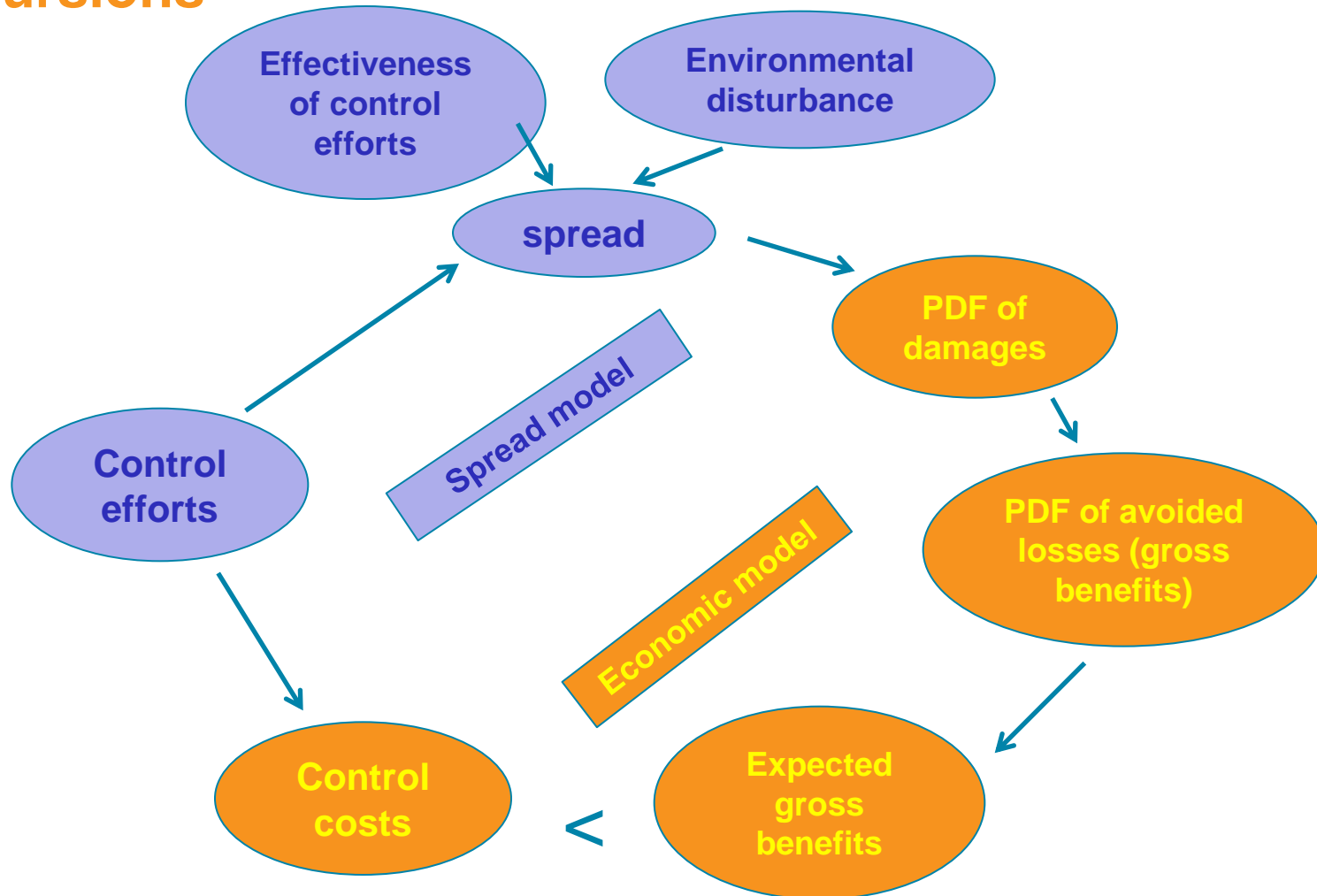


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Outline

- Modeling to underpin B/C analysis
- Pest spread process leading to the simple model used
- Partial equilibrium model of commodity markets
- Control strategies simulated
- How the model is applied
- Illustrative results with most likely values of spread rates
- Illustrative results of Monte Carlo simulations
 - frequency distribution of area spread
 - frequency distribution of gross benefits
- Cost of control strategies are not estimated

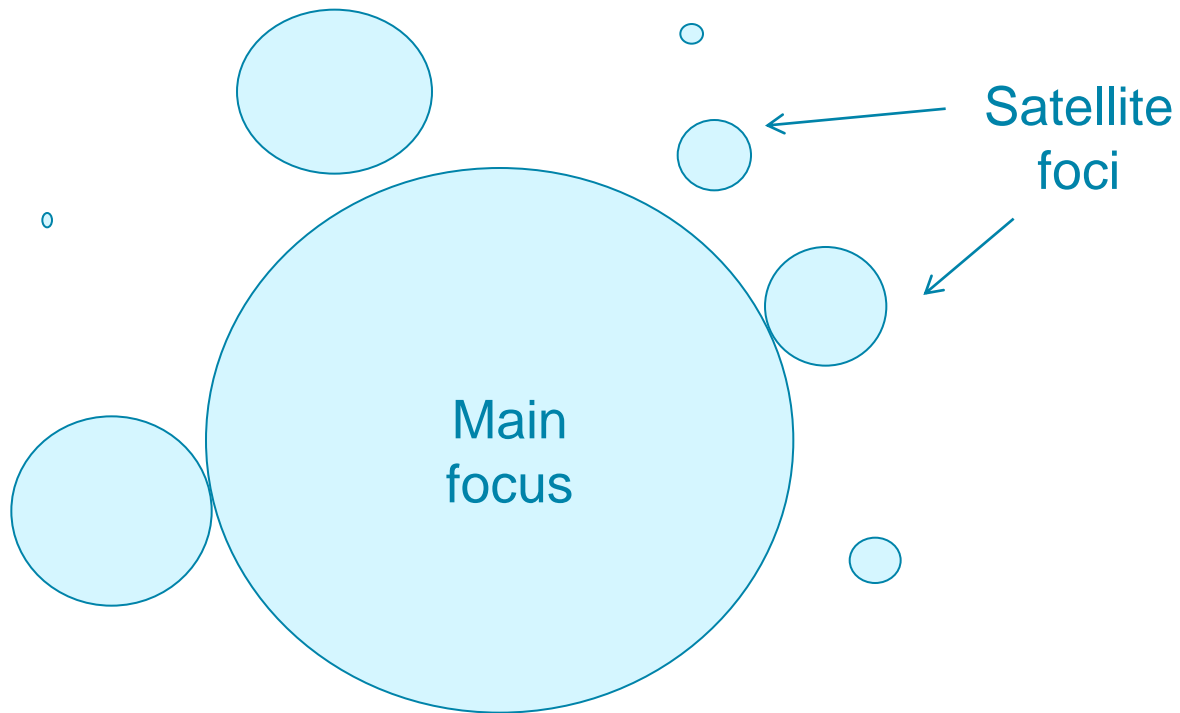
Modeling to underpin B/C analysis on potential pest incursions



Pest spread process

- A few individual invade first
- Individuals disperse while multiplying their numbers
- Random diffusion and local growth
- Spread over space and time
- An aggregate (non spatial) spread model
- We are interested in spread over time
- A set of logistic equations
 - One large main focus
 - Large number of smaller satellite foci

Spatial pattern of range expansion



Logistic equations

$$a_{ft+1} = a_{ft} + \varepsilon_f \left(1 - \frac{a_{ft}}{K_f} \right) a_{ft} - c_f$$

$$N_t = N_{\max} \left[1 + \frac{N_{\max} - N_{\min}}{N_{\min}} e^{-\gamma A_{t-1}} \right]^{-1}$$

$$A_{t-1} = a_{f=\text{main},t} + N_t a_{st}$$

Partial equilibrium module of commodity markets

- Producers supply both domestic and export markets
- Consumer demand domestically produced and imported products of the same good
 - they are imperfect substitute (Armington goods)
 - the rate of substitution depends on the elasticity of substitution assumed
 - preferred specification in most GE models used for trade analysis
- Domestic price is solved for by equating
 - supply = demand for domestically sourced product + exports
 - note: import doesn't enter in this supply - demand balance; and
 - imports are not residual
- Export market responds to domestic price
- Domestic demand responds to domestic and import share weighted price
- Import price is fixed for simplicity
- Exactly calibrated to base year levels of market variables
- Response in market variables depend on the elasticities assumed
 - Domestic demand elasticity, Export demand elasticity, Elasticity of substitution between imported and domestic products and Supply elasticity

Control actions

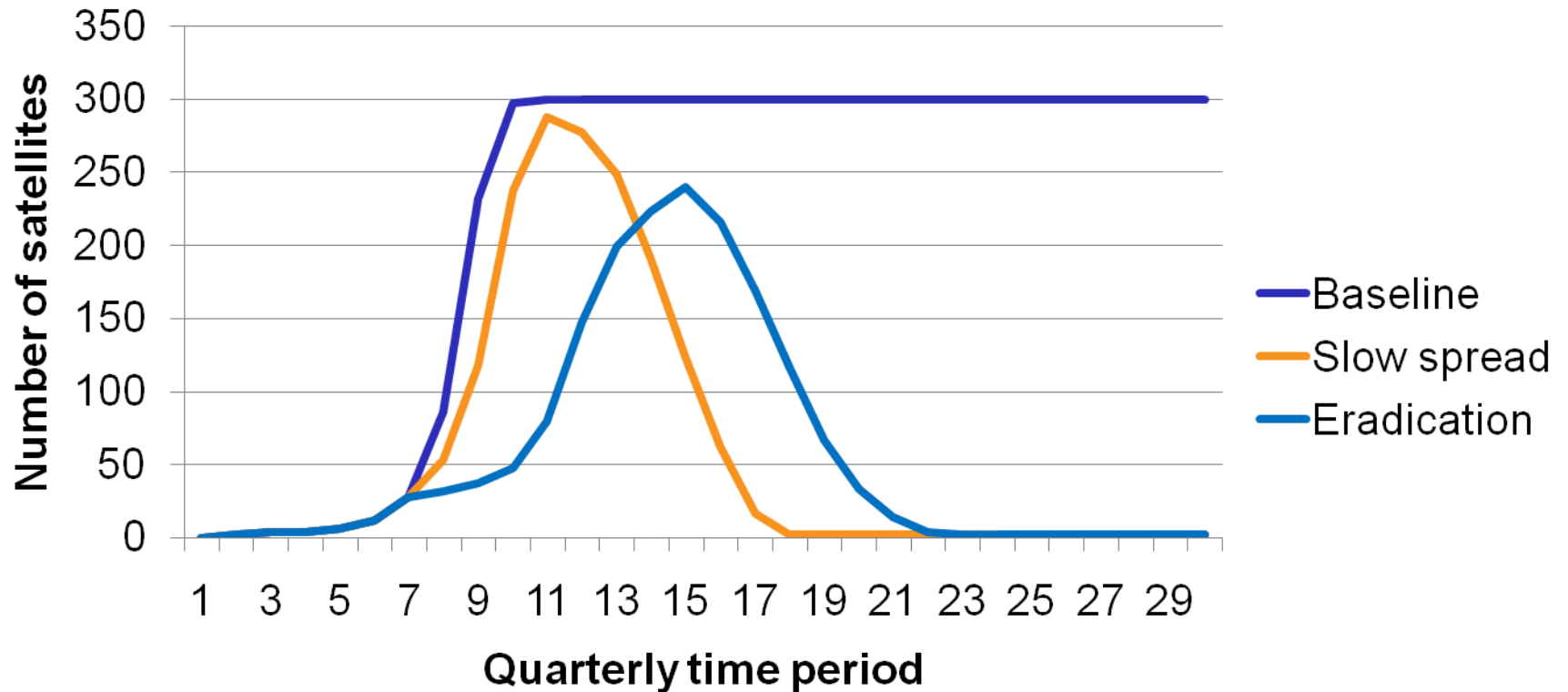
- Baseline 'do nothing'
- Eradication - remove
 - 1200 km²/y from the main focus
 - 25 % satellite each year from t=5
- Containment -remove
 - 600 km²/y from the main focus
 - 25 % satellite each year from t=5

Application of the integrated model

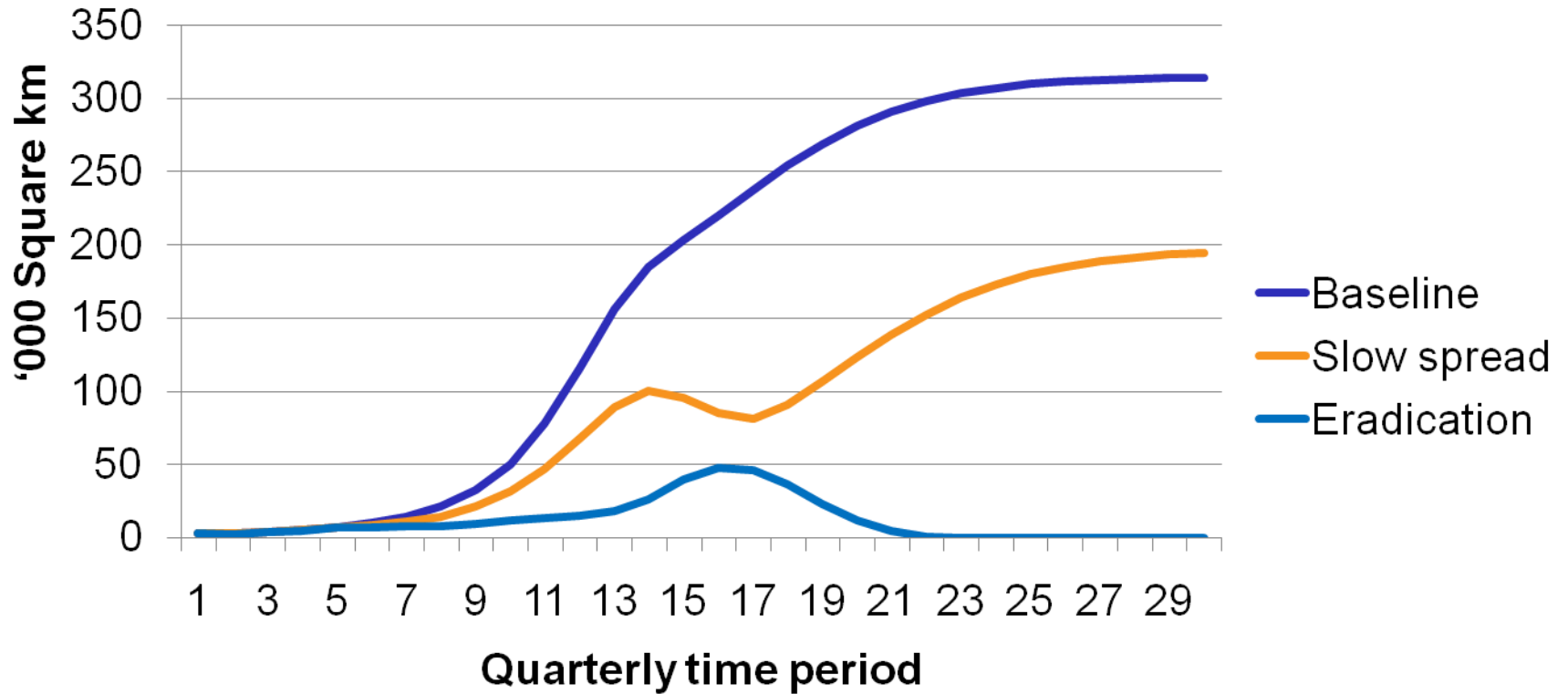
- A stylized data set
- 30 quarterly time periods (7.5 years)
- For each control strategy and each time period
 - Spread model estimates the area spread
 - Spread expressed as a percentage of the maximum potential area
- Percentage loss in production equals percentage spread
- 500 Monte Carlo simulations for each control strategy
 - PERT distribution used to generate random values for spread parameters
 - Lower bound, modal and upper bound values for growth rates



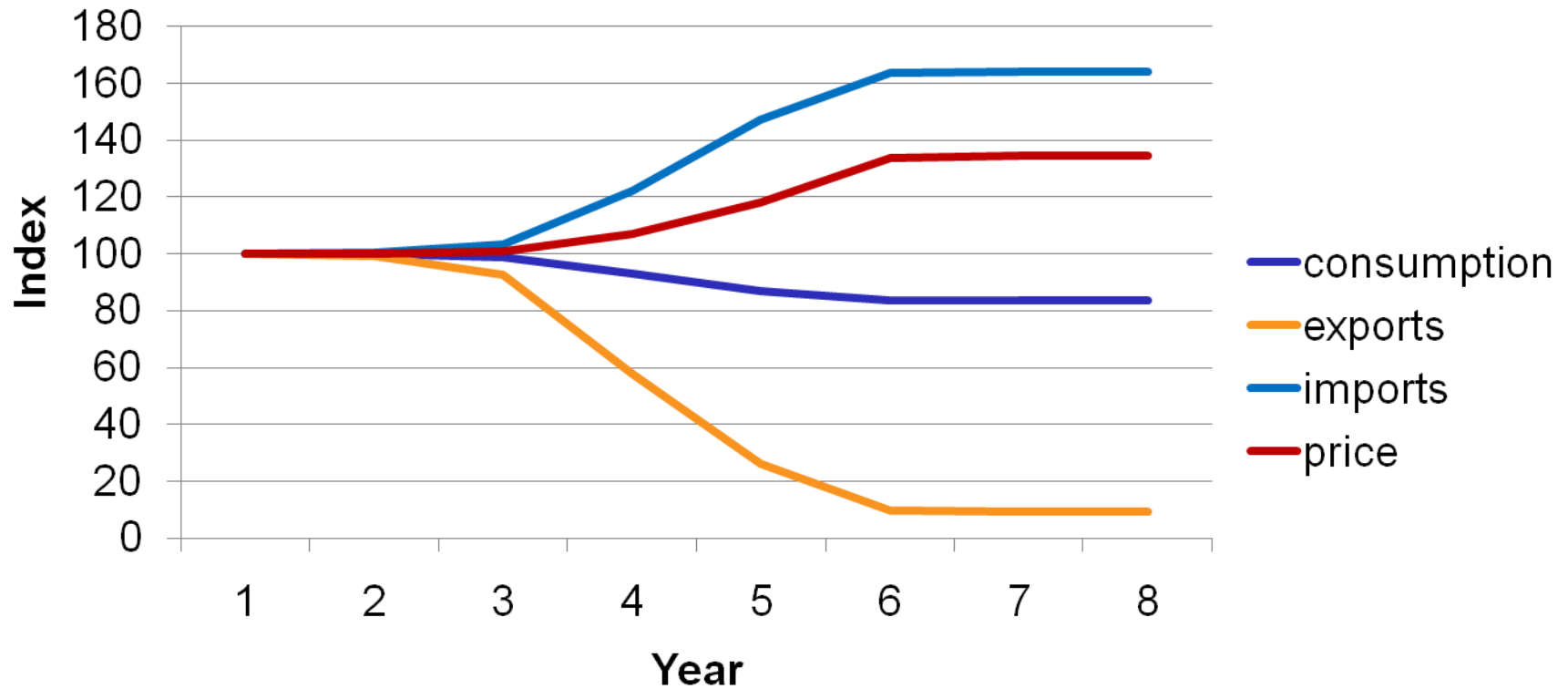
Satellite foci generation



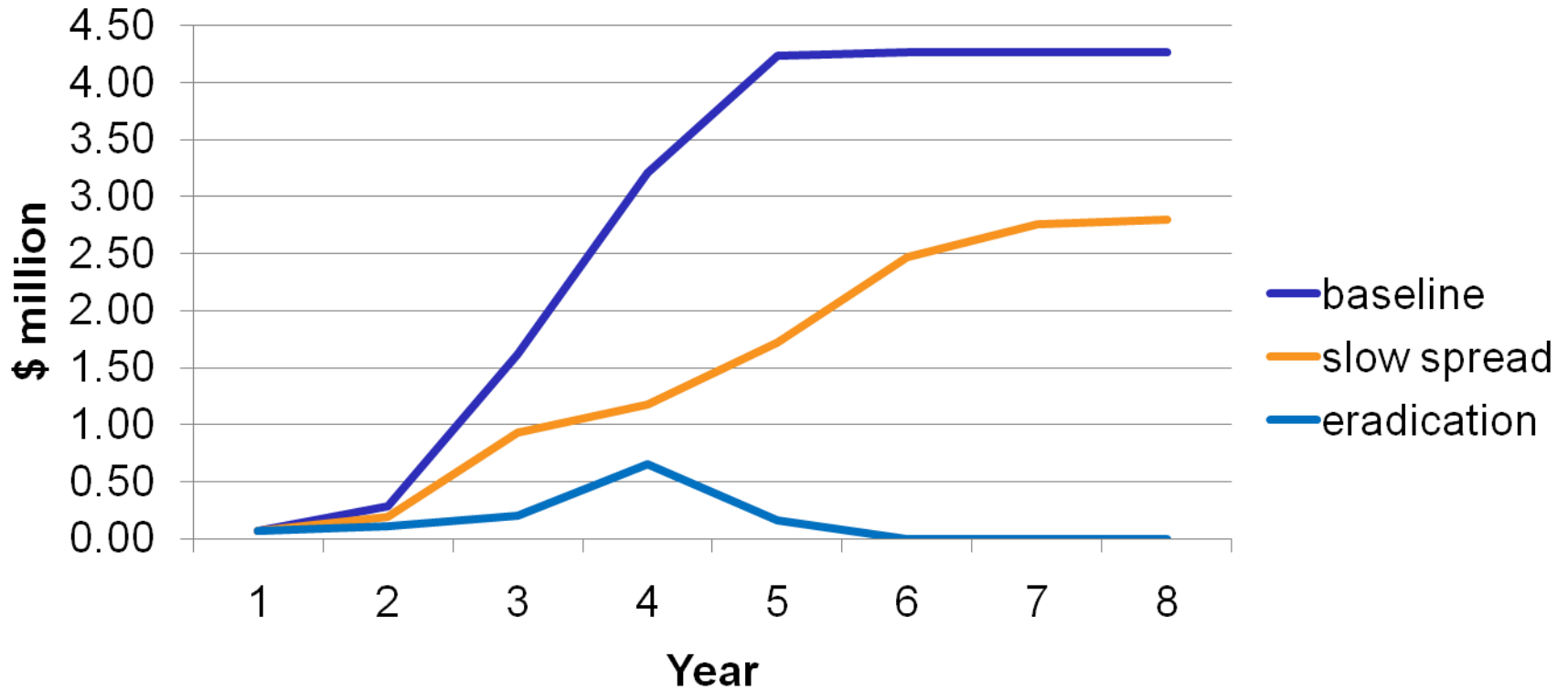
The area of pest spread



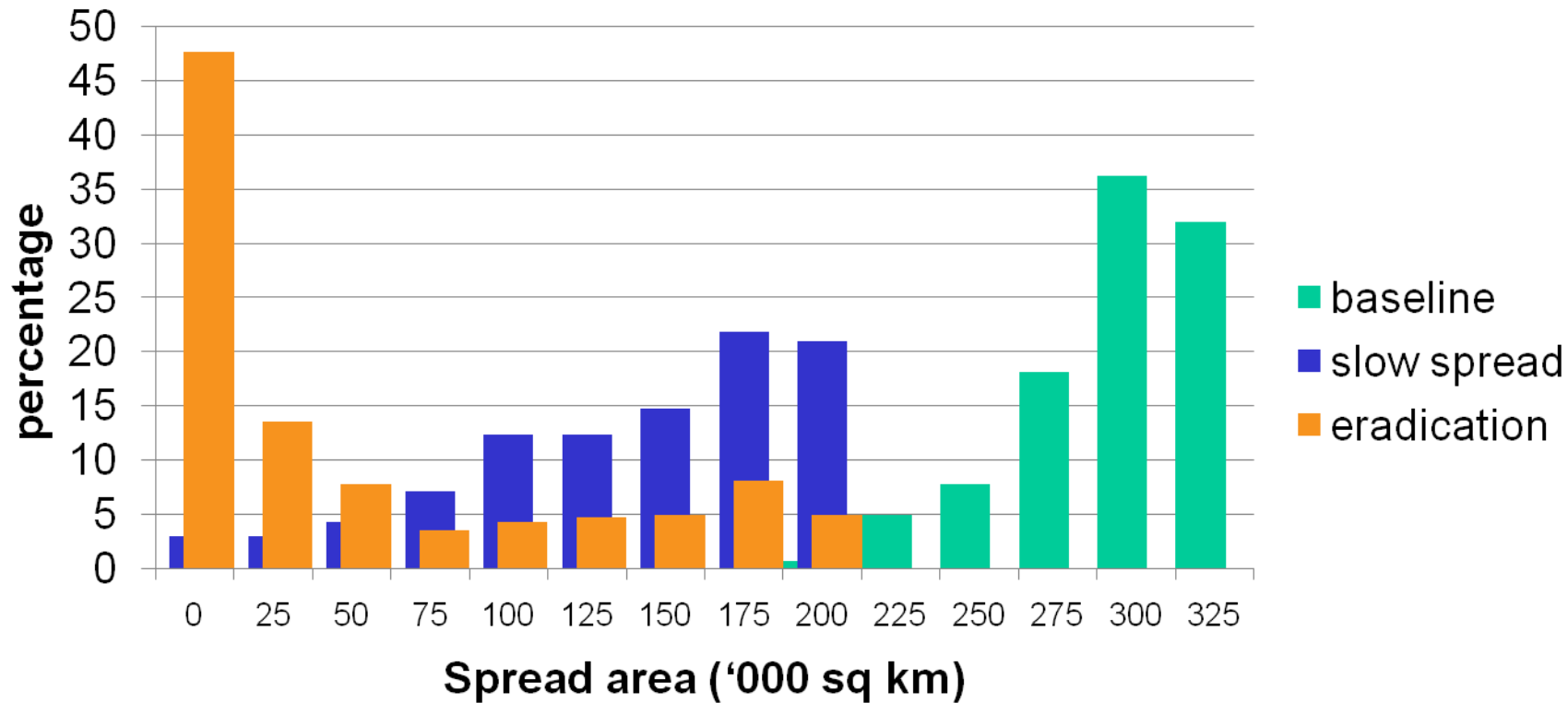
Effect on market variables - baseline



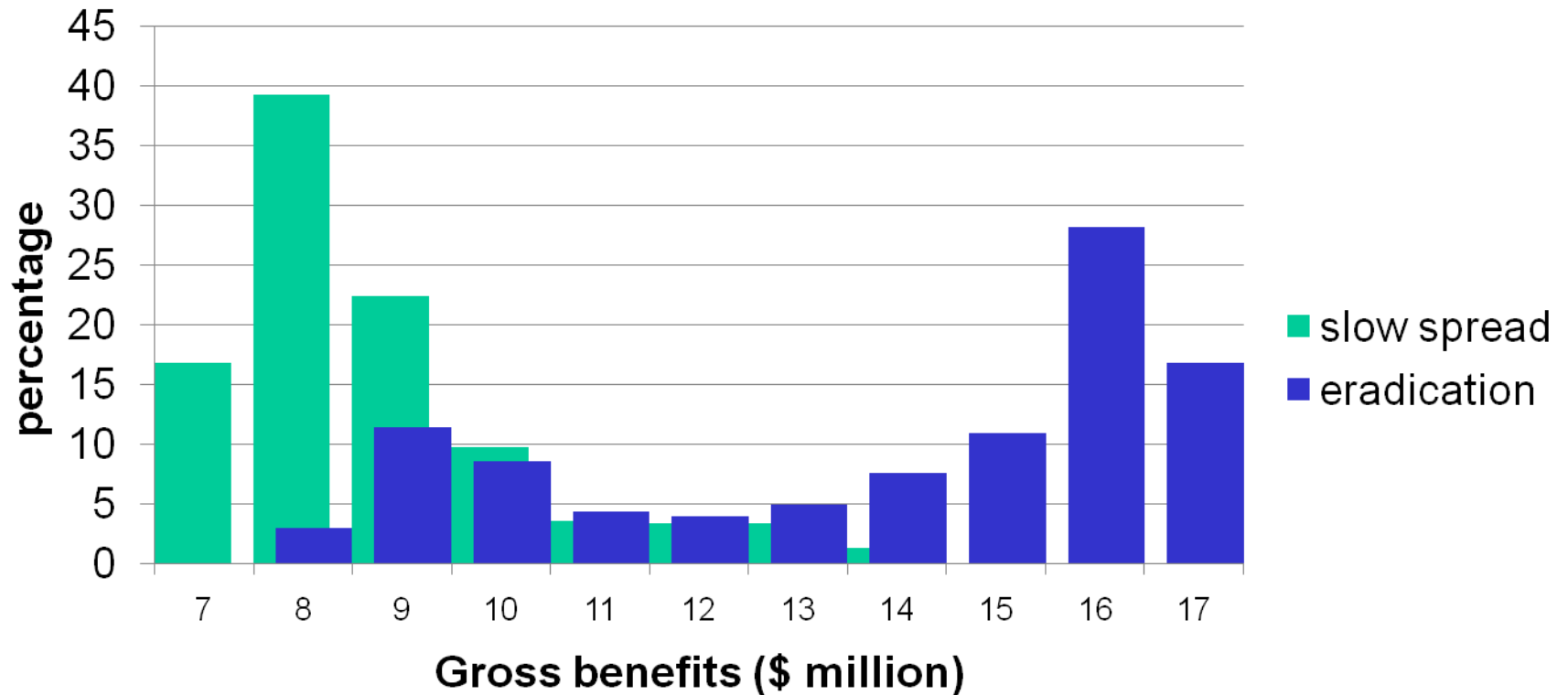
Direct economic cost of pest spread



Frequency distribution of spread



Frequency distribution of gross benefits



Conclusions

- Using an integrated approach is useful
- It is not necessary to keep the spread component simple as used here
- Spread results obtained from a complex spatially explicit spread model can be used as input to a partial equilibrium model.
- The modelling framework can be improved by specifying cost of control as a function of control efforts

