BQOM 2521: Decision Making in a Complex Environment

Kristin Evert, Ariann Polasky, Mei Yang

Organic Farming in the US
Will Subsidies Make a Positive Impact?

April 26, 2011

This model examines U.S. government subsidies for certified organic farms. Using empirical research for organic farming methods and agricultural subsidies, the model was developed using the Analytical Network Process. Taking into consideration the benefits, opportunities, costs, and risks involved in creating a special subsidy in the U.S. for organically certified farms, the model seeks to determine whether subsidies should be enforced. The three alternatives that we considered were no organic subsidies, partial subsidies for specific organic goods, and subsidies for all certified organic goods. The results of our analysis show that the U.S. government should subsidize all organic goods.

Table of Contents

INTRODUCTION

The concept of organic growing has been around since the 1930s and began because people were concerned about synthetic fertilizers used in agriculture. The movement has developed throughout the years with noted growth and increased popularity since the 1990s. While each country is able to determine their own measures for the growing, storing, processing, packaging and shipping of organic foods, the following list notes general standards for organic foods that are consistent across most countries:

- No synthetic chemical inputs such as fertilizers, food additives, pesticides, or antibiotics can be used in growing or production
- Farmland must be free of synthetic chemicals for a certain number of years before it can be organically certified (three years in the U.S.)
- Organically certified and non-organically certified goods must remain separate

Because organic growing prohibits the use of chemical agents, agriculturalists must rely on other methods for pest control and fertilization, making organic farming more labor intensive than traditional farming methods. Even though the elimination of chemical agents decreases the cost of production in comparison to traditional farming methods, organic production is actually more costly due to increased labor and land required to grow and produce organic goods. This leads to a higher premium charged on organic food than on traditionally grown food, and this higher cost often causes consumers to avoid organics.

As stated earlier, the environmental impact of the use of chemicals such as pesticides and fertilizers in traditional farming methods led to the creation of the organic movement. The damaging environmental impact of traditional farming is a negative externality, meaning it is not passed on to the consumer in the cost of the product. The negative effects of traditional farming, such as pollution of land and water, are passed on to society. Organic farming does not produce nearly as many negative externalities, although the cost of organic goods is more expensive, hindering consumers from purchasing them.

In order to encourage consumers to purchase organic goods and thereby reduce agriculture's impact on the environment, some countries have turned to organic subsidies. The subsidies provide extra income to organic farmers that are used to offset the increased cost of production over traditional growing methods.

This savings means that the growers do not to need to charge as high of a premium on organic goods, which lowers the cost of organic goods and makes them more affordable to consumers.

The European Union (EU) is one group which provides subsidies to encourage growers to adopt organic growing practices. The EU is often the first to adopt new environmental and social practices, and other developed countries generally follow suit shortly after. Based on this trend, it is natural to presume that the U.S. would consider subsidizing organic growing in the future. With the Farm Bill up for review in 2012, we may see this issue arising within the next year.

METHODOLOGY

The model was created using the Analytic Network Process (ANP), a decision making process used when the problem/decision can be structured as a network. Considering the benefits, opportunities, risks and costs involved, a BOCR model was used to evaluate and weigh the options for organic farming subsidies.

Before we identified our alternatives and built our model, it was essential that we clearly defined what is meant by "Organic."

> *Organic - In 2000, the National Organic Standards Board of the USDA established a national standard for the term "organic." Organic food must be produced without the use of conventional pesticides, petroleum-based fertilizers, sewage sludge-based fertilizers, herbicides, pesticides, genetic engineering (biotechnology), antibiotics, growth hormones, or irradiation. Animals raised on an organic operation must be fed organic feed and given access to the outdoors. Land must have no prohibited substances applied to it for at least 3 years before the harvest of an organic crop. The National Organic Standard became law on October 21, 2002. The law states that all farms and handling operations that display the "USDA Organic" seal must be certified by a State or private agency that ensures the National Organics Standards are followed. Certifying agents are accredited by the USDA. Farms that follow the National Organic Standards and have less than $5,000 in annual sales can be exempt from certification. These exempt farms can use the term "organic" but cannot use the "USDA Organic" seal (*"Census of Agriculture - 2008 Organic Survey").

The alternatives were defined as:

- No subsidies - US government would offer no subsidy to organic farmers (status quo)
- Partial subsidies - US government would offer partial subsidies to organic farmers for a select set of goods including wheat, corn, sorghum, barley, oats, cotton, rice, soybeans, minor oilseeds, and peanuts
- Full Subsidies - US government would fully subsidize organic farming for the production of all crops and livestock

Before moving forward, we had to make some assumptions before we could build our model. Our assumptions are as follows:

- Assumed that subsidies would be direct payments to organic farmers.
- Assumed that organic subsidies would have an adverse affect on complimentary industries (transportation, food processing/manufacturing etc.).
- Assumed that demand for skilled workers would decrease, but demand for unskilled workers would increase.

We then selected criteria and sub-criteria that would affect the decision. We considered the benefits, opportunities, costs and risks. (*A complete list can be found in Appendix A*.) Additionally, strategic criteria that would affect our decisions were determined. These included:

- Health of US citizens
- Environmental impact
- Economic impact

To build the BOCR model, a network for each of the merits was constructed. These networks contained the three alternative and the respective criteria (*An example of these networks and how they are structured can be found in Appendix B*). Once all of the networks were assembled, pair-wise comparisons were completed to assess the dependence of the criteria on each other and the alternatives. They were completed within the clusters and between the clusters. The result of these comparisons was a Supermatrix – see chart below. This matrix contains an idealized limit vector for each of the four merits, which gives the priority for each of the three alternatives.

Supermatrix

Merits	Criteria		Sub-criteria		Global Priorities (Normalized)
Benefits	Societal	0.250	Health	0.800	0.200
			Lifestyle benefits	0.200	0.050
	Economic	0.750	Environmental	0.667	**0.500**
			Market	0.333	0.250
Opportunities	Societal	0.667	Health	0.667	**0.445**
			Environmental	0.333	0.222
	Economic	0.333	Producers	0.750	0.250
			Production	0.250	0.083
Costs	Societal	0.667	Cost to US citizens	0.250	0.167
			Cost to government	0.750	**0.500**
	Economic	0.333	Non-organic Industry	0.333	0.111
			Production	0.667	0.222
Risks	Societal	0.800	Health	0.200	0.160
			Adoption	0.800	**0.640**
	Economic	0.200	Political	0.200	0.040
			Market	0.800	0.160

As the final step, we synthesized those vectors by weighting each of them (based on the weight derived from pair-wise comparisons) and then combining them using either an additive (negative) or multiplicative model. (See page 9-12 for model results.)

DATA

Table A shows the data that was used to develop our model and summarizes some of our judgments made from the data.

Criteria	No Subsidy	Partial Subsidy	Full Subsidy
Reduce ingestion of food additives / pesticides (Lotter)	Avg traditional crop has pesticide residue 33% of the time	Avg organic crop has pesticide residue 10% of the time (from neighboring non-organic production; assumption that farmers may supplement their organic crop with traditional crop since they do not receive full organic subsidies); 1.4 times better than no subsidy	Avg organic crop has pesticide residue 7% of the time (from neighboring non-organic production; slightly less residue than partial subsidy under the assumption that most farms would product only organics in this scenario); 1.5 times better than no subsidy and not materially better than partial subsidy
Less exposure to harmful chemicals for workers (Calvert)	Every 18.2/100,000 ag workers poisoned by pesticides from 1998-99	Every 0.53/100,000 non-ag industry workers poisoned by pesticides from 1998-99;	Every 0.53/100,000 non-ag industry workers poisoned by pesticides from 1998-99
Greater quantity of organic food available (Lotter)		Sweden saw a 300% increase in organic production following subsidy announcement; 1 times better than no subsidy	Sweden saw a 300% increase in organic production following subsidy announcement; 3 times better than no subsidy and 2 times better than partial subsidy
Greater affordability of organic food (Lotter)	In US (environment with not subsidies), the price premium on organic food is between 60-230%	In EU (environment with subsidies), the price premium on organic food is between 10-50%	In EU (environment with subsidies), the price premium on organic food is between 10-50%
Energy efficiency (Lotter)	A 100% conversion to organic farming is anticipated to produce a 9-51% reduction in energy use	A 100% conversion to organic farming is anticipated to produce a 9-51% reduction in energy use; 1.5 times better than no subsidy	A 100% conversion to organic farming is anticipated to produce a 9-51% reduction in energy use; 2 times better than no subsidy
Reduce CO2 emissions through greener production methods (Lotter)	The traditional production of a kg of wheat generates 163% more greenhouse gases	The traditional production of a kg of wheat generates 163% more greenhouse gases than a kg of OA wheat; 1.63 times better than no subsidy	The traditional production of a kg of wheat generates 163% more greenhouse gases than a kg of OA wheat; 1.63 times better than no subsidy

	than a kg of OA wheat		
Reduced wind/water soil erosion (Lotter)		Region-wide conversion to organic would reduce water-borne soil erosion by 39 to 50%; 1.7 times better than no subsidy	Region-wide conversion to organic would reduce water-borne soil erosion by 39 to 50%; 2 times better than no subsidy
Better yield in drought conditions (Lotter)		Some organic crops under drought conditions produce 70-90% more than comparable traditional crops; 1.7 times better than no subsidy	Some organic crops under drought conditions produce 70-90% more than comparable traditional crops; 2 times better than no subsidy
Job creation (Santos)		Labor needs 50% higher for organic crops over traditional; 0.5 times greater than no subsidy	Labor needs 20% higher for organic livestock and 50% higher for organic crops over traditional; 0.7 times greater than no subsidy and 0.5 times greater than partial subsidy
Growth in organic food industry (Lotter)	5.3% growth in U.S. organic sales from 2008-09 (without subsidies);	Sweden saw a 300% increase in organic production following subsidy announcement; 1 times better than no subsidy	Sweden saw a 300% increase in organic production following subsidy announcement; 3 times better than no subsidy and 2 times better than partial subsidy
Greater biodiversity/birds and insects (Lotter)		Study shows ten times greater abundance of non-pest birds on organic farms compared to traditional farms	Study shows ten times greater abundance of non-pest birds on organic farms compared to traditional farms
Reduced input cost (Lotter)		Input costs on organic farms average 50-60% lower for cereals/legumes and 10-20% lower for potatoes and horticultural crops compared to traditional farms; 0.5 times better than no subsidy	Input costs on organic farms average 50-60% lower for cereals/legumes, 10-20% lower for potatoes and horticultural crops, and 20-25% for dairy operations compared to traditional farms; 1.5 times better than no subsidy and 1 time better than partial subsidy
Lower Crop Yield		Organic yield 10% less than traditional yields	Organic yield 10% less than traditional yields
Greater Labor Costs (Santos)		Labor needs 50% higher for organic crops over traditional; 0.5 times greater than no subsidy	Labor needs 20% higher for organic livestock and 50% higher for organic crops over traditional; 0.7 times

			greater than no subsidy and 0.5 times greater than partial subsidy

Ratings Model

We developed a ratings model using the absolute scale below.

Ratings	Scale
Very High	0.056
High	0.030
Medium	0.015
Low	0.008

ANALYSIS

The overall idealized priorities for each of the merits (BOCR) are shown in the tables below.

Benefits Alternative Rankings

"Subsidize All Goods" is the most beneficial decision.

Graphic	Alternatives	Total	Normal	Ideal	Ranking
	No subsidies	0.2066	0.1228	0.2066	3
	Partial subsidies	0.4753	0.2826	0.4753	2
	Subsidize all goods	1.0000	0.5946	1.0000	1

Opportunities Alternative Rankings

"Subsidize All Goods" is the most opportunistic decision.

Graphic	Alternatives	Total	Normal	Ideal	Ranking
	No subsidies	0.4075	0.2116	0.4075	3
	Partial subsidies	0.5186	0.2693	0.5186	2
	Subsidize all goods	1.0000	0.5192	1.0000	1

Costs Alternative Rankings

"Subsidize All Goods" is the most costly decision.

Graphic	Alternatives	Total	Normal	Ideal	Ranking
	No subsidies	0.2952	0.1714	0.2952	3
	Partial subsidies	0.4273	0.2481	0.4273	2
	Subsidize all goods	1.0000	0.5805	1.0000	1

Risks Alternative Rankings

"Subsidize All Goods" is the riskiest decision.

Graphic	Alternatives	Total	Normal	Ideal	Ranking
	No subsidies	0.1324	0.0841	0.1324	3
	Partial subsidies	0.4429	0.2811	0.4429	2
	Subsidize all goods	1.0000	0.6348	1.0000	1

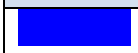
Overall Alternative Rankings

"Subsidizing All Goods" is the highest priority.

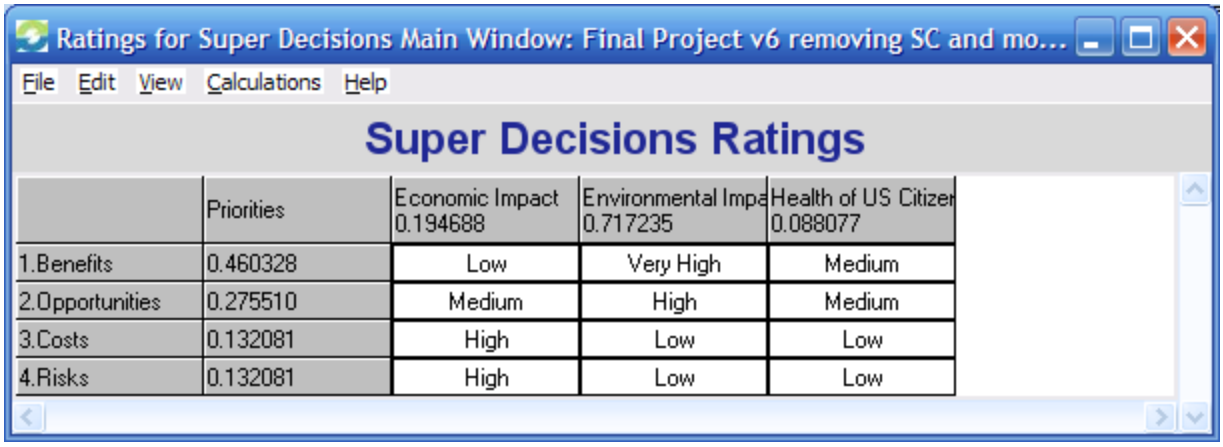
Graphic	Alternatives	Total	Normal	Ideal	Ranking
	No subsidies	0.1509	0.1736	0.3199	3
	Partial subsidies	0.2467	0.2838	0.5231	2
	Subsidize all goods	0.4717	0.5426	1.0000	1

Ratings Model

Ratings Table – The Benefits of Subsidizing All Goods is the highest priority.

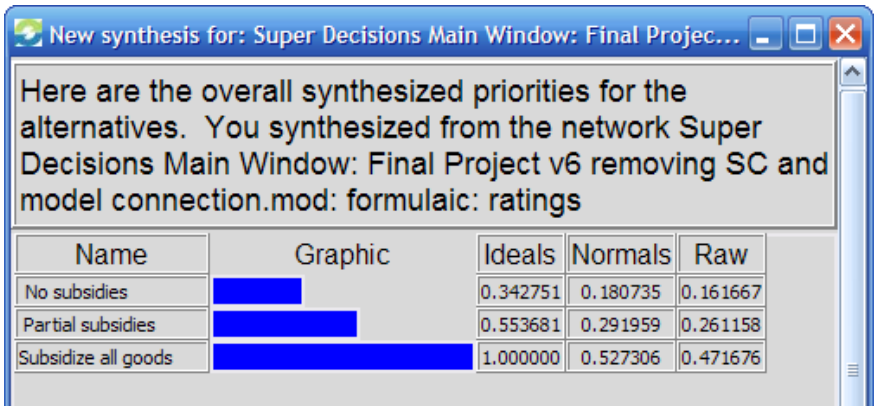
Graphic	Ratings Alternatives	Total	Ideal	Normal	Ranking
	1.Benefits	0.7690	1.0000	0.4603	1
	2.Opportunities	0.4602	0.5985	0.2755	2
	3.Costs	0.2206	0.2869	0.1321	3
	4.Risks	0.2206	0.2869	0.1321	4

The synthesized results of the Additive ratings model are depicted below. The Environmental Impact is the most important, weighing in at 72%.



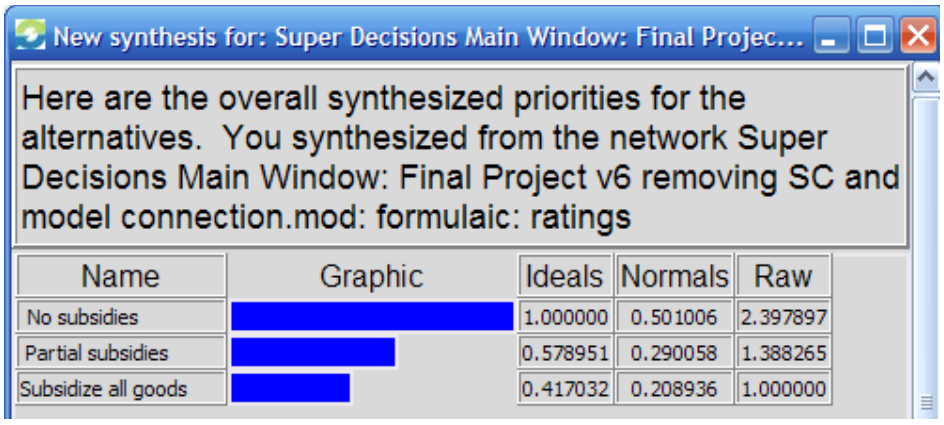
	Priorities	Economic Impact 0.194688	Environmental Impa 0.717235	Health of US Citizer 0.088077
1.Benefits	0.460328	Low	Very High	Medium
2.Opportunities	0.275510	Medium	High	Medium
3.Costs	0.132081	High	Low	Low
4.Risks	0.132081	High	Low	Low

The favored decision is to subsidize all goods.



Name	Graphic	Ideals	Normals	Raw
No subsidies		0.342751	0.180735	0.161667
Partial subsidies		0.553681	0.291959	0.261158
Subsidize all goods		1.000000	0.527306	0.471676

The following show the results of the overall synthesis for the multiplicative model. Interestingly, the alternative the high score in this synthesis is “No subsides”.



Name	Graphic	Ideals	Normals	Raw
No subsidies		1.000000	0.501006	2.397897
Partial subsidies		0.578951	0.290058	1.388265
Subsidize all goods		0.417032	0.208936	1.000000

Since additive (negative) formula is generally best for long term results and multiplicative formula is equivalent to marginal cost/benefit analysis and generally best for short term results, the two model results show that for the long term the government should subsidize all goods while for the short term the government should not subsidize organic food production. “Partial subsidies” is the second best choice in both models.

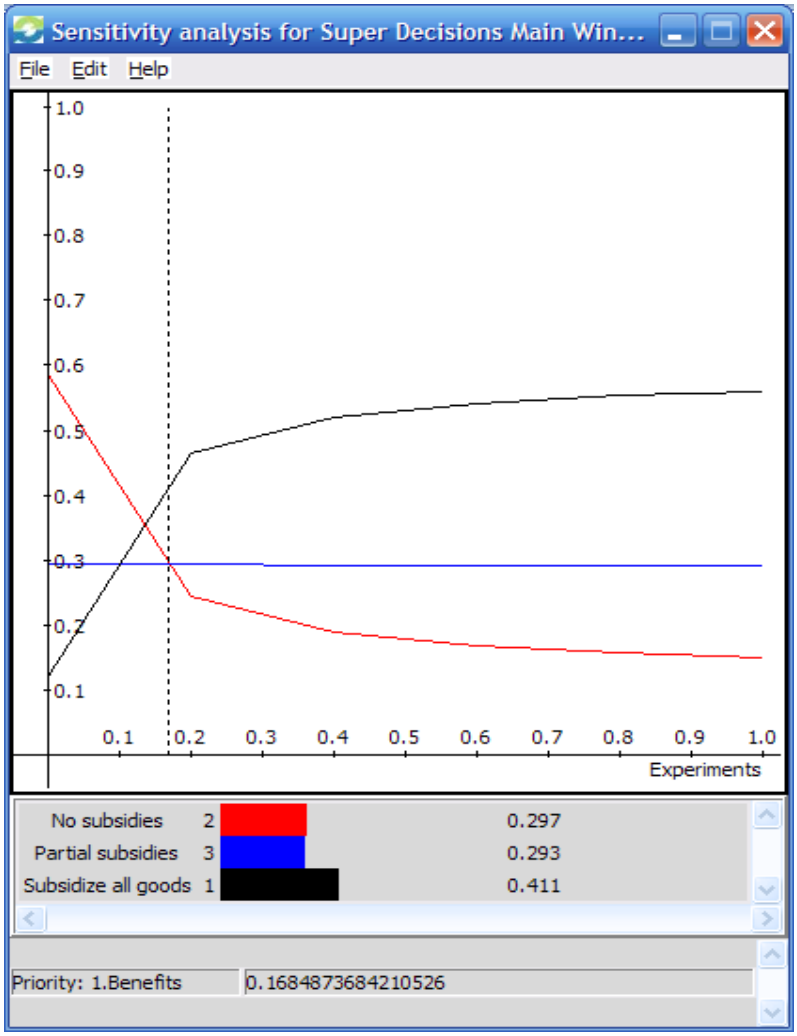
Our strategic criteria, Health of US citizens, Environmental impact and Economic impact, cannot be measured in the short term. If the government chooses not to subsidize, there will be no monetary cost but in the long term, other problems may arise such as health problems and environmental issues.

Sensitivity Analysis

The sensitive analysis was performed taking consideration the Benefits, Costs, Opportunities, and Risks as independent variables. (see next page)

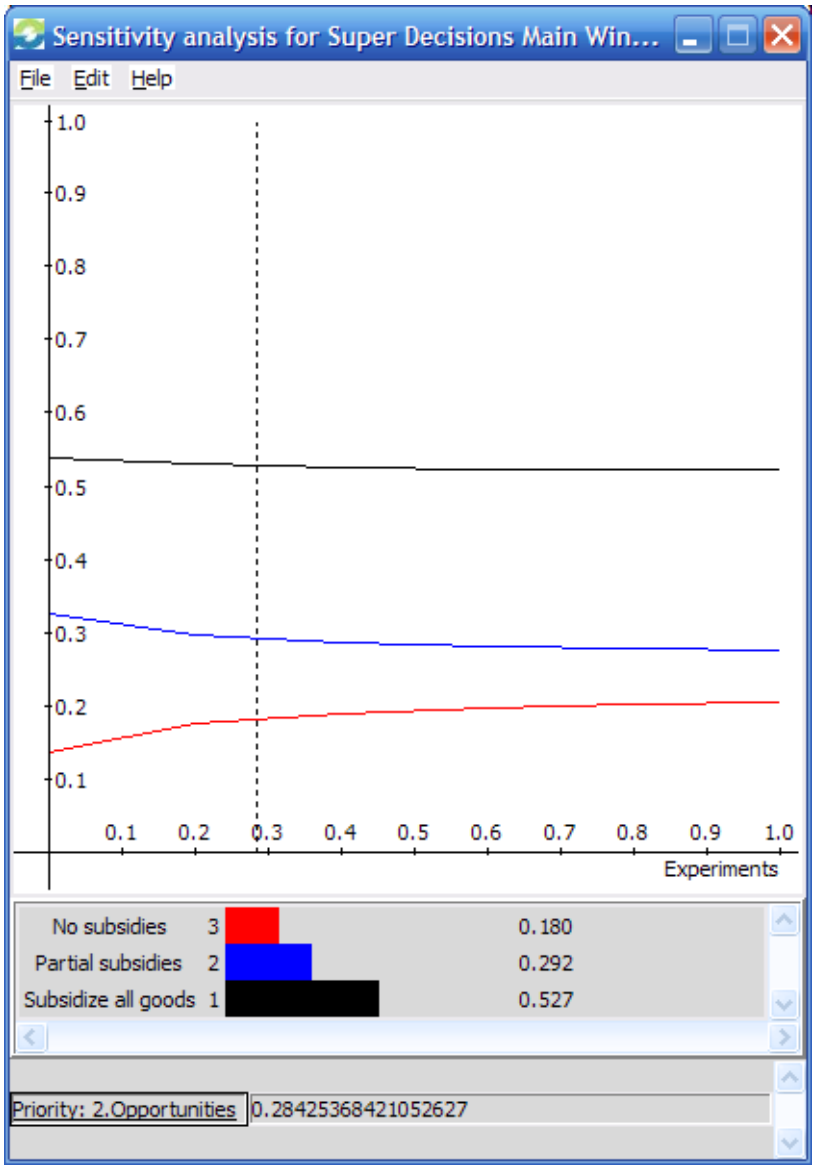
Benefits

The *Benefits* sensitivity analysis illustrated in the figure below indicates that “Subsidize all goods” has the greatest benefit when the priority is greater than/equal to 13.7% (0.137). If the benefits priority is less than/equal to 13.6% (0.136), then the alternative for “No subsides” has the greatest benefit.



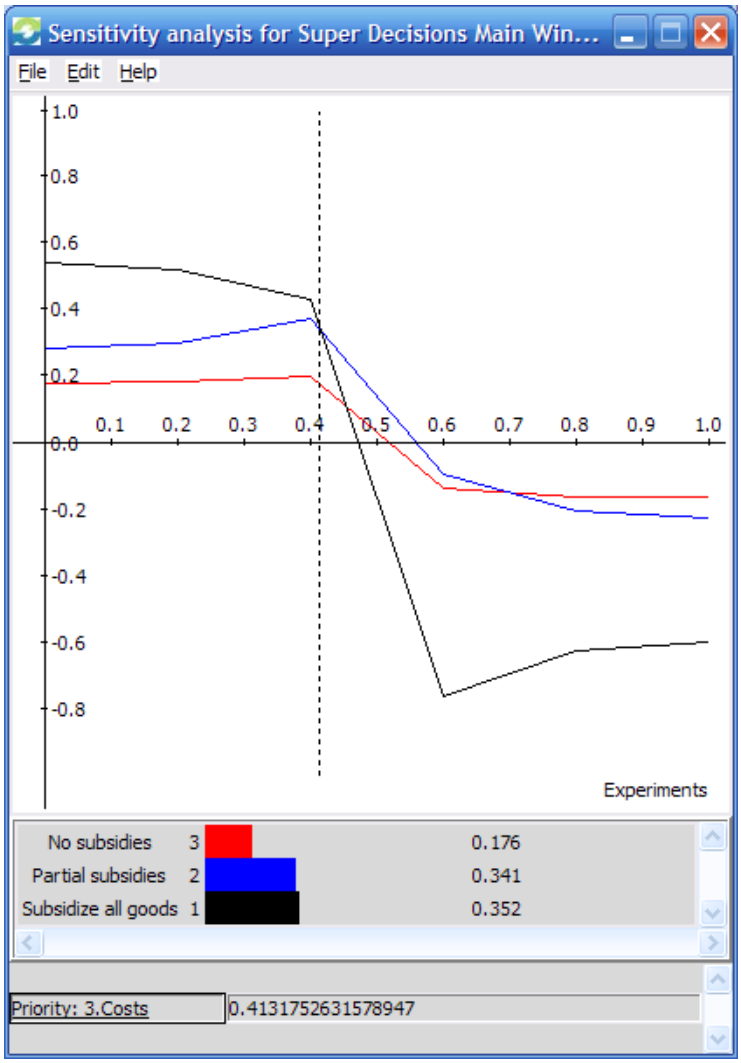
Opportunities

The *Opportunities* sensitivity analysis illustrated below indicates that "Subsidize all goods" is the best alternative at any priority level.



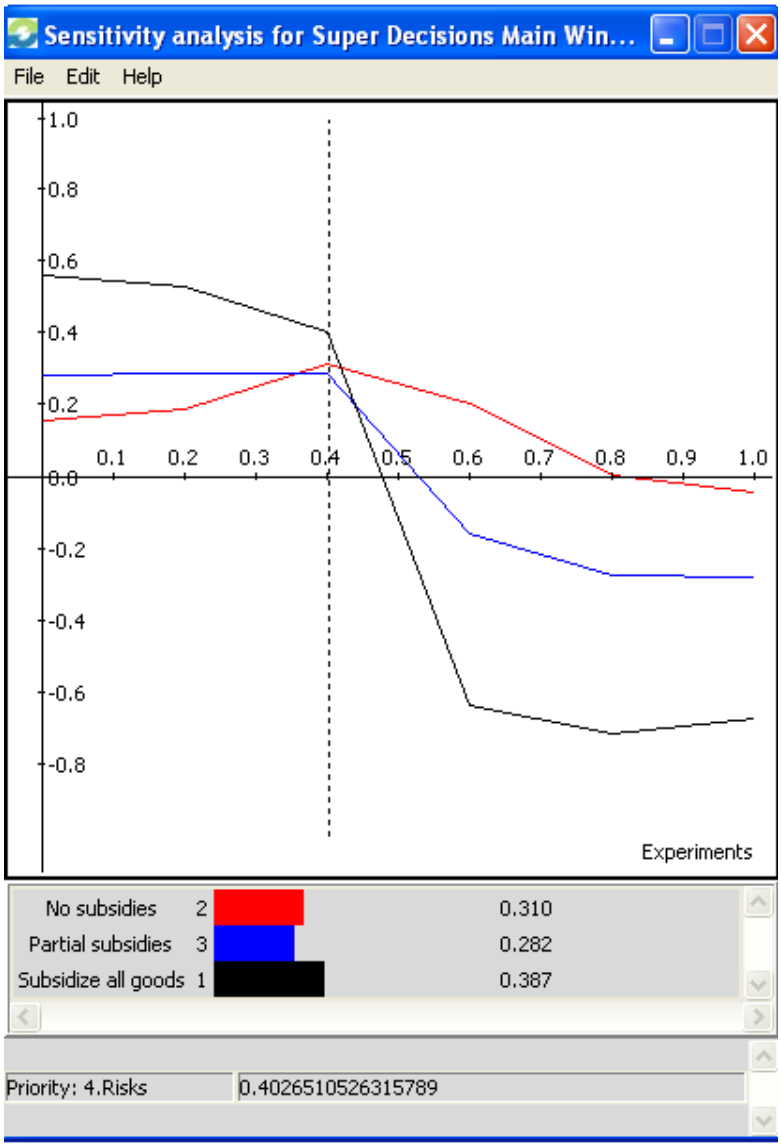
Costs

The *Costs* sensitivity analysis illustrated below indicates that "Subsidize all goods" is the alternative with the highest cost when the priority is below 42% (0.42). When the *Costs* priority is 56% (0.56) or above, all alternatives have negative costs, but "Subsidize all goods" has the largest negative margin.



Risks

From the figure below we gather that "Subsidize all goods" is the alternative with the greatest associated risk if the priority is equal or lower than 40% (0.40). If the priority is equal to/greater than 41% (0.41), then "No subsidizes" is the best alternative.



SUMMARY

This model set out to examine whether the U.S. government should offer subsidies for certified organic farms. Drawing from research studies and publicly available data, we applied the Analytical Network

Process to help reach a calculated decision. The merit node with the highest priority was 'Benefits," and the strategic criteria with the highest priority was "Economic Impact." An interesting outcome of the analysis was that the model calculated short term results from multiplicative synthesis in favor of the "No Subsidies" alternative, yet long term calculations favor "Subsidize all goods" under the additive (negative) synthesis. Furthermore, the risks and costs are extremely sensitive to changes in alternative priorities, often falling into negative ranges after reaching a certain priority level.

CONCLUSION

Based on our analysis, the best course of action that the U.S. government can take is to subsidize all goods. This is a very complex decision with many factors to consider, such as the environmental, societal, and economic impact that would be created this policy. Our findings in the model support our assumptions about the best course of action. The results according to the multiplicative formula indicate that the U.S. government should not provide subsidies. This formula is best used for short term decisions. Most of the costs for the subsidies would be incurred in the short term, and the benefits would not be realized yet. The additive-negative formula results, which consider the long term implications of an alternative, point out that subsidizing all goods is the best alternative in the long run. The benefits that do not occur in the short run are factored into the additive-negative formula which attributes to the difference in results from the multiplicative formula. In the long run, all of the benefits, opportunities, costs, and risks are fully realized making this formula more useful in this analysis of a long-term decision.

FUTURE RESEARCH & APPLICATIONS

The model developed in Super Decisions can be used by the United States government to determine the best choice to subsidize organic food production. However, the model could be improved in several ways to give better results. The three strategic criteria could be expanded to fully illustrate the scope of this decision, and additional sub-criteria and related elements could be included to further strengthen the argument. Additionally, lower ranking elements within the Supermatrix could be removed and replaced with stronger ranking, more relevant elements. The pair-wise comparisons between each cluster are limited to research conducted within the limited (7-week) course timeframe. There could be other data available that would be beneficial in this analysis. Also, we discovered in our research that many experts believe there is a lack of data surrounding the topic of organic growing. Because organic farming is

relatively new, there has not been enough time to conduct empirical research studies. If more research had been conducted at the onset of our model development, then we could come up with a more definitive and accurate answer to the question about whether the U.S. government should provide special subsidies to promote organic farming.

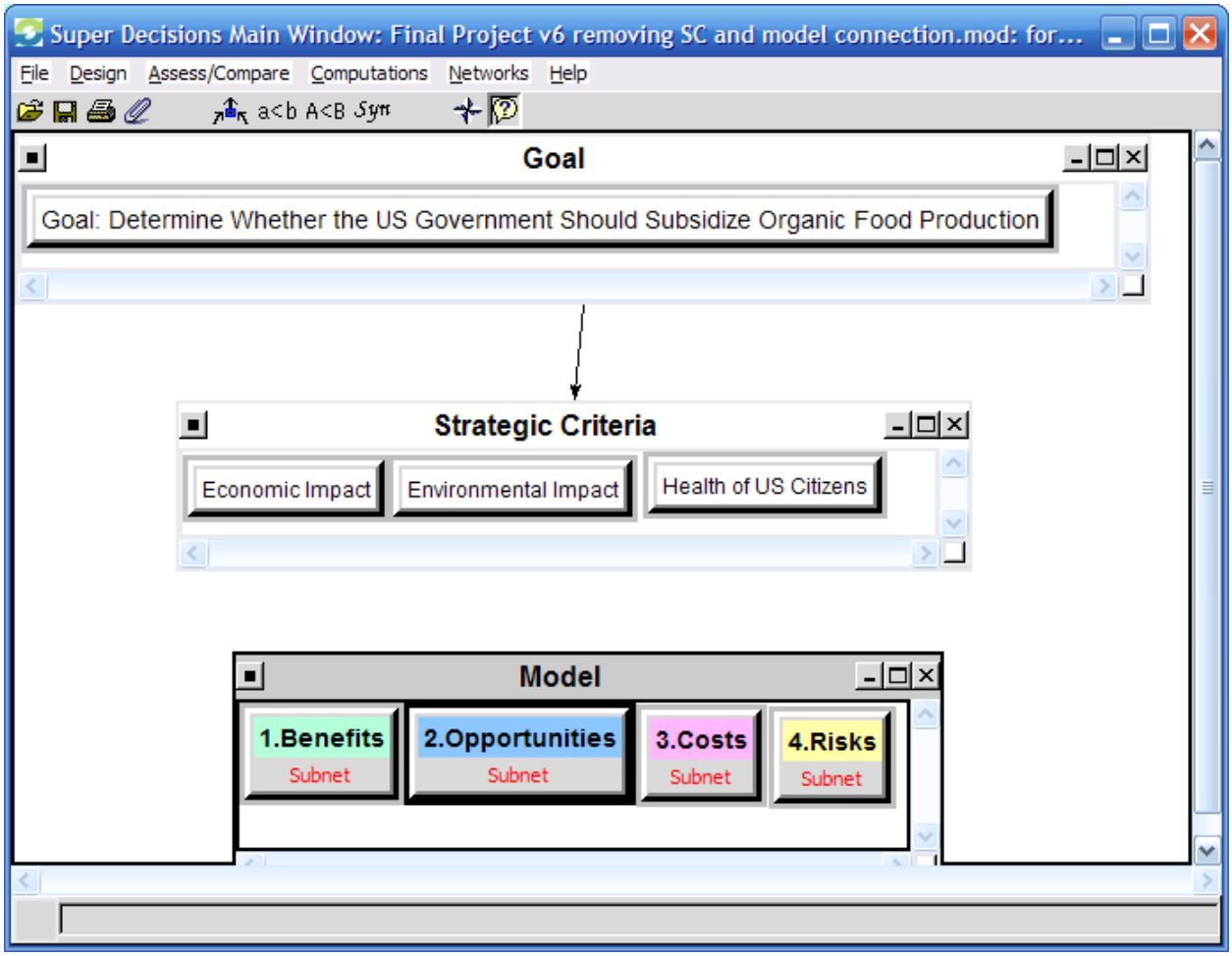
Appendix A

	BOCR Control Criteria	Clusters	Elements
Benefits	Societal	Health	Reduce ingestion of food additives/pesticides
			Less exposure to harmful chemicals (workers)
			Psychology of American consumer
		Lifestyle benefits	Greater quantity of organic food available
			Greater affordability of organic food
	Economic	Environmental	Energy efficiency
			Reduce CO2 emissions through greener production methods
			Reduced wind/water soil erosion
			Less land/water/air pollution from pesticides and chemicals
			Better yield in drought conditions
		Market	Job creation
			Growth in organic food industry
			Stimulate rural/local economies
Opportunities	Societal	Health	Exposure of organics to general population
			Changes in lifestyle choices among Americans (better choices)
			Increased health throughout population; lower insurance premiums through less health issues
		Environmental	Improved health of environments surrounding farms
			Greater biodiversity/birds and insects
			Increase research $ spent to improve organic growing
	Economic	Producers	Traditional producers adopting organic methods and becoming certified
			Additional entrants into the market
			Increase in exporting opportunities
			Change in employment opportunities
		Production	Greater availability to substitute organics for traditional foods
			Reduced input cost
			Greater variety of organic products available
Costs	Societal	Cost to US citizens	Potential for increase in taxes to fund subsidies
			Inefficiencies in supplying goods due to increased regulation of organic goods
			Increased food prices
			Distribution of subsidy funds

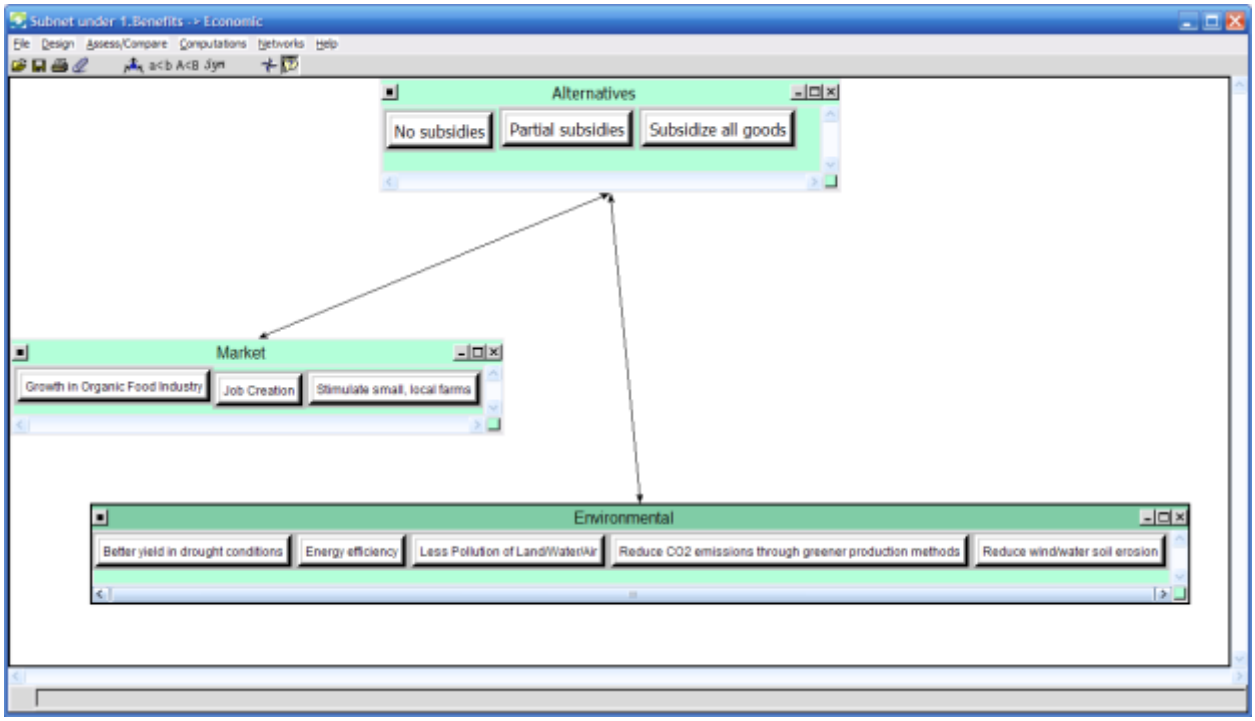
		Cost to government	Definition of program qualifications
			Enforcement of subsidy guidelines
	Economic	Non-organic Industry	current non-organic producers
			pesticide producers (etc)
			transportation and handlers
			retailers
		Production	production is more costly (more manual)
			greater labor costs
			more land is necessary
Risks	Societal	Health	No actual benefit to population health
			Opportunity cost of using funds in another health-related area
		Adoption	No adoption by growers
			No consumer adoption
	Economic	Political	Backlash from non-supporters
			Ineffective policy/infrastructure
			Loss of skilled jobs in the economy
		Market	Producers don't change behavior
			Supply can't keep up with demand for food
			Loss of sales of traditional growers
			Loss of sales for producers of complementary goods to traditional growers

Appendix B

This is an example of the networks that were developed. This screen shot shows the benefits subnets.



This screen shot shows the economic subnet for Benefits. Similar networks were assembled for each of the merits and control criteria.



SOURCES

Acute Occupational Pesticide-related Illness in the US, 1998-1999: Surveillance Findings From The SENSOR-pesticides Program. Geoffrey M. Calvert, David K. Plate, Rupali Das, Rachel Rosales, Omar Shafey, Catherine Thomsen, Dorilee Male, John Beckman, Ernest Arvizu, Michelle Lackovic. American Journal Of Industrial Medicine – 2004.

"Census of Agriculture - 2008 Organic Survey." *USDA - NASS - Census of Agriculture*. 1 Feb. 2010. Web. 23 Apr. 2011. <http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/Organics/>.

"Industry Statistics and Projected Growth." *Organic Trade Association*. June 2010. Web. 23 Apr. 2011. <http://www.ota.com/organic/mt/business.html>.

Lotter, D.W. 2003. Organic agriculture. *J. Sustain. Agric. 21(4)*. April 18, 2011. <http://donlotter.net/lotter_organicag.pdf>

Santos, Florence I., and Cesar L. Escalante. *Farm Labor Management Decisions of Organic and Conventional Farms: A Survey of Southeastern Farm Businesses*. Rep. Department of Agricultural and Applied Economics University of Georgia, Jan. 2010. Web. 18 Apr. 2011. <http://www.ces.uga.edu/Agriculture/agecon/pubs/Outreach%20Bulletin%20-%20Farm%20Labor%20Management%20Survey.pdf>.