Chapter 2
Three Principles

Economists adhere to a core set of ideas that govern how we approach problem-solving. While the details of any particular problem may become quite complex, underlying much of the analysis are three simple principles that we will do well to think about now.

- Economics is about happiness
- Incentives matter
- The indifference principle

We will come across many ideas that could also be called general principles during the course. But these three are critical and they suffice to get us started.

1. Economics is about happiness

Going to work five days a week and getting a paycheck is a terrible thing to have to do. I do it because I like my house, and to keep it I have to pay the rent. But I'd be a lot happier if I could go to work just three days a week and still pay the rent. I'd be even happier if I could be unemployed and still pay the rent. Many of my colleagues are different. Some of them work seven days a week. They also say they love their job so much they would do it for nothing. I doubt that, but I am willing to accept that teaching a Principles class is something that gives them pleasure. Me? I'd rather have a margarita by the pool. Some of my other colleagues have gone the other way. They already only work three days a week. Perhaps they have a nicer pool.

However we juggle work and leisure, we are all doing it in pursuit of happiness. I work five days a week because that is the amount of work that makes me happiest. "But you don't like to work!", you may say. True. But if I worked only three days a week I would have to move to a smaller house, and working three days a week while living in a cardboard box would make me less happy. I could work more, but working seven days a week so that I could have a bigger house would also make me less happy than I am now.

The pursuit of happiness is such a fundamental idea that it is enshrined in the Declaration of Independence (it's omission from the Constitution must just be an oversight). It is such a fundamental idea that all economists not only understand it, they have made it central to the profession. As economists we start from the assumption that whatever we observe people doing, they must be doing it because any other behavior will make them less happy.

So why do I drink beer while my wife drinks wine? Easy! We are each drinking what makes us happier. Why does Warren Buffett work so hard even though he is so rich? Easy! Because that's what makes him happier. Why does Jimmy Buffet not work hard, even though he is rich? Easy! Because that's what makes him happier. Why did Martha Stewart allegedly lie to the Securities and Exchange Commission about allegedly illegal trades in ImClone stock and go to prison. Easy! Because that's what made her . . . . OK, not so easy. Because at the time she thought she would get a way with it and – given the information she had – she believed her alleged actions would make her happier. Why did I write *alleged* three times? Easy! Because that's what made me happy.

Economics is concerned with just two things. First, we try to understand why people's behavior makes them happier. There is a mirror image to this challenge. If we know what people care about (i.e. what makes them happy), we can predict how they will behave in different environments. Our second concern is to try and understand how we can enact policies that help them become even happier. To do this, we of course need to know what people care about, and this in turn will enable us to predict how they will respond to policies we may design and implement.

All this is harder than it sounds, because economists impose restrictions on themselves. We want explanations for phenomena that teach us something about the wider world. If every explanation we gave for every behavior we observe were nothing more than "Oh, they do that because it makes them happier" we would essentially learn nothing. Let me explain by means of an example.

A few years ago, my former colleague Nick Feltovich of the University of Houston, came up with a puzzle: why do so many of the smartest students, like Bill Gates, drop out of college? A simple explanation would be that smart students dislike college more than mediocre students, so they are more likely to drop out. But then, why do the least smart people not go to college? Would we also argue that the least smart dislike college more than the mediocre? That would certainly be one explanation, but it is far from satisfying. Could there be another explanation, that does not involve asserting that both the least smart and the most smart dislike college more than those with middling ability?

Feltovich had one, which he published in 2002 in a paper with Rick Harbaugh and Ted To. Imagine there are three types of people: a lot of dumb people, some mediocre, and a small number of smart people.[1] Employers like ability. They are willing to pay a higher wage to mediocre employees than they are to dumb employees, and they are willing to pay a higher wage to smart employees than they are to mediocre employees. But the challenge for the employers is that they have difficulty identifying a potential employee's ability. They can conduct interviews, but this only provides so much information. Through the interview process they can tell the difference between the dumb and the smart, but they cannot tell the difference between the dumb and the mediocre, and they cannot tell the difference between the mediocre and smart.

[1] This is a slight variation on the story told in the paper.

Now, smart people want to distinguish themselves from the mediocre so they can get paid more. So what do they do? They go to college. Unfortunately, the mediocre will want to distinguish themselves from the dumb and confuse themselves with the smart. Thus, they also go to college. The dumb would like to go to college to confuse themselves with the mediocre. Unfortunately (and here is the catch) if they did they would fail out. Knowing that, they don't go to college. The mediocre are thrilled. They have distinguished themselves from the dumb and confused themselves with the smart. But the smart people are upset because they are confused with the mediocre. They decide to drop out of college. The interview process enables employers to distinguish them from the dumb, and the fact that they dropped out of college enables employers to distinguish them from the mediocre. Finally, the mediocre don't drop out to copy the smart. Because the dumb are more numerous, it is more important for the mediocre to distinguish themselves from the dumb than it is to confuse themselves with the smart.

This outcome is consistent with the idea that everyone is doing what makes them happiest given the constraints of everyone else's behavior. The mediocre would be less happy if they were to drop out of college and get confused with the dumb. The dumb would be less happy if they were to go to college because they would fail out anyway. And the smart would be less happy if they were to go to college because they would be confused with the mediocre.

Of course, some of these people might be happier in a parallel universe. The smart might be happier if there were no mediocre people. Then they could enjoy attending college. The mediocre might be happier if there were no dumb people. Then they would not have to attend college. But, sadly for these people, they don't live in a parallel universe, and they must do the best they can with the environment in which they live.

Why do Feltovich et al. (and economists in general) prefer this more complicated story to the simple one that college always makes the dumb and the smart more unhappy than it makes the mediocre? There are a number of reasons:

- It is more *interesting*, and that makes economists happy.

- It generates some predictions that can be tested. For example, imagine you could conduct an experiment in a controlled environment where you *knew* that people had the same preferences. Then if you observed the smart and the dumb behaving the same as each other, but differently from the mediocre, the simple happiness story could not be true. Feltovich et al. conducted just such an experiment, and they found *exactly* what their story predicted.

- Finally, once one understands the reason why different people would behave in this way in this particular context, it opens the door to understanding similar behavior in quite different contexts. Feltovich et al. offer a few examples:

    The nouveau riche flaunt their wealth while the old rich scorn such displays.

    Mediocre students answer the teacher's easy question, while the best students can't be bothered.

    Minor officials prove their status by being petty, while the truly powerful show their strength by being helpful.

    A person of middling reputation angrily refutes accusations against his character, while a highly-respected person does not dignify the accusations with a response.

    Inadequate but wealthy men drive a Porsche, while the more confident rich guys drive a Honda.[2]

A final comment is worth making in light of this example. Feltovich et al. assumed there are three types of people. In reality, of course, there are many types of people with equally many levels of ability. Feltovich et al. made the

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[2] OK, this wasn't Feltovich et al., but I can't afford a Porsche.

simplification in order to make it easier to tell their story (and make the math they had to do easier). This is standard practice in economics, because the world is a far too complicated place. But is it bad practice? It can be, sometimes. The hallmark of a good economist is that he or she knows what can be simplified without making the story incorrect, and what cannot be simplified. Not all economists are good at this, but some excel at it.

How do we as a profession decide when a story – an inevitably simplified representation of the real world – is a good story and when it is bogus? One is by following our instincts. Is it plausible? Does it help me understand *other* phenomena? If a story passes the "instinct test", that gets us as a profession to take it seriously. But that is only the first step. The second is more formal. We can collect data and see if the predictions of the model are true. Only when a story passes *both* tests – and this can take many years as other economists explore the idea and test it – does the profession begin to accept the story as part of our received wisdom. It is too early to tell whether the story given by Feltovich et al. will pass these tests. Maybe it is the reason why so many smart people drop out of college, maybe it isn't. The early reaction has been that it passes the instinct test. We will see over the years if it passes the data test. In the meantime, though, we can have fun thinking about it, and that makes economists happy.

Modeling happiness with utility functions

Economists, being economists, use a different word than happiness. They use the term **utility**. We say that if a person is happier driving a Porsche than a Honda, he gets more utility from the Porsche. I get more utility sitting by the pool than I do standing in the lecture hall. You no doubt get more utility from an hour by the pool than you do from an hour sitting in this lecture hall. Utility is not a concept we can ever expect to measure. Can we say whether I would get more utility from an extra dollar of income than you would? Sure, I earn more than most of you (otherwise why are you wasting your time sitting in this class?), and so you might think that a dollar would be worth more to you than it is to me. But it turns out that I have an unusual love for money, so I should have the dollar.

Although we don't expect to be able to measure utility in practice, it is nonetheless useful to us to think about happiness in terms of utility, and to imagine we can measure individual utility with a unit of measurement that we will call a **util**. The concept of utility will help us think through the logic of individual decision-making. As we will soon see, the concept of utility will predict that when the price of something rises people buy less of it. We cannot measure utility, but we can observe prices and quantities. Hence, although we cannot measure utility, we can test the predictions that the concept generates.

Table 1 provides an illustration. In this example, Mariela gets utility from drinking soda and from drinking water. If she drinks just one soda, she gets a benefit of 95 utils. If she has three sodas and two waters, she gets 495 utils, 255 from soda and 240 from the water. Total utility for any combination of water and soda can similarly be obtained by finding in each column the appropriate utility and adding the utils from the two columns together.

Before seeing what we can do with this concept, we should note a simplifying assumption in the table. The amount of utility from water is assumed not to depend on how many sodas Mariela has. In reality, the world is likely to be a more complex, and her utility from drinking water will depend also on how much soda she has. To capture this additional complexity, we would have to create a much larger table: we would need a separate column tabulating the utility from water for each possible number of soda bottles, and we would need a separate column tabulating the utility from soda for each possible number of water bottles. We won't bother with that additional complexity here. Later, we will have more convenient ways to capture this likely interaction between soda and water consumption.

Information such as that in Table 1 allows us to make predictions about the purchases that Mariela makes. Imagine Mariela has a **budget** of $10 to spend

TABLE 1
Mariela's Utility from Soda and Water

# OF BOTTLES	SODA	WATER
0	0	0
1	95	130
2	180	235
3	255	330
4	320	420
5	375	500
6	420	575
7	455	639
8	480	700
9	495	755
10	500	800
11	500	840
12	500	875
13	500	910
14	500	940
15	500	960
16	500	980
17	500	990
18	500	995
19	500	1000
20	500	1000

on soda and water. Soda and water both cost $1 per bottle. How will Mariela allocate her budget between soda and water?

Let us begin by assuming Mariela spends all of her money on soda. With $10 to spend, she can buy ten bottles of soda, and if she does so she will get 500 utils. Can she do better? Sure. If Mariela buys only 9 bottles of soda, she will get 495 utils from the soda. But then she has a dollar left for water, and one bottle of water gives her 130 utils. Thus, 9 sodas and one water gives her 625 utils. 8 sodas and 2 waters give Mariela 715 utils. If we continue to reduce the soda count by one and raise the water count by one, Mariela's utility will keep rising until she arrives at a **consumption bundle** of 4 bottles of soda and 6 bottles of water. This combination gives her 895 utils, which cannot be beat by any other combination she can afford.

Imagine now that Mariela has $15 to spend on soda and water. This increase in her budget obviously allows her to buy more of both. By the same process as before, we see that her utility is maximized when she uses her budget to buy 6 bottles of soda and 9 bottles of water. So we have predicted that an increase in Mariela's income will raise the quantity of soda *and* the quantity of water she chooses to consume.

Now return to the original budget constraint of $10. But assume now that the price of soda declines to $0.50. We can calculate Mariela's new preferred consumption bundle in the same way, and we find that now her utility is maximized when she buys 6 bottles of soda and 7 bottles of water. So now we have predicted that a reduction in the price of soda will induce an increase in the consumption of soda, and an increase in the consumption of water.[3]

Although the calculations necessary to find Mariela's preferred consumption are very easy, they are rather tedious. There is an easier way to go about this. Instead of writing down a table of utilities, let us instead write down a table that records the *increase* in utility gained by increasing consumption by one bottle. This measure is known as **marginal utility**, and the numbers for Mariela's problem are given in Table 2.

Consider the soda column. In Table 1 we saw that utility from consuming one bottle of soda is 95 utils. Thus, the marginal utility of going from zero to one bottle is 95 utils. In Table 1 the total utility from consuming two bottles of soda is 180 utils. Thus the marginal utility from changing from one to two bottles is 180–95=85 utils, as recorded in Table 2. And so we can go on down

[3] This is not always going to be the case. A drop in the price of soda could also have induced Mariela to drink less water. However, it will always be the case that she would drink more soda.

the columns. Note that the total utility from consuming, say, four bottles of soda in Table 2 is exactly the same as the sum of the marginal utilities for one, two, three and four bottles of soda. With a moment's reflection, you will see that the sum of the marginal utilities must in this way always equal the corresponding total utility.

TABLE 2
Mariela's Marginal Utility from Soda and Water

# OF BOTTLES	SODA	WATER
0	–	–
1	95	130
2	85	105
3	75	95
4	65	90
5	55	80
6	45	75
7	35	64
8	25	61
9	15	55
10	5	45
11	0	40
12	0	35
13	0	35
14	0	30
15	0	20
16	0	20
17	0	10
18	0	5
19	0	5
20	0	0

Remember that soda and water cost $1 each. From Table 2 we can ask the simple question, at what point does an extra dollar spent on soda provide no more utility than what is lost by reducing spending on water by the same amount? The answer is simple: when Mariela consumes 4 bottles of soda and 6 bottles of water. If Mariela were to deviate from this choice, she would be made worse off. Raising her consumption of soda by one unit (to 5) raises her utility from soda by the marginal utility, 55 utils. But to accomplish this she must reduce water consumption to 5, causing her utility form water to drop by 75 (she loses the marginal utility from the 6th bottle). The loss exceeds the gain and she is worse off. Alternatively, if she reduced water consumption by one bottle, Mariela loses 65 utils from soda consumption, but she can simultaneously gain one bottle of water, worth 64. The loss exceeds the gain and so she has no incentive to change in this direction either.

The analysis is only a little more difficult when soda and water have different prices. Imagine soda is only $0.50, while Mariela still has $10 to spend. We have already seen that in this case she buys 6 bottles of soda and seven of water. If she were to reduce expenditure by $1 on water, she would lose one bottle, for a loss of 64 utils. In compensation she could go from 6 to 8 bottles of soda, but this would only raise her utility from soda by 60 utils, 35 of which come from going from 6 to 7 bottles, and 25 by going from 7 to 8 bottles. On the other side, if Mariela were to raise expenditure on water by $1, she would gain 61 utils as she goes from 7 to 8 bottles. But to accomplish this she must give up 2 bottles of soda. This reduces her soda consumption from 6 to 4 bottles, for a loss of 100 utils. Moving in either direction away from a starting point of 6 sodas and 7 waters involves a net loss of utility. Hence, this consumption bundle must be optimal.

Diminishing marginal utility. You no doubt will have noticed a special feature about the numbers we have used in Mariela's allocation problem. The greater the number of soda bottles Mariela is already consuming, the smaller is the marginal utility of consuming an extra bottle. Similarly, the marginal utility of water is smaller the greater the number she is already consuming. This property of utility functions is known as the **law of diminishing marginal**

utility, and economists believe it is an extremely common, if not universal, feature of people's preferences.

There are two simple and intuitive reasons why marginal utility declines with increasing consumption. The first is that you tend to get sick of consuming the same thing. You satisfaction from your first bottle of soda is greater than the satisfaction from a bottle of soda consumed after you have already drunk four bottles. The second reason applies when the items you are consuming differ from each other in some way. Consider the case of CDs. If you have enough money to buy just one, you will buy your favorite. If you have enough money to buy two, you will also buy your second favorite. As your second favorite CD does not give you as much satisfaction as your first, the marginal utility of the first CD is greater than the marginal utility of the second CD.

Opportunity cost. When Mariela increases her consumption of water by one bottle, it costs her $1. But there is another way to describe the cost. In order to increase spending on water by $1, Mariela must give up some soda. If soda is $1 per bottle, then the cost of an extra bottle of water is equal to one bottle of soda. If soda is $0.50 per bottle, the cost is two bottles of soda.

This notion that the cost of something is what you must give up to get it is referred to as **opportunity cost**. This is a very useful concept. When the price of soda falls, the opportunity cost of water increases. Even though the dollar price of water has not changed, in a very real sense the cost of consuming water has increased – it implies an even greater sacrifice in terms of foregone soda.

Marginal utility of income. When prices are different, it turns out to be more useful to tabulate, not marginal utility per bottle, but marginal utility per dollar spent. Calculating the marginal utility per dollar spent is extremely easy. Simply take the marginal utility per bottle and divide by the price of the bottle:

$$\text{MU per dollar spent on soda} = \frac{\text{MU per bottle of soda}}{\text{price of soda}}.$$

These calculations are done in Table 3, for the case in which water is $1 per bottle and soda is $0.50 per bottle. Now, start out from the optimal bundle, of $3 spent on soda and $7 on water. Switching $1 from soda to water reduces utility by 39 utils. Switching $1 from water to soda reduces utility by 4 utils. Both are loss-making changes, so Mariela won't make them.

TABLE 3

Mariela's marginal utility of income, when spent on soda and water
Soda = $0.50 per bottle
Water = $1 per bottle

# OF DOLLARS	SODA	WATER
0	–	–
1	180	130
2	140	105
3	100	95
4	60	90
5	20	80
6	0	75
7	0	64
8	0	61
9	0	55
10	0	45
11	0	40
12	0	35
13	0	35
14	0	30
15	0	20
16	0	20
17	0	10
18	0	5
19	0	5
20	0	0

Some further insight can be obtained if we graph the numbers in Table 3. Figure 1 plots the marginal utility per dollar spent on soda and the marginal utility per dollar spent on water. The *x* axis plots the amount of money spent on soda. From Table 3 we see that marginal utility falls as expenditure rises, so the line plotting the marginal utility of expenditure on soda has a negative slope. At the same time, a rise in expenditure on soda implies a fall in expenditure on water. Thus, the marginal utility of expenditure on water rises as expenditure on soda rises. For example, when $2 is spent on soda, $8 is spent on water, which from Table 3 has a marginal utility per dollar of 61. This is indicated by the symbol marked with the letter a in Figure 1. When $5 is spent on soda, only $5 is available for water, and the marginal utility of a dollar spent on water at this expenditure level is 80.

Clearly, at the optimal bundle ($3 spent on soda), the two marginal utilities are close to each other. But they are not identical. This is only because we have been assuming Mariela can only by complete bottles. In fact, if it were possible, Mariela would like to consume fractions of bottles. If she could, then she could do no better than consuming where the marginal utility of money spent on each good is identical. As Figure 1 shows, this corresponds to an expenditure of about $3.75 on soda, and hence of about $6.25 on water. Beginning at this consumption bundle, if Mariela raises her consumption of soda and moves to the right in the figure, the gain in utility from consuming more soda (the marginally utility of soda) is less than the loss from consuming less water (the marginal utility of water). If she moves to the left, then the gain in utility from consuming more water (the marginally utility of water) is less than the loss from consuming less soda (the marginal utility of soda). A move in either direction results in a net loss of utility, so the intersection of the two lines must be the optimal consumption bundle.

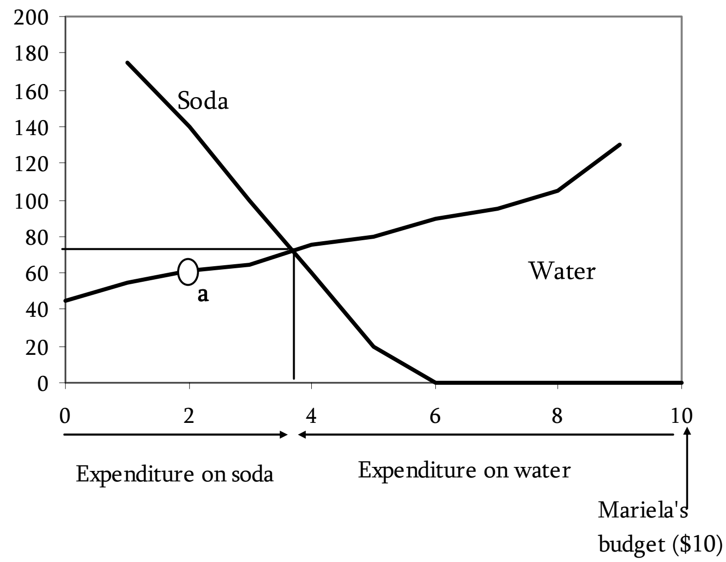

FIGURE 1. Marginal utility of income

In summary, then, Mariela's happiness from consuming soda and water is maximized by equating the marginal utility of a dollar spent on each of the goods:

$$\frac{\text{MU per bottle of soda}}{\text{price of soda}} = \frac{\text{MU per bottle of water}}{\text{price of water}}.$$

When Mariela optimizes her expenditure in this way, the marginal utility per dollar of expenditure evaluated at the optimal consumption levels is also known as the **marginal utility of income**. The name is intuitive. If we give Mariela an extra dollar of income, the best she can do is increase her utility by this amount.

2. Incentives matter

People behave in certain ways to make themselves as happy as possible given the environment they have to live in. It follows that if we change the environment, we can change people's behavior. Doing so may allow policymakers to achieve desirable goals. The key for the policymaker is to understand why people behave the way they do. If the policymaker can understand this, she can provide the right **incentives** to induce the behavior, and hence the social outcomes, that she wants.

All creatures respond to incentives. It is how we train dogs, for example. In my house we have a parrot. When we first brought him home, he used to bite us quite regularly. To induce him not to bite, we would put the parrot in his cage as a punishment. What we didn't realize is that there was another incentive at work. The parrot's food and water was also in the cage, and he soon learned to bite us every time he was hungry or thirsty. The parrot consequently gave us a strong incentive not to put him in the cage every time he bit us. We respond well to incentives and have changed our behavior in just the way the parrot prefers.

Failure to think about incentives can induce policies that fail. Steven Landsburg (1994a) tells a revealing story about road safety. In 1965 Ralph Nader published a book, *Unsafe at Any Speed*, which argued that, although technologies existed to make cars safer at reasonable cost, manufacturers were not installing them. In 1968, the Federal Government responded with a set of regulations that required manufacturers to install a number of items, including safety glass, seat belts, collapsible steering columns, padded dashboards, and dual brake systems. No doubt the government expected to reduce deaths from automobile accidents. But that's not what happened.

Because drivers felt safer in their newly-equipped cars, they drove faster and with less care. Doing so has a benefit – it's more fun. But it also has a cost in the form of an increased risk of death. The new regulations reduced the cost of careless driving by reducing the risk of death if an accident occurs. Responding, as any animal will, to a change in costs and benefits, people did what any economist could predict: they had more accidents. The death rate of drivers and passengers *per accident* went down, just as the government predicted. But the number of accidents went up, as did the number of pedestrian deaths.

The net effect on deaths could have gone either way. Whether the increase in accident rates and pedestrian deaths more than offset the reduction in motorist deaths per accident is a question that requires us to look at the numbers. And the numbers show that the 1968 safety regulations increased the number of motor vehicle deaths. After some complex analysis, Sam Peltzman (1975) concluded that, while the number of motorist deaths stayed about the same (the decline in the death rate per accident was just about offset by the rise in the accident rate), the number of pedestrian deaths rose beyond what it would have been had there been no regulations.[4]

There is no reason why this *had* to be the case. But because economists understand that incentives matter, any of them could have told the government that it was a distinct possibility. Interestingly, Peltzman also provided evidence on *why* it happened. He found that the increased deaths were driven (pardon the pun) by a number of behavioral changes, including increased speeding, an increase in the number of young drivers, and an increase in drunk driving. The numbers for drunk driving are particularly telling (see Table 4). Prior to the introduction of the 1968 regulations, arrest rates for drunk driving and general drunkenness had both been declining for at least fifteen years. But immediately after safety equipment began to be introduced, drunk-driving arrest rates rose. In fact, the drunk-driving arrest

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[4] The challenge is estimating what would have happened without the regulations, because many other things are going on to change behavior over the same time period. The statistical analysis of data to address such hypothetical questions is part of the specialized field of **econometrics**.

rate jumped by an astounding 63 percent between 1965 and 1971, while drunkenness arrests continued their declining trend.

Table 4. *Annual Arrest Rates*

	Drunk driving (per 1,000 drivers)	Drunkenness (per 1,000 adult population)
1953	4.45	23.81
1959	3.85	21.69
1965	3.53	16.60
1971	5.75	13.32

Source: Peltzman (1975), Table 10.

But "wait!" you should be screaming. If the government started getting serious about automobile safety in 1968, isn't it possible that they also started getting serious about drunk driving, so police were simply arresting more people?[5] The answer is yes. So, perhaps a better test of the theory that the regulations encouraged drunk driving would be to look at drunk driving arrest rates on new cars (with the safety features) in comparison to older cars. Unfortunately, Peltzman did not have the data make this comparison. He was able to discover,

[5] If you asked this question, you are already beginning to think like a critical economist. When faced with a an economic explanation for some observed data, the critical economists asks two questions:

- Is the story I am given plausible?
- Can I think of alternative plausible stories that explain the same observations?

If the answer to the first is no, the economist focuses only on the alternative stories. If the answer to the second question is no, the economist is probably not thinking hard enough. If the answer to both questions is yes, the economist thinks about how to test which of the different stories is the better one.

however, that drivers of cars with the safety features were more likely to be involved in accidents.[6]

Peltzman's study of the effects of safety regulations on automobiles is just one of many thousands of economic studies showing that incentives matter. The death penalty has been shown to reduce murder, at the rate of about eight murders avoided per execution (Ehrlich, 1975). Divorce rates have risen since no-fault divorce has lowered its cost (Friedberg, 1998). And your attendance at class will be better given that I have unannounced in-class exams.

Modeling responses to incentives with utility functions

Let us return to Mariela's water-soda consumption problem. With a price of $1 for both water and soda, and a budget of $10, we found that Mariela would prefer to consume 4 sodas and 6 waters. Perhaps the surgeon general thinks this is too many sodas. If so, she could easily induce Mariela to change her consumption habits. For example, the government could impose a tax of $1 on each bottle of soda. Doing this raises the price of a soda to $2, while leaving water at $1. We can easily predict how Mariela will respond. Given her budget of $10, if Mariela's consumption of soda doesn't change from 4 she can only buy 2 waters, giving her a utility of 555. But she can increase her utility by decreasing her consumption of soda. Consuming 3 sodas and 4 waters gives her 675 utils; 2 sodas and 6 waters gives 755 utils; 1 soda and 8 waters gives 795 utils; and 0 sodas an 10 waters gives 800 utils. So Mariela quits drinking soda altogether.

We could ask a related question. Suppose we wanted to reduce Mariela's consumption of soda from 4 to 3 bottles. What is the smallest tax that could

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[6] Moreover, the timing of changes to drunk-driving laws does not seem to be right. Although drunk driving laws had been around a long time (the first law was introduced in New York in 1910), it was not until the 1980s that states began to enhance penalties and policy to step up enforcement, largely in response to pressure from interest groups such as Mothers Against Drunk Driving (Wikepedia, 2004).

accomplish this? We can proceed in the following way. At the current price of $1 per bottle, Mariela gets 420 utils from soda if she buys 4 bottles, and she has enough money left over to buy 6 bottles of water. We need to raise the price of soda, so that if she continues to consume 4 bottles she won't have enough money to buy 6 waters. In fact, if we put a tax of one cent on the soda, she will only be able to buy 5 bottles of water. She will then have spent $4.04 on soda, $5 on water, and is left with $0.96 that she cannot do anything with. Given this reduction in water consumption, would she be better off consuming only 3 sodas? Her utility from 4 sodas and 5 waters is 820. If she reduces her consumption of soda to 3 bottles, she has $6.97 left over to buy water. She can buy 6 bottles, giving her utility of 255 from soda plus 575 from water, or 830 in total. So it turns out that she would be better off buying only 3 sodas. Hence, a tax on soda of just one percent reduces Mariela's consumption of soda by 25 percent.

3. The indifference principle

You have a choice between cleaning your apartment or watching television. The longer you spend cleaning the apartment, the cleaner it gets. Although you don't like cleaning, you like the end result. You may tell me you prefer watching TV to cleaning. I claim that either you are indifferent between the two, or your apartment is disgusting.

If you really preferred watching TV, you would clean less and watch more. And you would keep increasing the amount of TV until you *were* indifferent. As long as you are doing *some* cleaning, you must be indifferent between the two. The only time this may not be true is when you dislike cleaning so much that you keep increasing your TV watching until you are doing no cleaning at all. Then you may still prefer watching TV to cleaning, and you may want to watch yet more TV and clean even less, but you cannot do a negative amount of cleaning. So if you tell me you prefer watching TV to cleaning, don't invite me over for dinner.

At Pittsburgh International Airport there is a point at which you must go from the first to the second floor in order to get to your departure gate. At this point you must make a decision – do you walk up the stairs, or do you take the elevator, which is right next to the stairs? Some people choose one, and some choose the other. Why? One answer is easy – some people prefer the escalator, others prefer taking the stairs. Some travelers have heavy bags to carry (even though at this point they should just have their carry-ons, but that's a whole other story), so they choose the escalator. Some people just like exercise, so they always run jauntily up the stairs. So let me ask about people's choices in a more difficult setting. Imagine that everyone traveling is identical. You may guess that if everyone is identical they would all make the same choice. Either everyone takes the stairs or everyone takes the escalator. But this guess need not be correct.

If identical people make different choices we can be sure of one thing: they must all be indifferent between the two choices. Put another way: if identical people make different choices, the choice they make is irrelevant for their happiness. To see why this is the case, we need to make use of our first two principles. We first need to think about what makes people happy – what their utility depends on. We then need to think about how they respond to incentives.

So let's think about what might affect people's choices. A simple story might go as follows. People care about getting to the second floor quickly, but they don't like expending effort. Thus, everyone arriving at the foot of the stairs must trade-off speed against effort to maximize their utility. If someone arrives at the foot of the stairs, and both the escalator and the stairs are empty, we can confidently predict he will always choose the escalator. He can always walk up it at the same speed he would walk up the stairs. This undoubtedly makes him better off. First, he gets to the top faster. Second, he will expend *less* effort than going up the stairs (because the escalator is moving). The next person, finding only one person on the escalator is also likely to choose it. But as more and more people choose the escalator, it becomes congested. Walking up it becomes more and more difficult until, eventually, everyone is standing still. It is then quicker to take the stairs. At some intermediate point, the escalator is sufficiently congested that the extra speed of taking the stairs just compensates for the extra effort involved. At that point, the next person to arrive is indifferent between the two choices. But then, as everyone is identical, everyone must be indifferent.

Just as we can infer that you prefer watching TV only if your department is disgusting, we can also infer that travelers only prefer taking the escalator if *no one* is taking the stairs.

Our story has some testable predictions. If anyone is using the stairs, they will get to the second floor more quickly than people taking the escalator. Fast escalators are more crowded than slow escalators (test these predictions next time you have an opportunity to observe). And our conceptual focus on identical people does not undermine the observation that, *in addition*, people with heavy bags that will always use the escalator.

We can also make some policy predictions. If we think people don't get enough exercise and we would like to see more of them taking the stairs, we can accomplish this by slowing down the escalator motor. As long as we don't overdo it, so that the stairs themselves don't get congested, the only people we will make worse off are those with heavy bags. If no one has heavy bags, then there is a wonderful opportunity to make the world a better place. Slow down the escalator and induce more people to exercise. Everyone is indifferent between taking the stairs and the escalator so they won't mind switching, as long as the value of taking the stairs does not decline. Even if, as a policymaker, you don't care about exercise, you will at least have reduced electricity consumption.

Steven Landsburg (1994b) uses the indifference principle to explain why, as a first cut, we can assume that all cities in the United States are equally good places to live:

> Each year, the *Places Rated Almanac* and *The Book of American City Rankings* issue their reports on the best places to live in America. San Francisco gets credit for its cosmopolitan charms and Lincoln gets credit for the allure of its housing market. Weighing the importance of education, climate, highways, bus systems, safety and recreation, researchers rank cities in order of overall desirability. The implicit assumption is that researchers have identified features that most people care about, and that we all pretty much agree about their relative importance. If that assumption is correct, and <u>if your tastes are not atypical</u>, you can save yourself the expense of purchasing the manuals. When all factors are accounted for, all <u>inhabited cities</u> must be equally attractive. If they weren't, nobody would live in any but the best.
>
> Landsburg (1994b, p. 31)

I have underlined the key assumptions. First, the cities must be inhabited. If *everyone* has left, then it is likely that everyone prefers not being there. Similarly, if no one is using the stairs, it is likely that everyone prefers being on the escalator.

Second, your tastes should be typical. For example, if you like tropical weather much more than is typical, you will prefer Miami to Boston even though the average citizen is indifferent. If you are unusually good at software programming, you will prefer Silicon Valley to the Napa Valley, while if you have specific skills in winemaking, you will prefer the Napa Valley to Silicon Valley. If you are special in some way, you can be rewarded or punished for being different. Imagine you live in Boston but have an unusually strong preference for tropical weather. Then you will be unusually unhappy in Boston. But you may be able to do something about it: you can move, and become unusually happy in Miami. Similarly, if you have a heavy bag, you will be unusually unhappy going up the stairs. But you can do something about it: you can take the escalator, and be unusually grateful that the escalator is there.

Modeling the indifference principle

We return, once more, to Mariela's allocation problem. If Mariela were to consume no soda and 5 bottles of water, she earns 500 utils. If she were to consume 10 sodas and no water, she would also earn 500 utils. When the utility a person gets from two different consumption bundles is the same, we say that person is **indifferent** between them.

The concept of indifference gives us yet another way to think about Mariela's decision problem. We can choose an arbitrary level of utility, say 500 utils, and find every consumption bundle that gives this level of utility. In a graph that plots the consumption of soda on one axis and the consumption of water on the other, we know that the graph must pass through the bundles [0 soda, 5 water] and [10 soda, 0 water]. We could choose another level of utility, say, 880 utils. From Table 1, we can see that this line must pass through [3 soda, 6 water]. Figure 2 plots a handful of these lines, along with some points (marked by circles) indicating consumption bundles from Table 1 that give the indicated level of utility. Each line is called an **indifference curve**, and the collection of lines is an **indifference map**.

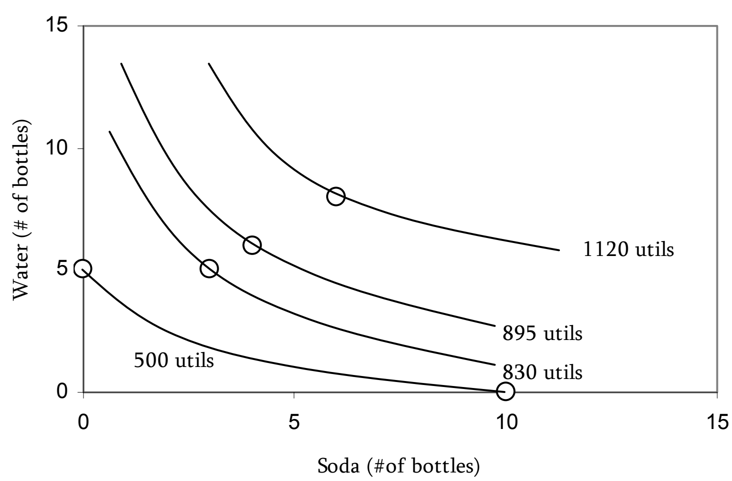

FIGURE 2. Mariela's indifference map

We have drawn Mariela's indifference curves with four distinctive features:

- "Higher" indifference curves correspond to higher utility.
- They are downward sloping,
- They get flatter as we move from left to right.
- They do not cross each other.

It is useful to take some time to understand why graphs of indifference curves for two goods have each of these properties.

Higher indifference curves correspond to higher utility. The reason for this is very simple. If Mariela likes soda and water, then she can always be made better off by giving her more of both. That is, if we move Mariela in a northeast direction in the graph, so that she has more of both goods, she will be happier. Clearly, then, Mariela would like to get on the highest indifference curve possible.

They are downward sloping, The reason for this is that for Mariela a reduction in water consumption must be offset by an increase in soda consumption if she is to maintain the same utility. Mariela likes both soda and water. If we were to give Mariela an extra bottle of soda while keeping the amount of water she has constant, she would be better off – she would have higher utility. The only way to stop Mariela from being better off when we give her the extra soda is to simultaneously take away some water. That is, along an indifference curve, an increase in soda must be accompanied by a reduction in water. Similarly, an increase in water must be accompanied by a reduction in soda.

How much water must we take away if we add a bottle of soda, in order to leave Mariela no better off than before? The answer to this is given by the slope of the indifference curve, as Figure 3 illustrates. Imagine we start from point a, where Mariela has four sodas and six waters. We now give her an extra bottle of soda, moving her to point b. Clearly, at point b, she is better off. In order to get Mariela back to the original indifference curve, we have to take some water away, and this is indicated by the vertical distance between **b** and **c**, indicated by *x*. As Figure 3 shows, this is just the slope of the indifference curve at that point.

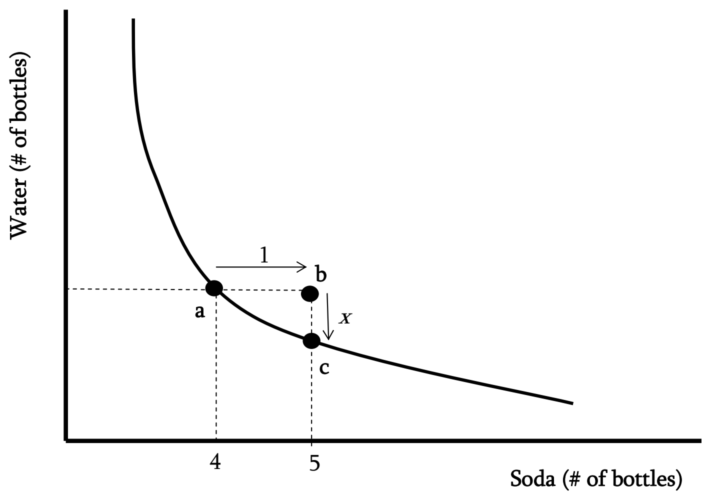

FIGURE 3. The marginal rate of substitution of water for soda.

Economists, of course, have a special name for the amount of water Mariela must give up when she receives this extra bottle of water in order to be no better and no worse off than before.[7] We call it the **marginal rate of substitution of water for soda**, which we denote by $MRS_{w,s}$. The $MRS_{w,s}$ is equal to the slope of the relevant indifference curve at each point. Note that we write it as the MRS of water for soda because water is on the vertical axis and soda is on the horizontal axis. If we switched axes, the slope of the indifference curve would give us at each point the MRS of soda for water. A little bit of thought and you will quickly realize that the two MRSs are related by

7. Equivalently, one can say "the maximum amount of water Mariela is willing to give up in order to get one additional bottle of soda."

$$\mathrm{MRS}_{w,s} = \frac{1}{\mathrm{MRS}_{s,w}}.$$

How does the MRS relate to utility? It turns out that there is a simple relationship between the MRS and Mariela's marginal utility for each of the goods. Too see this, let MU_s denote Mariela's marginal utility of soda, and let MU_w denote her marginal utility of water. Now increase her soda consumption by one bottle. Mariela's utility will increase by the amount MU_s. Let x denote the amount we must change Mariela's consumption of water of water so as to leave her on the same indifference curve . How big should x be? Well, MU_w is the change in Mariela's utility caused by changing her water consumption by one unit, so $-x\mathrm{MU}_w$ is the amount that her utility changes when we take x away. To leave Mariela on the same indifference curve, we require that $-x\mathrm{MU}_w = \mathrm{MU}_\mathrm{w}$. Solving for x:

$$x = -\frac{\mathrm{MU}_s}{\mathrm{MU}_w}.$$

The quantity x is, of course the slope of the indifference curve (review Figure 3), and this is of course the $\mathrm{MRS}_{w,s}$. Thus, we have

$$\mathrm{MRS}_{w,s} = \frac{\mathrm{MU}_s}{\mathrm{MU}_w}.$$

That is, the marginal rate of substitution of water for soda is given by the ratio of the marginal utility of soda to the marginal utility of water.

They get flatter as we move from left to right. This is because of diminishing marginal utility. When Mariela is consuming only a small quantity of soda, she requires a large amount of water to compensate her for any reduction in soda consumption. When she is consuming a large quantity of soda, she needs only a small increase in water to compensate for a reduction in soda consumption.

They do not cross each other. To show that indifference curves cannot cross each other, we will do a proof by contradiction. That is, we will assume that they *can* cross, and then show that we get a logical contradiction. This contradiction then allows us to conclude that they cannot cross.

Consider Figure 4, which contains two indifference curves that cross. Four different consumption bundles, **a**, **b**, **c**, and **d**, are shown on the diagram. Because **b** lies to the northeast of **a**, the assumption that more is better implies that **b** is a better bundle than **a**. Because **b** and **c** lie on the same indifference curve, **b** and **c** are by definition equally good bundles. But if **b** and **c** are equally good, and **b** is better than **a**, it must be the case that **c** is also better than **a**. So we have just concluded that **c** is better than **a**. Now, note that **d** lies to the northeast of **c** so **d** is better than **c**. But **d** lies on the same indifference curve as **a** so by definition they are equally good. But if **a** and **d** are equally good, and **d** is better than **c**, it must be the case that **a** is better than **c**. This conclusion contradicts our first conclusion. This contradiction – that **a** is better than **c** and **c** is better than **a** – is unacceptable, and we are forced to conclude that indifference curves cannot cross.

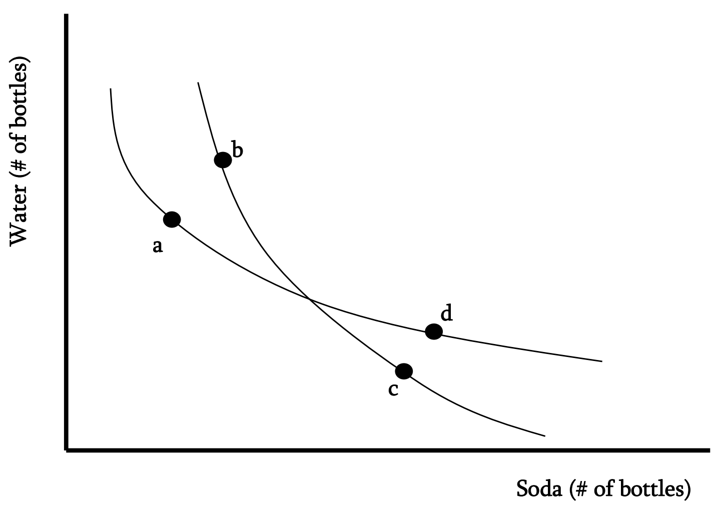

FIGURE 4. Proof that indifference curves cannot cross.

Do all indifference curves have the properties we have drawn here? The answer is no. For example, if Mariela hated soda, we would have to give her *more* not less water if we were to force her to consume more soda. In this case, the indifference curve would have a positive slope. You are asked to think about and draw some alternative possibilities in the problem set.

The consumer choice problem with indifference curves.

Mariela would like to get to the highest indifference curve possible. However, her **budget** constrains her ability to move to ever higher indifference curves. In Figure 5, this budget constraint is indicated by a straight line. Calculating where it should be on the graph is easy. Mariela's budget is $10. If she spends all her money on water (at $1 per bottle), she can buy 10 bottles. If she spends all her money on soda she can also buy 10 bottles. We mark these two end points on the graph, and connect them with a straight line. This is the **budget line**. Mariela can also buy any combination of water and soda that lies on the budget line. She can also buy any combination of water and soda that lies below and to the left of the budget line, but if she does so she will have some money left over. Mariela cannot buy any combination that lies above or to the right of the budget line, because all these combinations cost more than $10.

The best that Mariela can do then, is get on the highest indifference curve that has a point somewhere that does not lie outside the budget line. This is indicated at point **a**, where the budget line is tangential to the indifference curve. The indifference map not only tells us how well off (in terms of utility) Mariela is, but it also tells us the combination of soda and water that she will choose.

In practice, we do not expect to be able to measure any individual's indifference curve. But because indifference curves have the same general shape, we can use them in a conceptual way, as an aid to thinking. The following examples illustrate how economists use them.

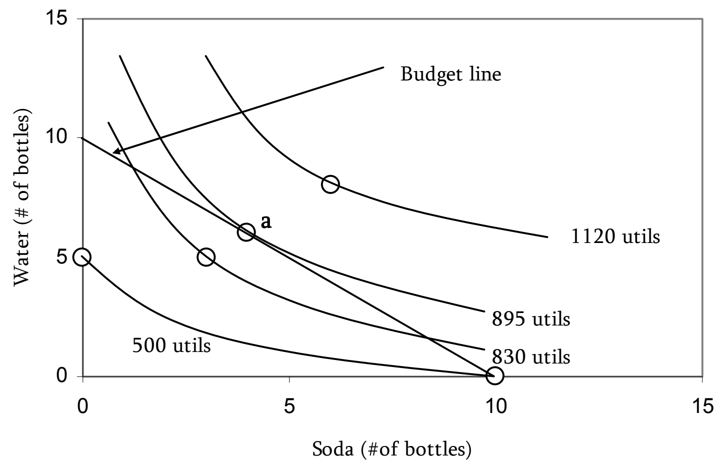

FIGURE 5. Mariela's indifference map and budget constraint

The effect of price changes. A change in the price of one of the goods under consideration causes Mariela's budget line to shift. The effect of a reduction in the price of soda is illustrated in Figure 6.[8] The original budget line is indicated by **Aa**. When the price of soda declines, the budget line rotates outward, to **Ab**. If all Mariela's budget is spent on water, she can buy no more than before, so the budget line must continue to pass through point **A**. But if all her budget is spent on soda, she can now buy more than before, and this is indicated by point **b**. The reduction in the price of soda allows Mariela to change her consumption bundle. With the new budget constraint, the best she can do is to switch from bundle **1** to bundle **2**, on a higher indifference curve.

Note that at bundle **2**, Mariela is consuming more soda *and* more water. It seems intuitive that Mariela would consume more soda when it becomes cheaper. But it is perhaps less intuitive that she would also consume more water. Here is one way to think about why this is the case: a decline in the

8 . Once you understand this, you can easily work out the effect of a price increase.

price of soda has made Mariela better off, in much the same way that an increase in income would. Soda becomes cheaper, so Mariela buys more. But even after she has bought the additional soda, she has some extra money left over, which can be used to buy additional water.

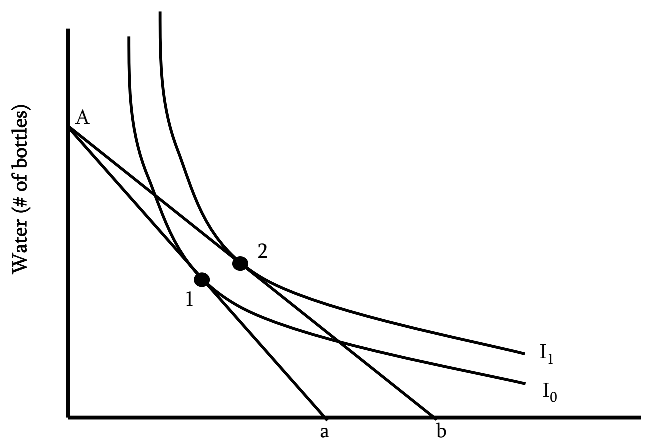

FIGURE 6. The effect of a reduction in the price of soda

If Mariela's indifference curves had a different shape, it is quite possible that a reduction in the price of soda would have induced her to consume *less* rather than more water. Perhaps more surprisingly, it is also theoretically possible for Mariela to have chosen to consume less *soda* after its price declined.[9] The problem set at the end of this chapter asks you to draw indifference maps that depict these outcomes.

The effect of income changes. If Mariela's income increases, her total budget for soda and water may also increase. If she allocates all her budget to water,

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[9] If the quantity of a good consumed declines when it's price declines, the good is called a **Giffen good** (named for the person who first described the idea). Although one can draw an indifference map for a Giffen good, none has ever been observed in the real world. Thus, it remains a theoretical curiosity.

she can buy more after the income increase than before. This is captured by the movement from A to B in Figure 7. If she allocates all her budget to soda, she can also buy more after the increase in income than before. This is captured by the movement from a to b. Note that the proportional jump from A to B is the same as the proportional jump from a to b. Hence, the new budget line is shifted outward, but it remains parallel to the original budget line.

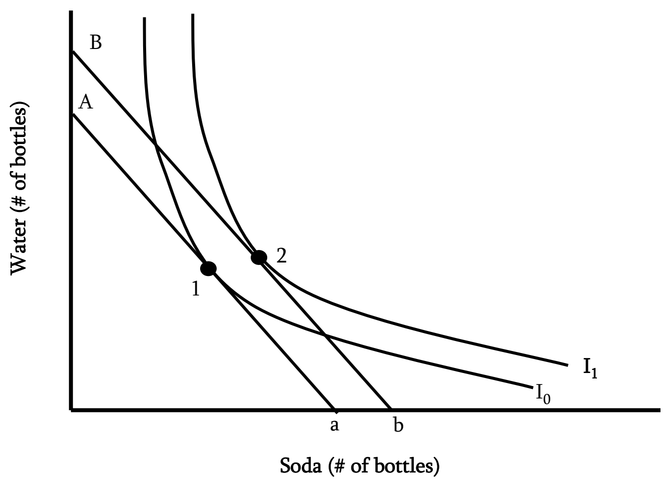

FIGURE 7. The effect of an increase in Mariela's income

In Figure 7, the increase in the budget enables Mariela to switch from consumption bundle 1 to bundle 2. She consumes more water and more soda and we know that she is better off because she is on a higher indifference curve.

If Mariela's indifference curves had a different shape, an increase in income could have caused to her to consume less soda or to consume less water (but you will not be able to draw an example where she consumes less of both!). If consumption of a good increases after an increase in income, we say that the good is a **normal good**. If consumption decreases, we say it is an **inferior good**. The problem set asks you to draw some of these possibilities.

The equations of budget lines and consumer choice. Imagine you have an amount M to spend on two goods, the quantities of which are denoted by x and y. The prices of these goods are p_x and p_y. Your budget constraint can then be written as the following inequality:

$$p_x x + p_y y \leq M \ ,$$

which simply says that expenditure on the two goods must be less than or equal to your budget. Along the budget line, the entire budget is being spent, so the equation of budget line is

$$p_x x + p_y y = M \ .$$

Figure 8 illustrates this budget. Because good y is on the vertical axis, it is useful to rearrange this equation so that y is on the left hand side and everything else is on the right. Doing so gives

$$y = \frac{M}{p_y} - \frac{p_x}{p_y} x \ .$$

This is the equation of a straight line that intercepts the vertical axis at M/p_y, and that has a negative slope equal to $-p_x/p_y$. So for Mariela's budget problem (Figure 5), where M=\$10, and both prices are \$1, the budget line equation intercepts the vertical axis at 10 units of water, and it has a slope of −1.

As we have seen, a reduction in the price of x rotates the budget line upward. The intercept with the vertical axis (equal to M/p_y) does not depend on p_x and is unchanged. But the absolute value of the slope, p_x/p_y, declines as the budget line becomes flatter. In contrast, if income changes, the budget line shifts (because M appears in the intercept term; but in this case the slope does not change.

Now consider the optimal consumption choice. We know that this is found where an indifference curve is tangential to the budget line. At that point, of course, the slope of the indifference curve is equal to the slope of the budget

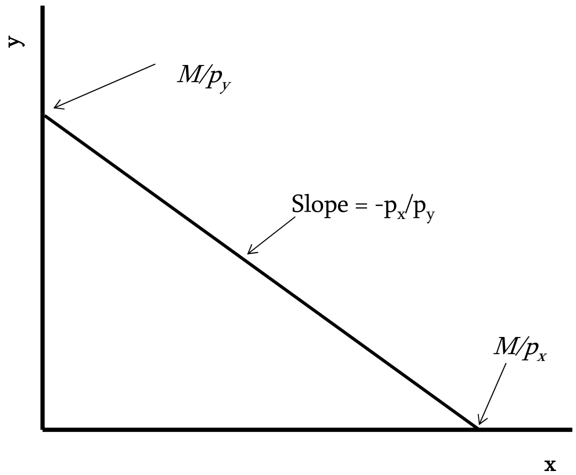

FIGURE 8. Budget line for $p_x x + p_y y = M$.

line. The slope of the indifference is given by $-\text{MU}_x / \text{MU}_y$, so at the optimal consumption bundle we have

$$-\frac{\text{MU}_x}{\text{MU}_y} = -\frac{p_x}{p_y}.$$

which says that the ratio of the marginal utilities must equal the ratio of the prices. We can rearrange this equation to obtain

$$\frac{\text{MU}_x}{p_x} = \frac{\text{MU}_y}{p_y}.$$

This equation should be familiar, because it is exactly the same equation defining optimal consumer choice that we had already worked out from Figure 1.

More complicated budget lines. Not all budget lines are straight lines. Consider the following price schedule. The price of good y is \$5. The price of good x is \$5 for the first ten units you buy, and then \$2.50 for each additional unit. As you already know that the slope of the budget line is equal to the ratio of prices, you can immediately see that the slope of the budget line must change when the price changes. Figure 9 plots the budget line for a person with $100 to spend. Note the kink in the budget line at x=10. Up to that point, the two goods have the same price, so the slope of the budget line is −1. Beyond x=10, the market exchanges two units of good x for each unit of good y, so the slope of the budget line changes to −1/2. Budget lines can be as complicated as the pricing schedule that gives rise to them. In general, every time a price changes, the slope of the budget line changes.

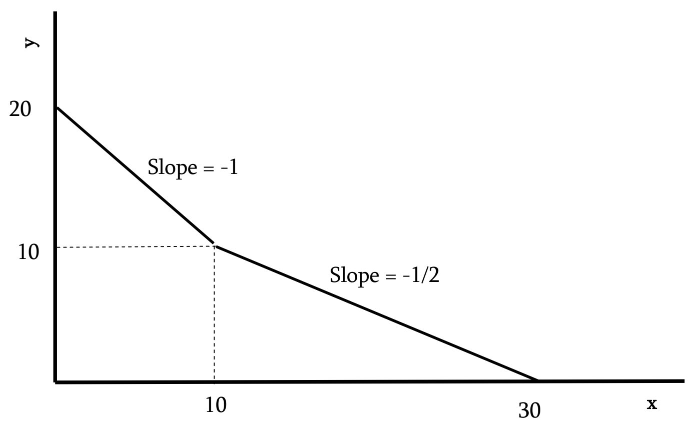

FIGURE 9. A discount after making a minimum purchase of good x.

For some pricing schemes, there may also be jumps in the budget line. Consider the following pricing schedule: The price of good y is $5. The price of good x is $5 per unit if you buy any quantity up to 10 units, and $4 per unit if you buy any quantity in excess of 10 units. Figure 10 illustrates for a budget of $100. Up to 10 units of x, the budget line has a slope of −1. But then if 10.00001 units of x are bought, the price for all the units falls by a dollar. To the right of this point, then, the budget line becomes flatter. But there is also an upward jump. Buying 10 units of x at $5 leaves enough money to buy 10 units of y. But buying 10.00001 units of x at $4 leaves enough money to buy (very nearly) 12 units of y.

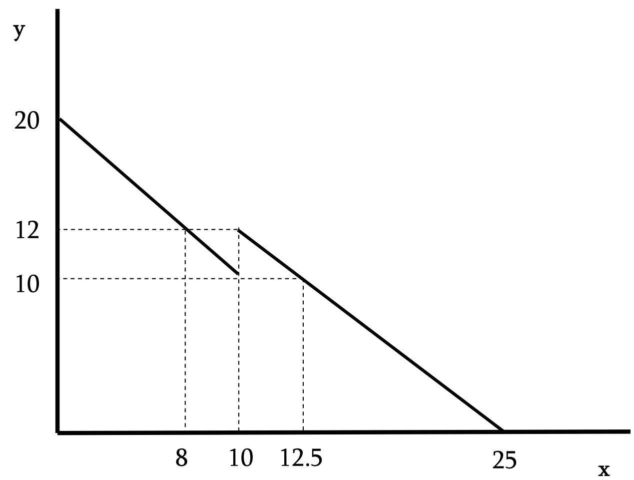

FIGURE 10. A bulk discount for good *x*.

Even though we do not know a buyer's precise preferences (i.e. the shape of her indifference curves), we can still make an interesting prediction about her choices. Any consumer that would buy at least eight units without the bulk discount will choose instead to buy at least 10 units when the discount is offered. The reason is easy to see. With the bulk discount, a consumer can consume almost exactly 12 units of *y* buy buying either 8 units of *x* or 10.00001 units of *x*. As more is better, why not buy the larger amount of *x*? This is, of course, the whole point of offering bulk discounts in the first place.

Price changes when you already own a good. Imagine you are a farmer. You have 10 pounds of beef and 100 pounds of corn. You like consuming beef and corn. The market price of beef is $10 per pound; corn is $1 per pound. Figure 11 illustrates your budget line. If you consume the corn and beef that you have, you can use the money to buy 10 pounds of beef. This consumption bundle is indicated by point E, where the letter E denotes your initial **endowment**. But you can increase your corn consumption by selling some beef and using the income to buy more corn. The rate at which you can do this is indicated by the segment of the solid budget line to the right of E. If you sell all your beef, you will be able to consume 200 pounds of corn. Alternatively, you can sell some corn to increase your consumption of beef. If you sell all your corn, you can consume a maximum of 20 pounds of beef.

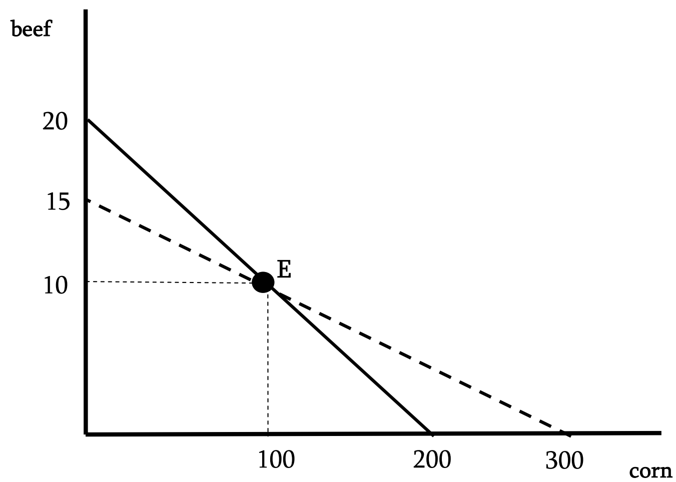

FIGURE 11. Price changes when you begin with an endowment of goods.

What is new about endowments is that price changes behave differently than when you start out with cash. Imagine the price of corn drops to $0.50 per pound. You can still consume your initial endowment, so E remains on the budget line. But now if you sell all your beef, you can consume 300 pounds of corn; if you sell all your corn, you can only buy 15 pounds of beef. This new budget line is indicated by the dashed line. Note how the price change caused the budget line to rotate around your endowment point. Compare this with a price reduction when your endowment is only cash.

Who cares about a real-estate crash? Ask anyone that owns a house how they would feel if the price of housing were to rise. They will tell you they would be pleased because the increase in price will make them better off. Ask them how they would feel if the price of housing were to fall. They will tell you it would make them worse off. On this second count, however, they would be wrong. An increase in the price of housing makes homeowners better off, but *so does a reduction in the price of housing*.

To see why this is the case, we need to make use of our indifference maps and budget lines. Figure 12 plots an indifference map depicting Daemon's choice between "housing" (by which we mean more housing is a better house) and "all other goods." Assume the original budget line is given by Aa. Given Daemon's budget, he went ahead and chose a quantity of housing and other goods that put him at point 1. Because this was Daemon's choice, it must be a point at which is budget line is tangential to his indifference curve.

But now imagine that the price of housing rises. Because Daemon has already bought his house, even when prices change we know he can still afford to consume at point 1. That is, the house is paid for and he has enough income to buy the quantity of other goods indicated at point 1. The new budget line has a flatter slope, reflecting the rise in the price of housing, but it must pass through Daemon's original consumption bundle. This is indicated by the line Bb. But with this new budget line, Daemon can now do better. He can sell this house at its higher price, buy a smaller house, and have money left over to buy more goods. Doing so allows Daemon to attain consumption bundle 3, on a higher indifference curve. Thus, an increase in the price of housing makes Daemon the homeowner better off.

And so does a reduction in the price of housing. When housing prices fall, the budget line gets steeper, but it still passes through point 1. Daemon can now sell his house, buy a new bigger house, and consume at point B on the new budget line Cc. Again, Daemon attains a higher indifference curve, and is better off than at point 1.

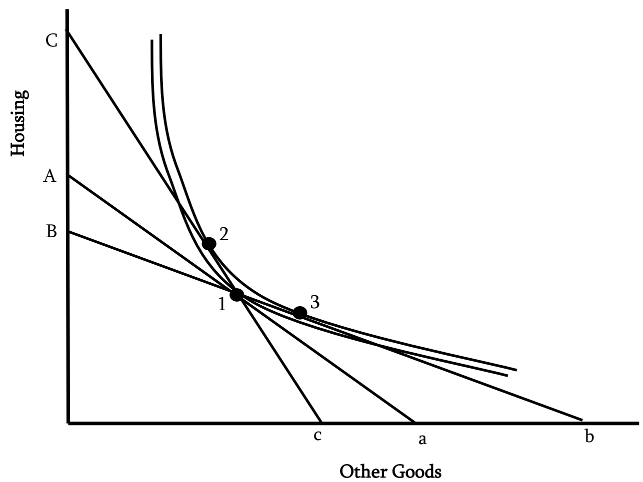

FIGURE 11. The effect of housing price changes when Daemon already own a house

When Mariela has a fixed money budget, and must choose between buying water and soda, she is made better off when the price of one of the goods falls (moving from 1 to 2 in Figure 4), and she is made worse off when the price rises (moving from 2 to 1 in Figure 4). But for Daemon, both a price increase in and price reduction make him better off. The difference for Daemon is that after the price change, his original consumption bundle was still attainable. He didn't have to sell his current house and buy a bigger one (if housing became cheaper) or a smaller one (if housing became more expensive). Thus, he would only do so if it made him better off. In contrast, Mariela's original consumption bundle is no longer feasible – she cannot afford it – when the price of one of the goods rises.

Being imaginative: the escalator problem. To think about the escalator problem, we have to get inventive. People care about speed and effort. But, while speed is a desirable thing, effort is undesirable. Our previous indifference maps had two desirable goods on the axes, and diminishing marginal utility gave the indifference curves their shape. What would the indifference map look like if we look at the choice between one thing that is good (speed) and one that is bad (expending effort)?

No doubt we could work it out, but here is a trick. If one of the items you are thinking about is undesirable, simply reverse the scale! That is what we have done in Figure 12. On the horizontal axis we have speed, with speed increasing as we move from left to right. On the vertical axis we have put effort. But zero effort is at the top, and high effort is at the bottom. Thus, as we move up the axis, we have less effort expended, and this is a desirable thing. We can now plot indifference curves with their usual shape, and we have plotted two, labeled I_0 and I_1. Moving in a northeast direction involves more speed and less effort, both of which are desirable, so I_1 involves a greater utility than I_0.

Next, we have to think about "budget" constraints. Consider first the constraint for taking the stairs. At zero effort, speed must be zero. At maximum effort the speed is positive. The feasible trade-offs between reduced effort and increased speed are traced out by the straight line Aa. Now consider the escalator constraint. Even at zero effort people have positive speed on the escalator. This is indicated by the horizontal distance AB, which must be equal to the speed of the escalator. For any given effort, the escalator will get you to the top quicker than the stairs by an amount that depends only on the speed of the escalator. Thus, the "budget" constraint for the escalator is a line parallel to Aa, shifted right by the escalator speed. This is indicated by Bb.

The best you can do on the stairs is choose point 1, where Aa is just tangential to I_0. On the escalator, you can do better, by choosing point 2 on I_1. But now, given that the escalator makes people better off (putting them on a higher indifference curve), everyone chooses the escalator. This will create congestion. What will congestion do? It will make it impossible to walk up the escalator too quickly. Because other people are in the way, congestion will force you to expend less effort and move more slowly. The effect of congestion is to make the right part of the line Bb inaccessible. Congestion must increase until people are indifferent between the stairs and the escalator. This is indicated by the vertical line **Cc**. Although people would like to expend more effort and move down the budget line to point **2**, congestion stops them from doing so, and they are stuck at point **3**. At this point, taking the stairs and taking the escalator both put you on the same indifference curve, I_0.

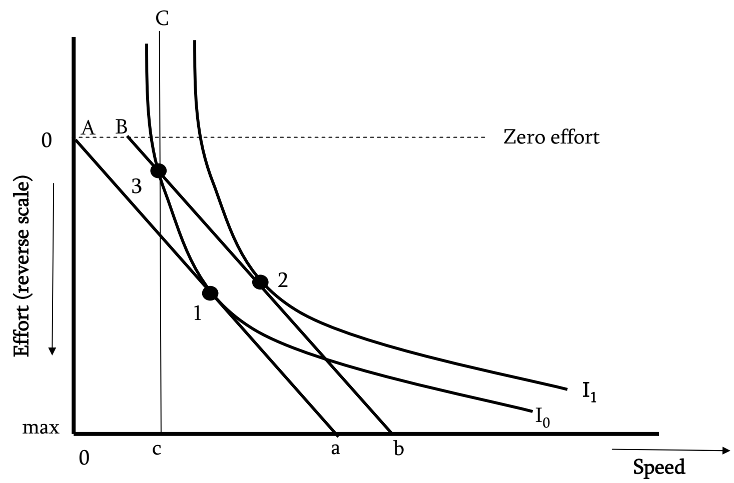

FIGURE 12. The escalator problem

This is the *only* equilibrium. If congestion were somehow to decline on the escalator, **Cc** moves to the right. But this allows people to get more utility by taking the escalator. Then, everyone chooses the escalator, congestion jumps up, and **Cc** moves left again. If **Cc** were to move to the left of point **3**, people would switch to the stairs. This would reduce congestion, shifting **Cc** right again. Note that at the equilibrium, points **1** and **3**, people expend less effort on the escalator while, just as we predicted, they move faster on the stairs.

4. Concluding comments

Despite its reputation as the "dismal science", economists care only about people's happiness. In many applications, this may involve giving them more money and more goods to consume. But the application of economics is far more reaching than that. Nobel laureate Gary Becker has been particularly productive in applying economic principles to address many issues not normally thought of as the domain of economics, including, fertility, marriage, divorce, addiction, organ donation, philanthropy, discrimination, and crime.

What makes a study economics, as opposed to, say sociology, is not the subject matter. rather, it is the methodology, and the basic principles that the researcher brings to bear on a problem. Central to these basic principles is that people respond to incentives. The fact that incentives matter leads us to a yet another basic principle, that if two otherwise identical people are doing different things, they must be indifferent between them. If not, one of them would have an incentive to change what he is doing.

We have used these basic principles to explore how individuals might choose how to spend their income on consumption goods, and to predict how they will change their behavior if prices and income changes. This is what most people consider the normal domain of economics. But we have also used the exact same principles to study how people choose between taking the escalator and taking the stairs. We will see many more applications of these basic principles throughout the rest of the course.

Concepts introduced in this chapter

- utility
- budget constraint
- opportunity cost
- consumption bundle
- Giffen goods
- endowments
- marginal rate of substitution
- optimal consumption bundles
- marginal utility
- diminishing marginal utility
- marginal utility of income
- indifference curve
- normal and inferior goods
- proof by contradiction

Problems

1. Agnes has $10 to spend on soda and water, and earns utility from consumption according to the following table.

(i) If the price of soda and water is $1 each bottle, how much soda and water will Agnes buy?

(ii) If the price of soda increases to $2 per bottle, how much soda and water will Agnes buy?

(iii) If the price of soda is $1 per bottle, but water increases to $3 per bottle, how much soda and water will Agnes buy?

(iv) What will Agnes' purchases be if her budget falls to $6?

TABLE 1

Agnes' Utility from Soda and Water

# OF BOTTLES	SODA	WATER
0	0	0
1	260	180
2	470	360
3	660	510
4	840	640
5	1000	750
6	1150	840
7	1280	910
8	1400	960
9	1510	990
10	1600	1000

2. Consider the problem of allocating a budget between the purchase of CDs and DVDs. Draw indifference curves that yield the following responses to changes in prices and income:

(i) A reduction in the price of DVDs causes an increase in DVD purchases and a decline in CD purchases.

(ii) A reduction in the price of DVDs causes a reduction in DVD purchases (i.e. DVDs are a Giffen good). What happens to CD purchases?

(iii) An increase in income causes a reduction in CD purchases (i.e. CDs are an inferior good). Are DVDs a normal or an inferior good?

Remember that indifference curves must have a negative slope, they become flatter as one moves from left to right, and they cannot cross each other.

3. Draw an indifference map for each of the following cases. Indicate which indifference curves represent higher utility:

(i) Mariela loves soda and hates water.

(ii) Mariela hates soda and water.

(iii) Mariela loves water. She likes soda as long as she consumes less than 120 bottles. Thereafter, additional soda makes her sick.

4. Good y has a price of \$1 per pound. Good x has a price of \$1 per pound for the first 10 pounds you buy, and then \$0.50 per pound for each additional pound. You have a budget of \$20. Draw the budget line for this problem (be sure to indicate its location with some numbers), and show an indifference curve such that there are <u>two</u> optimal bundles.

5. Farmer Giles owns 10 bushels of corn, and he also has \$100 in cash. The price of corn is \$10 per bushel, and the price is the same whether Giles buys or sells corn. The price of the only other good Giles cares to consume is beef, which costs \$10 per pound. Draw his budget line (be sure to indicate its location with some numbers). Then show how the budget line is affected by an increase in the price of corn to \$20 per bushel.

6. Now imagine that there is a difference in the prices at which Farmer Giles can buy and sell corn. If he chooses to sell corn, he must sell wholesale at \$8 per bushel. If he chooses to buy corn, he must par retail, which is \$10 per bushel. Draw his budget line for this case (Giles still must pay \$10 per pound for beef, and he still starts out with 10 bushels of corn and \$100).

7. John likes relaxing and dislikes studying. However, he likes to get good grades, and knows that studying helps him achieve them. John as 24 hours available per day to allocate between studying and leisure.

(i) Past experience tells John that if he does not study at all, he will get 20 percent on his final exam. But for every hour per day that he studies, his grade will go up by 10 percentage points. The maximum he can get on the exam is, of course, 100 percent. Draw John's indifference curves and "budget" line, and show an optimal amount of studying of 5 hours.

(ii) Now assume that John only cares about increasing his probability of getting an A. The probability of getting an A depends on the time spent studying according to the following formula:

$$\text{Prob John gets an A } = 0.1h - 0.01h^2,$$

where h is the number of hours per day spent studying. For example, if John spends 2 hours per day studying, his probability of getting an A is $0.1\text{x}2 - 0.01\text{x}2^2 = 0.2 - 0.04 = 0.16$. Draw the "budget" line for this problem (it is a curve). Explain why John will *never* choose to study more than five hours per day, whatever his preferences are. (NOTE: when budget lines are curved as in this question, economists usually refer to the line as a **production possibility curve**. Whether we call it a budget line or a production possibility curve, it depicts the same thing, in this case the technical ability that John has to substitute between leisure and grades).

8. The Department of Water at the County of Kaua'i, Hawaii has the following rate structure for residential customers. Each residence is charged a flat $12 monthly fee. In addition there is a charge for the quantity of water consumed according to the following price schedule

- $2.75 per 1,000 gallons for the first 10,000 gallons consumed in a month.
- $3.20 per 1,000 gallons for consumption beyond 10,000 and up to 20,000 gallons.
- $4.50 per 1,000 gallons for consumption beyond 20,000.

This type of schedule is called an "increasing block rate."

Using a graph with water on one axis and consumption of "all other goods" on the other axis, sketch out the budget line for this problem.

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