

Problem Set 3

An increasing demand for locally grown and malted barley has independent maltsters on the rise—but is it sustainable?

(Adrienne So, BeerWestMag.com)

As anyone who has ever taken a brewery tour knows, beer is composed of four simple ingredients: water, barley, yeast, and hops. While each component is essential, hops have gotten a disproportionate share of the attention. They're sexy, aromatic flowers, free for the plucking in many a backyard. They're accessible and understandable, in a way that an arguably more important ingredient—barley—is not. It's hard to develop a personal, emotional relationship with a commodity that's grown thousands of miles away, malted in large factories, and shipped to your doorstep in tidy little bags. But a handful of research scientists, farmers, maltsters, and brewers across the country are working hard to deconstruct and rebuild the long, complex supply chain that begins in a distant field and ends in the beer packaged and consumed by each of us at home.

Malting is the process of germinating grain in order to convert the seed's starches into usable sugars. It's also a process that requires a fair bit of time, space, and engineering skill. First the grain has to be soaked, or steeped, in order to start the germination process. Once the seed has just barely begun to sprout, the germination is halted and the green malt is converted into toasty brewing malt by heating, or kilning for a particular length of time at a particular temperature. For a society and industry that places an increasing emphasis on locavorism, it's shocking that we haven't paid more attention to barley. The questions pile up on top of one another: When we say that we're drinking a locally produced beer, is anything in it more local than the water? Where does the grain come from, and does its quality affect the beer's taste at all? And shouldn't we pay a little more attention to the most important ingredient in the sudsy beverage that we all know and love? Nowadays, a grain of barley that is destined to be malted and mashed into your favorite craft beer is probably grown in the American Midwest or somewhere in the Dakotas, Idaho, Montana, or eastern Washington. Economies of scale in transportation dictate that most large-scale maltsteries, like Cargill, Rahr, and Briess, are built near the grain they're malting. It's easier, and far cheaper, to transport malt than it is to transport raw grain.

In order to start a small, local maltstery, then, you need to find grain that's grown near your home. And since most people don't own 40 acres of farming land that's sitting fallow, you need to persuade a farmer to grow it for you. But what kind of barley do you plant? Will it grow in your local climate or succumb helplessly to some mysterious disease? Most importantly, how can we justify all this effort if we don't even know whether the barley will be suitable for brewing? Plant scientists in agricultural programs, like those

at North Dakota State University, the University of Idaho, and Oregon State University, are working to answer these basic questions in order to better serve the craft brewing industry. Although craft beer only accounts for about six percent of the beer sold in the United States, craft brewers account for 21.4 percent of the malt that's purchased. The Brewers Association estimates that craft brewers might use as much as one-third of malt produced in the United States.

"Beer is an agricultural product," Andrea Stanley, a small maltster from Massachusetts, concluded in her talk at the 2013 Craft Brewers Conference. Supporting the growth of local maltsteries also supports the livelihoods of the family farms that supply them with grain. "When you can connect a brewer with the farmer that grew his grain, that's something special."

In the following problems, you will be solidifying your knowledge of marketing channel models. In problems 2–4, please illustrate your solutions using marketing channel diagrams and then discuss the dynamics that you've graphed. Practice labeling all axes, curves, and points of equilibrium. Specifically, don't forget to label all original and new quantities, prices, and curves. In problems 5–7, you will be asked to solve for equilibrium behaviors analytically.

1. In your own words, explain how *derived demand* is found. That is, knowing the demand for products in the retail market and the supply of marketing and processing services, how do you determine the derived demand for the farm-level commodity? Explain the concepts of a marketing channel and derived demand as if you're talking to someone who has never taken an economics course.
2. Your goal is to analyze the farm level demand for malt. Let's consider that the related retail market is one for beer that is either a craft beer or one that is a macrobrew (typically produced by large brewers such as Anheuser-Busch or Coors).
 - (a) Illustrate the demands for the craft beer and macrobrews. Show each individual retail-level demand and also the final demand for all beer products. Explain your intuition for arranging the demands from top to bottom. That is, why is a particular demand curve above or below another demand curve. Carefully label each curve.
 - (b) Using the information in (a), illustrate the market for malt. Assume that the supply of processing & marketing services and the supply of barley are known. Carefully label each curve.
 - (c) What might be the "processing & marketing" services in this scenario? That is, barley can't be magically turned into beer; so what needs to happen? (Some research may be required to answer this question.)
 - (d) Illustrate the equilibrium quantity and price in the malt market, as well as the equilibrium quantity and price of retail beer. Using the latter quantity, illustrate the prices of macrobrews and craft beers.

- (e) Why are we able to use the malt quantity at the farm level as a proxy for the quantity of beer at the retail level?
3. Now let's examine the underlying barley market. Remember that malt is produced from barley, so the malt market may be seen as the "retail" market for barley.
- (a) In the barley farm market, what would be the corresponding "retail" demand curve?
- (b) Assuming that we know the supply of processing & marketing services in the barley market, graphically derive the demand for barley.
- (c) Illustrate the equilibrium quantity and price of barley in the farm market.
- (d) How does the quantity in the barley market relate to the quantity in the malt market and the quantity in the retail beer market?
4. Let's now examine what has happened in the previous 10–15 years within the retail beer markets. Assume that the demand for craft beer increased, while the demand for macrobrews remained the same.
- (a) First, without illustrating anything, carefully layout the logic of the resulting changes in the retail, malt, and barley farm markets. What change occurs first? What is the next event to happen? Etc.
- (b) Using a new three-diagram figure, illustrate what occurs in all three markets.
- (c) Create a table that describes what occurs to the quantity and price in each of the three markets.
- (d) Using economic intuition, explain why the changes that you've outlined occur in each of the markets. Who is likely better off and who is likely worse off?
5. Your next goal is to determine quantitatively the equilibrium values in the barley malt market and the retail beer market. Suppose that the individual demands for craft and macro beer are as follows:

$$D^{craft\ beer} : P_D^{craft} = 100 - 0.4Q$$

$$D^{macro\ beer} : P_D^{macro} = 50 - 0.6Q$$

You also know that the processing and marketing of beer is characterized by the function:

$$S^{PM} : P^{PM} = -300 + 4Q$$

Lastly, the supply of malt is represented by the function $P_S^{malt} = 100 + 2Q$.

Calculate the following:

- (a) The demand function for total retail level beer.
 - (b) The derived demand function for malt.
 - (c) The equilibrium quantity of malt (in hundred tons).
 - (d) The equilibrium price of malt (in dollars per ton).
 - (e) The equilibrium price of the craft beer (dollars per gallon) and the price of macrobeer (dollars per gallon).
6. Now, repeat the exercise above, but this time you will need to calculate the supply function of malt.

$$D^{craft\ beer} : P_D^{craft} = 100 - 0.4Q$$

$$D^{macro\ beer} : P_D^{macro} = 50 - 0.6Q$$

You also know that the processing and marketing of beer is characterized by the function:

$$S^{PM} : P^{PM} = -300 + 4Q$$

Lastly, barley production requires fixed and variable costs. The variable costs are characterized by the function $P_V = 25 + Q$ and the fixed costs are 175.

Calculate the following:

- (a) The demand function for total retail level beer.
 - (b) The derived demand function for malt.
 - (c) The supply function for malt.
 - (d) The equilibrium quantity of malt (in hundred tons).
 - (e) The equilibrium price of malt (in dollars per ton).
 - (f) The equilibrium price of the craft beer (dollars per gallon) and the price of macrobeer (dollars per gallon).
7. Now, let's quantify the scenario in problem #4. Suppose that the demand for craft beer is now $P_D^{craft} = 110 - 0.4Q$. Assume that all other conditions are as in problem #6. Calculate the following:
- (a) The demand function for total retail level beer.
 - (b) The derived demand function for malt.
 - (c) The supply function for malt.

- (d) The equilibrium quantity of malt (in thousand tons).
- (e) The equilibrium price of malt (in dollars per ton).
- (f) The equilibrium price of the craft beer (dollars per gallon) and the price of macrobeer (dollars per gallon).
- (g) Smell test: Do the price and quantity values intuitively correspond to the graphs in problem #3?

In the late 2000s, corn prices rose rapidly and were closely followed by prices of other major agricultural commodities. A widespread explanation for these market changes is an increased demand for corn in the production of ethanol, prompted by the introduction of programs intended to encourage biofuels production in the United States. Specifically, the Renewable Fuel Standard (RFS) program introduced in the Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007 prompted significant changes in agricultural markets. The latest RFS program mandates that 36 billion gallons of renewable fuels be blended into gasoline by 2022, with a maximum of 15 billion gallons from corn-based ethanol by 2015 (Renewable Fuels Association 2012).

Currently, excessive production costs and technological constraints limit the quantity of noncorn-based biofuels, placing a greater burden on the use of corn to fulfill the mandated ethanol production requirement and precipitating substantial reallocation of corn from its traditional uses in feed. For example, 53.4% of U.S. corn produced was used in livestock and poultry feed and 12.5% was used in ethanol production during the 2004–2005 marketing year; in the 2011–2012 marketing year, however, only 38% of the corn was used for feed, while 40% was an input to biofuel production. Technological advances that allowed a corn-ethanol byproduct—distillers’ dried grains (DDGs)—to be used as a supplement to livestock feed was a partial saving grace during this market transformation. The result was a quickly emerging domestic market (and more recently, an international market) for DDGs.

Recently, there have been many discussions and lobbying efforts in Congress to significantly reduce or fully eliminate the Renewable Fuel Standard. This would substantially change the market structure and could lead to important shocks at all levels of the biofuels marketing channel. An analysis of these changes would provide important insights about the future of U.S. agriculture.

8. Illustrate the retail market for products related to corn-based biofuels production and the farm-level market for the input, corn.
 - (a) Illustrate the retail and farm-level markets associated with corn-based biofuel production. Please ensure that all axes, curves, and points of equilibrium are labeled and that you specify the market that you’re illustrating.
 - (b) Illustrate the impacts of removing the RFS program in both the retail market for corn-based biofuels and the farm-level market for corn. In a table, describe the changes in prices and quantities of corn and each good in the retail market.
 - (c) In 2-3 sentences, hypothesize what would happen to the prices and quantities of wheat and discuss why you think these changes will occur.
9. Recall that in our discussion of elasticities, we saw that depending on economic conditions, markets may be operating on an inelastic portion of the supply curve, the elastic portion of the curve, or somewhere in the middle. Your task in this problem is to replicate #8(b), but explicitly consider that the corn supply is either very inelastic or very elastic. That is:

- (a) On separate graphs, illustrate the impacts of removing the RFS program in both the retail market for corn-based biofuels and the farm-level market for corn when the corn supply curve is highly inelastic. (Ensure that you draw your curves in a way that I can clearly tell the elasticity of the curve.)
- (b) On separate graphs, illustrate the impacts of removing the RFS program in both the retail market for corn-based biofuels and the farm-level market for corn when the corn supply curve is highly elastic. (Ensure that you draw your curves in a way that I can clearly tell the elasticity of the curve.)
- (c) For each scenario (inelastic and elastic), hypothesize the *magnitude of effect* on wheat prices. That is, don't simply tell me what the impact will be, but rather, tell me whether you expect prices of wheat to change by a lot or a little under each supply elasticity scenario in the corn market. (This is the "think like an economist" question.)
10. Now, determine the market conditions analytically. Suppose that you know the following about the corn-based biofuel market.

$$\begin{aligned} D_{ethanol} : P_{eth} &= 160 - Q \\ D_{DDG} : Q_{ddg} &= 60 - 2P \end{aligned}$$

You also know that processing and marketing corn into the corn-based biofuel products requires transporting corn to an ethanol plant, and incurring both variable and fixed costs for operating the facility. The supply of these processes are as follows:

$$\begin{aligned} S_{transport} : P_{tran} &= -2000 + 3Q \\ S_{variable} : P_{var} &= -5000 + 2Q \\ S_{fixed} : P_{fix} &= 7100 \end{aligned}$$

Lastly, the corn supply function is: $S_{corn} : Q_{corn} = -10 + 5P$.

- (a) Determine the equilibrium quantity (in millions of bushels) and price (in dollars per bushel) of corn.
- (b) Determine the equilibrium prices of ethanol (in dollars per thousand gallons) and DDGs (in dollars per ton).