Microeconomics with Ethics

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Chapter 2

The Economic Method - Models

Learning Objectives

1. Learn the methods used by the economics discipline to understand the workings of the economy.
2. Learn how models are constructed and applied to understand real world phenomenon
3. Learn why empirical data is collected and used to test the predictions of models

Economics is called a social science. This means that the discipline applies a scientific method to study and understand the social interactions that take place in an economy. The standard approach in economics is to apply deductive reasoning, inductive reasoning, and/or a combination of both to make sense of the economy in which we live.

Deductive reasoning begins with a set of assumptions and uses those to deduce certain outcomes or conclusions. The conclusions can be shown to follow logically from the assumptions that are made. The simplest example of deduction is, if we assume that all men are mortal, and that Socrates was a man, then we can deduce that Socrates was mortal. Deductive reasoning always takes the form, "If assumptions A, B, C, and D, etc. are true, then conclusions W, X, Y, and Z etc. will logically follow. The term economists use to describe this entire deductive statement is a "model." Here, A, B, C, and D are meant to represent different assumptions that will be presumed to be true. W, X, Y, and Z represent the implications that must follow if the assumptions are taken as true. A model will generally have many more than four assumptions and possibly more than four conclusions, although it is generally true that the number of assumptions will greatly outnumber the number of important conclusions. A model becomes an economic model if the statements included as assumptions or conclusions have something to do with an economy.

Inductive reasoning begins with observations (or collected data) drawn from the world. It starts with demonstrated outcomes and uses these to infer what must have caused these outcomes to arise. For example, if water is a solid whenever the thermometer reads less than zero degrees Celsius and is a liquid whenever the thermometer reads above zero degrees Celsius then we can infer that the freezing point of water is zero degrees Celsius. Induction is like saying that outcomes W, X, Y and Z are observed in the world and it only makes sense if A, B, C and D caused it.

Economics uses both deductive reasoning and inductive reasoning. It is typical for economists to construct a mathematical model of some economic phenomenon and then to collect data from the world to assess whether the model provides good predictions. This process does not work perfectly though. Even simple economies are extremely complex and it is not uncommon for economic models to fail to predict perfectly and/or for empirical data to leave us utterly confused about what may have caused the observed outcomes. Indeed this should not be too surprising since models are never perfect representations of the real world and empirical data is rarely perfectly measured. Attempts to solve these two problems account for the numerous empirical techniques that are presented in econometrics courses.

To begin to see how economic discoveries are made and to understand some of the weaknesses of the discovery process it will be useful to begin with a simple analogy. I will describe the process of model building by using something everyone should be somewhat familiar with: a map.

Key Takeaways

1. Economics uses both deductive and inductive reasoning to understand the workings of the economy
2. Economic models are deductive exercises designed to reason what implications follow from a set of assumptions.
3. Empirical data is collected as a part of an inductive exercise to reason why certain outcomes may have occurred.

2.1 The Map Model

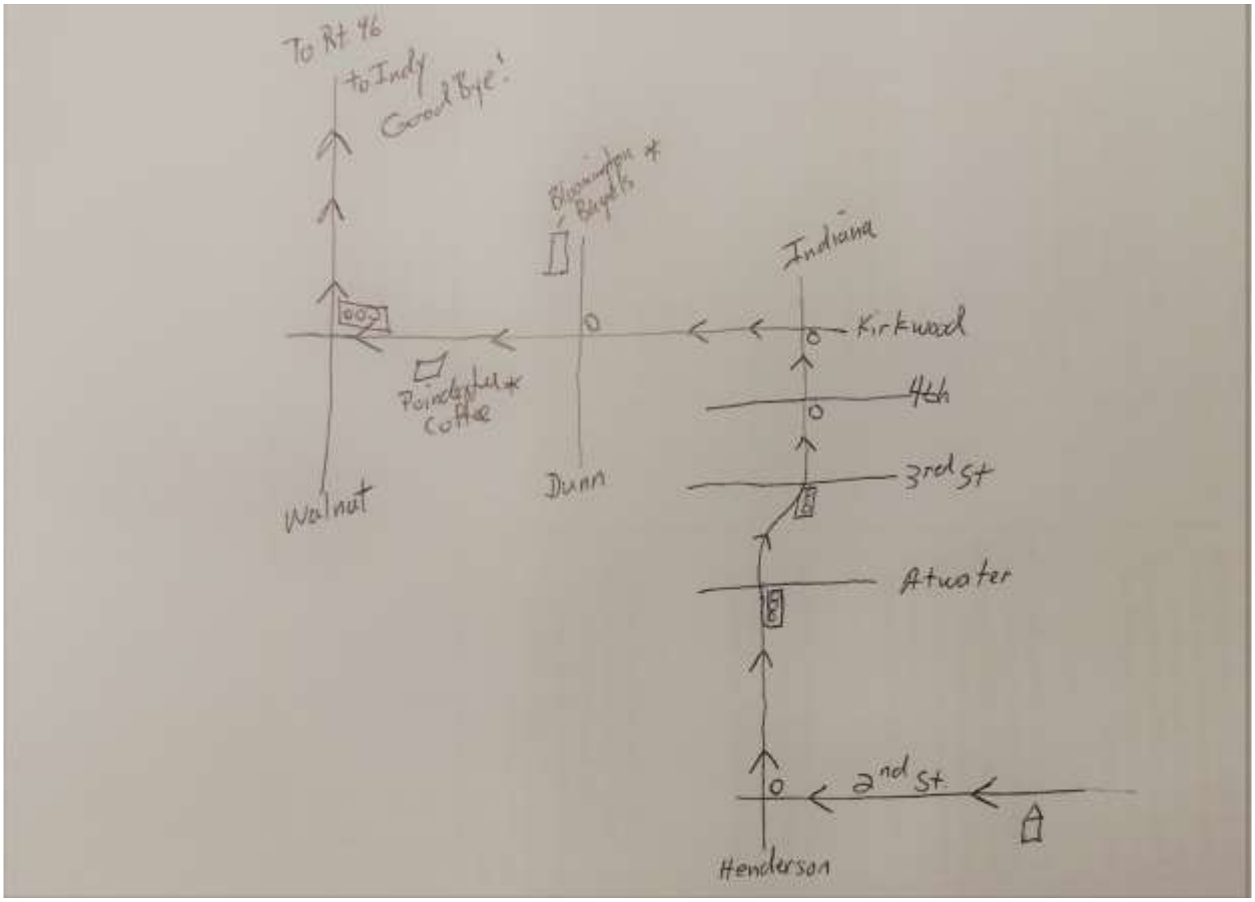
Learning Objectives

1. To understand the assumptions that are made in a geographic map
2. To understand what implications the map model deduces
3. To distinguish realistic assumptions from simplifying assumptions
4. To distinguish model assumptions from model implications
5. To distinguish explicit assumptions from implicit assumptions
6. To distinguish consequential from inconsequential assumptions

Figure 2.1 below is a hand-drawn map drawn by a resident of Bloomington, Indiana with the intention of helping their visitors navigate their car to the highway to return to Indianapolis. The map also provides some suggestions for coffee and breakfast along the way. This is the purpose of the map.

The map can also be conceived of as a model. It is a simplification of the roads in Bloomington and designed to provide enough information to get out of town with a good breakfast. But if it is a model then we must be able to put it into the form (If A, B, C, and D are true, then W, X, Y and Z). First let's consider the assumptions.

Figure 2.1 A Hand-Drawn Map



In the case of the map, many of the assumptions are so obvious to the users that they never need to be stated. They are a part of the social understandings of all people who use maps. We can call these either unstated, or, implicit assumptions. For example, in the map above the lines are meant to represent roads, the small circles near intersections represent stop lights or stop signs, the rectangular blocks represent buildings, the names next to the straight lines are street names, and the arrows are the suggested direction of travel to get out of town. Also indicated are locations for good coffee and good bagels and a friendly good bye at the end of the map. Most people familiar with maps can figure out what everything represents and they do not need to be defined so explicitly. When it is not obvious, mapmakers typically use a legend to provide meaning.

An important feature of a model is that it simplifies what it is representing. The map above grossly simplifies the town of Bloomington. The roads of Bloomington, for instance, do not look anything like a line drawn in pencil. The house drawn on the lower right, the starting point of the journey, does not look anything like the real house that is there. The buildings drawn don't look like real buildings and the stop signs don't look like real stop signs. However, these simplifications are not a problem as long as we can all accept the correspondence between the real objects and their representations on the map. In a similar way, when we construct an economic model we will assume things like, let P represent the price of butter, let Q represent the quantity of butter produced and consumed in the market. P and Q are merely letters meant to keep track of the values of the real things.

Simplification of the phenomenon we are studying is important for several reasons. First, it eliminates many complexities in the world that are not relevant to our immediate purpose. For example, a much better representation of Bloomington can now be found using the map in Figure 2.2. This map is a detailed map of Bloomington that has all of the streets as shown on the hand-drawn map, but it has many more too. Indeed, we might say it has too much reality for the purposes at hand. Even with the added detail in the second map there are still simplifications. For example the roads are represented merely by white or yellow lines. Colored areas are used to indicate locations of parks and other points of interest. Some details are lost too, as for example the locations of the stop lights and stop signs.

Figure 2.2 Map of Bloomington, In

For the purposes of getting out of town though, the hand-drawn simplification is perfectly adequate because it includes only what is needed. In a similar way economic models will exclude many details about the real world in order to focus on what is considered important and to avoid unnecessary complexity.

Assumptions that Simplify vs. Assumptions that Reflect Reality

Assumptions are the building blocks of a deductive exercise and a model. We identified many of the assumptions in the map model above. However, it is very important to recognize that in constructing a model, different assumptions are included for different purposes. In particular, some assumptions are made merely to simplify the world; that is, to eliminate extraneous or unnecessary information and to help make it easier to find a unique solution. We will call these simplifying assumptions. However, other assumptions are critical to the proper function, use, and implications of the model. These assumptions are ones that reflect an important aspect of reality.

In the map model, the simplifying assumptions are the ones we take for granted; for example, the lines represent roads; the circles at intersections represent stop signs etc. The realistic assumptions are the ones that specifically match the reality of the world. For example, the streets names must match the names of the actual streets in Bloomington, IN. The location of the stop sign symbols must match where they are found in the real world. The direction of the arrows must match the direction of travel on the real roads to get out of town. We cannot make up street names, or locations of the stop signs, or draw the arrows randomly, or else the map will be useless.

Assumptions vs Implications

Another important element of models is the distinction between assumptions and implications. In terms of deduction the difference is whether the statement appears on the left of the arrow or the right in the statement "If A,B, C, D, etc are true --> then X, Y and Z follow." The assumptions are those statements on the left and the implications are those statements that follow the inference arrow.

In the map model we can state it like this: If lines represent roads and names represent the street names, and circles represent stop signs, and the arrows represent the direction of travel in your car, and if you drive your car along the real roads in the direction shown on the map model, etc. etc. then you will be on the road home to Indianapolis. Also, if you want to find coffee and bagels on your way out of town, then you can use the map to find the locations in the real world.

Almost everything in the map model is an assumption. The implications are finding the way out of town and finding good places for coffee and bagels. This is the intended purpose of the (map) model.

Explicit (Stated) vs. Implicit (Unstated) Assumptions

Typically the number of assumptions we need to make to fully describe a model are sizable enough that to state them all becomes cumbersome. Thus, the most obvious ones are often left unstated or implicit. Instead, model makers only explicitly state those assumptions thought to be necessary to fully understand the model.

In the map model, for example, one unstated assumption is that there are many more roads and buildings in Bloomington than the ones drawn. Any user of the map who is familiar with cities should understand this without stating it. It is also implicit that the circles next to intersections are stop signs. However, it may be that there are more stop signs and stop lights along the travel route than are actually drawn. Model makers generally leave assumptions unstated either because it is presumed that users will automatically infer it themselves, or, because they believe it is immaterial to the purpose of the model. Sometimes the model makers are mistaken though. In fact, one of the prime sources of discovery in science is when someone notices that an assumption is implicitly being made that turns out to significantly affect the implications. We will see some noteworthy examples of this later in the course.

Consequential vs. Inconsequential Assumptions

Finally, it is important to recognize that some assumptions that are made are very critical to the final implications while other assumptions are not very critical. For example, in the map model, assuming that a straight line on a piece of paper is an actual asphalt covered street in the real world is inconsequential as long as the map user can understand the correspondence between the two. However, the street names on the map must match the actual street names or else the map user will not know where to turn and may not find his way out of town. Also, the arrows indicating the directions of travel must correspond to allowable directions of travel. If the arrows took the map user the wrong way down a one-way street, then the map would not lead to its implication and the user will not be able to get out of town without his own instinct.

In general, the assumptions that reflect reality tend to be the ones that are consequential while those made to simplify the model are inconsequential. Nonetheless, sometimes the simplifying assumptions do turn out to be very consequential to the results of the model. There are examples of this in the pure exchange model that is presented in the next chapter.

REALITY CHECK

Sometimes when studying economics you may become bothered by the large number of assumptions that must be made, especially because with so many simplifying assumptions in place, the model may seem like only a vague representation of the real world. One may wish for a model that makes very few or even no assumptions about the world. Unfortunately this is not only impossible, it is impractical.

One feature of economics is that the models are presented by explicitly stating most of the relevant assumptions that are being made. This makes it seem that there are an inordinate number of assumptions. However, the same is true in every other discipline that seeks to describe the world. Every discipline makes assumptions when they state some cause and effect theory or relationship. However, many times in other disciplines the assumptions are left unstated. That will often leave one unsure when the implications are true and when not.

Secondly, it is impractical not to make simplifying assumptions in building a model. I am reminded here of a joke by comedian Stephen Wright. In a deadpan one-liner during an old routine he claimed, "I have a map of the United States that is actual size: it says scale 1 mile equals 1 mile." This joke is funny because one will immediately recognize how ridiculous it would be to have such a map. It could serve no useful function at all! In the same way, it is absurd to strive for a completely realistic economic "model." Such a model would not be a model, and it would serve no practical purpose.

Key Takeaways

1. Maps include assumptions like, lines represent roads or borders, up represents north, distances are smaller-scaled version of the real world, etc.
2. Maps have implications like, finding the way out of town and getting coffee and bagels for the drive, as in the hand-drawn map.
3. Realistic assumptions are made to match some relevant aspect of the real world while simplifying assumptions are made to make the model tractable or solvable.
4. Model assumptions correspond to the IF elements while the models' implications correspond to the THEN elements of a deductive IF .. THEN statement.

5. Explicit assumptions are those clearly stated while implicit assumptions are those deemed too obvious to require being stated.
6. Consequential assumptions are those which if changed will affect the implications, whereas changes in the inconsequential assumptions will not alter the implications in an important way.

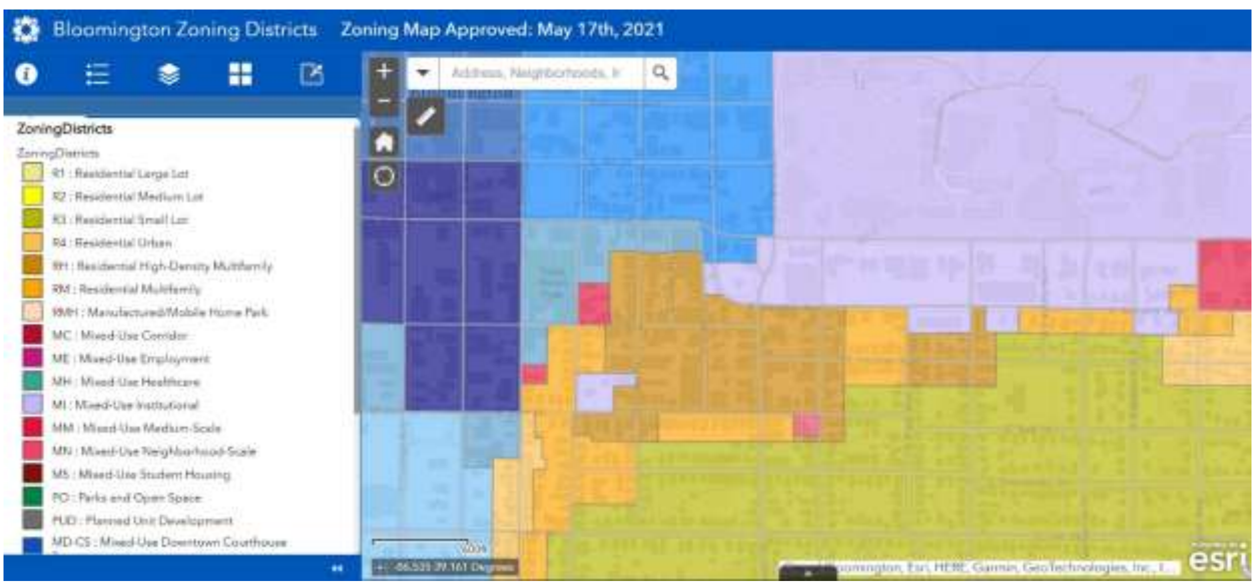
2.2 Multiple Models

Learning Objectives

1. Learn how models are built for different purposes
2. Learn that different models have different assumptions but may share some in common

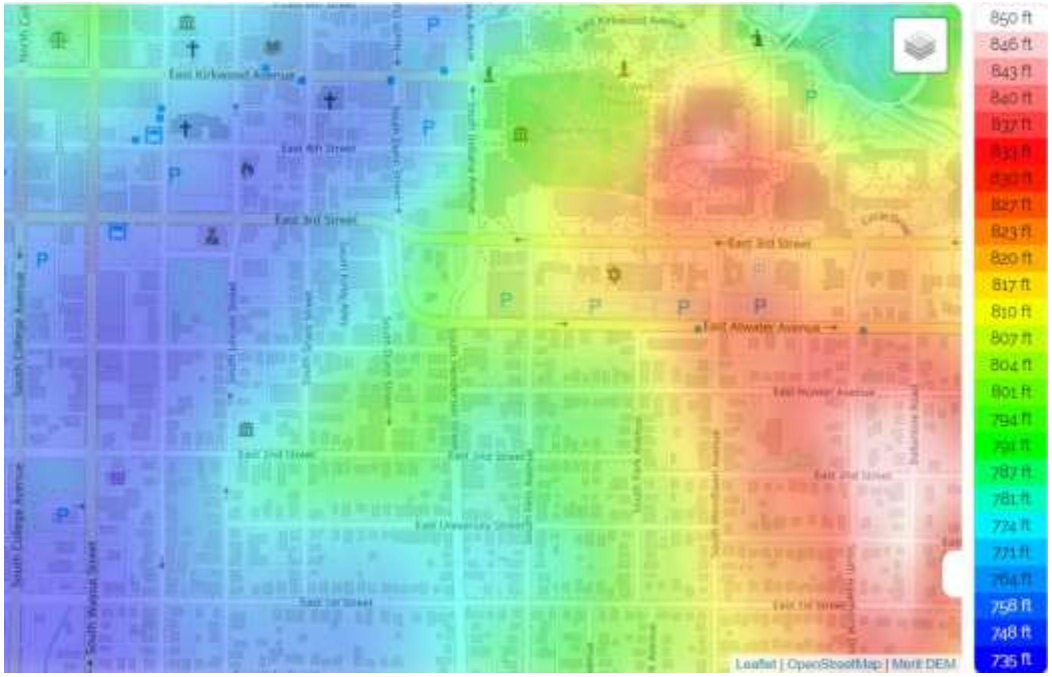
If you wish to understand the geography of a particular region, a map provides a model to assist. However, as everyone knows there are many different aspects of a region in which a person may be interested. Each aspect requires a different map. Below are two different maps of the Bloomington Indiana area. The first map in Figure 2.3 indicates Bloomington zoning districts in the same regions and the maps above. The street map remains the same as before but superimposed on top are different colors corresponding to different allowable building codes and usage requirements within the town. A legend indicating what the colors mean is provided to the left of the map. Such a map would be extremely useful for housing or retail developers in the area.

Figure 2.3 Zoning Map of Central Bloomington, IN



The second map in Figure 2.4 is a topological map of the same region of Bloomington, Indiana. Topological maps indicate the elevations across a geographical space. Sometimes elevations are drawn as thin lines where each line represents a unique elevation. In this map, color is used again but this time to indicate elevations. The color legend is provided on the right side of the map.   This map could be used to identify the difficulty of a potential marathon route or potential flood zones.

Figure 2.4 Topological Map of Bloomington Indiana



These three maps are shown to highlight the analogy with economic models. Each map (also each economic model) is a simplification of the real world. Each map shares some assumptions; for example they are all overhead views of the same geographic area. However, each map defines its own terms uniquely. In each map, the green areas represent something different. Also the level of geographic detail (roads, political boundaries, etc) is almost nonexistent in the first map, and highly detailed on the third map. Finally, each map is functional in its own way for its intended user. Each map provides some useful insight about the area around Bloomington, Indiana.

Economic models are similar. There isn't one economic model, there are thousands. Each one designed to a particular purpose or aspect of the economic system. Each will have its own set of assumptions and these will vary across models. Some assumptions will appear in many models, for example, self-interested behavior with profit and utility maximization. But some assumptions may appear only in a small set of models. Finally, just like geographic maps, each economic model will offer some useful insights about the economy, but no one model will succeed in explaining everything. Models will always be simplifications of the real world economy and as such they will never be a perfect representation of that reality. However, just like maps of geographic regions, economic models can be very useful to the economic practitioner.

Key Takeaways

1. Like with maps, there is not one economic model. Instead there are many different economic models that incorporate different assumptions to describe some relevant aspect of an economy.

2. No one economic model describes all relevant aspects of an economy. Rather, each economic model focuses on one or more features of an economy to the exclusion of other aspects.
3. Like with maps, even though economic models are unlikely to perfectly reflect the real world, they offer some important insights and understanding.

2.4 Using and Interpreting Models

Learning Objectives

1. Recognize that model results are always true, assuming the model is logically consistent.
2. Learn why models are tested using real world data
3. Learn some of the problems with model testing

It is important for students and users of economic theory to understand the relationship between models and the real world itself. Too often economists present the models as if they tell us what is actually happening in real markets. Students too would often prefer to be taught what is actually happening rather than what could be true under certain narrow conditions. Thus, too often both teachers and students are deluded into thinking that the models are the world. That misunderstanding may work out just fine in many practical situations, or for some period of time, but almost inevitably economic models will fail. One example from history occurred in macroeconomic theory with the acceptance of the Phillips curve showing an inverse relationship between the unemployment rate and the inflation rate. In the 1950s and 60s, many people believed that the relationship would always hold. In the 1970s that theory required reexamination as many economies experienced stagflation, a rising unemployment rate and a rising inflation rate at the same time. This is just one of countless such examples.

Remember that models are always simplifications and therefore cannot capture everything about the world. However, because of that simplification it is possible to make definitive statements about cause and effect relationships. For example, later in the course we will be able to make statements like this: If the price of coffee rises, and if coffee is a complement good to cream, then demand for cream will fall and the market price of cream will fall. This statement seems to be about the real world and indeed it may match what happens in the real world on many occasions. However, the statement is actually about what will happen in the context of the economic model when all of the assumptions of the model are valid. The implications in the model follow logically from the assumptions and are 100% true (assuming further that there had been no logical errors made). At the same time though, if we were to ask the following: if the price of coffee rises at the local supermarket then what will happen to the price of cream next week at the supermarket, our answer should be, I don't know. There is no way of knowing whether the conditions in the real world supermarket match all the assumptions that were made in the economic model. If they don't match 100%, which is highly likely, then we can't be sure what the effect will be in the real world situation.

This may seem like a highly technical and unimportant distinction. However, understanding this distinction is quite significant. Recently there has been much discussion and debate about the relevance of economics in the aftermath of the world financial crisis in 2008. Critics have pointed out that the economic theories failed. Not only did they fail to predict a crisis, they failed to explain the mechanism of the financial meltdown. It seems the critics who claim this do not understand the distinction between models and the real world. They expect, incorrectly, that models are supposed to describe the world perfectly and give economists foresight over economic events, much like the physicist can predict how much force can be produced by a turbine engine. However, although social sciences employ methods similar to the hard sciences, they do not have the same predictive power. But that does not make economic models useless.

Just like with geographic maps, economic models offer some insights that can be invaluable even though they are not perfect. To use them properly requires understanding their limits. One must understand the difference between consequential and inconsequential assumptions in the models. One must understand which assumptions are used merely to simplify and which are meant to incorporate an important aspect of the world. And finally one must understand how likely the model assumptions will be mostly true of a real world situation and thus can help us better understand the world. This last feature is a judgment about how well the model fits a real world situation and to what extent assumptions that are not 100% correct may nonetheless not have a consequential impact on the conclusions. The need for judgment makes the application of economic models sometimes closer to an art than a hard science.

Empirical Testing of Economic Models

One way economics gets closer to being a hard science is through the application of empirical data to test economic models. Economic analysis tends to progress in the following way. First, analysts pick out important features of the world and include these as assumptions in building an economic model. Second the model is analyzed to determine what kinds of implications or predictions it offers. Third, economists gather relevant empirical data about these outcomes and other features of the model and test to see if the predictions match what happens in the world.

Empirical testing is usually a complicated exercise. First because the appropriate data may be difficult to collect. Second the data that is available may not be precisely what the model calls for. Third the data may be collected with some error. In addition there may be many things that can influence the value of a measured variable and a good test should include all of these influences if possible. For example if one wishes to test whether an increase in the price of coffee causes the price of cream to fall, then one might like to include factors such as the cost of producing cream, the capacity of cream production, and the amount of advertising for cream - among other things - that might also affect the price of cream.

This type of exercise is called induction; beginning with data and inferring whether it can be explained by a particular economic model. However, if the data matches adequately, and if the cause and effect relationships being tested are statistically significant, then one can say that the data in the world are consistent with the model predictions. The test itself does not prove that the theory is true. We should not infer from a positive empirical test that the relationships are like scientific laws that will always be true in all circumstances. That type of conclusion is too strong. Instead an empirical test shows that there is evidence that the relationship holds in some circumstances .. which is better than a negative result indicating that the empirical evidence is not consistent with the model in some circumstances.

Failure to confirm the model with empirical evidence also does not mean the theory is wrong. It could be that the data was inaccurate in some way or was not close enough to the type of data needed for the study. It might also mean that one or more important assumption in the model was not often satisfied in the world. Sometimes the model is too simplified to expect it to match the complex real world very closely. Failure to confirm a model often results in attempts to improve the model by incorporating more realistic assumptions. In this way model testing becomes a way to keep the models that work pretty well in most circumstances and revise those that fail the empirical tests.

In this process models become better in the sense that they capture more elements of the world that may affect economic outcomes. Still, they will never match the real world 100%. The real world remains too complex and changes too frequently to expect that a model based on empirical estimations using data from the past will offer perfect predictions under changed circumstances in the future. That is too much to ask. If you expect perfect predictability from economic analysis you will ultimately be disappointed… Economics will never build a model that mimics the real world perfectly and accurately predicts everything. Indeed, if it could do that we wouldn't call it a model … it would be the real world!

Key Takeaways

1. The statements made within the context of a model are always true (assuming logical consistency), but these statements may or may not match the complex real world.
2. Models are tested by seeing if their predictions match the data in the real world.
3. A positive empirical test does not mean the relationship is always true though, only that the evidence is consistent with the model in at least one instance.
4. A negative empirical test does not mean the relationship is always false, but can be used to refine the model to make it more realistic.
5. Testing models is challenging because of problems with data availability and reliability