e-Post Graduate Diploma in Advanced Business Analytics- 2021-22

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APPLIED CASUALITY & EXPERIMENT FOR BUSINESS

Milton Friedman's Problem

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Background

In Milton Friedman's Thermostat problem, if a house has a good thermostat, we should observe a strong negative correlation between the amount of the oil burned in the furnace, (M), and the outside temperature (V).

But we should observe no correlation between the amount of the oil burned in the furnace and the inside temperature (P)

And we should observe no correlation between the outside temperature (V) and the inside temperature (P)

An econometrician, observing the data, concludes that the amount of oil burned had no effect on the inside temperature. Neither did the outside temperature. The only effect of burning oil seemed to be that it reduced the outside temperature. An increase in M will cause a decline in V, and have no effect on P.

A second econometrician, observing the same data, concludes that causality runs in the opposite direction. The only effect of an increase in outside temperature is to reduce the amount of oil burned. An increase in V will cause a decline in M and have no effects on P.

But both agree that M and V are irrelevant for P. They switched off the furnace, and stop wasting their money on oil.

Problem Statements

Using the Directed Acyclic Graph (DAG)

- Please check the conclusion of the econometrician 1
- Please check the conclusion of the econometrician 2
- Derive the right conclusion if the conclusion of the econometrician 1 and 2 are not right

Solution

1. Validating the conclusion of econometrician 1.

The 3 nodes in the system are

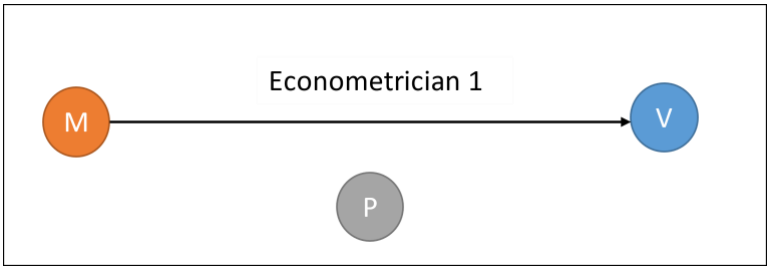
- Outside temperature – V
- Oil used in Furnace – M
- Inside room temperature – P

Econometrician 1 claims that – *"amount of oil burned had no effect on the inside temperature. Neither did the outside temperature. The only effect of burning oil seemed to be that it reduced the outside temperature. An increase in M will cause a decline in V, and have no effect on P"*

In symbol, it means

M > V, but V & M has no impact on P

The following diagram highlights the relationship among M, V and P



So, to summarize,

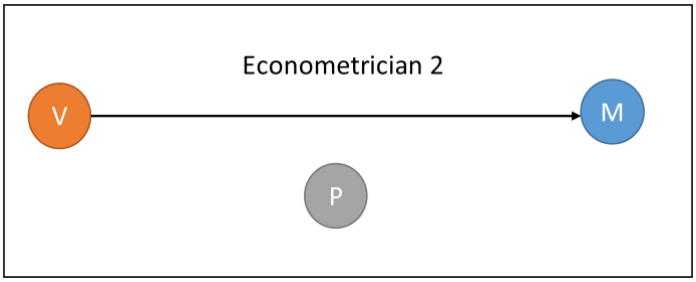
What Econometrician 1 is saying	What will happen if M is switched off	What are the actual Relationships
• M has an Impact on V	• P, the inside room temperature will start decreasing	• As shutting down of the M will have impact on the P, M has an impact on P
• V has no impact on P	• P will come in equilibrium with outside air temperature V after some time	• V is independent of M
• M has no impact on P		

We can then conclude that the above model of Econometrician 1 is not able to explain the actual relationships

2. Validating the conclusion of econometrician 2

Econometrician 2 claims that – *"The only effect of an increase in outside temperature is to reduce the amount of oil burned. An increase in V will cause a decline in M and have no effects on P."*

In symbol, it means V > M, but V & M has no impact on the P



So, to summarize

What Econometrician 2 is saying	What will happen if M is switched off as we can't switched off the outside air temperature	What are the actual Relationships
• V has an Impact on M	• P, the inside room start decreasing	• M is dependent on V
• V has no impact on P	• P will come in equilibrium with outside air temperature V after some time	• P is dependent on V
• M has no impact on P		

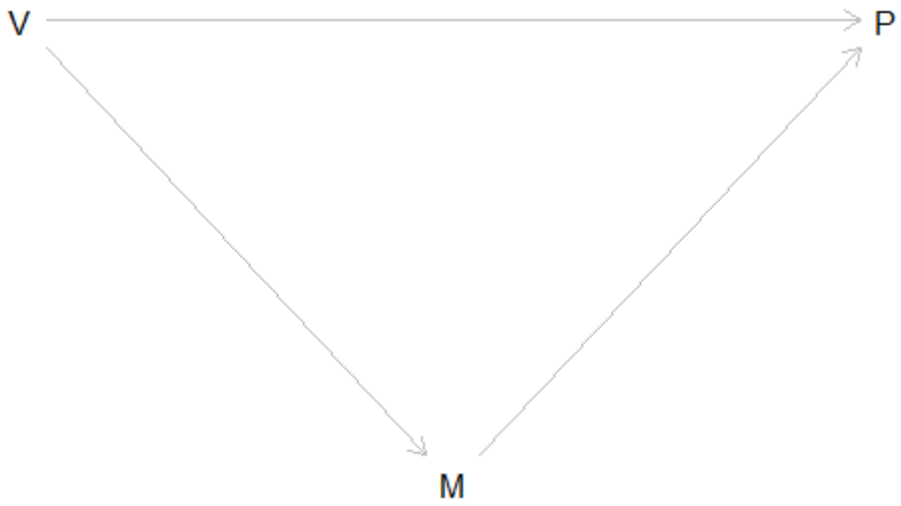
From the above table, we can conclude that the above model of Econometrician 2 is not able to explain the actual relationships

3. Building the Final Model

Based on the conclusion from **Econometrician 1 and Econometrician 2**, we can say that,

- M is dependent on V
- V is independent of M
- P is dependent on V
- P is dependent on M

The following shows the DAG of the above flows

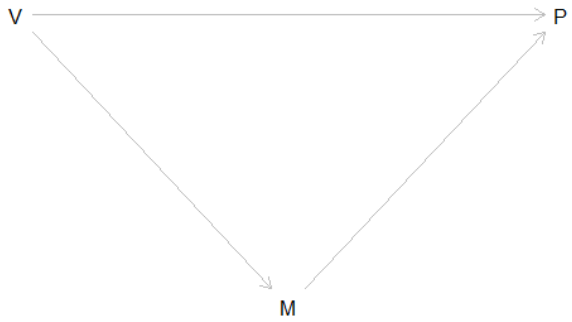


From the above DAG, we can conclude that

- Inside temperature P is dependent on both V, the outside temperature and M, the furnace oil temperature
- Outside temperature has impact on the furnace oil temperature or oil used in the furnace (M)

Checking the relationship between variables in the Final Model

- To check the relationship in the Final Model, let **make P as the final outcome variable and V as the exposure variables**



In this case, there exist

- One front door path, between V & P and that is V >P
- One back door path, between V &P, and that is V > M > P

Now if we make the **P as the final outcome variable and M as the exposure variable** rather than V, then there exists

- Only one front door path between M and P and that is M > P

Conclusion

Based on the above analysis, we can conclude that

- In the absence of a thermostat, the inside room temperature will drop closure to the outside temperature.
- Also, the oil burnt in the lamp depends on the outside temperature.