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Economic Analysis of Preventing Introduction of Ragweed in Denmark

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Abstract

Ragweed is an Invasive Alien Species natively growing in North America which is at risk of being introduced in Denmark thru import of bird seeds. The plant produces a high amount of pollen which causes allergy and asthma and is considered a very potent allergy source. It is estimated that 100.000 new cases of allergy and asthma will emerge if rag weed is fully established in Denmark leading to significant socio economic costs. As ragweed has not yet established in Denmark the management options are open for discussion. In this paper two basic options are analyzed: *a.* Prevention of introduction or *b.* Do nothing and treat the allergy symptoms thru standard medical care. The analysis shows that the costs of preventing introduction of ragweed thru yearly control campaigns is significantly lower than the costs of treating the allergy symptoms, implying that preventing introduction is the efficient and preferable management strategy. The robustness of the conclusions is tested by sensitivity analysis of the driving assumptions and is show that the conclusions hold even if the control costs are doubled and the benefits are reduced by 50%.

1. Introduction

Ragweed (*Ambrosia artemisiifolia*) is an Invasive Alien Species (IAS) natively growing in North America. Ragweed is at risk of being introduced in Denmark thru import of bird seeds and migration thru wind-carried pollen from central Europe where the species already have established populations. Ragweed has until now not had sufficient conditions to be established in Denmark but this is expected to change with increasing temperatures due to climate changes. The plant produces a high amount of pollen which causes allergy and asthma and is considered a very potent allergy source with a long season of 6 to 8 weeks (Astma Allergi Denmark, 2014).

According to the NGO of asthmatic and allergic patients in Denmark approximately over one million or one fifth of the Danish population suffers from pollen allergy and it is estimated that 100.000 (or 1.8 pct. of the Danish population) new cases will emerge if ragweed is established in Denmark (Astma Allergi Denmark, 2014). It is possible to treat most of the allergy symptoms thru standard medical care but it causes socio-economic costs in terms of expenses to medicine and loss of work days and leisure due to sick days for those where treatment is not instantly effective. Looking at the possibilities for preventing establishment of ragweed in Denmark and thereby avoiding the costs mentioned above this can be secured by an effective

control of the import of bird seeds, as the risk migration thru wind-carried pollen is considered small (Danish Nature Agency, 2014).

The controls of food, animals and seeds, e.g. imports of foodstuffs, is done by the Danish Veterinary and Food Administration (VFA) which sorts under the Ministry of the Environment and Food. The content of seeds of ragweed is regulated in an EU directive which set a threshold for the content of ragweed seeds in foodstuffs containing non-grinded seeds of 50 mg per kg (EU Commission, 2011). This corresponds to approximately 10 seeds per kg. In 2012 and 2013 the VFA held a control campaign against ragweed (Danish Veterinary and Food Administration, 2012; 2013). The first year seeds of ragweed exceeded the threshold in 4 out of 15 samples whereas it only the case in 3 of 30 samples the following year. Before introduction of the EU regulation the Danish Veterinary and Food Administration found seeds of ragweed in 50 pct. of the controlled samples.

In the economic literature the management of IAS is relatively well described in terms of theoretical contributions (Marbuah et al., 2014). The optimal management strategy for each IEA depends on damage costs and control costs (e.g. Born et al., 2005) and the level of uncertainty and irreversibility related to the effects (Sims and Finnoff, 2013). Due to the difficulties of controlling a new weed once it is introduced, the prevention strategy is often considered the least cost solution (Beck, G., 2012). To determine the optimal management strategy one first important step is to quantify the benefits and costs of avoiding introduction of the species in the country or region relevant for formulating policies. Damage costs of IAS include the effects on indigenous nature and nature use (biodiversity and recreational goods), health effects (allergy, rash), effects on production (output loss and increased production costs) as well as loss of capital due to damage to buildings and infrastructure. Control costs are linked to measures that limit the damages of IAS by reducing their population size and distribution or prevent them from being introduced. In the case of ragweed benefits more or less solely consists of the avoided health effects and costs relates to control of importers of bird seeds.

Only few empirical contributions and case studies of the costs and benefits of different management options for IAS are found in the research literature (Perrings et al., 2000; Born et al., 2005). Thus, this study contributes to the literature by demonstrating policy analysis of different management options for ragweed, thereby adding to knowledge of the actual scales of the economic effects and giving basis for discussion of the uncertainties associated with decision making related to management of IAS.

2. Method

Social cost-benefit analysis aims at evaluating if a project or a policy is beneficial to society based on a utility based approach. The consequences are described in physical terms and prices are used to reflect the change in marginal utility of a one-unit change of the good and thereby quantify the costs and benefits. If the benefits outweigh the costs the project is considered beneficial according to the Kaldor-Hicks efficiency criteria.[1]

[1] See e.g. Freemann (1993) for further discussion of the Kaldor-Hicks criteria

Marked prices are used for expressing the marginal utility of the goods involved as they express the marginal trade-off between one unit of the good and the monetary units related to achieve the right to consume the good. Thus, the cost assessment is based directly on the prices and the resource use linked to the management strategy.

Benefits should ideally reflect the preferences of the population for avoiding the extra nuisance in terms of asthma and allergy if ragweed were fully established. However, as the good (or rather bad) "asthma and allergy" is not subject to marked transactions the benefits are assessed by the avoided costs in terms of saved expenditures to medical care and the value of fewer sick days. In the following sections the measurement of costs and benefits are explained in detail.

Costs of control

Control of food, animals and seeds are done by the Danish Veterinary and Food Administration (VFA). The VFA are responsible for performing a number of campaigns directed towards areas where there is a suspicion of or knowledge of problems or high risks. Most of the campaigns have monitoring or control as main purposes. The VFA has done campaigns to control that the maximum amount of seeds from ragweed did not exceeds the EU standards. These campaigns involve control of both importers and retailers and usually takes place over tree month. During this period the importers are asked to account for which procedures they undertake to secure that they comply with the EU standards and samples are taken both at the importers and retailers.

The resource use of the additional control effort consist of the extra time spend by the authorities and the importers of bird seeds. The additional time is estimated to 2 man month (433 hours) a year and extra costs to equipment for testing the content of ragweed is assumed to be 10,000 DKK a year. Time spend complying with regulations by the importers is estimated to one work week (37 hours) a year for each of the certified importers. The unit costs per hour represents the loss of marginal productivity and is set at 277 DKK per hour in 2013-prises based on the average wage of skilled workers according to Statistics Denmark (2015).

Benefits of avoiding introduction of ragweed

If ragweed is introduced in Denmark and its population grows to the full potential the main societal costs derives from the health effects due to an increased number of pollen allergist. Usually the main concern from IAS derives from effects on the indigenous nature but this is not expected to be of any significant magnitude in the case of ragweed (Danish Nature Agency, 2014). Therefore, focus in the empiric analysis will be on the health effects.

Ideally the potential benefits of avoiding introduction of ragweed should be measured by the preferences for not being subject to the extra risk of pollen allergy. For services and goods trade on markets the marked price can be used as a proxy for the preferences. But since no marked transactions directly reflect the choice of avoiding pollen allergy no marked prices are available for this case. This is often the case for environmental goods as they seldom are subject to marked transactions but instead preferences can be measures by use of hypothetical valuation studies but no such studies have been found where the issue of avoiding pollen allergy is directly addressed.

In this study the potential benefits of avoiding introduction of ragweed are approximated by the avoided costs due to the reduced numbers of pollen allergy cases. In Petersen et al. (2005) the mean monetary consequences per patient of standard symptom treatment has been analyzed for a sample of 253 allergy patients in terms of costs to medicine, costs of medical staff and costs of sick days. According to Petersen et al. (2005) the annual medicine costs was DKK 1,925 per person and the resource costs of medical staff was DKK 609 per patient. Costs of sick days is based on the annual reported sick days of the persons in the sample corresponding to 2.67 work days and 12.80 days in the leisure time.[2] The loss of work days is valued as the loss of marginal productivity and again the average wage of skilled workers is used (DKK 277 per hour according Statistics Denmark, 2015). The costs of being sick during leisure time are approximated by the average income per hour after taxes. With a marginal tax rate of 51.7 percent (Danish Ministry of Taxation, 2014) the costs per hour of leisure lost is set to DKK 143.2.

3. Results

Table 1 summarizes the costs and benefits of preventing introduction of ragweed in Denmark thru yearly control campaigns directed at the importers of bird seeds. The benefits arise due to a reduction of the number of perceived incidents of pollen allergy of 100.000, whereas the costs are related to an extra control effort of 2 full work months a year for the authorities and one week for each of the 5 importers of bird seeds.

Total benefits with 100.000 avoided cases of pollen allergy amount to DKK 2.9 mia. DKK a year which should be compared to extra costs of control of 0.2 mio. DKK a year. Thus the benefit cost ratio is significant. The overall conclusion is very robust as the benefit cost ratio is still in favor of avoiding introduction even if the control effort is assessed to one full man year as this increases costs to 0.7 mio. DKK.

Table 1. Benefits and costs of avoiding introduction of ragweed, 1,000 DKK per year.

Benefits	
Avoided costs from pollen allergy	**2,970,700**
Medical care	262,600
Lost worktime and leisure	2,708,100
Costs	
Control of importers	**181**
Firms	51
Administration (time and equipment)	130

One major uncertainty in this study is the valuation of the benefits from avoiding allergy. As an alternative to the avoided cost assessment used here benefits could be measured using stated preferences methods such as contingent valuation or choice experiments. Using these techniques a number of representative

[2] With a sick day approximated to 7.5 hours this corresponds to 20 work hours and 96 leisure hours.

respondents are asked a to make the hypothetical trade-off between being subject to allergy or giving up a fraction of their consumption (egg. expressed by a marginal increase in taxes). In a study by Petersen et al. (2010) the willingness to pay for allergy vaccination among Danish patients with respiratory allergy has been explored. The study finds a mean willingness to pay at about DKK 4,800 per year. Although the study by Petersen et al. (2010) does not directly address the full discomfort of suffering from pollen allergy it can provide an indication of the preferences for avoiding pollen allergy given that respondent's preferences are independent of the treatment that reduces the risk. Benefits are estimated based on the WTP survey of avoiding pollen allergy benefits are 0.7 mia. DKK/year. Even with this more conservative estimate benefits still outweigh costs by more than a factor 1,000.

The by far largest costs from introduction of ragweed are the loss related to workdays and leisure resulting from asthma and allergy. The results from Petersen et al. (2005) show that asthma and allergy causes substantial socio-economic costs even when patients receive standard symptom treatment. For this reason a sensitivity analysis has been performed of the highly hypothetical case where the standard medical care is assumed to fully and instantly remove the loss related to workdays and leisure. In this case the aggregate costs per year are reduced to 2,6 mia. DKK corresponding to the costs of standard medical care for 100.000 persons. Even if this should be feasible the benefit-costs ratio is still substantially in favor of avoiding introduction of ragweed.

4. Conclusions and discussion

In this paper a socio-economic framework are developed for evaluating the effects of introduction of ragweed in Denmark. As ragweed is not yet established I Denmark two basic options are analyzed: *a.* Prevention of introduction or *b.* Do nothing (allow introduction) and treat the allergy symptoms thru standard medical care. It is found that total benefits with 100.000 avoided cases of pollen allergy amount to DKK 2.9 mia. DKK a year which should be compared to extra costs of control of 0.2 mio. DKK a year. Thus, the benefit cost ratio is significant. The results are robust to changes in the assumptions and the cases study provides a useful demonstration of how to apply economic analysis for supporting management decisions related to IAS.

In the environmental economic literature several examples of *ex post* CBA studies of IAS are found whereas *ex ante* studies are much more scares (see Born et al., 2005). This is due to the difficulties of estimating the benefits of avoiding introduction of IAS because of the non-marked characteristics of many of the goods affected by IAS, lack of knowledge of pathways of introduction, and lack of models for assessment of the effects once the IAS are introduced. Therefore, full cost benefit studies of the effects of IAS are not often found and little knowledge of the potential benefits saved from a timely effort for stopping introduction of IAS are not available for policy makers. For this reason case studies like this may have a significant impact on forming policies and choosing management strategies as they fill out a large gap of empirical knowledge and demonstrates how future studies may be performed.

In this study the introduction and migration of ragweed is rudimentary modelled by simply assuming that no control leads to establishment of a viable stock of ragweed in Denmark. Further, the estimates of extra cases of allergy and asthma stipulated by the Astma Allergi Denmark are taken for given. This is sufficient

for developing the framework for measuring the socio-economic effects, but in order to make *ex ante* evaluations of different management options and get a better understanding of the interactions between causes and effects of introduction of ragweed development of a bio-economic model is needed. Such a model should include the dynamic and spatial migration of ragweed and the extra pollen-exposure of the population resulting from this and requires cross disciplinary collaboration including economics and life science (agronomy and health science).

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