ECONOMIC ASSESSMENT OF THE IMPACT OF DEREGULATING CHRYSANTHEMUM WHITE RUST USING A PARTIAL BUDGETING MODEL

ANIMAL AND PLANT HEALTH INSPECTION SERVICE

APRIL 2009

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Executive Summary

Chrysanthemum White Rust (CWR) is a disease caused by a fungal pathogen, *Puccinia horiana* P. Hen. (Pucciniaceae: Uredinales). It is not known to be established in the United States and is currently considered to be a pest of quarantine significance.

The objective of this analysis was to estimate the economic impact of deregulating CWR. A partial budgeting model was developed to analyze the likely costs and benefits that would likely be associated with the deregulation of CWR. The changes that would likely result from deregulating CWR were compared to the status quo policy of eradication.

Because it is difficult to predict with certainty the effect an invasive species like CWR will have, a probabilistic model was used to determine the potential range of positive and negative impacts. Model parameters were specified using data from scientific literature; technical, economic, and agricultural reports; and expert opinion from USDA PPQ personnel.

According to the model, the net benefits of deregulation ranged from about -$2 million to about +$6 million, with a mean net benefit of +$593,141. The large range is a result of the uncertainty surrounding several parameters, especially the number of cut flowers currently destroyed each year as part of CWR eradication. According to the model, the net annual benefits of deregulation will be positive approximately 66.5 percent of the time.

1. Introduction

Chrysanthemum White Rust (CWR) is a disease caused by a fungal pathogen, *Puccinia horiana* P. Hen. (Pucciniaceae: Uredinales). The pathogen is native to East Asia, but is now found virtually everywhere in the world except North America (PPQ, 2007).

Based on a 1997 risk assessment that rated the pest risk potential as high, phytosanitary restrictions were placed on chrysanthemums to mitigate against the possibility of establishment and spread (Redmond and Kubicek, 1997). Despite these regulations, CWR has been found in the United States about five times per year over the last five or ten years. These outbreaks have been concentrated in a few states on the West Coast, and in the Northeastern states.

An updated pest risk assessment conducted in 2007 concluded that the risk potential for CWR was less than earlier estimated (Caton et al, 2007). The risk of CWR on cut flowers was rated as low, for both domestically produced and imported mums. The risks were moderate for CWR on some florist and garden mums, by region and season; for potted mums, the risk was low.

The revised risk assessment also found that the economic impact of deregulation and establishment of CWR on chrysanthemums in the United States would be much less than those estimated in the 1997 study. The new assessment reduced both the estimate of potential spread of CWR in the country, and the number of outbreaks. Nevertheless, the economic estimate was based on the original 1997 study that did not capture the three distinct commodities in the chrysanthemum industry. The objective of this analysis was to evaluate the economic impact of deregulation, recognizing the distinction in commodities.

2. Background

CWR has a very narrow host range, only infecting some varieties of flowering chrysanthemums. Florist's chrysanthemum, *Chrysanthemum* × *morifolium* Ramat, is particularly vulnerable to CWR, but there is evidence that many chrysanthemum varieties are resistant to the disease (e.g., Dicklow, 2003; Raabe *et al.*, 2002; Williamson, 2006). For example, Heinz and Thompson (2001) reported that 18 of the 37 varieties evaluated demonstrated high levels of resistance to CWR.

CWR is not known to be established in the United States. It is considered to be a pest of quarantine significance and is regulated as follows:

- Chrysanthemums for propagation may not be imported from countries in which the pathogen is known to be established including Brazil, Colombia, Mexico, The Netherlands, the Republic of South Africa, and the United Kingdom (PPQ, 2007d).
- Cut flowers of chrysanthemums are prohibited from Venezuela.

- Cut flowers are only allowed from approved growers in Mexico and The Netherlands.

CWR has been found in the United States about five times per year on average over the last ten years. Outbreaks have typically been concentrated in a few states on the West Coast (particularly California and Oregon) and the Northeast (e.g., New Jersey, New York, and Pennsylvania). When detected, an eradication plan is immediately implemented. Infected plants and all hosts within a one meter radius are destroyed, and other chrysanthemums at the affected business are quarantined until after a specified fungicide treatment regime has been completed. Surveys of the surrounding area and trace backs of infected stock are also required (PPQ, 2005).

3. Previous Analyses

3.1. PPD (1997)

In 1997, the USDA's Animal and Plant Health Inspection Service (APHIS) Policy and Program Development (PPD) conducted an analysis to determine the potential economic consequences that would occur if CWR were to become established in the United States (PPD, 1997). The authors examined two possible scenarios: 1) that CWR would establish in California, and 2) that CWR would establish nationwide (22 states). In the first scenario, costs to producers were estimated to range between $1.4 million to $2.2 million per year, and public costs, from $762,000 to $1.6 million per year (1997 dollars). In the second scenario, costs to producers were estimated to range between $14.0 million to $18.7 million per year, and public costs, from $2.7 million to $5.5 million per year (1997 dollars). The analysis concluded that based on the estimated costs of CWR in each of the two scenarios and the presumed effectiveness of eradication, that larger future costs would be avoided by maintaining regulatory controls.

It is important to note that one of the major assumptions of this analysis was that CWR would remain a quarantine-significant pathogen so that the sale of diseased CWR-exposed plants would continue to be prohibited. The authors noted the following:

> "Would expected future savings still exceed current costs if the sale of diseased or CWR-exposed plants were legal? There is no evidence that CWR will kill a chrysanthemum plant. The infection can spread over the stem and leaves, and even onto the petals, but the plant will survive. For cut chrysanthemums, usually sold with few leaves, CWR can result in little apparent damage. Even for potted florist chrysanthemums, which are usually kept by purchasers for not more than a couple of weeks, a spot on a leaf would probably result in a decrease in price, but there would still be a market for it, if it could be sold legally…If it were assumed that CWR-affected plants could be legally sold, then the benefits of current prevention and eradication measures would need to be reevaluated."

Hence, this assessment does not provide an estimate of the economic consequences that would be associated with deregulation.

3.2. PERAL, (2007).

In 2007, the USDA Center for Plant Health Science and Technology (CPHST)'s Plant Epidemiology and Risk Analysis Laboratory (PERAL) completed a risk assessment on Chrysanthemum White Rust. The purpose of the analysis was to estimate the likelihood that chrysanthemum production centers would become infected with CWR via infected garden mums, potted mums, or cut flowers.

Using weather-based mapping, the authors determined that conditions would only be suitable for CWR development and transmission in the Northeast and Pacific states. However, they also determined that the disease is only likely to overwinter in California and Hawaii. Therefore, even though CWR outbreaks may occur annually in the Northeast, Oregon and Washington, the disease would only be able to establish in Hawaii and California.

Based on the results of the weather-based mapping, the authors developed both qualitative and quantitative models to estimate the likelihood of chrysanthemum production centers being infected by CWR-positive plants. The results of their analysis indicated the following:

- CWR on cut flowers poses a low risk, due primarily to the fact that there is a very low likelihood that cut flowers would come into contact with suitable hosts.
- CWR on florist and garden mums usually poses a low risk, except in the flowing cases where it poses a medium risk:
    - On garden mums in HI, OR, and WA
    - On florist mums shipped in the spring and fall to Northeast states
    - On florist mums shipped in the winter to CA.

The authors also updated the previous PPD (1997) analysis, and concluded that the potential economic impacts of CWR are actually are much smaller than indicated in the original analysis. This was a result of a change in two assumptions: 1) the number of states at risk for the disease and 2) the number of likely outbreaks per year. The weather-based mapping (PERAL 2007) indicated the disease probably threatened mum production only nine states, whereas PPD (1997) estimated 22 states. PERAL (2007) estimated the number of annual outbreaks to be about 5, rather than the previous estimate of 20. Accordingly, PERAL (2007) estimated the total annual impacts to be about $4 million, with public costs accounting for only $0.5 to 1 million of that total (see Table 1).

Table 1. Estimated costs of CWR in original PPD assessment and updated analysis

Sector	Estimated costs (Million dollars) in 2007 dollars			
	Original analysis (PPD, 1997)[1]		New analysis (PERAL, 2007)	
	Lower	Upper	Lower	Upper
Producer	19.4	25.9	2.9	3.3
Public	3.7	7.6	0.5	1.0
Total	23.1	33.5	3.4	4.4

4. Methods

4.1 General Description of Model and Data sources

A partial budgeting model was developed to analyze the likely costs and benefits that would be associated with the deregulation of CWR. Partial budgeting provides a useful framework for comparing the changes in costs and returns that occur under various policy alternatives. In this case, we compared the changes that would result from deregulating CWR to the status quo policy of eradication. The partial budgeting model separates the positive and negative outcomes of a policy decision as follows:

Positive impacts:

1. Added returns: The additional income that will be received as a result of the change in policy.
2. Reduced costs: The current expenses that will be avoided by the change in policy.

Negative impacts:

1. Reduced returns: The current income that will be lost as a result of the change in policy.
2. Added costs: The additional costs that will result from the change in policy.

The net benefits of the policy being analyzed are found by subtracting the total negative impacts from the total positive impacts. Note that partial budgeting ignores all aspects of a situation that the new policy does not change.

Because it is difficult to predict with certainty the effect an invasive species like CWR will have, we used a probabilistic model to determine the potential range of positive and negative impacts. We specified the model parameters using data from scientific literature; technical, economic, and agricultural reports; and expert opinion from USDA PPQ personnel. For some parameters there was little information available. In those cases we tended to overestimate the risk to compensate for the uncertainty of the data. In this model, the following distributions were used:

[1] Original values were adjusted to 2007 dollars using http://www.minneapolisfed.org/research/data/us/calc

- *PERT:* A PERT is a special form of a four-parameter Beta distribution (Vose, 2003). A four-parameter Beta is a rescaled Beta, used to model a variable that runs from *a* to *b* and has the following formula: $x = a + \text{Beta}(\alpha_1, \alpha_2) * (b-a)$. A PERT makes the assumption that the mean = (minimum + 4 * Most likely + maximum)/6. This allows the four parameters to be determined from three input values: the minimum, most likely and maximum. Vose (2000) suggests that the PERT is ideal for modeling expert opinion when a central tendency is expected. A PERT distribution often represents the shoulders of the distribution better than a triangular distribution.
- *Triangle:* A continuous distribution with parameters for the minimum, most likely, and maximum values. Used in this model instead of a PERT when the information was more uncertain.
- *Uniform:* A continuous distribution bounded by minimum and maximum values in which each value is equally likely. This distribution was used when uncertainty existed about the distribution between the minimum and maximum or when the expected range was small.

All probabilistic analyses and simulations were performed using @Risk version 4.1.2 Professional Palisade, 2002. Unless otherwise specified, simulation settings were as follows: number of iterations = 100,000; sampling type = Latin Hypercube; random seed = 101.

4.2 Model Assumptions

We made the following assumptions in this model:

1. Because of the biology of the pest, CWR can only establish in the following states: California, Connecticut, Delaware, Hawaii, Maryland, Massachusetts, Oregon, New Jersey, New York, Pennsylvania, Rhode Island, and Washington (PERAL, 2007).
2. CWR only poses a risk to producers in states where development and transmission of the disease can occur.
3. Wholesale value of cut mums = $1.40; garden mums = $2.00; potted florist mums = $3.00 per stem (NASS, 2007).
4. Deregulation of CWR would result in the following changes:
    a. No domestic regulatory surveys for CWR will be conducted.
    b. There will no longer be any requirements for domestic eradication of CWR.
    c. There will no longer be any state or federal expenditures on CWR.
    d. Chrysanthemums will no longer be inspected for CWR at U.S. ports of entry, although they may still be inspected for other pests and diseases.
    e. All chrysanthemum varieties are equally susceptible to the disease. (This is a conservative assumption since there is much evidence that many varieties are resistant.)
    f. No change in the supply of imported chrysanthemums.

4.3 Model Components

4.3.1 Positive Impacts

4.3.1.1 Reduced costs to the Federal Government
Currently, the USDA Plant Protection and Quarantine (PPQ) conducts and funds ongoing surveys and inspections for CWR. When CWR is found, PPQ conducts delimiting surveys, trace backs, and trace forwards of infected plant material. Should CWR be deregulated, these expenses will no longer be incurred.

PPQ has two operational regions. We used a PERT distribution to estimate the annual expenditures on CWR by the Eastern Region (PPQ ER). We chose parameters for this distribution based on three years of spending data: $56,700 in FY 2006, $65,100 in FY 2007, and $78,750 in FY 2008. A 99% confidence interval was used to set the minimum and maximum values; the most likely value was set at the mean: min=$16,500; max=$83,400; most likely=$66,850.

We also used a PERT distribution to estimate annual expenditures on CWR by the PPQ Western Regional (PPQ WR), based on data for FY 2003 to 2008. Expenditures during these years varied widely (Table 2), from $8,647 in 2004 to nearly $160,000 in 2008. A 99% confidence interval was used to set the minimum and maximum values; the most likely value was set at the mean: min=$ $18,356; max=$156,782; most likely=$87,569.

Table 2. Expenditures by the Western Region 2003-2008.

Fiscal Year	WRO	CA	OR	AZ	CO	Total
2008	$32,174	$127,459	$0	$0	$0	$159,633
2007	$0	$112,216	$0	$0	$0	$112,216
2006	$30,755	$44,412	$0	$0	$0	$75,167
2005	$2,642	$125,360	$10,837	$12,916	$1,895	$153,650
2004	$607	$8,040	$0	$0	$0	$8,647
2003	$0	$16,100	$0	$0	$0	$16,100

4.3.1.2 Reduced costs to State Governments
Because of unknown factors, some states were reluctant to report their expenditures on CWR; therefore, very little data was available on the amount of money state departments of agriculture typically spend on CWR each year.

A PPQ WR program manager suggested that states in the western region typically spend two to three times more on CWR than PPQ WR does in those states.[2] Hence, to estimate CWR expenditures by WR states, we used a uniform distribution with the minimum value equal to the amount of money spent by PPQ WR, and the maximum value equal to three times that amount.

[2] Tim McNary, Sr. Regional Program Manager, personal communications, November 2008.

Data on CWR expenditures were available for only 15 of the 28 states in the ER (Table 3). To estimate the total amount of money spent by states in the ER on CWR, we substituted the average amount of money spent by the 15 reporting states for the missing values of the other states.[3]

Based on those results, we conservatively estimated total expenditures on CWR by states in the ER as a triangular distribution, with a minimum value of $50,000, a maximum of $350,000, and a most likely value of $250,000.

[3] Although some of the non-reporting states probably did not spend any money CWR, several others had outbreaks of CWR one or more of these years and presumably would have spent significantly more than the average. Therefore, we assume the average can be used as a proxy for the missing values.

Table 3. Expenditures on CWR by states in the Eastern Region. States that reported expenditures are in black. For states that did not report expenditures, an average value was used (red).

State	2006	2007	2008
AL	$0	$0	$0
CT	$14,738	$64,496	$67,736
DE	$0	$18,440	$18,440
FL	$5,822	$5,822	$17,921
GA	$0	$0	$0
IL	$5,822	$13,043	$17,921
IN	$0	$0	$0
KY	$5,822	$13,043	$17,921
MA	$1,110	$4,440	$8,720
MD	$5,822	$13,043	$17,921
ME	$960	$960	$0
MI	$5,822	$13,043	$17,921
MN	$5,822	$13,043	$17,921
MS	$5,822	$13,043	$17,921
NC	$5,822	$13,043	$17,921
NH	$0	$1,000	$500
NJ	$5,822	$13,043	$17,921
NY	$5,822	$13,043	$17,921
OH	$304	$1,200	$132
PA	$5,822	$13,043	$17,921
PR	$0	$0	$0
RI	$5,822	$13,043	$17,921
SC	$0	$1,804	$0
TN	$12,000	$12,000	$12,000
VA	$0	$0	$0
VT	$0	$0	$0
WI	$5,822	$13,043	$17,921
WV	$0	$0	$0
Total	**$104,803**	**$266,672**	**$340,505**

4.3.1.3 Reduced costs to producers

If CWR is deregulated, cuttings produced off-shore (currently prohibited) will be allowed. This will presumably lower the price of chrysanthemum cuttings. Because chrysanthemums represent a small niche market world wide, the current world price of chrysanthemum cuttings (faced by countries without import restrictions) could not be obtained. To estimate this parameter, we used a uniform distribution with a maximum of $0.01 savings per cutting and a minimum of $0.00 savings per cutting. The total number

of cuttings was estimated from the annual number of domestically produced cut flowers sold, the number of garden mums sold, and 5 times the number of florist mums sold (assuming there is an average of 5 cuttings per florist pot) (PERAL, 2007).

4.3.1.4 Added returns to producers

Currently, when CWR is found, all infected plants must be destroyed. However, since CWR does not actually kill chrysanthemum plants, if CWR were to be deregulated, not all infected plants would necessarily be lost. For example, PPD (1997) noted that CWR infection would likely have little impact on the marketability of cut chrysanthemums, since they usually sold with few leaves and would have little apparent damage. They also note that "even for potted florist chrysanthemums, which are usually kept by purchasers for not more than a couple of weeks, a spot on a leaf would probably result in a decrease in price, but there may still be a market for it."

Additionally, current regulations require that all hosts within a one meter radius also be destroyed, and that all other chrysanthemums at the affected business be quarantined until after a specified treatment regime has been completed. Often, a high percentage of these treated plants are eventually destroyed because they are no longer marketable (PPD, 1997). Growers are not compensated for lost plants; therefore, statutory eradication requirements can represent a large cost to producers. Under deregulation, such costs would not be incurred, representing an added return to producers.

A great deal of uncertainty exists about the number of chrysanthemums destroyed each year as a result of mandatory eradication procedures for a couple of reasons. First, this number is not reported very often or consistently. Second, based on the numbers that have been reported, it appears to vary dramatically—often by orders of magnitude—depending on the number and severity of outbreaks each year. For, example, in 1996, over 4 million cut flowers were destroyed (PPD, 1997), but in other years, the number appears to be closer to 10,000[4].

We used PERT distributions to estimate the number of flowers that are destroyed each year as a result of mandatory eradication procedures [5], based on data from PPD (1997) and a review SPRO letters issued by PPQ 2004 to 2008. For cut flowers, we used a minimum value of 10,000; a maximum value of 5,000,000; and a most likely value of 50,000. For garden mums, we used a minimum value of 1,000; a maximum value of 50,000; and most likely value of 10,000. Finally, for potted florist mums, we used a minimum value of 0; a maximum value of 10,000 and a most likely value of 5,000.

4.3.2 Negative Impacts

4.3.2.1 Reduced returns to producers

According to the risk assessment completed by PERAL (2007), CWR is only expected to pose a significant risk to the following states: California, Connecticut, Delaware, Hawaii,

[4] Based on a review of SPRO letters regarding CWR issued 2004 to 2008.
[5] That would not otherwise be destroyed if CWR were to be deregulated.

Maryland, Massachusetts, Oregon, New Jersey, New York, Pennsylvania, Rhode Island, and Washington. In these states, deregulating CWR may lead to more outbreaks of the disease, and consequently a greater number of plants lost to the disease. An assessment conducted on CWR in the United Kingdom assumed that deregulation of CWR would lead to a 5 to 10 percent loss of the least efficient (vigorous) 5 to 10 percent of chrysanthemums (Pemberton, 1988). Using uniform distributions and these max and min values, we estimated the additional loss of revenue to producers of garden and potted mums. Deregulation of CWR is not expected to result in a greater number of cut flowers lost to the disease because of the fact that CWR is expected to have little impact on the marketability of cut flowers.

4.3.2.1 Added costs to producers

Deregulation of CWR is also likely increase costs of production of chrysanthemums, because producers will increase inputs such as labor and fungicides. For example, in the Netherlands, CWR control reportedly increases the costs of production by an estimated 2 to 4 percent (van der Hoeven, 1987; Pemberton, 1988).

Estimates of the Average Variable Costs (AVC) associated with the production of garden mums range from $1.19 per unit to $1.65 (in 2007 dollars) (Whipker, 1990; Whipker and Cloyd, 1998). Chemical applications and labor account for only a portion of the AVC, but to be conservative, we assumed all variable costs could increase with CWR deregulation. We used a uniform distribution to estimate the increased costs of production for controlling CWR. The minimum was set at $.03 per flower (2% increase) and the maximum was $0.06 per flower (4% increase). We then used a PERT distribution to estimate the number of cut, garden and florist mums produced in at risk parts of the United States each year. [6]

5. Results and Discussion

According to the model, the net benefits of deregulation ranged from about -$2 million to about +$6 million, with a mean net benefit of +$593,141. The large range is a result of the uncertainty surrounding several parameters, especially the number of cut flowers currently destroyed each year as part of CWR eradication. According to the model, the net annual benefits of deregulation will be positive approximately 66.5 percent of the time (Figure 1).

In this analysis we only considered the effects of deregulation to domestic producers, State governments, and the United States Federal government, and did not account for the welfare effects to consumers at all. Empirically estimating those effects is beyond the scope of this analysis, but several factors lead us to conclude that if such effects were to be included in a future model, the welfare gains to consumers that would result from deregulation of CWR (and the removal of import restrictions on chrysanthemums) are likely to be greater than the losses that would occur to producers. First, demand for

[6] Cut mums: max=15,000; ML=13,000; min=8,000. Potted mums: max=15,000; ML=10,000; min=5,000. garden mums: max=25,000; ML=22,000; min=20,000 (based on NASS, 2007).

chrysanthemums is likely to be relatively elastic in relation to supply, because there are presumably many substitutes for chrysanthemums. Second, CWR has a narrow host range (only some varieties of chrysanthemums are at risk) and the disease is highly unlikely to affect natural areas. Further, CWR is unlikely to survive in much of the U.S. (Caton et al., 2007). Therefore, economic losses will likely be confined to a small group of producers and retailers of susceptible mums. Third, although the current world price of chrysanthemums is unknown, some evidence indicates that deregulating CWR will significantly drop the price of mums in the United States.[7]

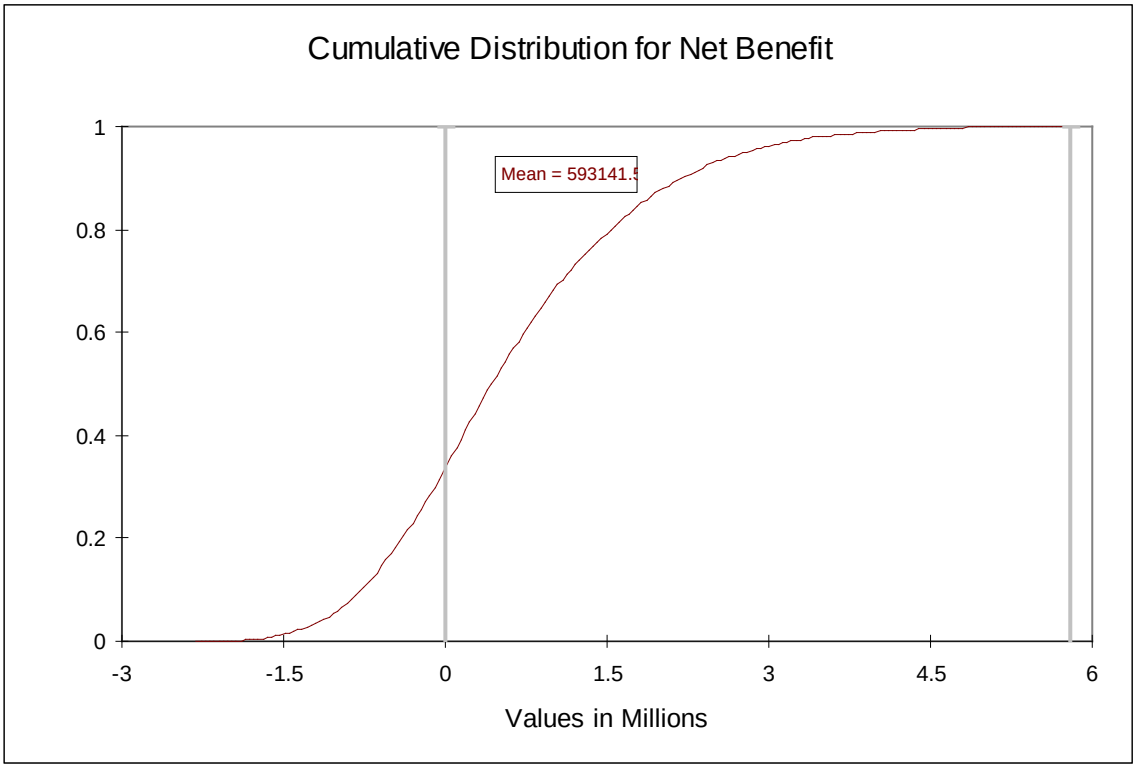

Figure 1. Cumulative Distribution of the Annual Net Benefits of Deregulation. The mean net benefit is $593,141 per year and will be positive an estimated 66.46% of the time, or approximately 2 out of 3 years.

[7] Notably, the domestic wholesale price of cut mums is approximately $1.40, whereas the price of imported cut mums is 1/10th that price at approximately $0.14 (NASS, 2007).

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