CHOICES
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A Statement from the Editors

We welcome you to the 2nd Quarter, 2008 issue of Choices. You will find two timely themes and an interesting individual article which present analyses of current importance to agricultural, food and environmental issues and policy. The first theme addresses high commodity prices and their causes and effects, offering very interesting insights by authors who have been doing extensive analyses of the issues involved. The second theme focuses on the role and value of ecosystem services provided by rural landscapes presented by authors who have published widely in journals and books on the topics they address. We hope this series of articles will help you better understand these current and emerging policy areas and the critical role played by farmland beyond the production of food so crucial to our world economy. The final article addresses an increasingly important trade policy issue of consumer preferences for "fair trade foods", incorporating insights based on the authors' recently completed research.

In addition to these quarterly Choices issues, AAEA is introducing a Policy Issues series designed to present timely topical policy analyses. We hope that you will find the first Policy Issues on the production features of the Food, Conservation and Energy Act of 2008 informative and valuable in your work. If you have not seen it, please access it at www.aaea.org/outreach.

Choices is the principal outreach vehicle of the American Agricultural Economics Association (AAEA). Published quarterly, it is designed to provide current coverage regarding economic implications of food, farm, resource, or rural community issues directed toward a broad audience. *Choices* publishes thematic groupings of papers and individual papers. The broad themes we will repeatedly visit in *Choices* are agriculture and trade, resources and the environment, consumers and markets, and agribusiness and finance. Submitted manuscripts are subject to peer review for publication consideration.

AAEA will also publish monthly *Policy Issues* articles addressing particularly timely topics with peer-reviewed, brief economic analysis of potential interest to those involved in the policy dialogue.

Editorial Communications

Proposed manuscripts, thematic proposals, and comments may be emailed to the editors: Theme and policy issues suggestions or submissions, send to walt@farmfoundation.org; Submitted articles, send to clement.ward@okstate.edu. Editorial communications may be sent to keoughwilson_239@msn.com.

We encourage submissions of proposals for future themed sets of papers, individual articles and timely policy issues analyses. Submit theme proposals and policy issues proposals to Walter J. Armbruster at walt@farmfoundation.org, and individual papers for the quarterly *Choices* to Clement Ward at clement.ward@okstate.edu. We look forward to working with you to address important economic and policy issues affecting food, farms, resources and rural communities.

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Commodity Prices Rock World Markets: Structural Shift or Short Term Adjustments?

Henry Bahn

Skyrocketing agricultural commodity prices are worrisome to consumers and policymakers world wide. Protests and food riots have occurred in over 30 countries, and while some importing nations eased tariffs to encourage trade, some exporters limited trade to protect short domestic supplies. As prices continued to rise over the past several months, key rice–growing countries imposed export restrictions leading to even tighter supplies; countries importing rice faced sticker shock, with prices 60% to 70% higher than just a few months ago. In some cases, family food expenditures have risen dramatically.

The World Bank issued an urgent call to rich nations to help stem rising food prices, warning that unrest in poor countries is spreading, and 100 million people risk falling deeper into poverty. United Nations Secretary General Ban Ki–moon has urged nations to seize an "historic opportunity to revitalise agriculture" as a way of tackling the food crisis. The UN Food and Agriculture Organization warned the developed countries that unless they increase yields, eliminate trade barriers, and move food to where it is needed most, a global catastrophe could result.

In the U.S. food inflation is hurting consumers, school lunch programs, and food banks. Domestic grain merchants, facing high transaction costs, are curtailing some types of contracts, leaving farmers to finance the price risk burden directly. Demand for food grains as biofuel feedstocks sparks moral, as well as economic, debate about the consequences. Adverse weather in the Midwest could result in reduced corn yields later this year.

Are these issues symptomatic of a massive change in agricultural commodity markets, or a short–term response to a collision between policy change, short carry–over stocks, and unpredictable weather? The search for causes leads to the rounding up of a variety of suspects, some usual, some unusual: increasing food demand in rapidly growing developing countries, unprecedented demand for oil from China and India, subsidized biofuel production, reckless speculation in commodity markets and the weak U.S. dollar are all cited as causal. But there is little solid evidence to indict a single cause. The current situation is a complex one that includes supply and demand changes that began over a decade ago, structural adjustments, short–term phenomena, and perhaps, just plain bad luck.

This series of articles by top U.S. agricultural economists explores what's been happening and provides some insight to this emerging phenomenon. Several topics are addressed, including grain prices, the changing behavior of grain merchandisers, the potential impacts of changing food demand and grain supplies, and how feed grain prices may affect meat supplies and prices.

In Farm Commodity Prices: Why the Boom and What Happens Now? Pat Westhoff identifies a number of supply and demand factors that have contributed to the increase in commodity prices. Some of these supply and demand shifts may be temporary, while others are more likely to persist.

Articles in this Theme:

John Lawrence, James Mintert, John Anderson and David Anderson, in Feed Grains and Livestock: Impacts on Meat Supplies and Prices, conclude that the challenge to producers will be to survive the transition from the old equilibrium based on lower grain prices and export driven livestock and poultry production to the new equilibrium with demand for grain also driven in part by energy demand.

The penultimate article, Scott Irwin, Philip Garcia, Darrel Good, and Eugene Kunda's "Convergence of CBOT Futures Contracts," notes that commodity price convergence problems are inconsistent over time and across markets and are different than, although related to, non-delivery basis performance issues. Commodity price convergence problems are not fully understood at this point, and the authors caution against substantial changes in contract specifications whose unintended consequences could be worse than the remedy, particularly if market conditions change in the near future.

The final article is Price Risk Management Alternatives for Farmers in the Absence of Forward Contracts with Grain Merchants. Darrell Mark, B.Wade Brorsen, Kim Anderson, and Rebecca Small address the thorny question of grain farmer alternatives to the cash forward contracts that risk–shedding commercial buyers are increasingly reluctant to offer. Several solutions exist, each with disadvantages relative to forward contracting grain with merchants or elevator operators, proving, once again, that there is no free lunch in the risky business of production agriculture.

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Farm Commodity Prices:Why the Boom and What Happens Now?

Pat Westhoff

JEL Classifications: Q11, Q18, Q42

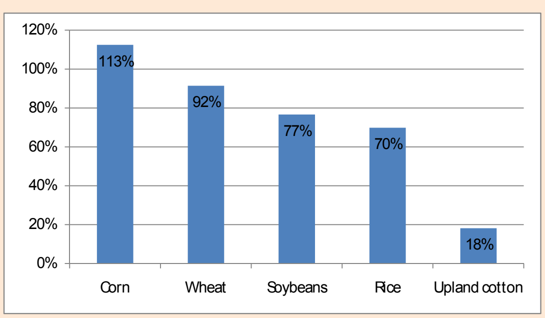
For many years, the price of food was a nonstory. Food price inflation was about the same as the general rate of inflation, and farm commodity market developments rarely drew the attention of those not directly involved in agriculture and the food industry.

That has changed. Rising commodity prices and high food price inflation here and abroad have put agricultural commodity markets in the spotlight. The media are full of stories about the causes and impacts of the commodity boom. In this context, it may be hard to imagine that there is an angle to the story that has not already been covered repeatedly. However, some very simple economics may help us to understand some of the reasons for the increase in prices and to speculate about what might happen in the future.

The Boom

The prices of corn, wheat, soybeans, rice and many other farm commodities have increased sharply since 2006. Exactly how much prices have increased depends on the indicator. Looking at marketing year averages, the U.S. producer price of corn has more than doubled over the last two years, and prices for wheat, soybeans, rice, and many other commodities have also increased sharply (Figure 1). Comparing the lowest futures prices of 2006 to the highest futures prices of 2008 would yield even greater estimates of the increase in commodity prices.

Figure 1. Change in U.S. season average farm prices between the 2005/06 and 2007/08 marketing years



Source: Calculations based on World Agricultural Outlook Board data from May 2008.

In contrast, the decline in the value of the dollar means that farm commodity prices have not increased as much in terms of most foreign currencies as they have in dollar terms. While grain, oilseed and milk prices have increased sharply, prices for cotton, cattle, hogs and many other commodities have not. Consumer food prices have increased more than at any time since 1990 and more than the general rate of inflation in the U.S. economy. Still, current annual consumer food price inflation of about 5% is far below the rate of increase in farm commodity or energy prices.

Why the Boom?

The increase in farm commodity prices clearly cannot be ascribed to any single cause. Two of the best explanations of how we got to the current situation are provided in reports by Trostle and Schnepf. Both make it clear that the list of contributing factors is very long, and that it is difficult even to rank the factors in order of importance.

Instead of trying to identify all the causes of the current market situation, let us apply some very simple economics to isolate developments that warrant further attention. All else equal, economists normally expect higher prices to increase quantities supplied and reduce quantities demanded. If grain prices have roughly doubled over the last two years, the quantity of grain produced in the world should have increased and the quantity of grain utilized should have declined. If instead we observe reductions in production or increases in use, we can conclude there must have been some underlying shift in supply or demand that is contributing to the rise in prices.

Supply Side Factors

Focusing first on the supply side, consider what has happened to grain production in a number of important exporting countries over the last two years. In the European Union, Australia, Ukraine and Canada, production of wheat and other grains was actually lower in 2007 than in 2005, in spite of sharply higher market prices (Figure 2). Reduced production translated into reduced exports, thus limiting supplies in international markets.

Why would production decline in the face of higher prices? The whole story may be complex, but weather is clearly an important factor. In all four exporters, grain yields per acre in 2007 were below 2005 levels, primarily because of drought and other weather–related factors. If better growing conditions result in a return to normal yields in 2008, the increase in production could put downward pressure on prices. The prospect of increased 2008 production in these major wheat exporting countries may be one reason why July futures market prices for wheat declined from over $12 per bushel in mid–March to less than $8 per bushel just two months later.

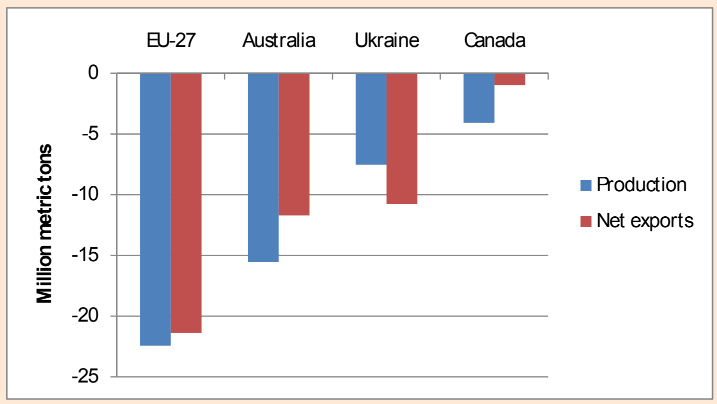
It would be a mistake to blame poor crops for all of the increase in world grain prices. While global wheat production in 2007 was less than in 2005, world corn production increased by almost 12%, with increased production in the United States accounting for most of the change. Considering five major grains (corn, wheat, rice, barley and sorghum), total world grain production increased by an estimated 81 million tons, or 4.1%, between 2005 and 2007 (Foreign Agricultural Service 2008). That suggests world grain production actually increased in per–capita terms, which is inconsistent with a story that production shortfalls are solely to blame for the run–up in world grain prices.

The full story on the supply side is, of course, far more complicated than suggested by these simple comparisons. While world grain production increased between 2005 and 2007, world oilseed production declined slightly, in large part because of the shift in U.S. acreage away from soybeans and into corn in 2007. World grain stocks have been declining, as consumption has exceeded production in most recent years. Stocks have now dropped to levels where it is harder to satisfy demand by continuing to draw down stocks. Grain production and exports from some countries may increase in 2008, but market participants are also well aware that U.S. corn acreage appears likely to decline significantly this year, limiting future supplies.

Demand Side Factors

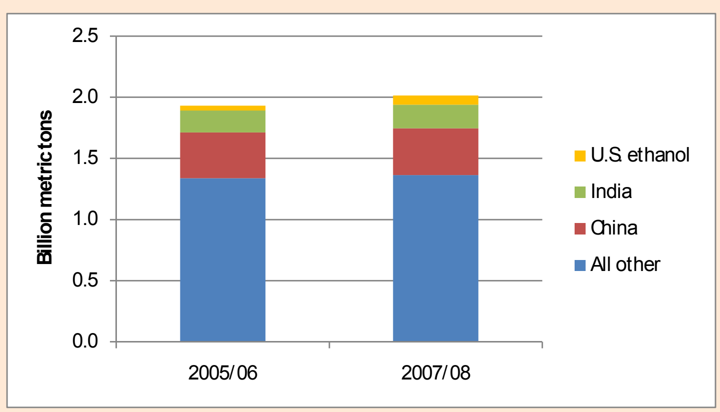
In spite of sharply higher prices, global grain consumption has actually increased by an estimated 83 million metric tons, or 4.3%, over the last two years (Figure 3). This only makes sense if there has been a significant shift in the demand for grain, as population growth alone could only explain an increase of about half that magnitude.

Figure 2. Change in production and net exports of five major grains for selected exporters between the 2005/06 and 2007/08 marketing years



Source: Calculations based on Foreign Agricultural Service data from May 2008 for corn, wheat, rice, barley and sorghum.

Figure 3. World consumption of five major grains, 2005/06 and 2007/08 marketing years.



Source: Calculations based on Foreign Agricultural Service data from May 2008 for corn, wheat, rice, barley and sorghum.

The Role of Biofuels in Higher Food Prices

The role of biofuels in the increase in food prices is hotly debated. Press reports from FAO's conference on world food security highlighted widely different estimates. USDA Secretary Schafer was quoted as saying, "According to our analysis, the increased biofuels production accounts for only 2 to 3% of the overall increase in global food prices" (Lynch). The same news story reports that, "A World Bank analyst estimated that biofuel production has accounted for 65% in the rise of world food prices."

Why do these and other estimates differ so greatly? In digging a little deeper, one quickly discovers that comparing the various studies is like comparing apples to rutabagas. The estimates often refer to different time periods, define "food" differently, and hold different things constant. One study may look at the last twelve months, consider a wide range of food products and separate effects caused by higher energy prices from effects caused by other factors. Another study may look at a longer time period, focus only on grain prices, and more broadly define biofuel effects. Thus, in trying to reconcile the various estimates, it is important to understand just what is being measured. It is critical to be clear about what the estimates do and do not mean in a case like this, where different parties have a very strong interest in "spinning" expert estimates to their advantage.

The data represented in Figure 3 can serve as a type of Rorschach test. Some look at the figure and note that demand has increased in a number of countries and that U.S. ethanol use of grain accounts for less than 4% of global grain consumption in 2007/08. These people tend to argue that strong economic growth in India, China and elsewhere is causing diets to change in ways that increase the demand for grain and other foods, and that growth in biofuel demand is at most a small part of the story.

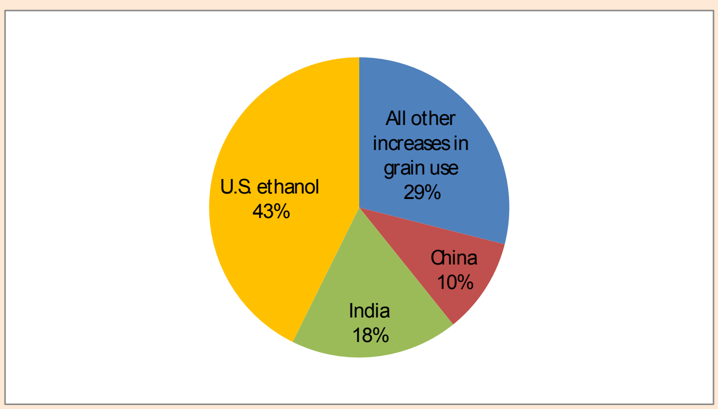
Other people prefer to focus on the changes in global grain consumption over the last two years (Figure 4). India and China continue to be an important part of the story, together accounting for about 28% of the increase in global grain consumption. However, since India and China account for an even larger share of the world's population, that suggests per–capita grain consumption in those two countries has not increased more than it has in the world as a whole.

Instead, the spotlight shifts to the 35 million metric ton increase in U.S. use of corn to make ethanol. This accounts for 43% of the increase in global grain consumption between the 2005/06 and 2007/08 marketing years. Excluding the use of U.S. corn to make ethanol, the increase in global grain consumption is about 2.5%, just slightly more than the increase in the world's population over the same period. In other words, world per–capita use of grain for purposes other than making ethanol is essentially unchanged from what it was two years ago.

In spite of sharply higher prices, oilseed meal and vegetable oil consumption also have increased in a wide range of countries. China is an even more important factor for oilseed meal and vegetable oil markets than it is in the case of grains. Biofuels are again an important part of the story. Industrial uses (including for biodiesel production) account for 36% of the increase in global vegetable oil consumption between the 2005/06 and 2007/08 marketing years. Unlike the case of grains, most of this increase in industrial use of vegetable oil has occurred in the European Union and other countries outside the United States.

Most would agree that food demand for grain is not very responsive to prices, but it is remarkable that even a doubling of world prices appears to have caused barely a ripple in the estimated consumption figures in most countries. Rising incomes change food consumption patterns, often in ways that make consumer purchases

Figure 4. Change in world consumption of five major grains between the 2005/06 and 2007/08 marketing years.



Source: Calculations based on Foreign Agricultural Service data from May 2008 for corn, wheat, rice, barley and sorghum.

less responsive to the prices of basic farm commodities such as grain and vegetable oil. Policies and other factors can limit how much of any given change in world commodity prices is transmitted to food consumers. Still, it is surprising that sharply higher world commodity prices have not made at least a dent in consumption estimates.

Factors Affecting Both Supply and Demand

Three additional factors affecting both the supply and the demand for food require at least a brief mention.

1. The weaker dollar means that food prices expressed in foreign currency terms have not increased as much as they have in dollar terms. This has supported U.S. exports and contributed to the increase in dollar–denominated prices. However, even after correcting for the weaker dollar, the prices of grains, oilseeds, and other farm commodities have increased in almost all currencies. Thus, the weaker dollar by itself cannot explain market developments.
2. Higher energy prices have contributed to higher farm commodity prices by increasing costs of production and by increasing the demand for biofuels. High petroleum and natural gas prices increase fuel and fertilizer costs. They also raise the cost of transporting agricultural inputs to producers and outputs to processors and consumers. High gasoline and diesel prices make biofuels more competitive, encouraging expanded production.
3. Countries have responded to high prices in ways that have exacerbated the situation. To restrain domestic price increases, some countries have restricted exports and reduced import barriers. These and other measures have suppressed domestic price increases, but at the expense of reducing supplies on world markets and, thereby, further raising prices in international markets.

Balance of Factors

A paper prepared by the Food and Agriculture Organization (FAO) reviews many of the factors contributing to the current situation. News reports about the FAO's High–Level Conference on World Food Security, held in June 2008, highlighted debates about the contribution of biofuels to the increase in global food prices (See Box).

What Happens Now?

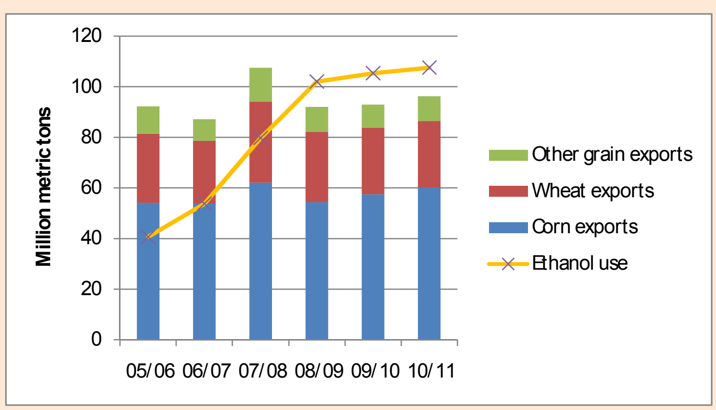
Some of the factors that have caused farm commodity prices to increase are likely to prove transitory, suggesting prices could decline from the lofty levels of early 2008. Already, the prospect of a larger 2008 wheat crop has contributed to a significant decline in wheat futures prices. By mid–May, futures prices for rice and soybeans had also retreated somewhat from record levels, as the most severe concerns about tight supplies had at least slightly lessened.

Producers have already demonstrated a willingness and ability to adjust their crop mix quickly to exploit changes in relative returns, as seen in the shifts in U.S. corn and soybean acreage in 2007 and 2008. However, a more important question is how supplies will respond in the aggregate and in the long run. So far, the sharp increase in prices has not resulted in large increases in the total area used for crop production in the United States or in other countries, nor has there been a large increase in yields that can be attributed to improved returns. Over time, however, one would expect high prices to result in more land being used for crop production than would have been the case otherwise, and investments in new technologies that will eventually pay off in terms of higher crop yields per acre.

Some of the demand–side factors that contributed to the increase in prices appear likely to stay with us for some time to come. Unless there is a severe global recession, continued income growth in China, India and many other middle–income countries is likely to result in further dietary changes and increased demand for many commodities.

While growth in the demand for biofuels could eventually slow, a lot of biofuel production capacity has already been built or is under construction. If petroleum prices stay above $100 per barrel and supportive policies remain in place, it seems likely that most of that capacity will be used and additional capacity will be built, provided feedstock prices do not rise to levels that make biofuel production unprofitable. Even at the lower

Figure 5. U.S. grain exports and ethanol use of corn.



Source: Calculations based on Food and Agricultural Policy Research Institute estimates from January 2008.

petroleum prices assumed in baseline projections prepared by the Food and Agricultural Policy Research Institute in early 2008, ethanol use of corn exceeds total U.S. exports of all grains combined in the 2008/09 marketing year (Figure 5).

The growth in biofuel production further tightens the linkages between energy and agricultural markets. If petroleum prices are high enough, petroleum and biofuel prices are likely to be closely linked—by mid–May 2008, the U.S. price of ethanol was already approximately equal to its energy value relative to gasoline, after correcting for the $0.51 per gallon tax credit then in effect.

In the long run, one would not expect biofuel producers either to make excess profits or to fail to cover operating costs. If expected biofuel profits are large, new plants will be built. This will result in increased biofuel production that will tend to increase demand for feedstocks, which in turn will result in prices for those feedstocks being bid up until the returns to biofuel production are no longer excessive. On the other hand, if plants cannot cover operating costs, they eventually will be forced to shut down.

To oversimplify somewhat, petroleum prices are likely to largely determine biofuel prices and biofuel prices are likely to largely determine prices for corn and other feedstocks in the long run. Since producers will choose which crops to plant based on relative profitability, this suggests that long–run prices for soybeans, wheat and other commodities also will be largely determined by petroleum prices.

This stylized picture does not tell the full story, of course. When they are binding, biofuel use mandates weaken or even sever the linkage between the price of petroleum and the demand for biofuels. In any given year, there is only so much capacity to produce biofuels, so biofuel demand for agricultural commodities is likely to be much less price responsive in the short run than it will be in the long run. There are many reasons why petroleum prices and grain prices will not always march in lockstep in the future.

Finally, one should not be blinded by short–run developments. Several times in the past, most recently in the mid–1990s, many people became convinced that the world had fundamentally changed and that agricultural commodity prices would be on a new higher plateau forever more. In each case the conventional wisdom was shattered shortly thereafter, and real prices for agricultural commodities resumed their long–term decline. While there are many reasons to think, "This time is different," it's important to remember that the same has been said before.

For More Information

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Feed Grains and Livestock: Impacts on Meat Supplies and Prices

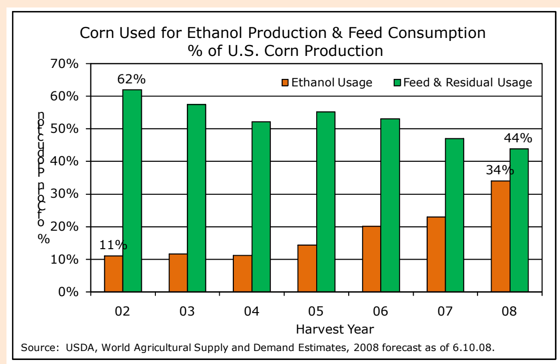
John D. Lawrence, James Mintert, John D. Anderson and David P. Anderson

JEL Classification: Q11

Agriculture in the United States is undergoing a significant change. Grain, oilseed, and land prices have increased significantly, creating a subsequent increase in the income and wealth of many rural Americans—unless you are in animal agriculture. Feed is the largest single cost item for livestock and poultry production, accounting for 60%–70% of the total cost in most years. Although energy, labor, and other inputs have increased, feed costs have increased anywhere from 40%–60% (depending on the species) in the last two years. As price takers in competitive markets, animal producers cannot simply pass their higher costs on to consumers. To date, rising costs have largely been absorbed by livestock and poultry producers, often with significant financial loss. However, higher costs of production will ultimately have to be reflected in higher prices for meat, milk, and eggs at retail counters in the United States and elsewhere. This adjustment process is complex, lengthy, painful, and not without unintended consequences. In this article we attempt to explain what is happening to feed costs, including the likely consequences of the recent ethanol boom on these costs and how the different sectors—beef, dairy, pork, and poultry—are adjusting to higher costs. Importantly, speed of adjustment will vary significantly as industries with shorter production cycles, such as poultry, are able to respond in a matter of months whereas adjustments in industries with longer production cycles, such as beef, can take a period of several years.

Rising Feed Costs

When analyzing the impact of escalating feed costs on animal agriculture, it's important to consider the causes of these increasing prices as well as overall solutions to the problems resulting from higher feed costs. A variety of factors have contributed to higher feed grain prices. However, unlike most other periods of rising grain prices, recent price increases have been driven primarily by strong demand, not supply shocks. In particular, rapid growth of ethanol production in the United States has been a key factor. Domestic feed usage has historically been the largest use for U.S. feed grains, but ethanol production is taking an ever–increasing amount of corn in the United States (Figure 1). Corn prices have increased dramatically. For example, Omaha corn prices average $1.91/bu in January–March 2006 and were $4.92 for the same period in 2008, a $3/bu, or a 158% increase. Yet, on the last day of May corn in Omaha was priced at $5.45/bu and July 2009 corn futures topped $7/bu, so feed costs continue to rise.



We have had high grain prices before so it's useful to examine how livestock producers responded in the past to a sharp increase in feed costs. Perhaps the best analogy to our current situation is the price shift that occurred in the 1970s. Corn prices increased from a season average of $1.08/bu for the 1971–72 crop year to $3.02/bu for the 1974–75 crop year, a 179% increase. In response, the U.S. hog breeding herd decreased nearly 15% in two years and U.S. beef cow inventories decreased 19% between 1975 and 1979. Retail prices for pork and beef increased 56 and 46%, respectively, during the same periods. Although the magnitude of the shifts may differ this time, smaller supplies and higher prices are expected.

Impact on Specific Sectors and Individual Industry Solutions

The current financial losses in most of animal agriculture are not sustainable. Ultimately, higher prices throughout the marketing chain will be required to offset the large increase in production costs. While increased domestic or export demand may help support livestock and poultry prices, higher prices will also come about because quantities supplied to consumers will decline. We'll offer insight into how the major components of the livestock sector have been impacted by rising feed prices and how each industry is responding to increasing costs and declining profits.

Beef Industry

As in all of animal agriculture, production costs have risen sharply in the cattle sector, primarily as a result of rising feed costs. For example, in the cattle finishing sector a monthly survey of commercial cattle feedlots by Kansas State University indicates that the cost of gain increased from an average of about $0.54 per pound in 2006 to $0.74 in 2007 and preliminary estimates indicate feedlot costs of gain will average well over $0.80 per pound during 2008, an increase of 54% in just two years. Cattle feeding returns estimated by Iowa State University indicate cattle feeders experienced the largest loss on record ($167 per head) during April since the series began in the 1960s.

Production costs in the cow–calf sector have also skyrocketed over the last two years. Again, most notable has been the rise in feed costs. Kansas Farm Management Association (KFMA) data documents the shifting cost structure as feed costs per cow increased from $287 in 2006 to $346 in 2007, an increase of 21%. Recent feed grain and protein supplement prices, along with a sharp increase in forage production costs, indicate that total feed costs will rise again during 2008, possibly approaching $450 per cow, an increase of more than 50% in just two years. The same KFMA data indicate that returns in the Kansas beef cow–calf sector still exceeded variable production costs in 2007 by about $50 per cow, but the projected rise in feed costs during 2008 will almost certainly push returns below variable production costs, encouraging some producers to either reduce their herd's size or to exit the industry.

It's important to note that the losses experienced in the cattle sector were not associated with large cattle price declines. In fact, prices for slaughter weight cattle in Kansas were record high in 2007, averaging $93 per cwt., 8% higher than in 2006. Increasing feed costs did push calf prices down 1 to 2% in 2007 compared to a year earlier, but annual average calf prices were still the third highest on record. So the reduced profitability was directly attributable to rising costs, especially feed costs.

Higher beef prices in the next few years from stronger domestic demand seems unlikely as beef demand has weakened moderately since 2004. Consumers' disposable income is a major determinant of consumer demand for beef and slow, or even negative, growth in the U.S. economy during 2008 and 2009 means there will be little likelihood of an increase in domestic beef demand in the short run.

Export demand for beef is improving and will help support beef and cattle prices. Since plummeting in 2004, following the discovery of BSE in the U.S. herd, beef exports have increased significantly. However, U.S. beef exports in early 2008 were still 36% below the same period in 2003. Based on the trend established early this year, U.S. beef exports in 2008 could total 6 to 7% of beef production (still below the 10% of production exported in 2003), which effectively reduces the supply of beef available in the domestic market and hence supports beef and cattle prices. Although current exchange rates will continue to boost U.S. beef exports and discourage imports, the short–run change in domestic supplies resulting from an improving international trade picture is not expected to be large enough to offset the dramatic increase in production costs.

If beef, especially export, demand does not increase enough to yield beef and cattle prices that are high enough to offset the rise in production costs, how will the industry respond? The short answer is that the industry will shrink in size to the point where fewer pounds of beef are marketed to U.S. and international consumers. This shift in the beef supply curve will yield higher prices throughout the beef sector and, over a period of several years, allow producers to cover average total costs. The magnitude of the supply shift that will be required will depend on whether feed grain prices continue to increase or stabilize at their current level and how rapidly beef exports recover, especially to the Pacific Rim countries. Modest herd liquidation is already underway as the U.S. beef cow herd declined by about 1% during 2007. Slaughter data through May 2008 suggests that the liquidation is still underway and might have accelerated somewhat from the 2007 pace. Looking ahead, the U.S. beef industry could be facing several more years of herd reduction before prices rise sufficiently to offset the new production cost regime.

Pork Industry

Pork producers enjoyed a nearly unprecedented string of positive returns between February 2004 and September 2007. However, at least part of the prolonged profitability was due to disease problems that increased farm costs but also reduced the supply of market hogs during 2006 and early 2007. An effective vaccine was widely adopted last year which contributed to a nearly 10% year–over–year increase in pork supplies during the fourth quarter of 2007. As a result, hog prices fell to their lowest levels in four years at a time when feed costs reached nearly their highest levels in history, resulting in losses that mounted quickly.

According to Iowa State University's Estimated Returns, farrow–to–finish hog producer losses for the seven months from October 2007 through April 2008 exceeded the estimated profits of the prior thirteen months. Hog prices during that time did not cover variable costs for producers raising their own grain. Feed costs for farrow–to–finish producers selling hogs in April 2008 were $91.81 per head, 35% higher than April 2007 and 75% higher than April 2006. In late May, corn and soybean meal futures projected an additional $30 per head increase in feed cost by April 2009. If realized, total costs per head in spring 2009 will be nearly $185 per head, 70% higher than in 2006.

The pork industry is reacting to higher costs by downsizing. Breeding herd liquidation is underway in the United States and Canada, and pork supplies are expected to show a year–over–year decrease by the end of 2008 that will continue through 2009. However, small reductions in supply are not likely sufficient to move farm level prices to a level that will sustain the U.S. pork industry.

A simple comparison of prices from 2006 (corn $2/bu and SBM $175/ton) with prices from the first half of the 2007/08 crop marketing year (corn $5/bu and SBM $335/ton) indicates total production costs increased 45%. An elasticity of demand of –.4 suggests that supply will need to decrease by 18% from 2006 levels to offset the cost increase experienced to date. Demand growth, especially in the export markets, will offset some of this reduction. For example, pork exports during January–April 2008 were up over 50% compared to a year earlier. Still, a significant decrease in U.S. pork production, possibly approaching 10%, could be required to push prices back up over average total cost.

Poultry Industry

The poultry industry has viewed the recent rapid expansion of the ethanol industry with considerable concern. Having few good, commercially viable alternatives to corn as a primary energy feed, the poultry industry responded to the initial surge in corn prices beginning in late 2006 by moving fairly aggressively to rein in production; however, when corn prices began to moderate during the 2007 growing season, poultry integrators ramped production back up. Strong demand for poultry, supported largely by export demand, helped the broiler industry to maintain fairly strong prices in the face of higher production.

The quick response of the industry to escalating feed prices in late 2006, along with fortuitous demand strength, especially exports, has helped soften the blow of higher feed prices on the poultry industry. However, that situation now appears to be changing. Despite prices that appear high by historical standards, poultry producers have begun to feel the pressure of mounting feed costs and significant cutbacks in poultry production are on the horizon, based on the rise in production costs. Feed accounts for about 65% of total live broiler production costs (Dozier, Kidd and Corzo, 2008). The 35% increase in corn prices just since the end of last year suggests a roughly 20% increase in farm–level production costs. The single–sector disequilibrium model described by Lusk and Anderson (2004) can be used to illustrate the potential impact of these higher costs. In that model, a 20% increase in broiler production costs at the farm level would result in a 2% decline in the quantity of broilers offered at the retail level and a 6.1% increase in retail broiler prices.

Dairy Industry

The dairy industry has had its own unique market situation since this period of increasing feed prices began. Milk prices through this decade can best be described as volatile, going from record high to record low prices and back to new record highs. Class III milk prices were low in 2005 ($10/cwt), but were already increasing in late 2006 because of stronger demand just as corn prices began to escalate. Milk prices peaked in July 2007 at $21.38/cwt, but declined to $16.76/cwt by April 2008. Despite the recent price decline, milk production is still increasing because, unlike the beef industry, output prices are still above production costs.

From 2006 to 2008 milk production costs increased approximately $2.00/cwt according to the Agricultural and Food Policy Center's representative dairy farms (Anderson, et al. 2008). Feed costs make up approximately 53% of all production costs on the representative dairies. Historically, a $2.00/cwt increase in costs might set in motion a production decline of 2% or more. However, given the current state of milk product demand, milk production remained profitable for most producers despite the cost increase and expansion in the industry is continuing.

The strength in milk prices was largely driven by strong export and domestic demand for milk products which kept milk prices above production costs, despite the increase in feed costs. U.S. milk product exports have increased for a variety of reasons. Drought in Australia, and reduced production in the EU as subsidies decline strengthened the U.S. position as an exporter. The combination of reduced competition in export channels and a weaker U.S. dollar is largely responsible for the growth in U.S. dairy product exports.

The dairy industry also continues to undergo structural changes. More large dairies enter production or expand from existing operations, small dairies continue to exit the industry, and production shifts regionally. Various areas of the United States have experienced rapid growth, like New Mexico, Idaho, and, more recently, the Texas Panhandle. So, dairy production in some regions of the U.S. will decline, while other regions continue to experience growth. Looking ahead, it will take more time for increased milk production to push prices below production costs, although any further increases in feed costs will accelerate that process. Still, strong demand growth, especially in export markets, has so far enabled the dairy industry to avoid the large financial losses attributable to rising feed costs that have hit other livestock species.

Unintended Consequences of the Ethanol Boom

A few short years ago, most analysts and policy makers contemplating a four– or five–fold increase in ethanol use would probably have envisioned an array of related external benefits: a reduction in harmful automobile emissions, a lessening of dependence on foreign petroleum, a boost in corn prices for farmers, and an abundance of cheap by–product feeds for livestock producers. While increased ethanol production has certainly yielded some benefits, it has also carried with it a number of unintended consequences, particularly for the livestock sector.

Growth in ethanol production has made carryover feed grain supplies very tight by historical standards exposing livestock producers to more feed price risk than in the past. In turn, tight carryover supplies not only push average prices up, but also contribute greatly to corn price variability. Thus, increasing ethanol production means that livestock producers face far more feed cost risk than in the past.

One of the more dramatic consequences of the ethanol boom has been its impact on by–product prices. As corn prices have risen to historic levels, prices of substitutes for corn in livestock rations have increased sharply as well. Anderson, Anderson, and Sawyer (2008) note that the price of major corn by–product feeds expressed as a percentage of corn price trended lower over the last twenty–five years, suggesting that by–products have gotten a little cheaper relative to corn. However, with corn prices at record levels by–products, in absolute terms, are more expensive than ever before.

If the market for by–products is efficient, by–products will be priced competitive with corn, based on their feeding value. In the long run, then, the advantage to feeding by–products will be mostly for those producers of ruminant animals that are situated close enough to an ethanol plant to realize a transportation cost advantage. In the cattle industry, this suggests a shift of comparative advantage towards Northern Plains and Corn Belt feeders with better access to wet ethanol by–product feeds than Southern Plains feeders.

With respect to the competitive position of various livestock species, prior to the ethanol boom, conventional wisdom held that increased availability of by–products would favor cattle, since ruminants are well–adapted to using these feeds. Additionally, the beef industry has the opportunity to use more forages to feed cattle and, while forage values are rising, the cost increase so far has been smaller than for grains and proteins. Longer term, however, if by–product feeds and forages are priced more competitively with corn, the beef industry's advantage could erode. With higher feed prices across the board, efficiency of gain again becomes the key determinant of comparative advantage. Thus, it is possible that, in the long run, the ethanol boom may actually enhance the poultry industry's comparative advantage derived from its greater feed efficiency.

What has been a boon to crop prices has had serious unintended consequences for livestock producers. In fact, the livestock industry has absorbed all of the costs of ethanol and the consequences of those costs are still to be felt in the rest of the economy. For example, through mid–year 2008, all major milk and meat supplies were still higher than during the same period in 2007. But as production of animal proteins decline in response to higher costs, consumer prices will increase and rural communities where livestock and poultry are produced and processed will experience downsizing and loss of economic activity that these sectors created. The new equilibrium in agriculture will have both livestock and renewable fuels. The challenge for animal agriculture is to survive the transition from the old equilibrium based on grain prices driven by the demand for domestic livestock feed and exports to the new equilibrium where demand for grain is driven by government policy and energy prices, which is expected to result in an industry providing a smaller supply of higher priced animal proteins to consumers.

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Recent Convergence Performance of CBOT Corn, Soybean, and Wheat Futures Contracts

Scott H. Irwin, Philip Garcia, Darrel L. Good and Eugene L. Kunda

JEL Classifications: Q11, Q13

Futures markets play a key role in price discovery and risk transfer in many agricultural markets. Concerns have been raised about the performance of Chicago Board of Trade (CBOT) grain futures contracts in a number of recent forums, most prominently at the Agricultural Forum hosted by the Commodities Futures Trading Commission (CFTC) on April 22nd, 2008. Market participants have expressed concern that futures prices have been artificially inflated since the Fall of 2006, contributing to weak and erratic basis levels and a lack of convergence of cash and futures prices during delivery. In this article, we focus on the nature and consequences of recent convergence problems in CBOT (now CME Group, Inc.) corn, soybean and wheat futures contracts. We also briefly comment on proposals for changing the contracts to address the problems that have surfaced recently.

Convergence problems at delivery locations are not necessarily identical to nondelivery basis performance issues, which are not addressed in this article. Basis in some nondelivery markets may be influenced by lack of convergence, but that is not uniformly the case. Corn basis at interior processing markets, for example, is less influenced by the Illinois River basis (delivery location) than cash markets close to the River. Basis at nondelivery locations is influenced by transportation costs, storage and ownership costs, supply of and demand for storage in the local market and merchandising risk (margin risk). All of these factors have likely contributed to weaker basis at many nondelivery markets.

Convergence Patterns

The delivery process is an essential component of futures contracts with physical delivery, as it ties futures and cash prices together. In a perfect market with costless delivery at one location and one date, arbitrage should force the futures price at expiration to equal the cash price. If futures were above the cash price, the cash commodity would presumably be bought, futures sold and delivery made. If the cash price exceeded futures, users could buy futures and stand for delivery. This type of arbitrage should prevent the law of one price from being violated.

In reality, delivery on grain futures contracts is not costless and is complicated by the existence of grade, location and timing delivery "options" that have a demonstrated value to sellers of contracts. A more realistic approach is to think of a zone of convergence between cash and futures prices during delivery periods, with the bounds of convergence determined by the cost of participating in the delivery process. Previous estimates of the direct costs of delivery are in the range of 6 to 8 cents per bushel. (i.e., barge load out, storage and interest opportunity costs).

Figure 1. Basis on the first day of delivery for December 2001 through May 2008 CBOT corn futures contracts at the Illinois River north of Peoria delivery area

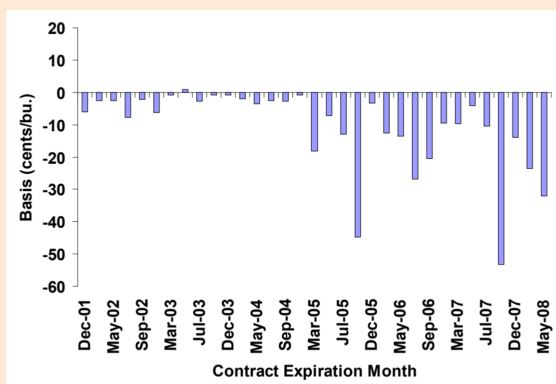


Figure 2. Basis on the first day of delivery for November 2001 through May 2008 CBOT soybean futures contracts at the Illinois River north of Peoria delivery area

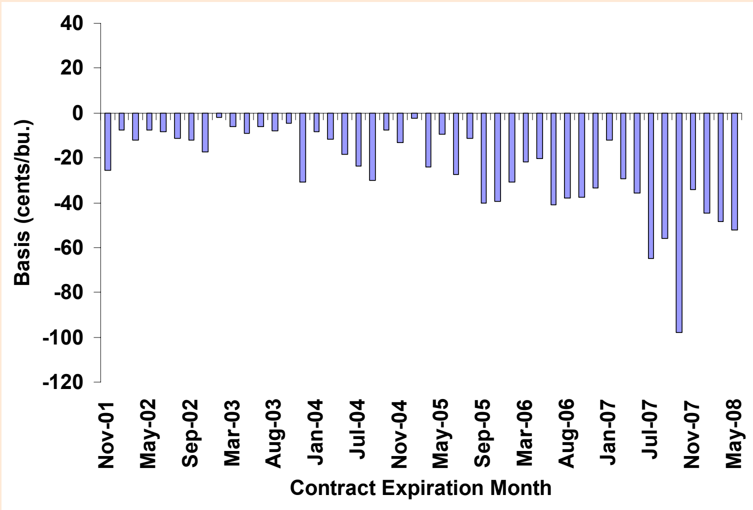
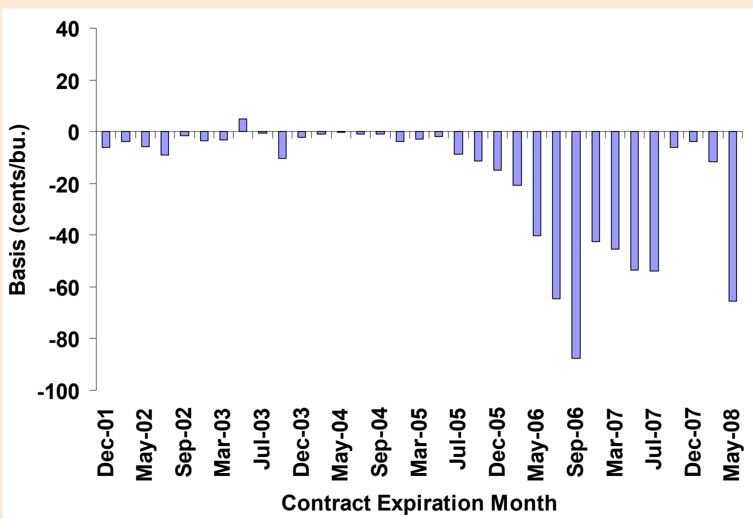


Figure 3. Basis on the first day of delivery for December 2001 through May 2008 CBOT wheat futures contracts at the Toledo delivery area



Figures 1 through 3 show the difference between cash and futures prices (the basis) on the first day of the delivery period for corn and wheat futures contracts expiring between December 2001 and May 2008 and soybean futures contracts expiring between November 2001 and May 2008. Note that a negative basis means the futures price is greater than the cash price and a positive basis means that futures price is less than the cash price. For these calculations, grade and location adjustments are made to the cash prices where appropriate. Convergence patterns at the presented location are representative of convergence behavior at other delivery locations.

Ignoring problems created by Hurricane Katrina in September 2005, convergence weakness first surfaced with the July 2006 wheat contract. Nonconvergence in wheat is extremely large by historic standards, reaching a low in September 2006 when the Toledo cash price ended up 90 cents below futures on the last day of the delivery period. This weakness in wheat persists through July 2007. Convergence is relatively good in September 2007, December 2007 and March 2008, but poor performance re-emerges in May 2008. Convergence in soybeans is poor beginning with the March 2007 contract, especially poor in September 2007, improves to almost acceptable in November 2007, but returns to very poor performance in January, March and May 2008. In general, convergence since July 2006 is better for corn than for wheat and soybeans. Convergence performance is weakest for corn in September 2007 and March 2008.

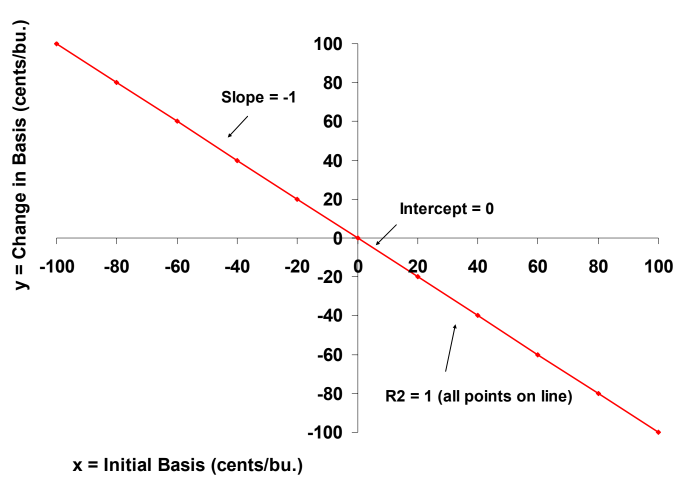
Table 1 presents average convergence performance at all delivery locations for corn, soybeans and wheat before and after 2006. Average basis levels on the first and last day of the delivery period during 2001-2005 generally are +/- 6 to 8 cents per bushel, with the exception of Illinois River delivery locations for soybeans. This is within the range of previously mentioned estimates of the direct costs of delivery. Average basis at delivery locations during 2006-2008 deteriorated (weakened) substantially in all three markets. The deterioration averaged about 14 cents per bushel in corn, 25 cents in soybeans and 50 cents in wheat.

Table 1. Average Basis on the First and Last Day of Delivery for November or December 2001 through May 2008 CBOT Corn, Soybean and Wheat Futures Contracts

Commodity/ Delivery Location	Contract Expiration Months: Nov or Dec 2001 - Nov or Dec 2005	Jan or Mar 2001 - May 2008	Difference
First Day of Delivery		cents/bu.	
Corn			
Chicago	0.1	-14.9	-15.0
Illinois River North of Peoria	-4.2	-19.1	-14.9
Soybeans			
Chicago	-6.0	-30.8	-24.8
Illinois River North of Peoria	-14.3	-41.1	-26.8
Illinois River South of Peoria	-15.1	-39.7	-24.6
St. Louis	-4.2	-24.3	-20.1
Wheat			
Chicago	0.2	-46.8	-47.0
Toledo	-4.2	-41.3	-37.1
St. Louis	5.7	-58.8	-64.5
Last Day of Delivery			
Corn			
Chicago	-0.1	-12.8	-12.7
Illinois River North of Peoria	-5.8	-20.1	-14.3
Soybeans			
Chicago	-11.4	-33.2	-21.8
Illinois River North of Peoria	-17.4	-47.3	-29.9
Illinois River South of Peoria	-17.5	-44.3	-26.8
St. Louis	-8.4	-28.2	-19.8
Wheat			
Chicago	-4.1	-35.4	-31.3
Toledo	-4.1	-36.9	-32.8
St. Louis	0.1	-70.7	-70.8

Note: September 2005 corn and soybean contracts excluded from 2001-2005 averages.

Figure 4. Perfect predictability of delivery location basis



Implications

While recent convergence failures are dramatic, in isolation each episode is not necessarily damaging to the overall economic functioning of markets. Real economic damage is associated with increased uncertainty in basis behavior as markets bounce unpredictably between converging and not converging. As first noted by Holbrook Working many years ago, this is damaging because basis in storable commodity futures markets should provide a rational storage signal to commodity inventory holders. A weak basis should be a signal to store and vice versa. However, this depends on the predictability of the subsequent change in basis. That is, the basis should strengthen over time thereby earning "the carry" for someone holding stocks of the commodity and simultaneously selling the futures.

The reliability of basis signals can be quantified by measuring the level of basis at some point before the delivery period and comparing this "initial" basis to the change in basis from that point forward through the delivery period. Perfect predictability of delivery location basis is illustrated in Figure 4.

Note that when delivery location basis is perfectly predictable, the relationship between initial basis and the change in basis has a slope of -1 and runs through the origin. In other words, if basis is -50 cents/bushel two months before expiration, the change in the basis over the subsequent two months should be +50 cents/bushel. Additionally, all points lie directly on the line, which indicates that storage hedges over the interval are perfectly effective in eliminating storage return risk.

Figure 5. Predictability of CBOT corn basis change to first day of delivery with all delivery locations pooled

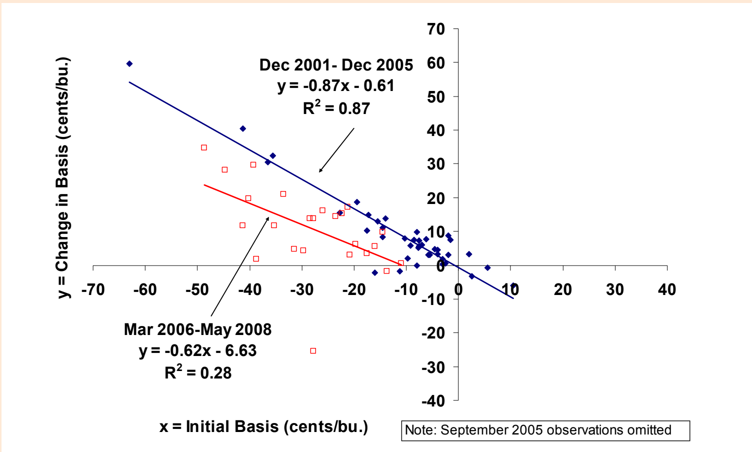


Figure 6. Predictability of CBOT soybean basis change to first day of delivery with all delivery locations pooled

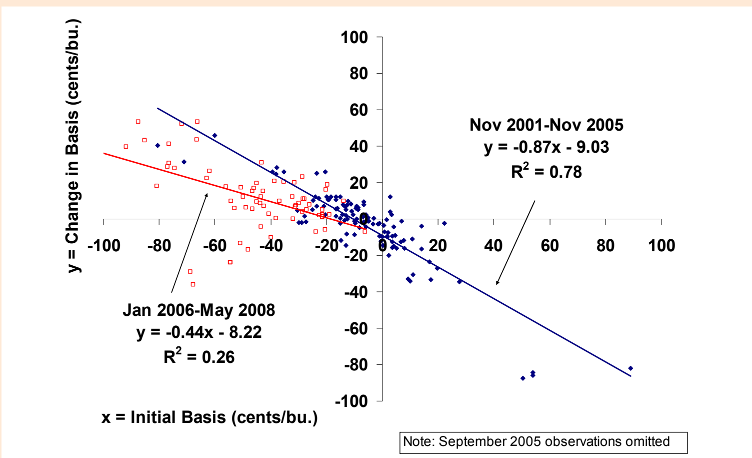
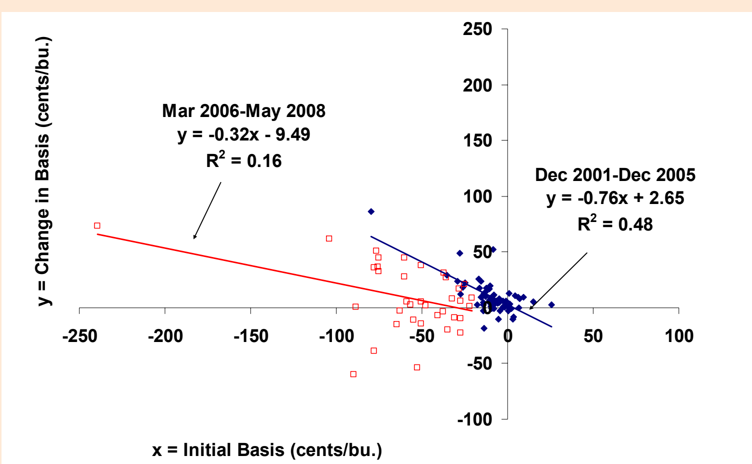


Figure 7. Predictability of CBOT wheat basis change to first day of delivery with all delivery locations pooled



Figures 5 through 7 show the predictability of delivery location basis for CBOT grain futures contracts for two periods: December 2001 - December 2005 vs. March 2006 - May 2008 for corn and wheat and November 2001- November 2005 vs. March 2006 - May 2008 for soybeans. The horizontal axis in each chart measures the level of the delivery location basis on the day after the preceding contract expires. The vertical axis measures the change in the delivery location basis from the day after the preceding contract expires to the first day of delivery. Note that observations for all delivery locations (see Table 1) and expiration months for a given commodity are pooled together in the analysis and that observations for new crop December and November contracts in corn and soybeans start on the first trading day of October, rather that the first day after preceding September contracts expire in order to avoid old/new crop cash price instabilities. In addition, September 2005 contracts are omitted for corn and soybeans due to the effects of Hurricane Katrina.

The charts indicate a sharp decline in basis predictability for all three markets over March 2006 – May 2008. In corn, the upper right regression line indicates the futures market performs reasonably well in terms of basis predictability before 2006, as the slope and intercept are near -1 and 0, respectively, and hedging effectiveness (R^2) is a respectable 87%. The lower left regression line shows the precipitous drop in basis predictability over the last two years in corn. The slope declines moderately, but the intercept increases substantially, and hedging effectiveness drops to 28%. (Similar results are found if the outlier observation in the lower left quadrant is dropped from the 2006-2008 regression.)

Basis predictability results for soybeans are even more dramatic. The lower left regression line indicates delivery location basis during March 2006 – May 2008 changes much less than the initial basis (slope = -0.44) and hedging effectiveness drops to 26%. Results for wheat are different from corn and soybeans, in that basis predictability was poor before 2006. Nonetheless, predictability over March 2006 – May 2008 followed the pattern of corn and soybeans and deteriorated substantially relative to the earlier period.

The bottom line from the predictability analysis is that delivery location basis in corn, soybeans and wheat generally is weaker and far less predictable over March 2006 through May 2008 compared to the preceding period. This potentially has far-reaching implications for hedging use of these markets. In particular, Holbrook Working argued persuasively that futures markets for storable commodities depend primarily on hedging for their existence. The long-run viability of a futures market may be threatened if the market does not provide an efficient hedging mechanism for producers, merchants and processors. Over the last two years, these hedgers have found the corn, soybean and wheat futures markets to be increasingly inefficient for making storage decisions and managing the risk of market positions. Since trading volume has been setting records during the same time period, this is offset to some degree by the high degree of liquidity (ease of buying and selling) available in these markets. However, if liquidity advantages do not outweigh hedging inefficiencies, decreased hedging use may result, as commercial hedgers seek alternative mechanisms for transferring and managing price risks.

Proposed Solutions

There has been no shortage of proposed solutions to the convergence problems of CBOT grain futures contracts. The solutions suggested to date tend to focus on:

1. Encouraging longs to liquidate before first notice date by changing delivery rules to force takers to load out (demand certificates) or by increasing maximum storage charges to make owning delivery instruments less attractive. The assumption being that forcing longs out before delivery would drive down the nearby contract and improve convergence.
2. Changing terms of the futures contact to a cash index rather than a certificate market, thereby forcing convergence to the cash index.
3. "Managing" the influence of long-only index funds and perhaps other groups by limiting hedge exemptions, thereby forcing those groups to trade with speculative margins and speculative limits. This solution emerges from the notion that these traders have artificially and permanently forced futures prices above fundamental value of the commodities in the cash market.
4. Expanding delivery capacity in order to accommodate more arbitrage of cash and futures prices during the delivery period and thereby force convergence.

In our view, all of the proposed solutions put the cart before the horse because we have yet to nail down exactly what caused the convergence problems observed over the last couple of years. A relevant observation in this regard is that the nature of convergence problems has been inconsistent through time and across markets. Convergence in wheat was weakest during 2006 but recovered somewhat in late 2007 and early 2008, only to return to very poor performance with the most recent contract expiration (May 2008). Convergence in soybeans was weakest in the second half of 2007 and the first half of 2008. The inconsistency makes it difficult to identify a single cause and difficult to accept a one-solution remedy.

Without a consensus as to the causes of poor convergence performance, it is questionable whether substantial changes in contract specifications are appropriate at the present time. Unintended consequences could be worse than a poorly designed remedy, particularly if market conditions change in the near future. Tweaking some contract specifications and monitoring performance makes sense, but may not be palatable to market participants who would like an immediate fix.

Agricultural economists have played a key role in analyzing similar controversies about delivery specifications in the past. Examples include onion futures contracts in the 1950s, Maine potato futures contracts in the 1970s and live hog futures contracts in the 1990s. This rich literature points to a number of variables that need to be carefully investigated with respect to CBOT corn, soybean and wheat futures contracts, such as transportation differentials, storage rates, congestion during delivery, deliverable stocks and arbitrage incentives of the different firms regular for delivery. We are currently in the process of investigating the impact of these variables on the delivery performance of the grain futures contracts.

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Price Risk Management Alternatives for Farmers in the Absence of Forward Contracts with Grain Merchants

Darrell R. Mark, B. Wade Brorsen, Kim B. Anderson and Rebecca M. Small

JEL Classifications: G13, G20, Q13

Grain producers have historically made much less use of futures and forward contract markets than grain merchandisers and other middlemen in the grain marketing channel. When grain prices are close to government support levels, producers are well protected from price decreases and they have little need to manage risk through forward pricing. Also, producers must make many long–term investments in land and machinery, which coupled with yield risk, has made forward pricing somewhat less effective in protecting producers against the risks they face. However, as grain prices rise government supports have also become less effective in protecting producers against price decreases. Moreover, increased use of crop insurance allows producers to be able to pay nonperformance penalties associated with cash forward contracts in the event of a crop failure. Thus, producer demand for forward contracts has skyrocketed in recent years.

Most producers prefer forward contracts to futures contracts because they then avoid basis risk as well as the cash required for margin calls. Producers who forward contract receive a few cents less per bushel than they would by hedging (Brorsen, Coombs and Anderson, 1995; Shi, Irwin, Good and Hagedorn, 2004). Elevators have been willing to offer this service because it assures them a supply of grain. At the same time when farmers have a greater demand for cash forward contracts, grain merchants and elevator operators now have limited capacity to offer these contracts. The extra costs associated with margin accounts and extra working capital have been reflected in lower forward basis bids for corn, soybeans, and wheat in many Midwest and Corn Belt states. In Oklahoma, for example, elevators lowered their wheat forward basis bids about 30 cents/bushel rather than discontinue offering forward contracts. Many grain buyers began to restrict their offerings of cash forward contracts in March 2008 instead. Some elevators simply quit offering forward contracts. In other instances, buyers quit offering cash forward contracts beyond the current crop year. Some buyers are only offering cash forward contracts for grain to be delivered within 60 days.

The question then is what do producers do now? This article first explains the problems faced by elevators and offers possible solutions to their problems that would let them again offer competitive forward contract bids. Then, we review producers' alternatives to forward contracts for price risk management.

Elevators and Forward Contracts

Goodwin and Schroeder (1994) found in a sample of Kansas producers that only 11% hedged any of their grain using futures. Schroeder, Parcell, Kastens and Dhuyvetter (1998) summarized several studies that consistently showed that more producers used forward contracts than used futures hedges. These studies showed that 42–74% of producers used forward contracts to price any of their grain. Merchants and elevator operators can offer producers cash forward contracts, agreeing to purchase grain at a later date, because they can offset their risk in the futures market. Essentially, by doing so, they have hedged the producer's price risk in the futures market on behalf of the producer. So, the merchant maintains the margin account on behalf of the producer. Further, the producer is generally offered a flat price contract without basis risk. Hedging in the futures market typically involves changes in basis (the difference between the cash price in a particular market and the futures market price) from the time the futures hedge is initiated until it is offset. Grain merchants incur the risk of trading these changes in basis with the intention of profiting from these moves.

Due to higher price levels and increased volatility of futures market prices, the exchanges have increased both daily price limits (the maximum move up or down allowed in a day) and margin requirements. For example, the Chicago Board of Trade corn and soybean futures market daily price limits were increased in March 2008 from $0.20/bu to $0.30/bu and $0.50/bu to $0.70/bu, respectively. Margin requirements have increased as well. A margin account is a performance bond posted by traders to guarantee their financial performance in the market. The margin requirement is roughly equal to the maximum loss a trader can incur in one day's trade. The margin account balance is updated daily to reflect the trader's actual gain or loss for that day's trade. If the position lost money, the trader, be it a hedger or speculator, has to deposit additional funds into the margin account. This demand for a deposit is referred to as a margin call.

Therein lies the challenge for most grain hedgers—whether farmers or grain merchants or elevator operators. These traders, known as commercials, have long (ownership or buy) positions in the cash market and hedge their risk in the futures market by taking an opposite position (a short or sell position). Therefore, if prices decline, they make money in the futures market to compensate for the lower price received in the cash market. If the futures price increases, the hedger with the short futures position still realizes the same hedged price because the losses in the futures market are offset by higher cash market prices. The challenge now for commercials is that the price increases have become sudden, large, and highly volatile at a time when producers are forward contracting a higher percentage of total production. As a result, the amount of money needed to margin their positions has increased substantially. This leads to higher working capital needs and greater interest expenses being incurred. A typical grain elevator in Nebraska, for example, could be faced with a $3–5 million margin call *each day* when the futures market makes limit moves higher. Their credit lines for hedging have increased substantially as a result, so their interest costs have similarly grown.

It is possible to design a derivative such that elevators can hedge against the costs created by extremely high margin calls. Such options are not currently traded on futures exchanges, but they are offered in over–the–counter markets. It remains to be seen whether the industry will purchase many such options. But, the point is that markets can respond to protect elevators against the increased risk of large margin calls.

In addition to the increased capital requirements created by margin calls, elevators now face increased basis risk. The biggest source of basis risk has been the lack of convergence between cash and futures or more precisely as Roberts (2008) argues, the inconsistent convergence of cash and futures. In addition, there has been structural change in basis relationships, which makes historical basis values less useful in predicting future basis levels. For example, in Iowa basis relationships have shifted so that cash prices are highest near the concentration of ethanol plants rather than near the river as in the past. Increased transportation costs have also changed basis levels.

The inconsistent convergence of basis is likely to be a short–run problem because futures exchanges tend to take immediate action when they identify problems. Futures exchanges have already taken some action. The Kansas City Board of Trade has increased the number of delivery points. Storage costs at delivery points have been increased for the Chicago grain contracts. Exchanges may have already acted to take care of the problems of basis convergence.

Another alternative is for elevators to offset their forward contract with producers by contracting with a grain buyer like a livestock feeder or ethanol processor. In some respects, though, this is a return to the type of contracting that originally prompted the development of the futures market in the first place. Futures markets have been successful because they typically have lower transaction costs and they assure performance of the contract.

Some elevators are writing forward contracts which allow the elevator to "pass–on" margin costs, transportation, and other cost increases to the producer. The result is a quoted basis that may, under specific circumstances, be adjusted downward.

What Are Farmers' Alternatives for Risk Management?

Although not all cash grain buyers have abandoned or limited their use of cash forward contracts to originate grain, the potential loss of this important risk management tool should prompt farmers to evaluate other risk management strategies. Several traditional risk management tools are available that can provide price protection.

Hedging grain sales directly in the futures market is the primary alternative to forward contracting. Because hedging with futures may lead to higher net prices than forward contracting (Brorsen, Coombs and Anderson, 1995), one possibility is that producers might actually be better off by using futures in the first place. Although producers would still have basis risk, they may find that basis risk does not create too large of a problem, depending upon their location.

Capital requirements created by margin calls, however, can be a major drawback for many producers. At $1,500 per contract for the initial margin requirement, establishing a position in the corn futures market requires \$0.30/bu. For soybeans, the initial margin requirement is \$3,250 per contract or \$0.65/bu. While initial margins are essentially a performance bond rather than a payment, there is an opportunity cost associated with committing that capital to the margin account. For a producer hedging new crop corn or soybean sales on April 1 and holding the futures positions until October 1, interest expenses amount to slightly more than \$0.01/bu for corn and nearly \$0.03/bu for soybeans at an 8.5% interest rate. For a farmer growing 1,000 acres each of corn and soybeans with yields of 160 and 50 bushels per acre who decides to hedge 50% of the production using futures, the initial margin requirements for the corn and soybean futures trades would be \$24,000 and \$16,250, respectively. The interest costs to fund these margin requirements would total \$1,023 and \$693, respectively. Thus, the total committed money for this producer hedging half of expected production would total nearly \$42,000.

Capital needs to fund the margin account would increase further if the futures position(s) lost money and margin calls resulted. For the short hedger, this would occur when the market price increased. So, in situations similar to those seen recently, additional funds must be added to the margin account dollar–for–dollar with market price increases. As a result, farmers could quickly exhaust their lines of credit. As one Oklahoma producer recently remarked when asked why he did not use futures markets, "I used futures once a few years ago, but the market went against me and I had to sell one of my farms just to meet my margin calls."

Farmers can enter into a basis contract with a grain merchant in addition to hedging in the futures market to provide both the price level and basis protection that a cash forward contract offers. While the risk protection of the futures hedge and basis contract combined is equivalent to the cash forward contract, the availability of basis contracts may be limited, similar to forward contracts. Recent transportation cost increases are changing how elevators offer basis contracts. The historically weak basis bids currently being offered by grain merchants suggest that producers would be better off to accept the basis risk themselves.

Options on futures positions are another viable hedging strategy, although, like futures hedging, they do not protect against basis moves. Farmers can purchase put options to establish the right, but not the obligation, to sell a futures contract at a specified strike price. For example, a producer might buy a \$6/bu December corn put in the spring during planting to hedge a new crop sale. In the event that the futures price is below \$6/bu at harvest time when the cash sale is made, the put option will let the hedger recover the difference between the lower futures price and \$6/bu. However, if prices are higher than \$6/bu at harvest, the value of the option will be near zero and not used. In many respects, purchasing an option is similar to an insurance policy.

Option premiums are determined by a number of factors, including the length of time before expiration and the volatility of the underlying futures contract. Premiums for options bought further in advance of their expiration will be higher because there is more time for the futures price to move in an unfavorable way and for the option to gain value or become "in–the–money." This large cash outlay can be a drawback for farmers when contracting a long way into the future, which is especially important when they are also contracting and paying for inputs. Additionally, options are thinly traded in deferred months, so even being able to purchase options several months or years in advance of a sale may not be possible without significantly moving the market. No research is available on the liquidity costs in options markets, but we expect that options markets are more expensive than futures markets for an equivalent amount of price protection.

Option premiums become more expensive when the volatility of the underlying futures contract increases because there is a higher probability that the option will expire in–the–money. Since grain futures market prices have become increasingly variable in recent years, option premiums have increased.

Producers can reduce the net premium cost of purchasing a put option to hedge a future cash sale by making sales of other options through either a fence or spread trade. A fence, for example, establishes a price ceiling as well as a price floor, but the ceiling price can be at a higher level than the maximum price created through a futures hedge or cash forward contract. Selling a call option (which gives the buyer the right, but not the obligation, to buy the underlying futures contract at the call strike price) with a higher strike price than the purchased put option creates this price ceiling in exchange for the premium received. Thus, a price fence, or window, between the two strike prices is created. The put gains value at prices below the put strike price and, therefore, creates a price floor, while the call option loses value for the seller at price levels above the call strike price, thus creating a price ceiling. One problem with the fence strategy is that it leaves producers exposed to possible margin calls if prices rise. Another drawback is increased costs from having two option trades instead of one.

Similarly, a vertical put spread can be created by purchasing a put option and selling another put option with a lower strike price. Collecting the premium on the put option sold reduces the net premium cost of the hedge; however, it also removes the down-side price protection at levels below the strike price of the put option sold. While a multitude of other option trades can be made to provide price risk protection, most are so complex that many farmers are not comfortable using them and it is not clear that they offer much advantage over the simple purchase of an out–of–the–money put option.

Direct contracting with a downstream end–user is another alternative. Several cash market participants also need to hedge against the *opposite* risk that grain farmers have. Such downstream contracting, which bypasses grain merchants that are not offering forward contracts, has both advantages and disadvantages. These downstream end–users, such as livestock feeders and ethanol plants, are concerned about price increases and may be more willing than ever to forward contract and lock in their input prices. The disadvantage, however, is that transaction costs may be higher for both parties because they have to identify a willing second party, negotiate contract details, and likely seek legal counsel in constructing the contract. Additionally, these downstream end–users may not be protected by bonds, and therefore pose additional risks to sellers.

Another alternative for farmers is to obtain revenue protection that would simultaneously cover both price and yield risk. Premiums for crop revenue insurance are subsidized by 38–67% and therefore may be increasingly attractive as option premiums become more expensive. Crop revenue insurance does not, however, protect against basis risk and has limitations on how much price levels can change from year to year. While it must be purchased before planting, it does not require a cash payment until after harvest. The recently enacted 2008 farm bill offers another type of revenue protection called Average Crop Revenue Election Program (ACRE). ACRE provides indemnities to producers in states that have revenue shortfalls (determined by a 5–year state olympic average yield and national marketing year average price) who also have revenue shortfalls, after crop insurance, on their own farms. Producer risk management decisions will likely change as the details of the ACRE program and disaster payments provided in the 2008 farm bill become known.

Summary

Due to significantly higher and more volatile prices in recent years as well as the working capital required to manage risk associated with offering cash forward contracts, some grain merchants have restricted or eliminated these contracts, thereby limiting a risk management strategy at a time when farmers need it most. Grain farmers still have alternatives for price risk management, including futures and options hedges and downstream forward contracting. Each, however, has some disadvantages relative to forward contracting grain with merchants or elevator operators. For some farmers, these disadvantages will be surmountable and relatively easily overcome.

Farmers with larger operations, more working capital, and more familiarity with the futures market will likely find futures and option hedging to be a reasonable alternative to cash forward contracting. Other farmers, without knowledge of the alternatives or comfort in using them may elect not to use any risk management tools and remain completely exposed to price risk. That is possibly the biggest concern of all.

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Ecosystem Services: A 21st Century Policy Challenge

Steven E. Kraft

In the 31 years since Walter E. Westman (1977) published "How much are nature's services worth?" there has been extensive research into the nature of ecosystem services, the ways in which past and existing public policies influence the viability of ecosystem services, the valuation of such services (see NRC 2005), and the challenges of developing markets in which ecosystem services are traded (see Forest Trends 2008). While the scientific literature reporting this research is also extensive and found in the journals of a number of fields, ecological and economic, the informed discussion about ecosystem services by the lay public and policymakers is just beginning.

Notwithstanding these early discussions, in its proposal for the 2007 Farm Bill, the Bush Administration included a program for a "market–based approach to conservation" structured around environmental benefits (i.e., ecosystem services) produced by rural landscapes (USDA 2007). In the final version of the 2008 Farm Bill approved by Congress over the president's veto, the USDA is directed "to establish a framework to measure environmental service benefits from conservation and land management activities" as well as to focus on carbon markets for producers (U.S. Senate 2008); both are references to ecosystem services and rural lands.

While many in the research and academic communities are conversant about the nature of ecosystem services, the same cannot be said for those who are and will be impacted by them: landowners and operators, farmers, local agency personnel, policy designers and implementers, congressional staffers, and the members of the general public whose welfare is tightly bound to the continued vitality and availability of a diverse range of ecosystem services (MEA 2005). In the following papers, the authors provide an introduction to ecosystem services and the policy challenges they provide for the 21st century.

Articles in this Theme:

In his article, Scott Swinton describes agriculture as a managed ecosystem. As a consequence, agriculture has great potential to generate a broad mix of ecosystem services, going beyond the traditional agricultural commodities of food, fiber and biofuels. However, Swinton points out that a better understanding is needed of how ecosystem services can be produced, measured and valued in order to design policy incentives to assure a for greater supply. J.B. Ruhl points out that landowners have incentives to maximize the production of food, fiber, and energy commodities, but little incentive to provide flows of ecosystem services that benefit other lands and members of the public. Ruhl raises the question whether a renewed focus on agricultural multifunctionality using ecosystem services as its fulcrum can lead to new ideas about how to strike a more socially optimal balance for agricultural production: traditional commodities <u>and</u> ecosystem services. Rhonda Skaggs describes how the awareness of the broad array of ecosystem services from rangelands has grown in recent years. Rangelands are primarily viewed as contributing to human welfare through primary production and provisioning services; however, these lands also provide regulating and cultural services. Skaggs points out that rigorous economic analysis of nonprovisioning rangeland ecosystem services remains elusive. Stephen Polasky in his paper points out that while nature provides a range of goods and services of value to people, these ecosystem services may not be provided optimally both because of the lack of information and because of public goods problems. Consequently, economists need to work closely with natural scientists to understand the ecological production functions determining the provision of ecosystem services, apply valuation techniques to generate estimates of the value of ecosystem services, and design policies to internalize externalities and provide correct incentives for the provision of ecosystem services. Stephen Swallow, Elizabeth C. Smith, Emi Uchida and Christopher M. Anderson argue that while governmental and philanthropic actions have been useful for managing the environment and conserving some ecosystem services, little work has been doneto link people's individual values for ecosystem services directly into the economy. The authors show how experimental economics could be used to develop new, market approaches based on demand-side values for ecosystem services, which could stimulate entrepreneurship built around ecosystem services. The authors conclude with an preliminary look at an experimental ecosystem service market for grassland nesting birds on farms.

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Reimagining Farms as Managed Ecosystems

Scott M. Swinton

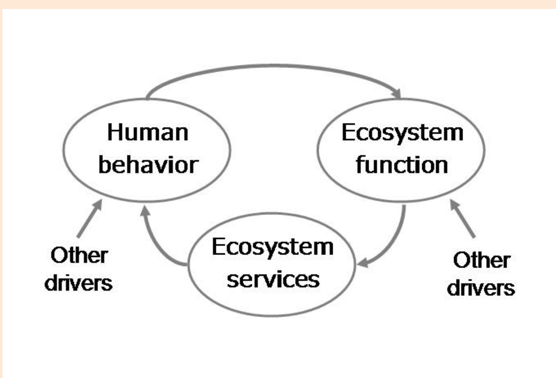
JELclassifications: Q57, Q51, Q12

How scientists perceive people and nature to interact is changing. These changes will likely transform how we perceive farming. Along the way, they are reshaping the research agenda for agricultural and environmental economists. In short order, farmers will be faced with dramatically different management opportunities.

Farming began as a means to produce food more reliably than hunting and gathering. Over time, the scope of farming expanded to fiber and fuel crops. The historic focus on producing goods has led most farmers to view themselves as "producers." While this role will not change, new roles are becoming available as providers of more diverse ecosystem services than food, fiber and fuel.

Broadly speaking, "ecosystem services" are the valued services that people get from nature (Daily, 1997) (Figure 1). They encompass four broad areas (Millennium Ecosystem Assessment, 2005):

Figure 1. Ecosystem services link people and ecosystems



- Provisioning services include food, fiber, wood, fuel and fresh water that provide for human subsistence.
- Regulating services maintain the balance of the Earth's systems at levels that enable human survival. These services include climate, flood, water quality and disease regulation. Examples include vegetation that buffers the effects of natural flooding, or predator–prey systems that limit the spread of pathogens.
- Cultural services include the spiritual, inspirational, aesthetic, heritage, recreational and tourism benefits.
- Supporting services include the myriad natural systems that enable the three tiers above. For example, organic matter cycling contributes to soil creation, which makes food provisioning possible. Photosynthesis transforms solar energy into plant matter, enabling provisioning services, carbon cycling, and various other services.

The idea of ecosystem services transforms the way we think about nature in three ways. First, when viewed as a web of ecosystems, nature is no longer a background resource, but rather a system that can malfunction. Second, the idea of service flows implies a need to maintain the capital base that produces those services. Last, and most important, "ecosystem service" expresses a link between people and ecosystems whereby people enjoy benefits from ecosystems—but also influence their functioning.

Agriculture as Managed Ecosystem

From an ecological perspective, agriculture is an ecosystem that is frequently disturbed to favor desired products. Tillage and herbicides prevent competition from undesired weeds. Veterinary care and housing protect livestock from pathogens and predators. What ecologists call "human disturbance" agriculturalists call "management." But farmers who manage those ecosystems influence flows of many ecosystem services, whether they think about it or not. Herein lie opportunities for farmers and society at large, by perceiving the larger role of agricultural ecosystems. The opportunities are many, for crops and pasture already occupy roughly half the Earth's land area that is not barren rock, desert or permafrost (Millennium Ecosystem Assessment, 2005), and farmland is expanding.

New opportunities for farmers to manage for ecosystem services are emerging from recent research (Swinton, Lupi, Robertson and Landis, 2006). Two specific examples come from pest regulation and climate regulation.

Managing habitat for pollinators and the natural enemies of agricultural pests can enhance farm food, fiber and fuel production. Pollination and the regulation of pests and diseases are two natural ecosystem services. Like food production, they can be enhanced by management. While many farmers rely on the European honey bee for commercial pollination, native bees and other pollinators also play important roles (National Research Council, 2006). Habitat essentials typically involve a nearby landscape with suitable nesting sites and a sequence of flowering plants for food to keep the pollinators from migrating elsewhere. The natural enemies of agricultural pests have shown the ability to suppress potentially damaging populations of such invasive pests as soybean aphid. Their habitat needs are similar, though their food requirements are not.

Farming can play a major role in climate regulation, both by limiting emissions of greenhouse gases and by sequestering carbon in plants and soil (Robertson, 2004). Agriculture generates two particularly potent greenhouse gases. Methane, from rice paddies, manure and livestock digestion, has a global warming potential of 21 CO_2 carbon equivalents. Nitrous oxide has over 300 times the global warming potential of CO_2. It is generated by excess mineral nitrogen, particularly from heavily fertilized crop fields. More livestock waste management, fertilizer application and efficient machinery use can mitigate these ecosystem disservices. Sequestration of carbon into agricultural soils through no–till farming and production of biofuel crops that remove CO_2 from the atmosphere as they grow can directly reduce global warming potential.

Other opportunities abound for farmers to manage for ecosystem services, from wildlife habitat to water quality to aesthetic landscapes.

Value of Ecosystem Services

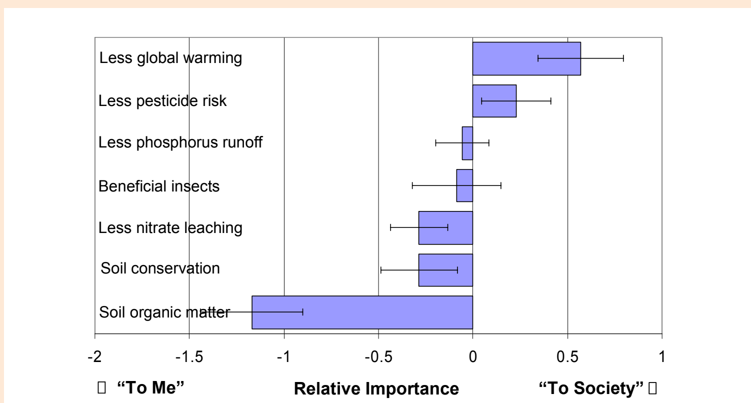
Why would farmers bother to provide ecosystem services that lack markets? To be sure, certain ecosystem services contribute to private profitability, but others do not. In 2007 focus group interviews, Michigan crop farmers identified increased soil organic matter as offering private benefits to their farms, but found reduced global warming to chiefly benefit society at large (Figure 2).

Of course, if there are clear benefits to society at large from ecosystem services that lack markets, then policymakers have justification to create incentives that stimulate more supply. In order to make such incentives operational, four steps are needed, 1) understand how humans can affect the production process for ecosystem services, 2) find cost–effective ways to measure those services, 3) estimate the value of ecosystem services to humans, and 4) design policies that fit both the environmental setting and existing legal institutions.

Agricultural ecosystems offer special opportunities to generate other ecosystem services as joint products along with food, fiber or fuel production (Wossink and Swinton, 2007). Hence, costs of providing joint ecosystem services can be much lower than if they were produced alone. Understanding how agricultural practices affect ecosystem functioning and generate ecosystem services is highly complex. For management purposes, performance indicators are needed that track high–priority ecosystem service in a cost–effective way across space and time (Dale and Polasky, 2007).

The valuation of ecosystem services that lack markets can be viewed from two perspectives: what consumers would be willing to pay for it, or what producers would be willing to accept to supply it. Many techniques exist to estimate consumer willingness to pay, including responses to questions about hypothetical purchases and calculations based on what consumers already spend. In the latter category, for example, expenses made to travel to a distant site for fishing or hiking can be used to estimate the value of the

Figure 2. Farmer ratings of the relative importance of the environmental benefits "to me" (negative) versus "to society" (positive), 34 Michigan farmers, 2007. (Likert scale paired difference t–test error bars = 1 std error).



fishery or the aesthetic ecosystem services. Land prices can be analyzed to infer the values of ecosystem services in the vicinity. Producers' willingness to accept payment in exchange for providing ecosystem services can be estimated from the implied costs due to changes in farming costs and foregone crop revenues. Because farm locations vary in potential commercial productivity and potential abundance of ecosystem services, farmers' willingness to supply ecosystem services will vary from place to place (Antle and Valdivia, 2006). These methods are discussed in greater detail in a recent special section of the journal, Ecological Economics, devoted to the topic, "Ecosystem Services and Agriculture" (Swinton, Lupi, Robertson and Hamilton, 2007).

Incentives for Farmers to Provide Ecosystem Services

If we understand how ecosystem services are produced, how to measure them, and what they are worth to consumers and producers, then incentives for their provision can be designed. Incentive programs can be divided between government programs and private sector ones. U.S. farm policy has a history of cost–share support for clearly observable practices, such as soil conservation investments, and land retirement policies, such as the Conservation Reserve Program. In the 2002 farm bill, the Conservation Security Program created payments for environmental stewardship.

Private sector activities include business–to–business payments and markets for pollution credits (Kroeger and Casey, 2007). One rapidly developing example of a market for pollution credits is the global carbon market. The Chicago Climate Exchange has developed rules for buying "carbon management offsets" from U.S. farmers whose use of reduced tillage practices can sequester atmospheric carbon in soil (Chicago Climate Exchange (CCX), 2007). Payment levels are very modest at present ($2–3/acre/year for 5–year commitments on the most productive lands). Related offset payments are available for livestock farmers who collect and burn methane, so that it is not released into the atmosphere. If international agreements to limit global warming become more binding—especially if the United States joins in—then opportunities for farmers to profit by providing climate regulation services are likely to grow in number and value.

Business–to–business payments for environmental services are also developing, particularly linked to water markets (Pagiola, Bishop and Landell–Mills, 2002). In most successful programs, such payments have compensated farmers or foresters for maintaining vegetative cover so as to protect drinking water supplies. More recent efforts are underway to pay for more diverse ecosystem services, such as biodiversity and soil conservation.

Biodiversity conservation is particularly challenging for policy design, because it often calls for coordinated action among multiple landowners. Many large mammals and migratory species require contiguous habitat over large areas. Recent research involving experimental games has shown that land owners can rapidly learn to cooperate if offered policy incentives that favor cooperating by agglomerating contiguous habitat (Parkhurst and Shogren, 2007).

Demand for Research on Economics of Ecosystem Services

Because so many ecosystem services have intrinsic value yet lack markets, scientists and policy makers are keen to see economic measures of their value. The twin challenges of lucid communication and sound economic methodology are formidable. Scientists and policy makers would like clear numbers, while economists want to explain that "it depends" on various parameters. Can economists meet these twin challenges? Ecosystem services pose broad, complex valuation problems, but the benefit transfer literature has progressed impressively in recent years (Wilson and Hoehn, 2006).

Research opportunities on the economics of ecosystem services are proliferating. A growing consensus among science research administrators seeks to fill a perceived void in research efforts on multidisciplinary problems, notably those associated with global change. The National Science Foundation has just converted a temporary initiative into a permanent program in Coupled Natural and Human Systems—its first such multidisciplinary program. It is currently evaluating follow–on ideas for its successful initiative in Human and Social Dynamics. New opportunities in these areas involve multidisciplinary teams, especially focused on socioecological research.

Rethinking farming as ecosystem management offers fresh and promising ways to imagine contributions from agriculture. Agriculture's history as a managed ecosystem and its scale, coupled with society's growing needs for a broad mix of ecosystem services, create a formidable research and policy agenda. That agenda calls for multidisciplinary research into how farmers can produce a wider range of ecosystem services, what those services are worth, and what policy designs could effectively induce more such services to be provided. Successful answers will capitalize on the unique productive potentials of diverse ecosystems using incentives tailored to fit farmers' objectives, resources and property rights. The challenge is great, the rewards as well.

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Farms and Ecosystem Services

J.B. Ruhl

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Over the past decade two themes have emerged as organizing principles in natural resources policy. One, ecosystem management, builds a framework for landscape–level decision making (Christensen et al. 1996). The other, ecosystem services, opens a new dimension for thinking about what we hope to achieve through ecosystem management (Daily 1997; Costanza et al. 1997). The convergence of these two themes has become a driving force behind the concept of agricultural multifunctionality, the idea that farms can have multiple outputs—not just commodities—and thus can contribute to several societal objectives simultaneously (Jordan et al. 2007; OECD 2001).

Agriculture has been engaged in ecosystem management since long before the term came into the natural resources policy lexicon. Farms alter and then manage ecological processes and functions on small and large scales. In so doing, farms reconfigure ecological attributes to maximize what are known as *provisioning services*—the food, fiber, energy, and other commodities supplied by nature (Millennium Ecosystem Assessment (MEA) 2005). Farms manage these provisioning services to optimize on–site farm production, often at the expense of off–site environmental conditions. Farms are associated, for example, with soil erosion, nutrient and pesticide runoff, and groundwater depletion (Ruhl 2000; Vitousek, Mooney, Lubchenco and Melillo 1997).

Another off–site impact of farming heretofore little noticed, however, is the depletion of *regulating services*. These are the economically beneficial results of ecosystem functions that modulate ecological conditions, such as gas sequestration, water recharge, pollination, temperature and humidity regulation, and stormwater adsorption (Millennium Ecosystem Assessment 2005). Unlike provisioning services, the market value of which is embedded in commodity prices and thus easily measured and monitored, regulating services tend to behave more like nonmarket public goods (Costanza and Farber 2002). Farms thus have all the incentive to optimize provisioning services available to them, but little incentive to provide regulating services that benefit other lands (Swinton, Lupi, Robertson and Landis 2006). The question is whether a renewed focus on agricultural multifunctionality using the balance between provisioning and regulating services as its fulcrum can lead to new ideas about how to strike a more socially optimal balance for agricultural production (Abler 2004; Dobbs and Pretty 2004; Smith 2006). This essay outlines the factors that must be considered as that conversation unfolds.

A Framework for Thinking about Farms and Ecosystem Services

In *The Law and Policy of Ecosystem Services* (2007), Steven Kraft, Christopher Lant, and I build an analytical framework for identifying obstacles to socially optimal management of ecosystem services and designing effective policy responses. The framework moves through three stages. First, place the problem in its ecological, geographic, and economic contexts. Second, examine and assess the capacity of existing property rights, regulations, and social norms. Third, identify policy drivers and models, the trade–offs of different policy approaches, and the instruments and institutions that are well suited to transition to new policy designs. The question of whether and how farms can move to new ecosystem service production frontiers presents an opportunity for application of our framework.

Context

Farms, individually and in working agricultural landscapes, have ecological, geographic, and economic attributes that influence the stream of ecosystem services they manage and provide. In this respect farming is perhaps the classic case study of the obstacles society faces in designing policy around the goal of yielding appropriate flows of regulating ecosystem services.

Almost nothing takes place on a farm without ecological impacts somewhere else. In this respect a farm is like any other ecological unit—changes in one ecosystem usually affect other ecosystems, however we draw the boundaries. But as highly managed ecological units, farms significantly tilt the production frontier for ecosystem services toward provisioning services and away from regulating services (MEA 2005; OECD 2001). Ecological practices at a cornfield are designed to produce corn efficiently within the relevant regulatory environment. Putting aside the question whether regulation of farms has established appropriate environmental performance baselines (Ruhl 2000), unless paid to provide regulating services such as carbon sequestration, one would not expect to find significant flows of off–site regulating services from farms except as incidental to management of provisioning services. Hence, the ecological context for agriculture with respect to ecosystem services is that we need to know more about the geographic and economic contexts before we can assess the prospects of realigning the ecological profile.

Agriculture presents a difficult geographic scenario for purpose of developing generalized strategies for ecosystem services. Farms are numerous, dispersed, come in all sizes, and produce many different commodities under many different climate and landscape conditions. Farms also manage ecological resources for relatively small spatial scales (the farm) and short temporal scales (the next harvest). The focus on optimizing on–site provisioning services also tends to sever farms and larger agricultural landscapes from surrounding ecological resources. Managing ecosystem services sustainably, by contrast, requires multi–scalar approaches that integrate connected ecological units across space and time (Holling, Gunderson and Peterson 2002).

These geographic disconnects strongly influence the economics of farming and the bias toward provisioning services. The payoff for providing regulating services, assuming some mechanism for compensation, is likely to be marginal compared to commodity production or, worse, selling to urban development interests. In the absence of any compensation, economically rational farmers will not provide free regulating services to off–site lands unless doing so is incidental to optimization of on–site commodity production or is forced by regulation (Daly and Farley 2003). Promoting farm multifunctionality, therefore, is a balancing exercise between providing farms the flexibility to continue benefiting from their skill at managing provisioning services on the one hand, and providing the impetus to produce more regulating services for society on the other. Moreover, market distortions from subsidies, which have promoted intensive production on marginal and environmentally sensitive lands, have made it only that much more difficult to integrate ecosystem service values into agricultural production decisions. Society cannot assume that the flow of regulating services off of farms (or any land for that matter) will continue to be provided for free, lest they not be provided at all, nor can we expect farmers to forego the incentives the collection of production and insurance subsidies deliver. Ideally, the economics of farming, including market distorting subsidy policies, can be worked on to change the flow of services, rather than forcing the issue through command–and–control regulation.

Existing Capacity

Farms are often portrayed in policy circles as the "first stewards of the land." As noted above, however, what this really means is that agriculture has done a very effective job at stewarding land for provisioning services, and the evidence is that this has come at considerable cost to not only the environment, but also the supply of regulating services to society. The negative environmental externalities of farms, though well documented to be significant and pervasive, have persisted for decades even while other polluting industries have been subjected to intense social pressures to change (Ruhl 2000). This legacy will make it all the more difficult to overcome the associated effect that farms are depleting regulating services of tremendous value to society.

To a large extent we are in this position as a result of an even longer history of the development of property rights in such a way as to deter the production of regulating services. Although true stewardship was promoted by the British common law of property as a result of its densely settled agricultural landscape, the open frontier of American settlement prompted common law courts, gradually but unmistakably, to shift away from doctrines promoting stewardship and toward pro–development doctrines (Sprankling 1996). In short, there is nothing in American property law to suggest to a landowner that there is any advantage to continuing to supply regulating services to society, much less an obligation to do so.

Nor has regulation filled this gap. While other industries are evolving through second and third generations of environmental regulation, the regulation of agriculture is decades behind the curve in terms of scope and innovation. To be sure, the task of regulating hundreds of thousands of farms raising different crops and livestock under different conditions around the nation would be daunting. But rather than try, federal and state legislatures have provided farms what amounts to a safe harbor from environmental regulation, and agriculture has fought tooth–and–nail against any retreat (Ruhl 2000). To this day there is no clear message in regulatory frameworks for what the baseline norm of environmental performance is for farms, other than there is none. As a consequence, opening a discussion of farms and ecosystem services runs headfirst into the ecological, geographic, and economic problems discussed above, with capacity for building policies existing in what is truly a vacuum in so far as property rights, regulations, and norms are concerned.

Policy Design

Farming thus typifies what Kraft, Lant, and I (2007) call the Tragedy of Ecosystem Services. In the absence of regulation or incentives to steer them toward production of regulating services, farms naturally manage their ecological resource base toward the provisioning services associated with the production of agricultural commodities. Unlike Hardin's famous Tragedy of the Commons (1968), which resulted in an over–exploitation of the resource base, the Tragedy of Ecosystem Services results in undersupply of valuable regulating services. And whereas better design of property rights, regulations, and norms has been shown to overcome the Tragedy of the Commons (Ostrom, Burger, Field, Norgaard and Policansky 1999), as noted above there has been little traction gained on the effects of farming from either of those sources.

Of course, it is important to stay focused on what the goal of agricultural multifunctionality is. We *do* want farms effectively to manage provisioning services to provide society food, fiber, and energy. And we should *not* force farms unfairly to bear the cost of supplying regulating services to society in addition. We pay farmers for corn; how much should we also pay them for supplying carbon sequestration and groundwater recharge? The answer to the Tragedy of Ecosystem Services when it comes to agriculture cannot be simply to regulate farms toward greater production of regulating services. That is not only politically unrealistic, it may also be economically inefficient and normatively inappropriate. On the other hand, just like all landowners, we should demand that farmers meet a minimum baseline of environmental performance as part and parcel of respecting the property rights of others before it would be appropriate to consider paying them for higher performance levels.

An intelligent approach, therefore, must start with identification of the drivers at the interface between agriculture and ecosystem services and developing a model of how these drivers operate. How do farm subsidy programs influence farm behavior toward ecosystem services? How do the upstream and downstream food and fiber industries affect farm behavior toward ecosystem services? If we were to change these or other conditions, how would farms respond with respect to ecosystem services? And which regulating ecosystem services do we wish to promote?

As we understand more about how and why farms manage ecosystem services in particular ways, we must then widen the lens to consider the trade–offs associated with different policy approaches (Rodruiguez et al. 2006). How would encouraging farms to shift toward greater production of regulating services, however accomplished, affect farm income, food prices, and land costs? Who would benefit, and by how much, where, and when? Would moving a significant portion of existing agricultural lands into, say, carbon sequestration, simply prompt conversion of undisturbed lands into farming to replace lost food supply? Would promoting a particular regulating service such as carbon sequestration, have a trade–off effect with other regulating services, such as groundwater recharge? How will other services that farms might provide, such as providing cultural and historical context for surrounding communities, be enhanced or degraded by moving to greater farm multifunctionality?

Once these trade–offs are better understood, the difficulties of transitioning to new policy regimes can be identified. The costs and benefits of new policies almost never are evenly distributed. For example, are global, national, regional, or local regulating services to be favored, and which interests are affected positively and negatively by that decision? What new skill sets will farmers need to acquire to take advantage of the new policies, and how much will gaining them cost? Will agricultural communities prosper with increased farm multifunctionality? Those who stand to "lose" under new policy regimes are likely to oppose them unless their interests are appropriately accounted for in the transition. After decades of habituating farms (and farm communities) to subsidies designed around provisioning services, it may be unfair and unwise to shift to new policies without addressing the impact to those interests most affected. Should those farms be exempt from new programs, or compensated for losses suffered, or simply forced to play under the new rules?

Ultimately, if promoting greater production of regulating services is the goal for agricultural policy over the next decade, we must choose the instruments and institutions to make it happen. As with almost all else in agricultural policy, political expediency will point toward incentive programs administered through federal agencies. Indeed, putting aside the politically charged question of what baseline of performance to demand from farms, a strong case can be made for incentive–based approaches, as it is appropriate for farms to receive at least some compensation for satisfying public demand for economically valuable regulating services. But federal agencies may be poorly equipped to administer the incentives for all relevant services. Ecosystem services are, after all, benefits to human populations, meaning they satisfy demand at different scales. Some services relevant at national and global scales, such as carbon sequestration, seem well suited for incorporation into federal programs designed to influence land retirement or crop selection. By contrast, ecosystem services such as groundwater recharge, water quality control, and sediment capture are most valuable to local populations. Farmers should be paid in such cases to provide local services, but only based on local demand, meaning local government programs are more likely to calibrate compensation for local services efficiently. Indeed, as the economic values of ecosystem services become better appreciated, local land trusts and other nongovernmental organizations are also likely to play an expanding role in providing payments and other incentives for farm multifunctionality.

The point is to ensure that incentives for ecosystem services, as opposed to general environmental and ecological performance, are demand driven, not supply driven. In this sense policies designed to promote farm production of regulating services may give multifunctionality a renewed purpose and goal at local scales, connecting farms to their urban and suburban surroundings in ways that make all interests recognize the advantages of maintaining working agricultural landscapes.

A New Direction?

The concept of ecosystem services is no panacea for agricultural policy, but agricultural policy must awaken to its message. For decades, social, political, and economic forces have driven farms to manage ecological resources toward production of food, fiber, and energy commodities. They have done so well, but at the expense of maintaining the stock of natural capital necessary to provide a sustainable flow of ecosystem services of more general benefit to society, such as groundwater recharge, water purification, and flood control. Natural disasters and the effects of climate change are focusing society on the value of those services. While it may be a long time before we think of buying units of services from farms the way we do ears of corn at the grocery store, it is not too soon to think of ways to change the economic incentives farmers face to induce production of a more balanced portfolio of commodities and services. Doing so through Farm Bill reform, reorienting "green" subsidy programs toward a more multifunctional agricultural suite of outputs, will be an important component of the effort. But the goal of balanced, sustainable flows of ecosystem services from agricultural lands presents new opportunities for state and local programs to tap into and promote farm multifunctionality with true demand–driven market incentives. In the long run, such measures could reconnect agricultural lands and their surrounding communities in ways federal policy could never hope to achieve.

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Ecosystem Services and Western U.S. Rangelands

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Rangelands are expansive, unimproved lands located in arid or semi–arid regions, spanning a variety of landscapes including savannahs, high and low altitude deserts, mountain meadows, and tundra. Rangelands are generally unsuitable for crop production due to aridity, topography, and extreme temperatures. Rangelands support varying mixtures of native and nonnative grasses, grass–like plants, forbs, or shrubs which provide forage for free–ranging native and domestic animals (Stoddart, Smith and Box, 1975). There are more than 760 million acres of rangelands in the United States, including Alaska, comprising 33% of the nation's total land base (USDA–USFS, 1989a). While exact determinations are unavailable, it is estimated that more than 50% of U.S. rangelands are privately owned, 43% are owned by the federal government, with the remainder owned by state and local governments (National Research Council, 1994). Approximately 262 million acres of U.S. rangelands are controlled by the U.S. Forest Service (USFS) and the U.S. Bureau of Land Management (BLM) and leased to private individuals for the purpose of land–extensive livestock grazing (CAST, 1996). Many more acres of rangelands in the 11 western states1 are controlled by state or local government agencies and leased for livestock grazing, with all these states having a high degree of intermingled public and private ownership of rangelands.

Arid and semi–arid rangelands in the western United States are characterized by low and variable precipitation, high evaporative demand, nutrient poor soils, high spatial and temporal variability in plant production, and low net primary production (Havstad et al., 2007). These rangelands are often subject to desertification or invasion by shrubs and other woody plants as a result of drought, low resilience, and past management practices. Increased woody plant populations are strongly correlated with reduced forage availability for domestic livestock (primarily cow–calf, with some sheep and lambs) and wildlife grazing.

The public ownership of many western rangelands has led to ongoing, often contentious, policy debates regarding the ecological impacts of livestock grazing, and the types and levels of acceptable uses of the public lands. Given the nature of western rangeland ownership, it is often difficult to separate discussion of rangeland ecosystem services from discussion of public land policy. While western rangelands have been viewed primarily through the prism of livestock production, a broader awareness of the ecosystem services arising from rangelands has developed in recent years. This awareness has provided new grist for the public land policy debate, even though hard ecosystem services data for western rangelands remain elusive.

The concept of ecosystem services provides a framework for organized thinking about the relationships between humans and nature (Swinton, Lupi, Robertson and Landis, 2006) and for relationships within nature. Daily (1997) defined ecosystem services as "…the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life." The Millennium Ecosystem Assessment (2005) further developed the concept by defining the various categories of services human receive from the natural environment. Supporting ecosystem services which benefit people include nutrient cycling, soil formation, and primary production. These services in turn make provisioning, regulating, and cultural ecosystem services possible. Provisioning is the ecosystem's generation of food, fiber, fuel, and fresh water supplies. Regulating services include the ecosystem's role in providing pollination services, climate mediation, watershed functions (including flood control, storage, and filtering), and waste absorption and processing. The ecosys-

1 *Washington, Oregon, California, Nevada, Idaho, Montana, Wyoming, Utah, Colorado, Arizona, and New Mexico.*

tem also provides cultural services to humans, which include educational, aesthetic, spiritual, and recreational opportunities.

While forage production for domestic livestock has been a key ecosystem service of western U.S. rangelands, there is a broad array of ecosystem services forthcoming from rangelands. These services include wildlife habitat, recreation (including that associated with wildlife), watershed functions, carbon sequestration, and biodiversity conservation. As working lands, western U.S. rangelands have been managed primarily to generate provisioning (e.g., forage) ecosystem services now or in the future. Public policy controversies regarding western rangelands since the 1970s have been largely based on real or perceived trade–offs between provisioning (e.g., forage production and livestock products) and other ecosystem services (e.g., wildlife, recreation, biodiversity). Research has attempted to address these trade–offs; however, many questions remain unanswered even after decades of research. Thus, our ability to value and represent trade–offs through the use of traditional economic tools such as the production possibility frontier is limited. Furthermore, U.S. rangelands cover vast expanses of land, encompass numerous climatic, ecological, and vegetative types, and are extremely diverse. U.S. rangelands are located in remote areas distant from population centers, on the urban fringe, and everywhere between these two extremes throughout the West. Thus, the characteristics, quality, and quantity of ecosystem services arising from rangelands (as well as the value of the services) are highly variable. This diversity further complicates economic valuation efforts and the development of policies or programs designed to enhance the flow of ecosystem services from rangelands.

Valuation of Rangeland Ecosystem Services

About 20% of beef cattle in the United States, or six million head, are in the eleven western states (CAST, 1996). The USFS has estimated that less than 10% of total national forage consumption by domestic livestock is provided by public lands (USDA–USFS, 1989b). Torell, Fowler, Kincaid and Hawkes (1996) estimated that 15% of the nation's beef cows and 44% of the sheep and lambs were produced on public land ranches, that approximately 5% of the nation's grazing capacity comes from BLM and USFS lands, and that 4% of the forage for the nation's beef cow herd is supplied by these lands. While neither the overall national beef cow herd nor the national beef supply is greatly dependent upon public rangelands, many individual ranching operations in the inter–mountain West are almost 100% dependent upon total annual or seasonal forage provided by publicly–owned rangelands. Torell, Fowler, Kincaid and Hawkes (1996) also concluded that 41% of beef cows in the eleven western states grazed on federal lands for part of the year, and that 19% of the total annual forage demand in the region was met from federal land. From these numbers, aggregate estimates of the value of forage provided by public–domain rangelands can be made; although precipitation changes from year to year can greatly affect the values.

Rangelands represent a vast store of carbon, both in soils and vegetation (Havstad et al., 2007). The general conclusions of rangeland–related climate regulation research are that the carbon sequestration potential of rangelands depends greatly on appropriate management of the lands, minimizing degradation or desertification (including encroachment by undesirable species), and restoration or improvement of degraded rangelands (Follett, Kimble and Lal, 2001). Restoration of arid–region degraded rangelands is extremely difficult, and variability in precipitation throughout most U.S. rangelands adds additional uncertainty to the carbon sequestration regulating service provided by these lands. Although rangelands can contribute to carbon sequestration, the generally low productivity of arid rangelands also means that their sequestration potential is also lower than other types of land.

The first rangeland carbon credits pool was created in 2008, intended for sale on the Chicago Climate Exchange (CGX). According to AgraGate (2008), the company creating the pool, the number of carbon credits available from rangeland varies from 0.12 to 0.52 tons per acre, depending on soil types and precipitation. Ranchers wanting to sell carbon credits from rangelands must follow approved management plans designed to achieve targeted CO2 uptake levels. These management plans generally require reduced stocking rates, more dispersed livestock distribution, reduced forage utilization rates, and various rangeland improvements.

Rangelands continue to be largely natural systems; thus, all rangeland ecosystem services depend in some way on local biodiversity (Havstad et al., 2007). Given the diverse nature of rangelands and the traits of different species of flora and fauna present in rangeland ecosystems, it is not surprising that research has found both increases and decreases in biodiversity services as a result of livestock grazing and relative to varying grazing intensities. Endangered species and related biodiversity issues on rangelands are further complicated by situations where attempts to improve rangelands through shrub removal and restoration of natural grasslands reduces the preferred habitats of threatened or endangered species (e.g., the sage grouse).

As noted above, ecosystem services include cultural values. While broad–scale valuation of nonutilitarian or nonuse values of U.S. rangelands are not available, research by Torell, Rimbey, Ramirez and McCollum (2005) provides some insight into how individual ranch sales prices reflect the values of rangeland aesthetics. These authors found that ranch location, terrain, elevation, and scenic views have a greater influence on ranch value than livestock income earnings obtained from the land. Ranch buyers appear willing to pay for desirable quality–of–life ranch attributes—many of which are a function of the natural environment.

In recent years, efforts have been made to examine the impacts of shrub control treatments on ecosystem services other than provisioning. However, the growing appreciation of nonprovisioning rangeland ecosystem services has not been matched by rigorous long–term quantification or valuation of the services (Herrick, Schuman and Rango, 2006). As noted above, woody plant invasion of rangelands reduces livestock carrying capacity. Thus, rangeland managers generally have an interest in controlling or reducing shrub encroachment. However, the costs of shrub control treatments usually exceed the livestock producers' benefits attained from increased forage production (Lee, Conner, Mjelde, Richardson and Stuth, 2001). The response of federal and state governments has been publicly funded shrub control programs, which usually pay for 50–85% of the cost of the treatments.

Torell, McDaniel and Ochoa (2005) have noted that if brush control projects are to be profitable expenditures of public funds then the unmeasured benefits of ecosystem services to nonlivestock entities must exceed the state, county, or federal subsidies necessary to induce livestock producers' participation in brush control programs. Thus, if the programs and actions of the land management agencies accurately reflect social priorities, then public funds spent on the cost–share payments may provide some sense of the social value of nonprovisioning ecosystem services enhancement on rangelands. Skeptics, however, will counter that land management agencies' budgets and spending priorities most often reflect political and bureaucratic objectives. While the use of public expenditures on brush control as a surrogate measure of the value of ecosystem services is problematic, it does provide some insight into the value society (reflected in the political process and agency decisionmaking) places on rangelands. However, it is currently unknown whether these expenditures are reflections of society's willingness to pay for rangeland ecosystem services, indications of nonmarket valuation (e.g., rangeland option, preservation, or existence values, etc.), or the perceived benefits arising from recreational opportunities such as hunting or bird watching.

Government land management agencies are increasingly justifying brush control efforts on the basis of rangeland health and improved rangeland condition, with both concepts encompassing the broadest possible array of ecosystem services (Olson, Hansen, Whitson and Johnson, 1994). Perceived benefits of brush control include ecological restoration and stabilization, enhanced biodiversity, improved wildlife habitat, aesthetic improvements, increased carbon sequestration, reduced wind–caused soil erosion, and increased off–site water yields. The commonly heard argument regarding water yield on rangelands is that more water will be available for run off and/or deep drainage if there is more grass and fewer shrubs; however, potential increases in water yields resulting from brush control are highly variable, unpredictable, and may be unrealistic (Wilcox, 2002; Wilcox and Thurow, 2006). The value of wildlife habitat has been reflected in higher ranch values (Torell, Rimbey, Ramirez and McCollum, 2005), conservation easement values (Knight and Johnson–Nistler, 2004) and in fee–hunting opportunities (Sorg and Loomis, 1985). The research results likely reflect some combination of both intrinsic and market wildlife values in selected locations, although it is difficult to separate the two values.

While past research provides some insight into specific ecosystem services from specific rangelands, quantification and valuation of ecological restoration, stabilization, and biodiversity in the aggregate and at a broad–scale remain elusive. Furthermore, ecosystem and biodiversity trade–offs between woody species, grasses, and associated wildlife species can exist (Connelly, Schroeder, Sands and Braun, 2000), and both woody and grassland plants sequester carbon (Havstad et al., 2007)

As noted above, cultural ecosystem values include educational, aesthetic, spiritual, and recreational opportunities. Western U.S. rangelands are the legendary wide–open spaces of American history and mythology (National Research Council, 1994); as a result they are settings for two–stage ecosystems services processes. First, rangelands provide forage; secondarily, the process of herding and managing the forage–consuming livestock appears to have high cultural and social value for many Americans. Placing a value on this "cattle culture" would be very difficult; however, it is possible that some sense of the magnitude of cultural values of western rangelands could be obtained through estimating the extent to which many ranching operations are subsidized by nonranch incomes. Gentner and Tanaka (2002) found that half of western public land ranchers earn less than 22% of their total income from ranching, that a ranch business "profit motivation" is a relatively low–ranked objective for all types of ranchers, and that public land ranchers are strongly motivated to be in ranching for tradition, family, and lifestyle reasons (i.e., cultural objectives). Pope (1987) concluded that "romance, recreation, the achievement of a desired social status, or simply the maintenance of a family tradition" are the primary motives for many western U.S. cattle producers.

The multiple roles of livestock in traditional societies have long been recognized by anthropologists, human ecologists, and other social scientists. In these societies, livestock are mobile stores of wealth and status. And even though the United States has a very advanced economy, livestock continue to be viewed as "banks–on–the–hoof" by many producers (Eastman, Raish and McSweeney, 2000). For many ranchers, cattle and the rangelands used to produce them are investments, savings, and financial safe–havens. Cattle provide emergency funds, and are also a stable supply of high quality meat for family consumption. Similar to their counterparts in traditional societies, western U.S. rangeland cattle production is a source of identity and a sociocultural touchstone. However, the fact that this source of identity often is derived from public domain rangelands continues to be a source of controversy and competing strong opinions. The middle–ground of western public rangeland use policy opinion holds that these lands can be sustainably managed for multiple uses (and multiple ecosystem services)—including livestock grazing (Brown and McDonald, 1995).

In Summary

Goods and services have value to humans because they provide utility and because they are scarce. Realistically, western U.S. rangelands are so expansive and so remote to the citizenry at large that attempting to infer broad–scale ecosystem values from small, localized studies will fall victim to the fallacy of composition. If broad–scale rangeland ecosystem services are valued at the margin, the values of those services are likely to be quite small.

Rangeland "restoration," primarily through brush control, continues to be a priority for federal land management agencies in the West. For example, through Restore New Mexico, the BLM is seeking to enhance wildlife, allow reintroduction of native wildlife species, improve watersheds, reverse the expansion of invasive plant species, and protect outdoor values (USDA–BLM–NMSO, 2007). Previous research would lead to the tentative conclusion that the value of increased provisioning through forage production resulting from landscape restoration is very likely lower than the costs of restoration. While it is possible that the sociocultural and intrinsic ecosystem values of landscape restoration in the region are high enough to justify public expenditures on the federally–funded effort, these values have not been quantified. Thus, the sociocultural and intrinsic ecosystem values rationale appears to be the justification for an ecosystems management policy which is likely to defy rigorous economic analysis now and in the future.

For More Information

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What's Nature Done for You Lately: Measuring the Value of Ecosystem Services

Stephen Polasky

JEL Classifications: Q57, Q20, Q51, Q15

The natural world generates a range of valuable goods and services that support human well–being. These goods and services, collectively called ecosystem services, are typically provided free of charge and often have characteristics of public goods. Like other public goods, ecosystem services will not be provided optimally by aggregating the decisions of individuals motivated by self–interest. For example, an individual farmer gains the benefits of increased yields from the application of nitrogen fertilizer but often bears an insignificant portion of the costs from additional release of nitrous oxide, which is a powerful greenhouse gas, increased air pollution from emissions of nitrogen oxides and ammonia, and increased water pollution from release of nitrates into ground or surface water. In such cases, the sum of individual actions may result in the disruption of the flow of valuable ecosystem services thereby making all individuals collectively worse off. Even in cases where ecosystem services provide localized benefits, if individuals are not aware of the consequences of their actions they may still take actions that unknowingly damage ecosystem services on which their long–term welfare depends.

The presence of both incentive problems and information problems means that ecosystem services are often not provided efficiently. There is an important role for economists to play in improving the provision of ecosystem services, which includes understanding how management choices affect ecosystems and the services they provide, understanding of the relative value of ecosystem services to different groups in society and designing appropriate incentive mechanisms for the efficient provision of ecosystem services.

The recent focus on ecosystem services grew out of efforts, led primarily by ecologists, to highlight the importance of ecosystems and the natural world to human welfare. Just over a decade ago, the publication of *Nature's Services: Societal Dependence on Natural Ecosystems* (Daily 1997) and a controversial article published in the journal *Nature* entitled *The Value of the World's Ecosystem Services and Natural Capital* (Costanza et al. 1997) brought significant attention and research focus to assessing ecosystem services. The *Millennium Ecosystem Assessment*, a major international research effort to summarize the current condition and potential future trajectories of the world's ecosystems and biodiversity, used ecosystem services as its major organizing principle and emphasized the link between ecosystems and human well–being (MEA 2005). Major research efforts on ecosystem services are underway in government agencies such as the U.S. Environmental Protection Agency, international organizations such as the World Bank and nongovernmental organizations such as The Nature Conservancy and World Wildlife Fund. Many of these efforts are being led by natural scientists and there is a compelling need for greater economic input.

Economists have much to contribute to research on ecosystem services. In fact, properly understood the research agenda on ecosystem services is a continuation of a long–standing set of research objectives in agricultural, resource and environmental economics. Agricultural economists know that soil and climate are necessary inputs to the production of agricultural crops and have studied production functions and agricultural profitability under a wide variety of circumstances. Resource economists know that natural resources (oil, minerals, timber, and fish) contribute to a wide range of intermediate and final products and have studied optimal harvesting and inefficiencies caused by open access. Environmental economists know that peo-

1. *Carbon taxes can apply to carbon emissions only or to a broader array of greenhouse gases. In this paper, we will use the term "carbon tax" to apply to a tax on some or all greenhouse gases.*

ple value the environment directly even where there is no market and have developed tools of nonmarket valuation to analyze such things as the value of a scenic vista or clean air. In fact, in the 1970s economists set out a research agenda to measure "the value of services that natural areas provide" (Krutilla and Fisher 1975, p. 12). The "new" topic of measuring the value of ecosystem services can build from a large existing base of prior research on the value of agricultural production (Beattie and Taylor 1985), bioeconomic modeling of fisheries and other renewable resources (Clark 1990), nonrenewable resources (Dasgupta and Heal 1979), and nonmarket valuation of environmental amenities (Freeman 1993).

A Research Agenda for Economists on Ecosystem Services

What is needed now is to bring the full set of economic tools and expertise to bear on the analysis of ecosystem services. To do this, economists will need to engage with ecologists as well as other natural and social scientists. In measuring, valuing and providing proper incentives for the provision of ecosystem services, economics is necessary but not sufficient. Knowledge of ecosystems and how they are altered by human actions, which is more in the domain of natural sciences, is also necessary but not sufficient. In research on ecosystem services, integrating both economics and natural science is essential. In what follows, I briefly describe a research agenda and a set of challenges for economists in addressing issues related to ecosystem services. Challenges for economists exist both in developing new applications and analysis as well as more effectively integrating with other disciplines.

Measuring the value of ecosystem services and providing an efficient level of provision of these services requires tackling three main tasks:

- Provision of ecosystem services ("ecological production functions")
- Value of ecosystem services ("valuation")
- Designing policies for efficient provision of ecosystem services ("incentives")

I briefly discuss each of these three tasks in the following sections.

The Provision of Ecosystem Services: The Ecological Production Function

Policy and management actions chosen to accomplish certain objectives, such as increasing the yield of agricultural commodities or allowing development of industry, often have a range of effects, both intended and unintended, on ecosystems and the services they provide. For example, expanding agricultural land will increase crop production but may also lead to greater release of greenhouse gases and a decline in water quality downstream. Evaluating alternative policy or management actions in terms of ecosystem services involves understanding the full range of consequences the action has on ecosystems and how these consequences translate into changes in the suite of ecosystem services provided. Like a typical production function that predicts output of goods (e.g., crop production) as a function of inputs (e.g., land, fertilizer, water), an ideal "ecological production function" would predict the outputs of a range of ecosystem services given ecosystem structure and function.

Though considerable ecological knowledge exists about the structure and function of ecosystems, the translation to how these contribute to the provision of important ecosystem services is sometimes lacking. Ecological production functions for some services, such as above–ground carbon sequestration in plant material are well understood. But understanding carbon sequestration or release in soils or the net production of other greenhouse gases (e.g., nitrous oxide or methane) is less predictable. Sequestration or release of greenhouse gases in soil is a complex function that depends on whether chemical reactions are aerobic (with air) or anaerobic (without air), temperature, soil water content, the presence of various organic compounds and minerals.

In general, estimating the provision of the complete range of ecosystem services from any particular ecosystem is beyond our ability at present (NRC 2005). Key limitations that prevent complete understanding of ecological production functions include imprecise understanding of ecological processes, complex interaction among ecosystem processes, and lack of data.

Despite these limitations, ecological understanding is often sufficient to provide reasonable estimates of many important ecosystem services. The intense interest focused on ecosystem services at present is also helping to advance our understanding of ecological production functions for important services. In fact, framing issues in terms of ecosystem services has helped to redirect ecological research creating more rapid progress and easier links between ecological and economic analysis.

The Value of Ecosystem Services: Market and Nonmarket Valuation

The provision of ecosystem services yields outcomes in terms of physical units (e.g., bushels of crops, tons of carbon sequestered, concentrations of nitrate in water). But comparing outcomes of alternative management options is difficult when there are impacts on multiple ecosystem services and when each service is measured in

2. *We set aside here the distributional implications of climate change itself.*

its own physical units. Is a management option that increases crop yields but also results in increased carbon release and decreased water quality beneficial for society? The answer to this question depends on how one views the trade–offs between various services. In a standard economic problem, economists compare consumption bundles that might differ in many dimensions by converting the measures to a common metric of value measured in monetary terms. The same conversion to a common metric of value can be done with ecosystem services through the application of market and nonmarket valuation techniques.

Some ecosystem services result in outputs of marketed commodities (e.g., agricultural crops, commercial fisheries, timber) making valuation relatively straightforward. The analysis of the value of these ecosystem services only requires the application of standard tools of market analysis to assess the change in consumer and producer welfare with a change in the provision of ecosystem services. Ecosystem services that provide a necessary input to the output of a marketed commodity can be analyzed in a similar fashion. For example, the value of pollination services can be assessed by looking at the change in the quantity and quality of crop production when pollinators are present versus when they are absent. The only danger in analyzing the value of ecosystem services that are inputs to the production of other ecosystem services (e.g., pollination for crop production) is that one cannot count both the value of the input and the value of output at the same time because this would result in double–counting.

Most ecosystem services, however, are public goods that are not traded in markets. As mentioned above, the lack of markets is one of the main reasons for concern over the inadequate provision of ecosystem services. For such ecosystem services, nonmarket valuation methods (revealed preference, stated preference) are needed. The value of some nonmarket ecosystem services has been well studied by economists. For example, there are numerous applications of random utility models to assess the value of outdoor recreation (hunting, fishing, bird watching, backpacking), and numerous applications of the hedonic property price model to assess the value of various environmental amenities (access to open space, access to water resources, local air quality). The strengths of weaknesses of applying both revealed and stated preference methods to value aspects of the environment are well understood and a number of excellent summaries of this literature exist (e.g. Freeman 1993, Champ, Boyle and Brown 2003, Haab and McConnell 2003). Though estimating nonmarket values can be challenging, valuing ecosystem services is not inherently more difficult than applying nonmarket valuation to other areas of environmental economics. In fact, many things that are now called ecosystem services are things for which economists have routinely applied nonmarket valuation techniques.

Some prominent examples of the value of ecosystem services have been derived using replacement cost, i.e., what would it cost to replace a naturally provided ecosystem service with a human–engineered alternative. For example, the value of providing clean drinking water to New York City by protecting watersheds in the Catskills has been estimated to be worth $6–8 billion dollars because this is the cost of building and operating a water filtration plant (Chichilnisky and Heal 1998). Though popular, especially with noneconomists in part because it is easier to understand than methods to estimate willingness–to–pay, the replacement cost approach should be used with caution. Costs are not the same thing as benefits and estimates of cost can only be used to give an estimate of the value of ecosystem services under certain conditions: i) there are alternatives to provide the service, and ii) people would be willing–to–pay the cost of the alternative if the ecosystem service is not available (Shabman and Batie 1978).

What the Millennium Ecosystem Assessment labeled "cultural services," which includes aesthetic and spiritual values, can be quite important and is perhaps the most difficult type of value to assess using economic tools. Critics of economic valuation of the cultural or spiritual significance of nature raise both practical and philosophical objections. For some noneconomists, attempting to "put a price on nature" is deeply troubling (e.g. Sagoff 1988). One critique of the ecosystem services approach is that conservationists should use ethical arguments based on moral principles: "Nature has an intrinsic value that makes it priceless, and that is reason enough to protect it." (McCauley 2006, p. 28) Most economists including myself find it hard to apply arguments about "intrinsic value" to typical policy and management questions. For example, should we view decisions by farmers to convert a wetland to an agricultural field, or to increase the amount of fertilizer application, each of which will have an impact on an ecosystem, as a moral issue with clear right and wrong? These types of decisions seem better suited to weighing the full set of costs and benefits rather than being subject to moral absolutes.

Setting aside the philosophical debate, practical difficulties in assessing value in a manner that will be viewed as objective, authoritative and accurate is difficult for some ecosystem services like cultural services. This difficulty may argue for simply providing information about potential trade–offs among services without attempting to measure all services in the same monetary metric. For example, Polasky et al. (2008) derive a production possibility frontier showing trade–offs between feasible combinations of the value of commodities produced measured in dollars and species conservation measured in biological units. This approach illustrates consequences of alternative land use decisions but avoids the difficult task of putting a dollar value on species conservation. It is then up to the decision–making process to make value judgments about the relative value of species conservation versus commodity production and choose which land use alternative is most preferred.

Valuation of ecosystem services is likely to become more important in the future. With improvements in our understanding of ecological production functions there is greater understanding of the impacts of human actions on ecosystems and the consequences these impacts have on the provision of a suite of valuable ecosystem services. Application of valuation methods can help illuminate what policy or management options generate the greatest social welfare.

Policies and Institutions for Efficient Provision of Ecosystem Services

Though there are many interesting and worthwhile scientific questions to pursue, the prime motivation for assessing the value of ecosystem services is practical. Understanding the full consequences of policy or management decisions and comparing the net benefits to society of alternative choices can result in better policy and management decisions for use of land, water and natural resources. The title of a National Research Council report on valuing ecosystem services sums it up nicely: *Valuing ecosystem services: towards better environmental decision–making*. Integrating ecological and economic analysis to value ecosystem services can improve decision–making by clearly illustrating the consequences of alternative choices.

Information on ecological production functions and on values will almost surely be incomplete. Such incomplete information, however, should not paralyze decision making. In some cases, enough information will be available to make good decisions. In the Catskills watershed example, watershed protection could be justified on the basis of avoiding building a filtration plant, making it unnecessary to know the value of other ecosystem services. In other cases, decision–makers may have to make choices based on the best available information, with an eye to learning and adjusting policy or management based on new information ("adaptive management").

The supply of ecosystem services is often influenced by a different set of individuals than those who benefit from the provision of these services. For example, the farmer who maintains wetlands and limits fertilizer application provides benefits of cleaner water and lower probability of flooding to individuals who live downstream. The mismatch between those who influence the supply of services and those who benefit from services gives rise to a classic externality problem. Numerous potential solutions have been proposed for internalizing externalities, including payments for ecosystem services, tradable development rights, taxes on activities that result in damages to services, or some form of direct regulation (e.g., zoning laws, restrictions on actions that harm endangered species). Research that studies the incentive properties of these approaches and empirical analysis of results of implementation should be a high priority.

In the end, more efficient provision of ecosystem services will require that society overcome both information and incentive problems. The challenge for economists in the first case is to be able to work closely with natural scientists to build understanding of ecological production functions and to apply appropriate valuation methods. The challenge in the second case is to design policies simple enough to be implemented yet sophisticated enough to do justice to the underlying biophysical and socioeconomic complexities involved. These are important tasks and the sooner and more fully that economists tackle them the better.

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Ecosystem Services beyond Valuation, Regulation, and Philanthropy: Integrating Consumer Values into the Economy

Stephen K. Swallow, Elizabeth C. Smith, Emi Uchida and Christopher M. Anderson

JEL Classifications: Q20, Q57, C93, H41

Ecosystem services have been identified as a central link between society, or human systems, and the structure and function of natural systems (e.g., U.S. LTER 2007, MEA 2005). A fundamental economic problem is that while almost everyone—environmental groups, policy makers, and broad segments of the general public—seems to believe ecosystem services are valuable, the available public policy tools and approaches for private action fall short, and often omit, a direct link to the real values of the people. If ecosystem services are of economic value, then a fundamental challenge concerns how to identify the link between ecosystem services and the quality of life of individual households, and how to use that link to integrate ecosystem service values into the decisions of businesses and individuals in society. Given current markets and policies decision–makers are unable to recognize the full value of services ecosystems provide. What can be done to integrate ecosystem service values into the economy? After reviewing a fundamental cause for why markets often overlook ecosystem services, and after considering some limitations of the often effective approaches of philanthropy and government, we consider the potential to leverage experimental economics to create and test approaches to integrate values at the individual level into markets addressing ecosystem services.

A Fundamental Problem

One daunting frontier for ecosystem services originates from the natural character of many services, which sharply restricts or prevents the ability of providers to capture a return from many, often most, beneficiaries. This is the nature of "public goods" and "fugitive resources." Both involve "nonexclusivity": providers cannot exclude beneficiaries from benefit without payment for the cost of provision. For public goods, many people may benefit simultaneously, so no one provider (or user–beneficiary) can exclude anyone else at any particular moment. An owner of undeveloped farm, forest or lake shore often cannot insist on payment from the sprawling, urban–fringe residents who value open space for aesthetic tranquility; therefore, the landowner has little incentive to consider his community's open space values in choices about current use of his land. For fugitive resources, Nature does not allow a provider to contain and control the resource she has provided or protected; rivers flow and wildlife migrate across boundaries. A farmer or lawn–owner whose fertilizer percolates to the Mississippi or Potomac cannot insist on a return from the fishermen who would gain from a smaller Gulf Coast dead–zone, or from the patrons of oyster bars who seek a Chesapeake culture of local shellfish. Moreover, the opportunity for every beneficiary to benefit without payment creates the incentive to "free ride" or hang back and wait for potential providers—or public–spirited philanthropists—to "do the right thing" at their own expense, despite their own opportunity to ride free on others' generosity.

As a result, the could–be bounty of ecosystem services, and the conditions of ecosystem structure and function, often arise as a residual, left–over after–thought of decisions that potential providers make to sustain their livelihoods. For example, even conservation–minded farmers must implement practices within the annual, weather–dependent, schedule of their business, and society receives fish, wildlife, open space and water quality that results (or doesn't result).

Current Solutions

To be sure, we have institutions, public policies and private actions underway that mitigate the nonexclusive nature of Nature's services. But most existing tools remain short on their ability to integrate ecosystem services into the economy in a manner that is fully commensurate with familiar, commercially viable products.

Government authority generates land–use and environmental regulations that place enforceable limits on the degree to which individuals and firms can impose consequences on a broader community, such as through pollution or use of resources held in the public trust, with impacts on public health or endangered species. Government can also implement incentive payments which directly or indirectly compensate providers for actions to provide for ecosystem services, such as through federally funded conservation reserve or wetland reserve programs. It should be noted that, as market–based approaches, government incentive payments primarily focus on the supply side opportunity costs of providers, such as compensating farmers who forego crop production on land enrolled in a conservation reserve. Centrally–guided incentive payments may reflect politically or bureaucratically attenuated demand–side, public values through a benefit–cost analysis, but, in this article, we discuss the potential to integrate demand–side values through more complete market mechanisms.

Philanthropy, such as through wildlife conservation organizations or land trusts, can provide complementary actions. Philanthropists can provide payments for ecosystem services by, for example, compensating ranchers for tolerating wolves or purchasing conservation easements on undeveloped farms or forests. Philanthropists can stimulate government action by offering matching funds for taxpayer–approved conservation bond–issues or providing some offsets for debts of developing countries that protect biodiversity. Of course philanthropy exists under the shadow of incentives for individuals to ride free–waiting for some other donor to step forward.

Clearly, however, the limitations of government and philanthropic action may create additional expenses or opportunities lost. Philanthropists face their dependence on good will of donors, and costs to fight free–riding, and despite the effectiveness and nimbleness that can come from a carefully focused mission, philanthropic approaches can generate bureaucratic costs. Government may be better positioned to provide a broad approach, perhaps including equity considerations, casting a wide umbrella supported by more stable (if sometimes controversial) funding. But government's costs to obtain detailed (local–level) information, to safeguard public integrity, and to balance political tensions, can sometimes create the agility and efficiency of a bull at Tiffany's china shop. Both may find it difficult to focus their mission or goals in detailed alignment with the interests of a diverse public.

In contrast, decentralized market approaches to provision of valued goods and services are respected for agility, responsiveness to diverse preferences, and efficiency in directly aggregating consequences of individual values and choices into fairly universal signals of relative scarcity (called relative prices). Often supported by a coalition of nationally or internationally known, large, commercial firms and philanthropic organizations, we see nongovernmental organizations (NGOs) developing standards and practices for certification of ecosystem or natural resource–based products as "sustainably produced" through harvest and process chains that are environmentally friendly. The Marine Stewardship Council (MSC), concerning seafood, and the Forest Stewardship Council (FSC), concerning forest products, provide two examples, and we are witnessing a proliferation of green–marketing efforts—sometimes supported by third–party verification exemplified by MSC or FSC eco–labeling—whereby firms are recognizing a public demand for attention to environmental stewardship. While laudable, these efforts tie ecosystem services to the consumer's choices among familiar commercial products, rather than directly targeting the consumer's value for specified ecosystem services.

Approaches to ecosystem services based primarily on a natural–science perspective can overlook another significant challenge: identification of what people value, rather than simply what scientists currently measure. From the human household's perspective, what is the service? Physical measures of ecosystem output, such as for water quality and quantity, may often be salient and intuitive for, say, provisioning services like water for drinking or irrigation purposes. But what about measures linking water quality and services of interest for recreation? Egan, Herriges, Kling and Downing (forthcoming) show that individual households, pursuing a diverse set of activities, are responsive to a broad suite of water quality measures suggested by biologists, but careful modeling is needed to link biological measures through the process by which households seek ecosystem services and therefore value various dimensions of water quality.

Innovation Addressing Consumer Values

Private NGOs, government, and academia have stimulated innovative work on the valuation of ecosystem services. Society's representatives' need a better understanding of what it is that households actually value from ecosystems. We need, and are pursuing, better methods to measure value, and to link available actions to restore or sustain ecosystem structure and functions that yield desirable ecosystem services. Support for the social science of ecosystem services is critical to developing effective policies supporting the public welfare.

But what is substantially missing from the mission of economics relative to ecosystem services is work focused on integrating values directly into the economy, particularly demand–side values. Market–based approaches that integrate demand–side values give the people a direct and immediate voice—an economic voice—to indicate whether particular levels of or changes in ecosystem services are more or less valuable than particular levels of or changes in familiar, commercially produced goods.

How can society stimulate the integration of demand–side values in policies and market–based approaches addressing ecosystem services? This integration is already done for many provisioning services of ecosystems, through long established markets for food, fiber and natural resource–based commodities. How can we directly attack nonexcludability and give beneficiaries an economic voice upon which entrepreneurs can capture a return from enhancement of ecosystem services?

Experimental economists are increasingly investigating mechanisms that stimulate individuals to go beyond baseline donations and to transform a higher portion of their values into revenues in support of public goods. Experimental economists bring human subjects into a controlled laboratory setting to study how incentives and rules of exchange lead to individual or collective choices and outcomes. In public goods experiments, researchers design a set of monetary payoffs that individuals can earn through their choices, and these payoffs simulate the manner in which individuals benefit from real public goods. For example, working agricultural ecosystems might give rural residents aesthetic pleasure when farms provide grassland habitats for songbirds; every member of the community receives a "songbird benefit" whenever the habitat is provided, regardless of who bore the costs. In the laboratory, a group of individuals may be asked to pay for provision of a group–fund that provides a monetary return to everyone in the group, including those members who chose not to invest. Since the group–fund does not exclude noncontributors from benefiting, it comprises an abstract, monetized simulation of a public good.

Such experiments have shown that changing the incentives for individuals to ride free on the contributions of others can increase the degree to which individuals voluntarily pay for the cost of a public good and can bring their payments into a closer correspondence with their own value for the good. While practical mechanisms reduce the incentives for individuals to free–ride, additional effort is needed to evaluate and improve the degree to which mechanisms balance the provision of benefits net of costs. Since many people benefit simultaneously, an efficient balance of costs and benefits occurs when a provider delivers increments of public good until the costs of delivering the last unit are just offset by the combined total amount that all beneficiaries would willingly pay for that increment rather than doing without it.

Since different people have different values, some may value the public good more or less highly than others, so a combined total amount may involve different people paying different prices. This issue is not surprising; obviously with familiar donations mechanisms, different people donate different amounts. But it means the nonexcludable character of some ecosystem services will require entrepreneurs to explain the rationale for market mechanisms to newcomers from the general public.

Real Markets for Ecosystem Services

The insights from economics experiment already offer potential to support markets for real ecosystem services. Through USDA funding, the authors have established an experimental market in Jamestown, R.I. This example shows both promising results and significant areas where progress requires additional work to design and test mechanisms by which entrepreneurs could develop ecosystem service markets.

Jamestown is widely regarded for supporting conservation of undeveloped farm, forest and open space and is in the process of completing transactions to purchase development rights on the last few operating farms. However, while setting aside development rights may prevent the construction of additional residential neighborhoods or other developed uses, it may still be challenging for farmers to maintain farm operations. Moreover, changes in the intensity of farming, along with rising costs for energy or other inputs, push more ecosystem services outside the margin that farmers can sustain while maintaining their business.

This applies, for example, to the cultural or aesthetic services provided by grassland wildlife to residents who seek to live in a rural community that supports a healthy ecosystem. The experimental market centered on selling, to Jamestown residents, an opportunity to protect grassland habitats during the nesting season. This product was presented as contracts with farmers who agreed to forego hay harvesting and restrict grazing on 10–acre fields during eight weeks from the beginning of May to the beginning of July.

Using insights from laboratory experiments, the research design allowed a comparative test of three market mechanisms, including one intended only to measure potential value and two intended to raise revenues sufficient to cover the costs of a contract. The study created an experimental (but nonprofit) business and advertised under the trade mark of the Nature Services Exchange of Jamestown, created as a partnership of the University of Rhode Island and EcoAsset Markets Inc., an independent business in Providence, R.I. Residents were randomly assigned to groups. Each household in a group was asked to make a monetary offer subject to rules of the market mechanism assigned to that group; offers were made by personal check or by credit–card authorization.

The rules for all mechanisms included a "provision point," which corresponds to the minimum amount of funding that a group must provide in order to cover the costs of a public good. In Jamestown, the provision point is linked to the cost of a contract with a farmer who agrees to omit any harvest of hay on a specified, 10–acre field during the late–spring nesting season for Bobolinks, a grassland–nesting bird. Contracts were negotiated to cover the farmer's cost to replace the loss of feed by foregoing a hay harvest and to compensate for additional risk and management inconvenience to manipulate herds around the protected field(s). However, the provision point is more than a simple fundraising goal; rather it also comprises an implicit (beneficent) threat that a specific, quantified increase in the services of a public good will not occur unless the group provides for its costs. Laboratory experiments have shown a money–back–guarantee reinforces the provision point and the tie between contributions and the specific service offered. The guarantee establishes the rule that if funding falls short of the provision point, so the good is not provided, the fundraiser (seller) will not simply redirect revenues to other purposes. The provision point and money–back–guarantee rules reduce the incentives to ride free because group members (should) realize that the responsibility lies with the defined group and no one outside the group, so there are limitations on the opportunity to wait for others to pay. These rules were used in the Jamestown experimental market.

Laboratory experiments have also demonstrated that rules to rebate excess funds to contributors increase the offers that individuals will make, given their values. Rebates reduce the free–riding incentive for individuals to hold–back in a strategic effort to offer just–the–right–amount rather than paying more than was necessary after the contributions of others. The rebate feature was varied across mechanisms tested in Jamestown.

Our "pivotal mechanism" (PM) established a full rebate to any individual whose offer was not needed to meet the provision point for their field after all other contributions from their group were taken into account. This PM creates an incentive for each person to view their own contribution as if it was the last one needed, and their decision would make–or–break the outcome for their group's hayfield. The PM provides incentives for individuals to reveal their full willingness to pay to protect a hayfield for grassland birds, but it's advantage in measuring value is off–set by the practical limitation that very few or no individuals will be pivotal in most situations, so the PM generally fails to raise actual revenues.

Our "proportional rebate" (PR) mechanism is one of two we designed to raise revenues. Under the PR rules, any funds collected above the amount needed to cover the cost of a farm contract would be rebated to each contributor in proportion to their own contribution to the total of all contributions from their group. In our 2007 market, the second revenue–raising mechanism used the set of offers from a group to calculate the lowest possible "uniform price" (UP) such that everyone who paid would receive a rebate of the excess of their offer above the UP; anyone who offered to pay less than the UP would receive a full refund. Under the UP, everyone who pays will pay the same price (after their rebate).

The market generated total offers of around $9700, across all three mechanisms, with substantial variation across groups depending upon the rules by which excess funds would be rebated. Based on laboratory experiments, we expected the PR mechanism to come closest to the "full value" estimated under the pivotal mechanism (PM), and Jamestown's preliminary results support this prediction. While the UP approach was expected to, and did, elicit lower offers (and lower revenues) from groups, in on–going research we are investigating the possibility that similar mechanisms may produce more stable revenues year–after–year, as compared to PR. In the 2007 market, of six hayfields available for bird conservation, revenues met the provision points for three. Initial analysis suggests, however, that for about 400 homes participating there is potential value–as revealed under the various mechanisms– ranging from $8800 to $28,000 to protect a field for grassland birds. The on–going challenge will be finding better ways to align revenues with this potential value.

The Jamestown experience shows that, even in the case of a cultural or aesthetic ecosystem service, experimental economic markets might prove successful. In Jamestown, all three of the fields that were ultimately protected would have been harvested during the 2007 nesting season had the farmers been unable to obtain support to offset costs to their operation. Moreover, other data from this study suggests that not only did residents value contracts focused on Bobolinks, but they may also value contracts that help farmers to restore previously idled hayfields to a state that provides additional habitat and also eliminates invasive plants that may be harmful to other aesthetically–valued wildlife (like the monarch butterfly). The ecosystem service market may eventually enable farmers to expand their operations with services that Jamestown's exurban residents' value.

Concluding Observations

Developing mechanisms to enable entrepreneurs to leverage consumer values may substantially expand the potential for market approaches to lead to valuable impacts for ecosystem services. Consider for a moment the cap–and–trade approaches used for air and water pollutants, and currently under discussion for carbon emissions. If market mechanisms create a closer alignment between individual and collective values and incentives to support the public good, then markets may create an avenue by which communities can directly influence the key choice of the overall cap on emissions; individuals and groups who value a further reduction in emissions could buy and retire a quantity of permits in a manner that effectively lowers the overall cap. Markets enable private action that can complement or improve upon the government, or philanthropic, actions already underway for ecosystem services.

Here again the Jamestown Bobolink market provides an example. After seeing a summary of the experimental market in Audubon magazine in November 2007, a community–garden club in Grant, Minnesota, contacted the authors and developed their own entrepreneurial approach to protect a hayfield next to their community garden. This year their club members have rented the hayfield in consideration of grassland birds, illustrating that once enabled, entrepreneurship can expand to enhance the provision of ecosystem services in a nimble fashion.

Furthermore, research on the implementation of ecosystem service markets may benefit from interdisciplinary teams and inclusion of outreach. In Jamestown, farmers' independent experimentation is likely to yield modifications to contracts, such as to plan for early–season grazing, that both enhance farmers' ability to deliver ecosystem services and lower the costs (or provision points) implied. At this writing, Jamestown farmers are weighing options to alter grass species in their hayfields, to better manage joint production of grassland birds and feed for livestock (G. Neale, personal communication). Moreover, ecological research on bird behavior may enable the design of methods that allow environmental managers to guide birds toward fields that are likely to be protected in the next season. Such considerations may be critical to establishing hayfield harvest rotations through a series of years that sustain the quality of hayfields for both feed production and habitat. The field experience also has raised a number of questions that were not apparent from a review of experimental economics literature alone, including questions about which mechanisms would produce stable revenues over time or be adaptable to situations where many increments to ecosystem services might be possible.

The challenge of ecosystem services is as complex as the complexity of human and ecological systems combined. Ecosystem services link us with Nature and progress will often require a comprehensive approach with disciplinary, interdisciplinary and integrated teams on the frontier.

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Consumer Preferences for Fair Trade Foods: Implications for Trade Policy

Matthew C. Rousu and Jay R. Corrigan

JEL Classifications: Q18,Q51 Effects

Economists overwhelmingly support free international trade. According to a 2006 *Economists' Voice* survey, for example, 87% of economists polled agreed that "the U.S. should eliminate remaining tariffs and other barriers to trade." Yet a vocal community of activists opposes globalization due to concerns that trade exploits workers and the environment in the developing world. In response to these concerns, Congress has recently taken steps to make pending trade agreements contingent on trading partners abiding by international labor and environmental standards. And while campaigning for the Democratic presidential nomination, both Hillary Clinton and Barack Obama called for reopening NAFTA negotiations in order to include more stringent environmental and labor rules. Whether these proposed policy changes are motivated by altruism or by more familiar protectionist arguments, the new restrictions are likely to increase production costs in developing countries, ultimately increasing the price U.S. consumers pay for imported goods. However, this welfare loss may be at least partially offset if Americans derive satisfaction from knowing that the imports they consume are produced in a safe, clean environment.

In order to understand whether this proposed legislation is likely to have a positive net impact on American consumers, it is necessary to understand the premium they place on imported goods produced under stricter labor and environmental standards. A straightforward way to answer this question is to estimate the premium consumers are willing to pay for the "fair trade" designation.

The Fair Trade Designation

According to the Fairtrade Labelling Organizations International, producers of agricultural commodities who meet environmental and labor standards that are broadly similar to those policymakers are currently proposing are guaranteed a price "that covers the cost of sustainable production

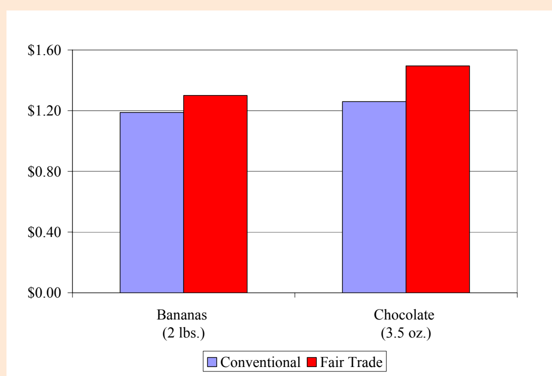
Information on Fair Trade Given to Participants

The following statement on fair trade has been approved by a group of academic, religious, and community leaders who have no financial stake in fair trade foods:

The fair trade movement promotes international labor, environmental, and social standards. The movement focuses on exports from poorer countries such as Ecuador and Ghana to richer countries such as the United States. Standards may be voluntarily adhered to by importing firms, or enforced by governments. Proposed and practiced fair trade policies vary widely, but most often take the form of minimum price support schemes for products such as bananas, cocoa, and coffee. Non-government organizations also play a role in promoting fair trade standards by serving as independent monitors of compliance with fair trade labeling requirements.

Source: Wikipedia

Figure 1. Mean Bids for Conventional and Fair Trade Products (N = 122)



and living." For example, as of December 2005 cocoa producers were guaranteed a price of either $1,750 per metric ton if the world price for similarly graded cocoa was at or below $1,600, or the world price plus $150 per metric if the world price exceeded $1,600. At the time this standard was implemented, the world price of cocoa was $1,519 per metric ton, according to the International Cocoa Organization.

According to the Fairtrade Labelling Organizations International worldwide sales of fair trade goods increased by 41% in 2006 to $2 billion, making fair trade goods a small but rapidly growing segment of the larger market for "ethical goods." TransFair USA, a California-based nonprofit that certifies fair trade food products in the United States, currently offers fair trade certification for coffee, tea, herbs, cocoa and chocolate, fresh fruit, sugar, rice, and vanilla.

Loureiro and Lotade (2005) use contingent valuation techniques to estimate consumer willingness to pay for the fair trade designation. The authors find that 85% of consumers are willing to pay a positive premium for fair trade coffee, with the average consumer willing to pay 22¢ per pound more for fair trade coffee than for conventional coffee. However, contingent valuation studies may be vulnerable to hypothetical bias. Cummings, Harrison, and Rutström (1995), for example, find that fewer than 40% of participants who indicated that they would be willing to pay $3 for a calculator in a hypothetical market were actually willing to buy the calculator when real payment was required. List and Gallet's (2001) review of 29 experimental valuation studies found that hypothetical willingness to pay estimates overstate real willingness to pay by roughly a factor of three.

Experimental Design and Results

In this section we present the design and results of a nonhypothetical experimental auction comparing shoppers' willingness to pay for conventional and fair trade food products. Lusk and Shogren (2007) provide an extensive review of the experimental auction literature and demonstrate that these controlled auctions are enormously useful in examining consumer preferences. Experimental auctions have, for example, been used to examine consumer preferences for food safety, meat tenderness, and genetic modification. To our knowledge, the results we present here are the first nonhypothetical estimate of consumer willingness to pay for fair trade goods.

One hundred and twenty-two shoppers at two grocery stores in Harrisburg, Pa. participated in this study in October 2005. According to the market research firm Acxiom, Harrisburg is one of the twenty most demographically representative metro areas in the United States.

Participants bid on a 2 lb. bunch of bananas, a 2 lb. bunch of fair trade bananas, a 3.5 oz. chocolate bar, and a 3.5 oz. fair trade chocolate bar using the Becker-DeGroot-Marshak auction mechanism which is widely used by economists for this type of research. For a more detailed presentation of the experimental design or participant characteristics, we refer the interested reader to Rousu and Corrigan (forthcoming). Participants in this type of auction submit their bids with the understanding that the selling price will be chosen at random. Anyone who submits a bid above this randomly determined price purchases the item at the random price. Anyone who submits a bid below this price purchases nothing. Because the price participants pay if they win the auction is not influenced by the bid they submit, there is no incentive for participants to understate their true willingness to pay.

After collecting the first set of bids, the experimenter presented participants with objective information about fair trade certification. The exact information presented to participants is shown in Box 1. Participants then submitted another set of four bids. Participants understood that only one of the bidding opportunities would be binding and that bidding opportunity would be determined randomly at the end of the experiment.

After the bids were collected and the binding bid and the selling price were randomly determined, participants completed a brief exit survey. They were then paid $10 for participating in the study, and any transactions agreed to were carried out.

Because we are primarily interested in the premium consumers are willing to pay for stricter environmental and labor standards, we focus on bids submitted after participants received objective information about the fair trade designation. We estimate the fair trade premium by taking the difference between bids submitted for the fair trade and conventional versions of a product. We found that the median fair trade premium was zero for both bananas and chocolate, suggesting that the typical Harrisburg shopper places no value on the fair trade designation. However, the mean fair trade premium was positive for both goods. Specifically, participants were, on average, willing to pay an 11¢ premium for fair trade bananas and a 24¢ premium for fair trade chocolate. The mean bids submitted by participants are shown in Figure 1. Taken as a whole, these results suggest that the mean fair trade premium is driven by a minority of consumers who place a relatively high value on the fair trade designation. For example, one in ten participants was willing to pay at least a 50¢ premium for fair trade bananas or at least a $1.25 premium for fair trade chocolate.

Conclusion: Don't Mandate Stricter Standards

Congress would like our trading partners to abide by stricter labor and environmental standards. In cases where these standards impose a binding constraint on foreign producers, the associated increase in production costs is equivalent to a nontariff barrier to trade. Other examples of nontariff barriers include voluntary export restrictions in the automobile industry, agricultural price supports, and restrictions on U.S. gamblers limiting their access to foreign online gambling sites.

Basic economic theory predicts that these kinds of restrictions benefit domestic producers who compete directly with the affected foreign firms, while simultaneously reducing consumer surplus. The net effect is a decrease in domestic welfare. However, if domestic consumers prefer goods produced under stricter environmental and labor standards, the "warm glow" they receive from consuming such goods may offset the lost consumer surplus to such an extent as to make the imposition of stricter standards welfare enhancing for society.

Our results show that while the typical grocery shopper in a representative U.S. city derives no value from the fair trade designation—and, by extension, the stricter environmental and labor standards that go with it—a minority of shoppers place substantial value on that designation. Under the current market–based system of optional fair trade labeling, individuals who derive added value from consuming goods produced in a clean, safe environment are free to buy fair trade products. Imposing stricter environmental and labor standards on all imports is likely to increase the prices consumers pay, but it is unlikely to generate enough of a "warm glow" to offset this price increase given that the consumers who place the highest value on these stricter standards have presumably already embraced fair trade certification. Therefore, we conclude that current market–based practices are preferable to rewriting trade agreements.

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