Causation versus Correlation: Explaining the difference through a Simple Paper Plane Experiment

Goals:

1. Show students how economists construct simple models.
2. Have students build paper airplanes to illustrate the difference between ceteris paribus, endogenous and exogenous factors.
3. Teach students to distinguish between causation and correlation.
4. Make the lecture memorable to increase retention.

Overview:

In the first 2 weeks of any principles-level ECON course, a lecturer must introduce the concept of model building. We use economic models to simplify a complex part of the economy. The underlying assumptions are very important. This is a real challenge, as many students struggle with abstraction. For many, this is their first exposure to economic models and you need to start with ceteris paribus, then distinguish between variables which are built into the model (endogenous) from those that remain outside (exogenous).

Students often get correlation and causation mixed up. This is a nice time to show the clip "Causation" from Big Bang Theory. Penny and Leonard return early from dinner because Leonard hits his head on the table while retrieving an olive. On the car ride home Leonard vomits out the window. Penny believes they should go to the hospital because he may have a concussion but Leonard assures her that it's probably just because he gets carsick.

Penny assumes that because the two variables (Leonard hitting his head on the table, then vomiting on the ride home) are correlated that hitting his head causes the vomiting. In this case, Leonard offers a different rationale (cause): car sickness. Causality implies correlation (one causes the other value to change). But correlation does not imply causation; just that their values change at the same time.

Demonstration:

The following activity will help students understand how economists create models. The model in this case is a paper plane which they build. You need to break the students into 3 sections: the left-hand, center, and right-hand sides of the class. As the activity unfolds, the center and left-hand sections will make changes to their model (the left-hand section will violate the concept of ceteris paribus by changing 3 factors!) then make predictions about how their plane will fly. The point you want to stress is: when you change too many variables in a model, it breaks down and has no predictive ability. Like Penny in the clip above, we can't distinguish between events which move together (correlation) and causation.

Preparation:

Before you conduct this activity in class, you need to prep your students by covering the key concepts highlighted above. This usually takes 10-15 minutes. The only materials needed are

paper and students. The activity takes 7-10 minutes, depending on class size. This is one activity which works best in a large venue.

Class Day:

Begin by asking the following rhetorical question: “Has anyone here ever wanted to fly a paper airplane in class? Here is your chance. I am going to give you 4 minutes to construct the best paper airplane you can and then we are all going to fly our planes to learn about economics. Go!”

As soon as you say “go,” begin playing “Airplanes” by B.o.B (with Hayley Williams). Take the opportunity to walk around the room while the song is playing and interact with the students and comment on some of the best and worst designs. Be encouraging. Before the song ends, make your own airplane design. When the song ends, hold up your airplane and ask the following: “What makes a model paper airplane?” Students will respond in a number of ways, including how far it flies and how long it stays in the air. Ask students to write an exogenous factor on the outside of the plane and an endogenous factor on the inside.

Once you have a few responses, indicate that you would like to find the “best” model airplane. In order to do this, you need to break the class into three groups (the left-hand, center, and right-hand sides of the class). Have the group on the right all simultaneously attempt to hit a target (bin) at the front of the class. “What affected the flight of your plane? Which factors were endogenous versus exogenous?” Pick up the plane that comes closest to the target. Then point out that in order to be sure that the model is the best, you would have to run hundreds of controlled experiments. Note as well that each of the designs is endogenous—or built into the model. Also, a classroom provides a controlled environment. If you go outside, the wind and precipitation affect how the planes fly. These “outside” factors affect how each of the models performed, and they are the exogenous variables.

Then, turn to the center section. Here you want to emphasize that economists like to make predictions once they have the best model. Use the plane you picked up and create some drag on the left wing by tearing off part of the wing in the back. Make sure every student can see what you have done. Ask the class whether they think the torn left-side wing will cause the plane to fly left or right, higher or lower. “Can we assume causality?” Once they have made their predictions, it is time to find out what happens when everyone in the center section makes the same notches that you have made.

Have the center group simultaneously fly their airplanes at your target. (It doesn’t really matter whether these planes fly as predicted—what matters is that these altered planes can be tested over and over to test the hypothesis.) More important, altering one characteristic of each airplane while holding everything else constant gives economists the ability to determine how changes to the basic model design impact performance.

Finally, turn to the left. Ask this group to tear off the left-side wings of their planes like the center group but also have them bend down the front tip and bend in the right wing. There are now three changes to the original design. Ask the students “How will your plane fly?” Groans and laughter from the audience. “Can we imply causation?” Then ask them to try to hit the target. Pick up the plane that lands closest to the target and point out that there is no way of knowing exactly how much effect each of the individual changes had on how these model airplanes performed. There are too many variables in motion.

Discussion:

I like to remind students that our objective is to build simple yet effective models, and then change one variable at a time in order to understand what the model predicts will happen as a result. You can use this activity to get the students to think about why some models don't work, e.g. violation of ceteris paribus or the danger of faulty assumptions (reference to the Great Recession).

Then, I introduce a model used to predict the wage of a person. I give the students a list of endogenous variables (age, education, experience, gender) and ask them to predict the effect of each on the dependent variable – assuming ceteris paribus. I deliberately leave out a few important variables (race, nationality, location). "Can you think of any variables which should be in the model? What do we call them?" You can then prompt a discussion on the tradeoffs involved in selecting variables: creating an effective model means prioritizing variables. This is a normative judgment.