An introduction to demand functions, supply functions, and competitive market equilibrium

Edward Morey Draft, September 17, 2018

The intent of these notes is to compliment the demand, supply, and equilibrium sections in Chapter Three of Krugman and Wells.

1 Demand for Vail ski days

So, you need to draw a graph on a sheet of paper you can share with those around you.

I want you to do the following and then ask the people around you if it looks reasonable to them.

Assume you have a season ski pass to Vail (with free parking), new ski equipment, and a new SUV (you won it all in a raffle for breast-cancer research). You attend college near your home (live in same town you attend college). First guesstimate how many days **you** will ski Vail this winter assuming you live in Boulder (100 miles to Vail). Then for Fort Collins (150 miles), Summit Country (25 miles) and Vail (zero miles, you go to the U. of Vail).

Plot on a graph (per-season ski days at Vail on the vertical axis and miles to Vail on the horizontal axis) your guesstimates, and connect the points. Put your name of the graph, or an alias

Does your line slope up? down? is it flat? Is it vertical?

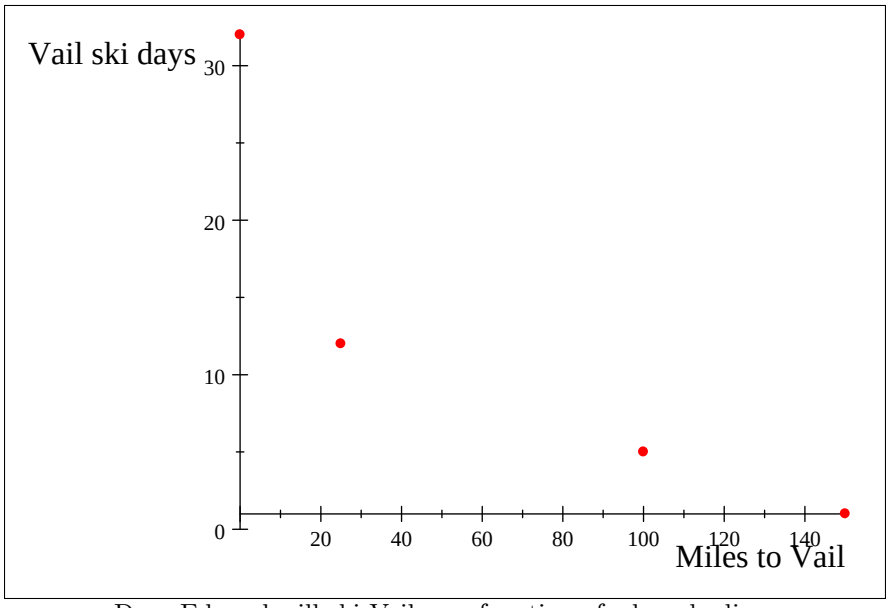
Describe your line in words to your neighbors
Describe, in words, what the graph tells an observer about you.

How does the graphs of those around you differ from your graph. Are their graphs reasonable? (I should collect some of the graphs.)

My guesstimates are

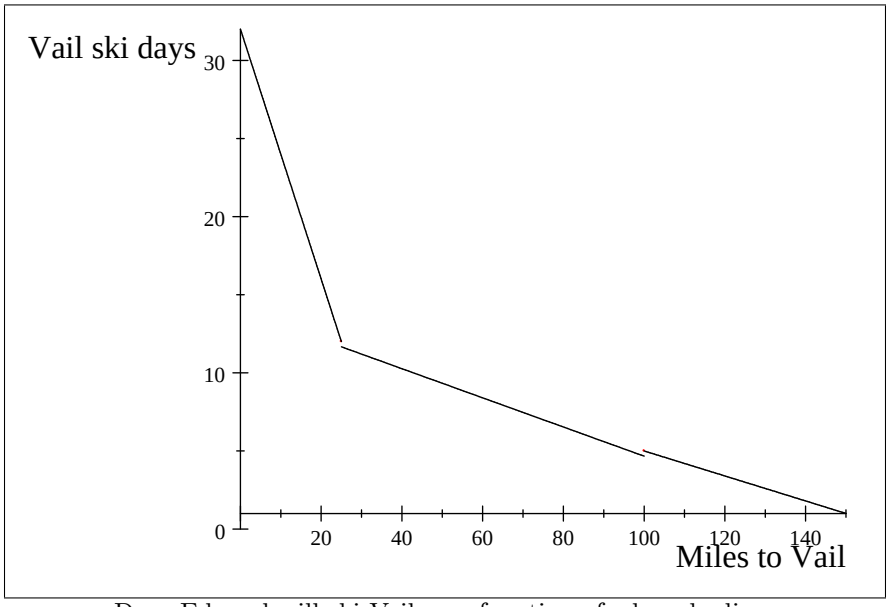
	Vail	Summit County	Boulder	Ft. Collins
Number of Vail ski days	32	12	5	1
miles to Vail	0	25	100	150

Plotting these numbers:



Days Edward will ski Vail as a function of where he lives

Now let's connect the dots with straight lines. Note that points on the straight lines between the red dots might be wrong.



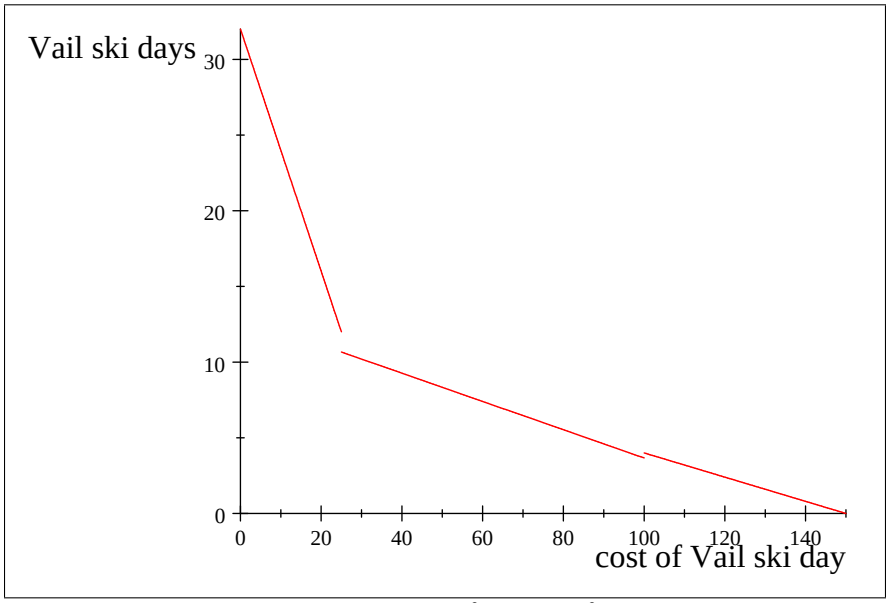
Days Edward will ski Vail as a function of where he lives

This is an estimate of my *demand function* for ski days at Vail as a function of how far I live from Vail. Why only an estimate

(how many days I want to ski Vail as a function of how far I live from Vail)

Now convert things to money by assuming it cost 50 cents a mile to operate my new car (remember I have a pass, free parking, etc.)

So at \$0 go 32 times, at \$25 I would go 12 times, at \$100 I would go 5 times, and at \$150 I would go once.[1]

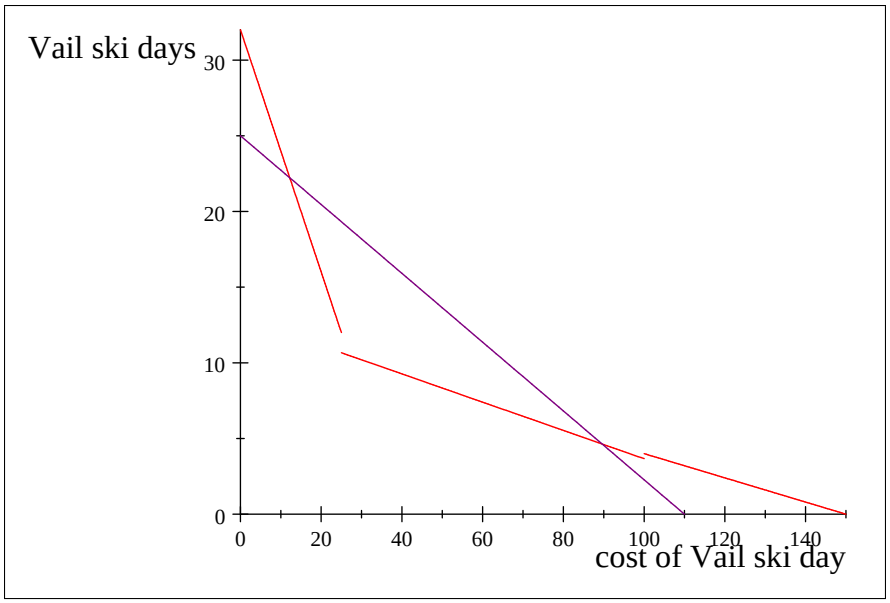


Days Edward will ski Vail as a function of his cost per day

Note that it does not look like my demand function is a straight line.

[1] Don't forget its a roundtrip.

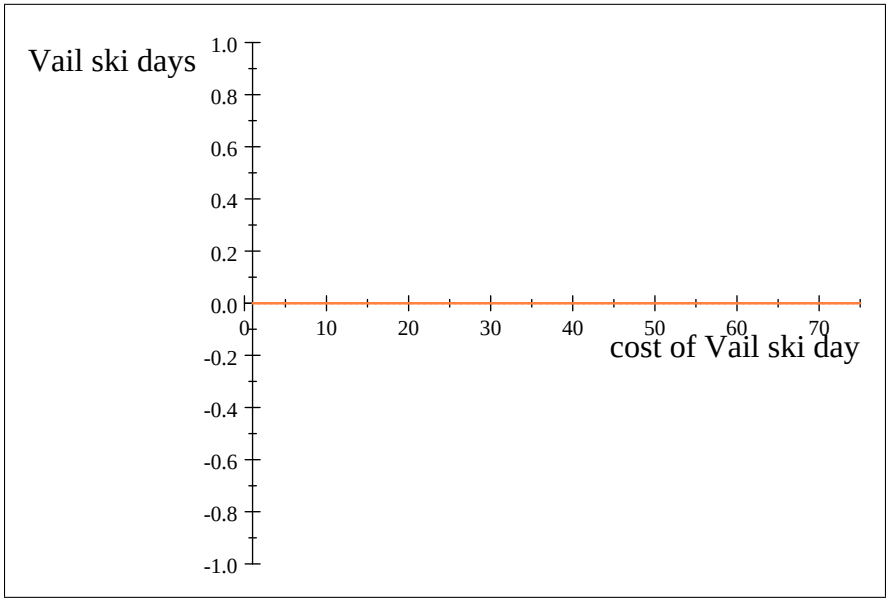
If we forced my demand function to be a straight line (ony to make the math simplier), what would be a good guess of where the straight line will lie?



Days Edward will ski Vail as a function of his cost per day

Note that the straight purple first underestimates, then overestimates, then underestimates.

What would Wanda Sue's demand function for Vail ski days look like if Wanda hates skiing?

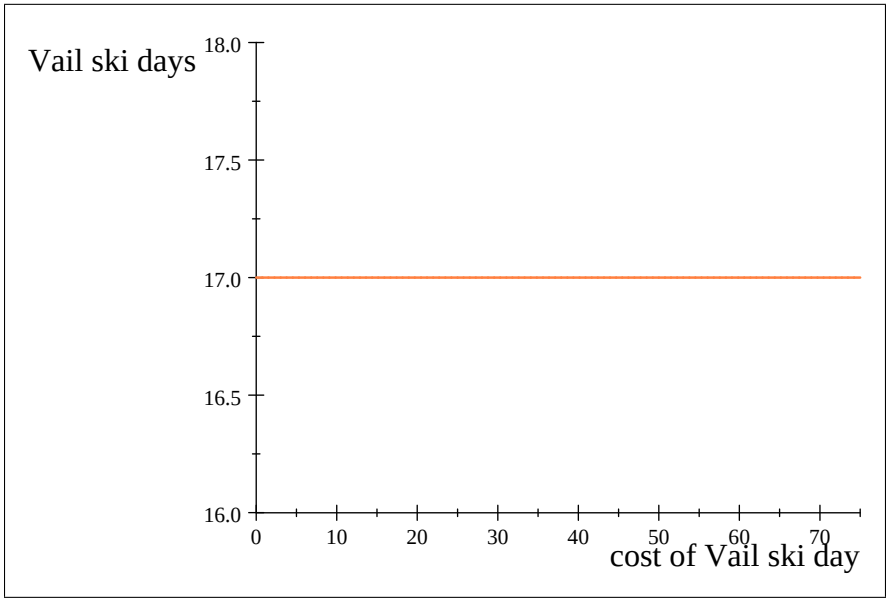


Days Wanda will ski Vail, 0, as a function of her cost per day

The orange line is her demand function.

Wanda is insensitive to price because she hates skiing. She goes the same amount, zero. independent of the cost

What if Wanda's abusive boyfriend **forced** her to ski Vail 17 days this year. Her "demand" function would look like



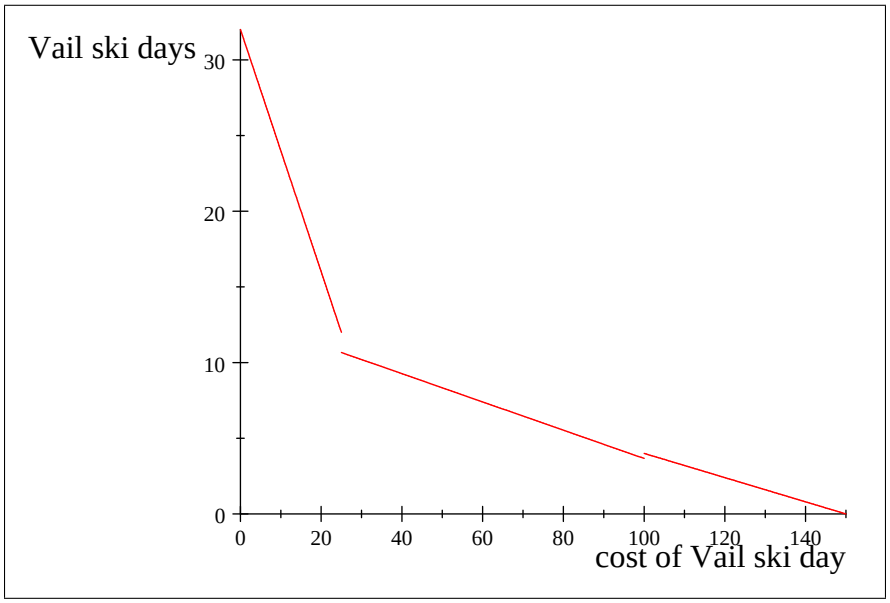
Days Wanda will ski Vail, 12, as a function of her cost per day

Wanda is again insensitive to price.

Is this really a demand function? It is a conditional-demand function, conditional on Wanda keeping her jerk boyfriend.

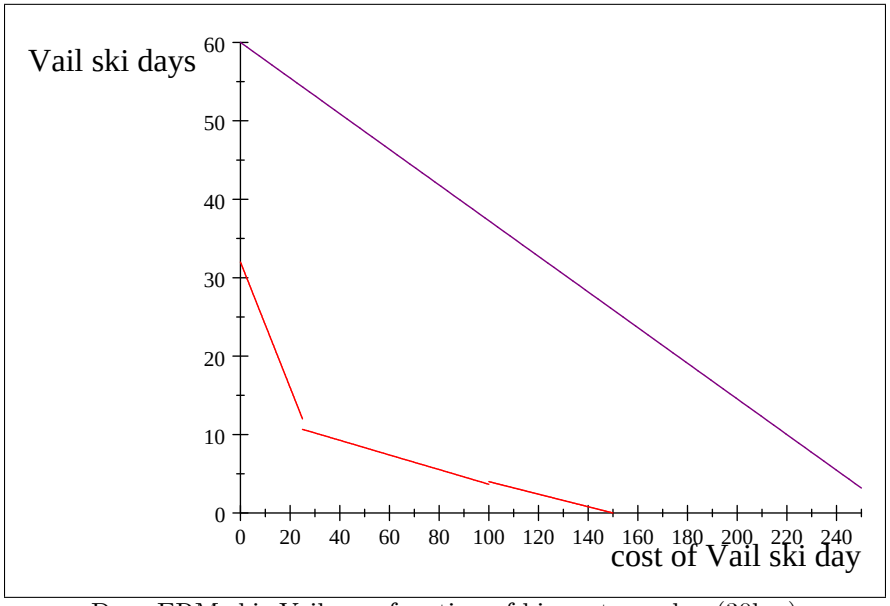
Let's return to my demand curve for Vail ski days

Let's assume my guestimates were based on the fact that I currently work 60 hours a week (the red demand function is based on my 60-hour work week)



Days Edward will ski Vail as a function of his cost per day

Draw a new guesstimated demand function for my Vail ski days assuming I cut back work to 30 hours a week (or my wife and daughter dump me for George and I have a lot more free time).

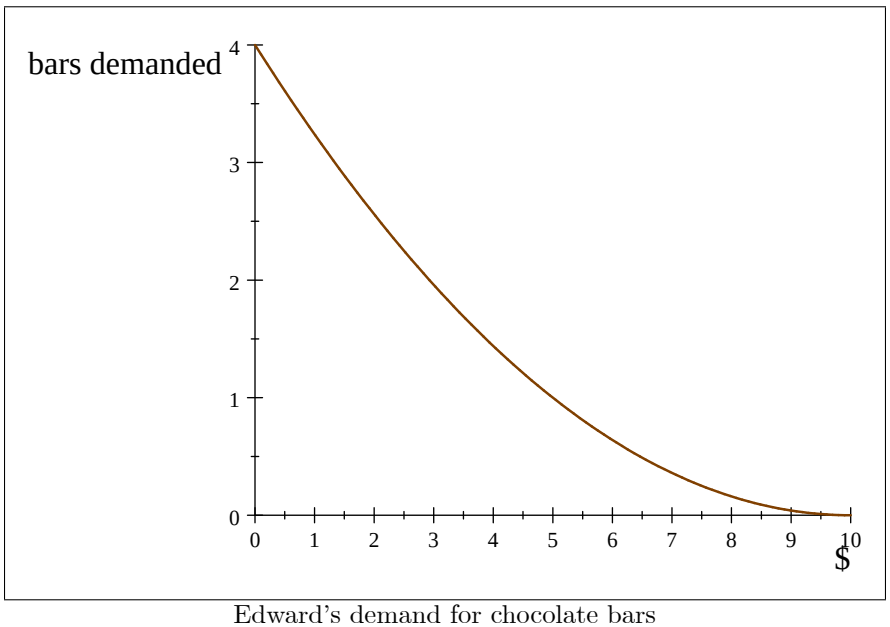


Days ERM skis Vail as a function of his cost per day (30hrs)

What if: Good or bad snow year? If the new wife does not ski? If the kid enjoys skiing? What if I don't want to ski with kids?

2 Changing pleasures: the daily demand for bars of dark chocolate

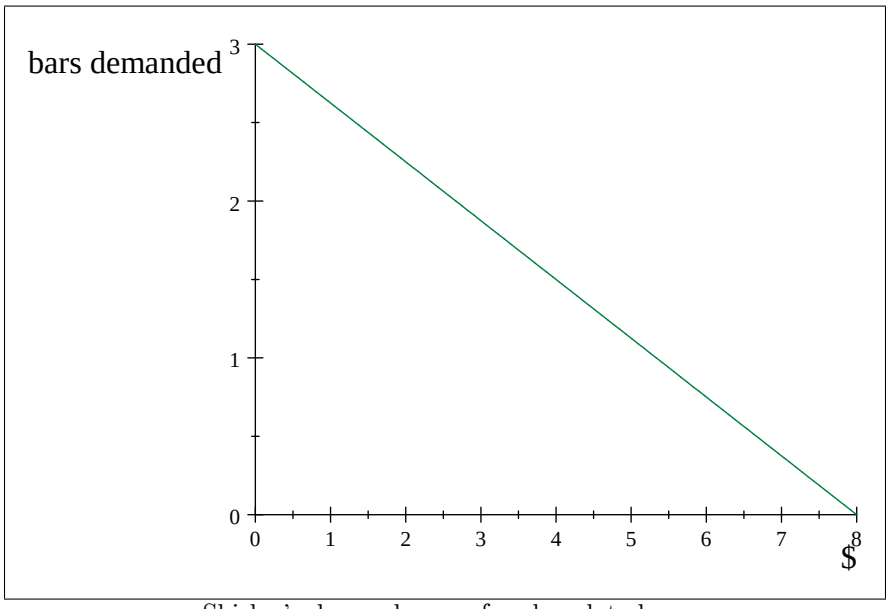
Assume Edward's daily-demand curve for chocolate bars is



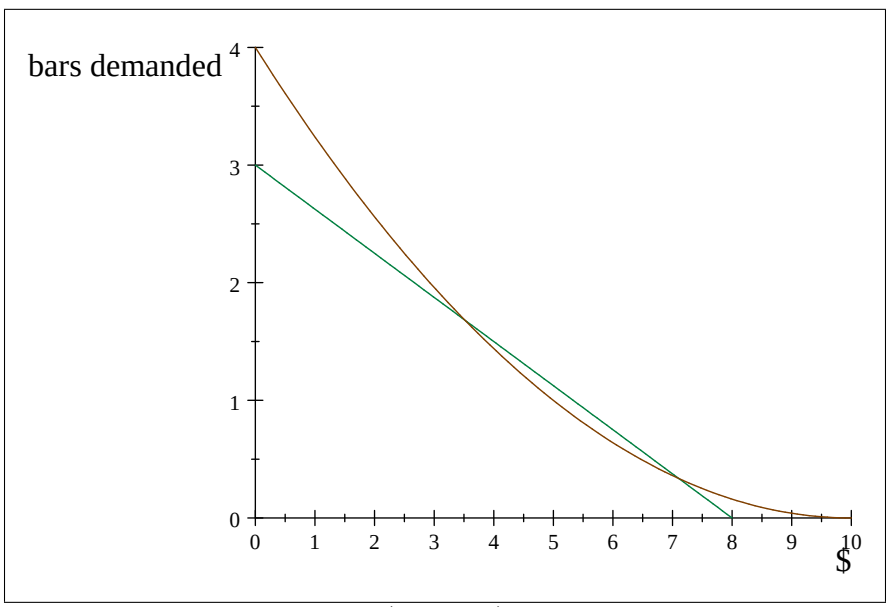
Edward's demand for chocolate bars

Note that my demand curve is chocolate colored, and I can demand fractions of a bar. Note that I actually eat about two bars a days.

Assume Shirley's daily-demand curve for chocolate bars

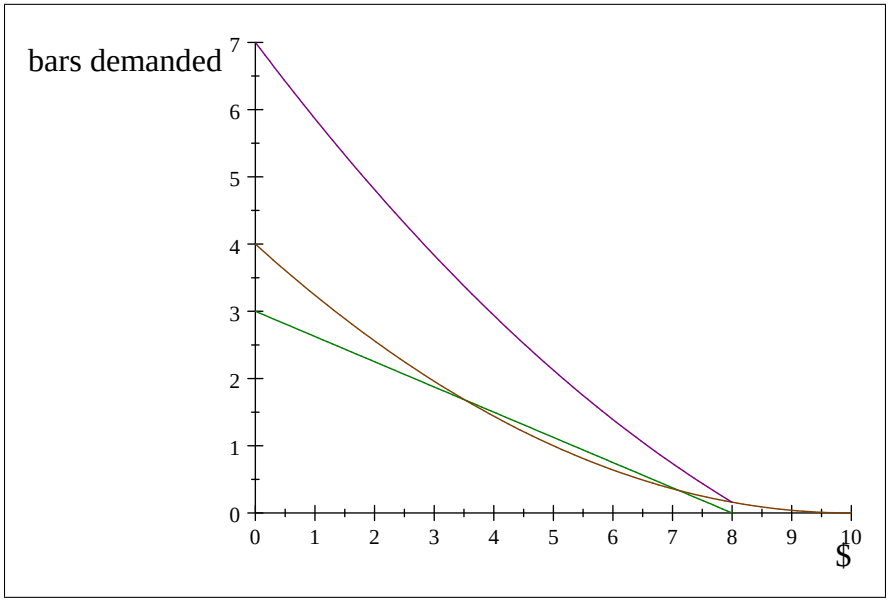


Shirley's demand curve for chocolate bars



Edward's demand (in brown), Shirley's in green

2.1 What does their aggregate demand function look like? Assuming only Shirley and Edward exist, aggregated demand is the total demand of the two as a function of price

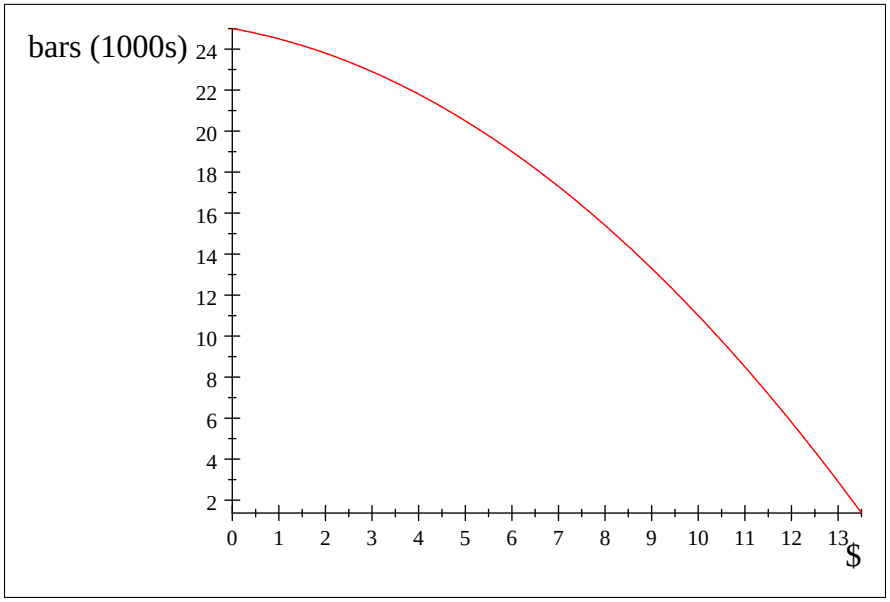


Demand by Edward and Shirley

Aggregate demand at each price is determined by adding up everyone's demand at that price. In terms of the graph (with bars on the vertical axis and dollars on the horizontal access) it is a vertical summation.[2]

2.2 If there were a hundred thousand people living in Boulder the demand function might look like

[2] If the graph had $ on the vertical access and bars on the horizontal access it would be a horizontal summation. Hopefully, a T.A. will make up a question that requires horizontal summation.



Boulder's aggregate demand for chocolate

This demand curve traces out how many bars will be sold in Boulder everyday as a function of the price of a bar. At a zero price $25,000$ bars, and 0 at \$13.50 a bar.[3]

[3] Keep in mind that the example graph is the graph of a specific mathematical function. I simply chose a function that looked feasible.

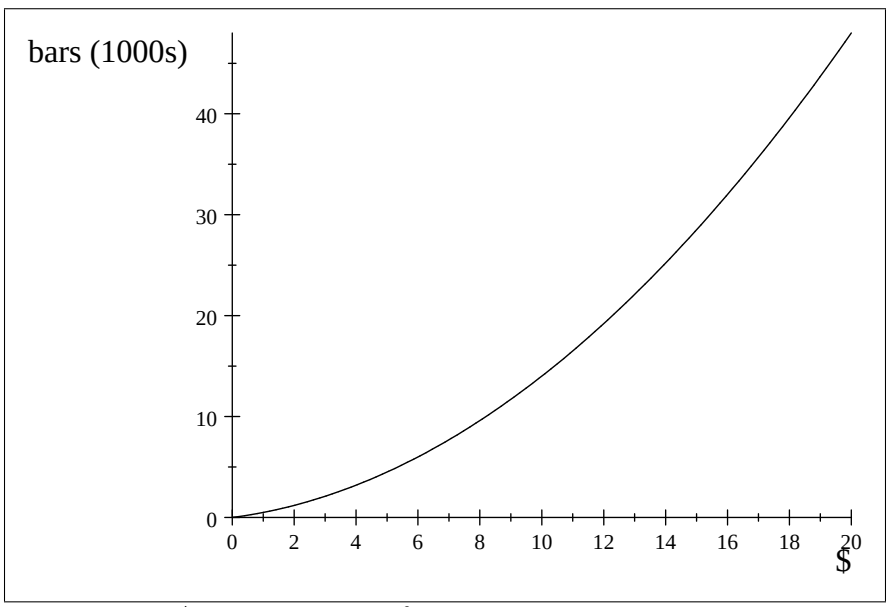
3 How many chocolate bars will the stores want to sell?

Stores sell chocolate bars to make profits, so, ceteris paribus, at higher prices they will want to sell more.Why?

Assuming the the wholesale price of bars and shelving costs remain constant, the higher the price the more profit they will make on each bar sold.

If a bar sells for a little and they make only a penny or two on each bar, they won't devote much effort or shelf space to selling bars. If they can make $5 a bar, they will stock a lot of chocolate.

Assume, for example, that the following curve represents how many bars all the stores together **want** to sell at each price.



Aggregate supply of chocolate bars in Boulder

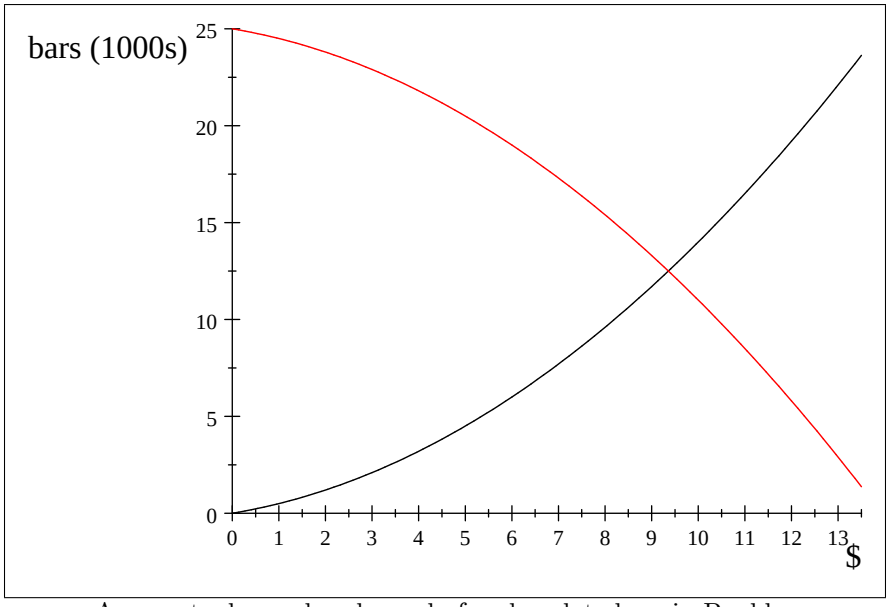
This is called an aggregate supply function (curve) because it identifies how many bars all the stores together will want to sell (supply) at each price point.[4]

[4] The aggregate supply curve for all of the stores is the vertical summation of all the firms' supply curves. We will consider the supply curve for an individual competitive firm in our section on the theory of the firm.

What would make the supply curve shift? Change in temperature in Boulder? Rainfall increase in Costa Rica?

Make sure you can tell a story about how a temperature change in Boulder or a rainfall change in Costa Rica might affect Boulder's aggregate supply curve for chocolate bars. For example, if it is hot in Boulder, chocolate will melt unless the room is cooled, making it more expensive to stock chocolate bars.

4 Supply and demand for chocolate bars in Boulder



Aggregate demand and supply for chocolate bars in Boulder

What will happen? That is, how many bars will be bought and sold, and at what price?

It depends on whether the price of chocolate bars is, or is not, flexible (neither fixed nor rigid)

4.1 Disequilibrium and equilibrium in the Boulder chocolate-bar market

Imagine that the price is fixed by the City of Boulder at $1 a bar (according to the Ciy Council, "Everyone in Boulder, even the poor, deserve access to fine dark chocolate–a "living chocolate allotement").

In this situation, Boulder residents will **try** to buy a little less than $25,000$ bars, but the stores will have almost no bars for sale. The stores will be crowded with unfulfilled and frustrated shoppers—people who made the mistake of coming to the store. Sellers will be frustrated as well, everyone wants to buy chocolate from you and you have none to sell because you do not want to sell many at that price.

The potential buyers are not in equilibrium (they are not buying the number they want to buy at the $1 price). They want to change their behavior in that they want to bribe the store owners to sell them some chocolate.

The potential sellers are in equilibrium in the sense that they are selling the amount they want to sell at $1. But they are not in equilibrium in the sense that they would like to illegally sell chocolate at an illegal higher price.

Both potential sellers and buyers will want to make side/illegal deals, which indicates the current situation is not an equilibrium

One would not be surprised if people start offering the store owners illegal bribes to get one of the few available chocolate bars. Some of the people who manage to acquire one of the few bars available at $1, will turn around and sell them for a higher price on Craig's List or EBay (chocolate scalpers)

Alternatively, think about what would happen if the government fixed the price at an artifically high level? (There should be a exam question on this.)

What would happen if the price was flexible rather than fixed artificially low or high by the government?

If, for some reason the initial price is \$1 a bar, demand greatly exceeds supply. This is not an equilibrium and the stores will raise the price (why?) and start to stock more bars. As the prices rises, the number of frustrated buyers (whose who want to buy at the going price but cannot) will decline.[5] Price and supply will continue to rise as long as demand exceeds supply at the going price.

\$1 a bar is not an equilibrium price.

Alternatively, if the current price is \$15, the stores will initially want to stock approximately $30,000$ new bars each day. This is not an equilibrium. This will lead to great disappointment/frustration on the part of the store owners because at this price not even Richy Rich the chocolate fanatic will buy a bar - demand is zero at \$15.[6]

The stores will respond by putting their stock of chocolate bars on sale. The more they lower the price the more bars they will sell.

\$15 is not an equilibrium price, the stores will want to change their behavior: lower their price

Equilibrium is where supply equals demand. Examining the graph one see that the equilibrium price is approximately \$9 and the equilibrium quantity is approximately 12 thousand bars. Explaining the high equilibrium price, people in Boulder are affulent and love dark chocolate.

The exact numbers are \$9.36 and $12,505$ bars.[7]

At the equilibrium price everyone who want to buy (sell) a bar at that price can. If prices are flexible, the market will move toward equilibrium and get to the equilibrium unless supply or demand shifts before it is achieved; in which case the market will start moving toward the new equilibrium.

[5] At \$1 the store will be selling the amount they would want to sell at that price. That said, they would like to raise the price.

[6] Everyone who want to buy a bar at \$15 is buying one–that is, no one.

[7] The mathematical function that produced the aggregate demand function in the above graph is

$25 - .4p - .p^2$ and the mathematical function that produced the aggregate supply curve is $.4p + .1p^2$. In equilibrum demand equals supply ($25 - .4p - .1p^2 = .4p + .1p^2$). Solving this equation for p, the equilibrium price is $\$9.36$

$$.4p + .1p^2 = .4(9.36) + .1(9.36)^2 = 12,505.$$

(Briefly discuss the labor market, equilibrium and the marco economics at the start of the Great Depression. Draw an aggregate demand and supply function for labor with the wage rate on the vertical axis)

Remember how equilibrium in an economic system was defined in an earlier lecture: everyone is doing the best they can given what everyone else is doing - given everyone else's behavior no one can make themselves better off by changing their behavior.

This is the case when the Boulder price of chocolate bars is $9.36: everyone who want to buy a bar at this price can and does, and everyone who want to sell a bar at this price can and does. Given the price, there are no frustrated sellers or buyers wanting to change their behaviors.

(Of course some people people will wish the price was lower. But those people are doing the best they can (buying few or no bars) at the equilibrium price.)

Just like when both I and my soon to be ex-wife have divorce lawyers (given that the other has a lawyer neither has an incentive to fire their lawyer (change their behavior)).

4.1.1 Is equilibrium in the Boulder chocolate market a good thing from an economist's point of view? That is, it is efficient?

The answer is **maybe**.

Consider the buyers, potential buyers, sellers, and potential sellers.

To begin, assume there are no external affects. That is, assume that when a firm produces a chocolate bar, the process does not directly affect consumers or other firms. And assume when an individual eats a chocolate bar, the eating does not affect firms or other consumers.[8]

Start by considering a situation where the market is not in equilibrium but some trades have taken place, and cannot be undone – the buyers have already eaten the bars. At this point, there are additional un-consumated trades that would make both parties to the potential trade (the potential buyer and seller) better off: both potential traders would gain from consumating the trade.

(For example, if the price is above the equilibrium price, the seller can sell me some bars at a lower price, making some people (me and the seller) better off.

Assuming other parties would **not** be directly affected by such trades, consummating them will increase efficiency; some will be made better off and no one will be made worse off.

In this case, a move from disequilibrium in the chocolate market to a point closer to the equilibrium will make some potential buyers and some sellers better off (they will become actual buyers and sellers), without making any other potential buyers or sellers else worse off, assuming prior trades stand. So efficiency increases.

Once we get to equilibrium, among the traders and potential traders, there is no remaining potential to make some of them better off without hurting some of the others.

Continuing to assume no external effects in the production or consumtion of chocolate, at equilibrium the only way to make some of the players in this market better off will require that other players in this market be made worse off.

So **this** equilibrium in a competitive chocolate market is efficient from the perspective of the buyers and sellers, and potential buyers and sellers, in this market.

[8] Eating chocolate does not turn you into a crazed maniac or a more passionate lover. And, producing chocolate does not, for example, create pollution or drive Costa Rican parrots to extinction.

It will also be efficient from the perspective of society, if the production or consumption of chocolate does **not** directly effect third parties (other consumers or other firms).

If the production or consumption of chocolate effects third parties, there are *external effects*, and things are more complicated.

If there are external effects in the production or consumption of chocolate, competitive, unregulated equilibrium in the chocolate market will not necessarily be efficient from society's perspective.

When external effects exist and are neither controlled or restricted, the outcome is often inefficient. And we say the market has failed, a *market failure*.

This is an important qualification.

For example, if consuming chocolate makes people produce smelly farts, the market equilibrium price of chocolate will be too low (too much chocolate will be consumed from society's perspective).

In such a case, the market is "failing" because it is not accounting for the negative impact chocolate consumption is having on third parties (the victims of the bad gas).

Alternatively, if eating chocolate reduces the incidence of spousal abuse (it does at my house; I get hit less when my wife eats chocolate) – chocolate mellows people – then the benefits to society of you eating another bar are more than the benefits to you. In which case, in the market equilibrium, there will be too few bars sold and consumed from an efficiency perspective.

Equilibrium in the chocolate market would also be inefficient if the production of chocolate involved a lot of unregulated pollution, or, possibly inefficient if it drove some plants and animals in Costa Rica to extinction.

Think about the cigarette market and second-hand smoke. The cigarette producers are happy to sell me cigarettes at the going rate. I will keep smoking another cigarette as long as the benefit to me of the last-one smoked is greater than what it cost me. Put simply, I will maximize the net benefits **to me** from my smoking cigarettes (do what is efficient from my perspective). Of course, I will include, in costs, any negative health effects on me. Will I smoke the efficient number from society's perspective? NO

Who has a cigarette?

Another example of buying, selling, and a negative external effect. The competitive market for gasoline does not fully account for the pollution costs imposed by the oil producers and and the pollution costs and congestion costs imposed by drivers, so fails to achieve efficiency– a market failure.

When oil is produced, pollution is produced—a cost to society. If the oil producers don't have to pay these costs, too much oil will be produced from an efficiency point of view.

When you drive you impose pollution and congestion costs on others. If you don't have to internalize these costs (for the most part, you don't) too much gasoline will be consumed from an efficiency perspective.

4.1.2 You need to play with how equilibrium in a competitive market will change in terms of equilibrium price and quantity when the supply or demand curve shifts

Make sure you can do it with either price on the horizontal axis or on the vertical axis.

Make sure to read the following notes I created to help you to study for the first midterm.

"Graphing a demand function" which are lecture notes on the course web page.