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Gains from Bundling

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SI 646: Information Economics

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Introduction

In this notebook, I illustrate the averaging of heterogeneous consumer values for information goods that is one motivation for bundling. In this discussion, I assume that consumers want at most one unit of each particular good, and so their preferences can be stated in terms of their willingness to pay for the good.

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Simulating demand for one information good

Over a set of goods, different consumers will have different values. For example, suppose consumer values for good 1 are uniformly distributed between 0 and 1. If there are 100 consumers, the list of their values for the good might look like this:

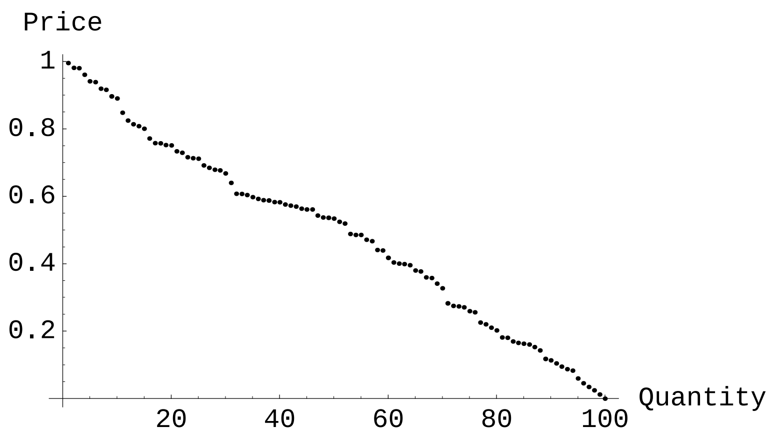
```
In[2]:=  values1 = Table[Random[Real, {0, 1}, 2], {100}]; Short[values1, 5]

  Out[2]//Short=
       {0.087, <<98>>, 0.44}
```

(The code above is written for the *Mathematica* programming system. I created a list called "values1" that contains 100 random numbers uniformly distributed between 0 and 1 (and with 2 significant digits). I then printed a short version of the list which shows some of the elements and abbreviates the other n with the symbol <<n>>.)

The demand facing a seller can be determined from this list of consumer values for the good. Each consumer will buy one unit if its value is above the offered price. If we sort the values from high to low, we can see how many total units will be sold at any particular price.

```
In[3]:= demand1 = ListPlot[Reverse[Sort[values1]], AxesLabel → {"Quantity", "Price"}];
```

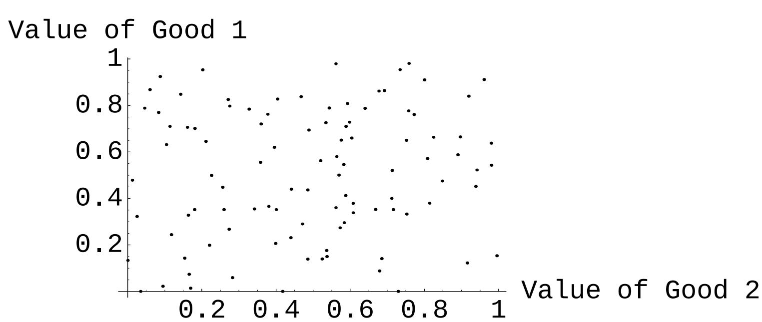


Thus, if the price is \$0.60, about 40 consumers have a value ≥ \$0.60, so the quantity demanded will be about 40.

Simulating *independent* demand for a second information good

Now suppose there is a second good. Suppose that again that consumer values for this good are distributed uniformly between 0 and 1. But let's assume that for each consumer there is no correlation between the values of the two goods. That is, if Tom has a high value for good 1, that indicates nothing about Tom's value for good 2. So, let's generate an independent list of 100 consumer values for good 2:

```
In[4]:= values2 = Table[Random[Real, {0, 1}, 2], {100}];
        demand2 = ListPlot[Reverse[Sort[values2]],
           AxesLabel → {"Quantity", "Price"}, DisplayFunction → Identity];
        ListPlot[Transpose[{values1, values2}],
          AxesLabel → {"Value of Good 2", "Value of Good 1"}];
```



In the graph I plotted each consumer's values for the two goods against each other on a scatter plot. What this shows is that the values are randomly distributed: a consumer with a high value for good 1 is equally likely to have any value in the range for good 2.

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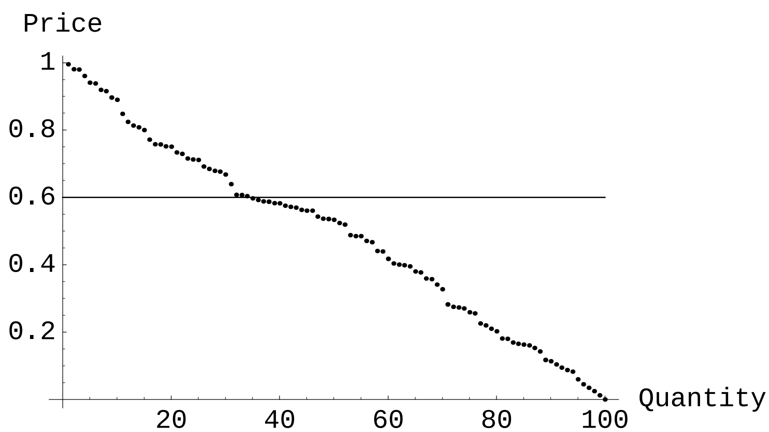
The seller's problem: separate goods

Now, let's think about the seller's problem of setting prices on these two goods. Suppose the seller sets a price of $0.60 for the first good.

```
In[7]:=  Show[demand1, Graphics[Line[{{0, 0.6}, {100, 0.6}}]]];
```



We saw from the demand curve above that about 60 consumers would not purchase at all. They represent potential revenue the seller is not obtaining. The other 40 consumers will purchase. However, each of them would be willing to pay somewhat more than $0.60;some of them would be willing to pay a lot more. That's more potential revenue not obtained by the seller.

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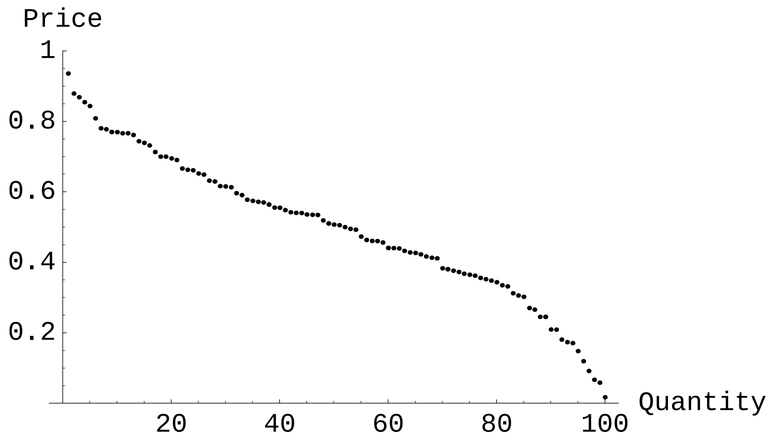
The seller's problem: bundling goods

Bundling can sometimes help extract more value from consumers when they have heterogeneous preferences for different goods. Staying with just two goods for a moment, suppose a seller considers selling them as a bundle. What will the demand curve look like? To get the bundle, each consumer is willing to pay the sum of her values for the individual goods. (Recall, we're assuming the consumer values the goods independently, which means the value of getting both is the sum of their separate values. We'll talk in class about relaxing this assumption.)

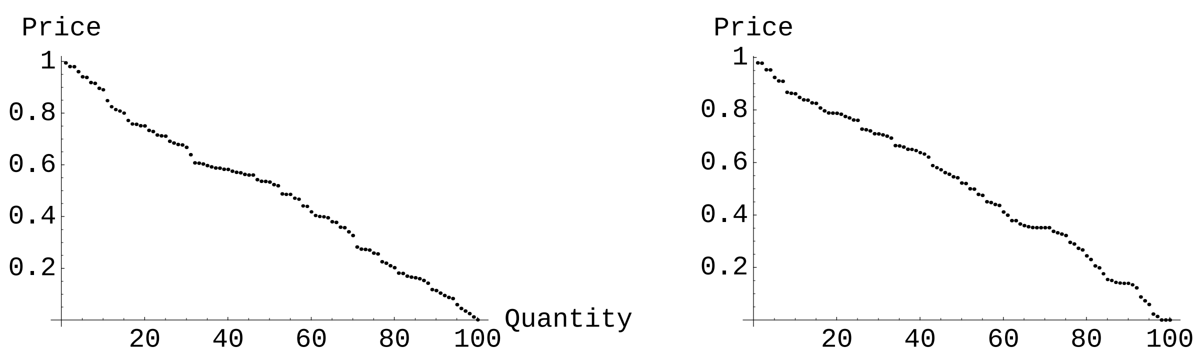
So, I'll sum the two lists of values, and plot the result. I'm going to plot the *average* value (the sum divided by two), because that preserves the same value units: it's the average value per good in the bundle, to compare to the value of a single separate good.

```
In[8]:= valuesAgg = (values1 + values2) / 2;
        demandAgg = ListPlot[Reverse[Sort[valuesAgg]],
          AxesLabel → {"Quantity", "Price"}, PlotRange → {0, 1}];
```



We can learn more from comparing the demand for bundles (in per good prices) to the demands for each good sold separately that we graphed earlier. Here are all three demand curves:

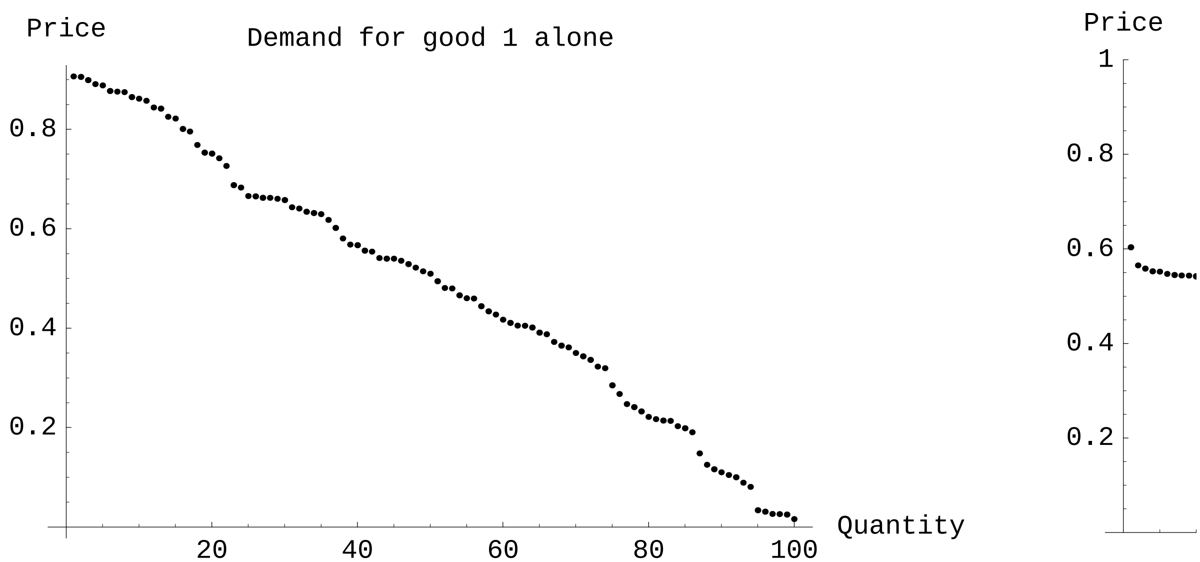
```
In[10]:= Show[GraphicsArray[{demand1, demand2, demandAgg}], ImageSize → 800];
```



It's not too obvious what's going on yet, with only two goods in the bundle. But notice that the demand curve seems to be squished a bit: there are not as many consumers with really high values, and not as many with really low values. There are more consumers with values near the middle (say in the $0.40 to $0.60 range).

Now let's let the number of goods to bundle grow substantially, to 100. For each of 100 consumers, I'll generate 100 different random U[0,1] numbers to indicate their independent values for the 100 different goods. Then I'll aggregate the demand by summing the individual values for each consumer, and I'll plot demand for the bundle (versus the average price per unit in the bundle) next to the demand for one of the goods separately for comparison.

```
In[11]:= valuesAll = Table[Random[Real, {0, 1}], {100}, {100}];
         ones = Table[1, {100}];
         valuesAllAgg = Dot[ones, valuesAll] / 100;
         demandAllAgg = ListPlot[Reverse[Sort[valuesAllAgg]],
            AxesOrigin → {0, 0}, PlotRange → {0, 1}, DisplayFunction → Identity,
            AxesLabel → {"Quantity", "Price"}, PlotLabel → "Demand for 100 good bundles"];
         demand1 = ListPlot[Reverse[Sort[valuesAll[[1]]]], DisplayFunction → Identity,
            AxesLabel → {"Quantity", "Price"}, PlotLabel → "Demand for good 1 alone"];
         Show[GraphicsArray[{demand1, demandAllAgg}], ImageSize → 800];
```



Now we've got some real action! Although there is wide variation in consumer values for each individual good, when we bundle enough together, each consumer's average value is almost exactly the same. Now, for example, if the seller set a price of $0.50, it would sell to essentially every consumer.

Going further: relaxing the assumptions

We'll talk in class about what happens when some of the assumptions are relaxed. For example, this has all been about revenue. That means it is relevant if marginal costs are truly zero, but what if there is some unit cost?