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Questions? Email dwheat@wheatresources.com

Loops Tutorial

Prepared for students
in ECO201

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Learning Objectives

In this slide show, you will be introduced to the concepts of

- *feedback loop*
- *reinforcing feedback loop*
- *counteracting feedback loop*

You will also learn

- *how to identify a reinforcing feedback loop*
- *how to identify a counteracting feedback loop*

Suggestion: *Review causal links in last week's Links Tutorial.*

Drawing Feedback Loops

Purpose of drawing feedback loops

Understanding an economic system (or any system) is enhanced by precise expression of your thinking about the way the system works--what is called your “mental model” of the system.

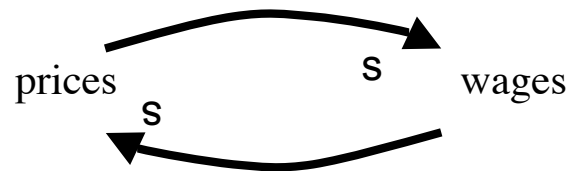
Causal link and feedback loop diagrams provide a common language for sketching mental models and displaying your thoughts about how a system functions.

Learning to use the “language” will improve your ability to grasp how any system--including an economy--functions. The diagramming language will also improve your ability to communicate to others the knowledge that you are building and to engage in a constructive dialogue.

Feedback Loop Diagrams

Feedback exists when, after some time passes, two variables switch cause-and-effect roles. The initial “cause” gets a feedback effect from one of its “effects.”

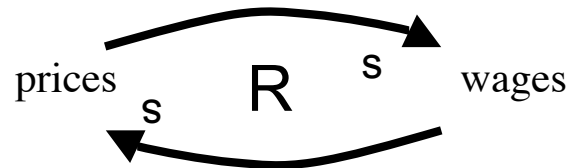
For example, suppose prices are rising year after year throughout the economy and business managers, responding to pressure from the workforce, increase their workers’ wages. Wage increases, of course, raise costs of production. Rising production costs are likely to set off another round of price increases followed by another round of wage increases.



The previous tutorial stressed that a causal link is a hypothesis about the one-way cause-and-effect relationship between two variables (e.g., prices--> (s) wages). Likewise, the feedback loop sketched here is a hypothesis about two-way causation between prices and wages.

Reinforcing Feedback Loop Diagrams

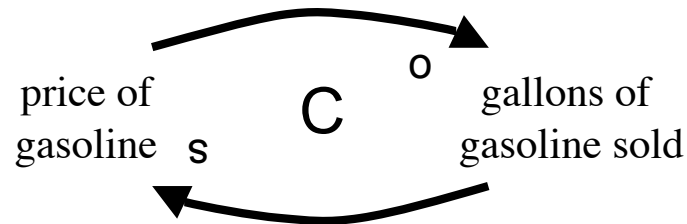
- The previous example illustrates the concept of **reinforcing** feedback.



- A reinforcing feedback loop feeds on itself. Once it starts changing, it changes faster and faster until another force slows it down.
- Assuming one-year lag times in this example, the more that prices rise in year 1, then the larger the wage increases in year 2, and then the larger the price increase in year 3. And on and on.
- Of course, in the real world, nothing grows without limit. This diagram would have to be enlarged to add other factors that would influence the behavior of prices and/or wages.

Counteracting Feedback Loop Diagrams

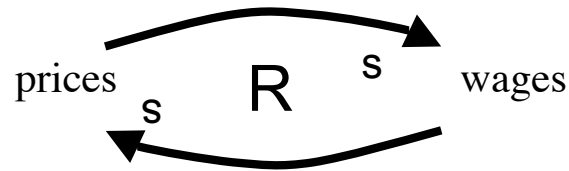
- Feedback loops can also have **counteracting** effects. A counteracting feedback loop opposes some initial trend.



- In this example, assume the price of gasoline rises. The higher gas price would cause some motorists to drive less, which would reduce the volume of gasoline sold. (The “**o**” link means that the sales volume moves in the *opposite* direction from prices, after a price change.)
- The more that gasoline sales dropped, the more pressure there would be to reduce gasoline prices. (The “**s**” link means that prices move in the *same* direction as sales, after a sales change.)
- We began this example with prices rising, but after one “trip” around the loop, we found downward pressure on prices. The initial trend of rising prices was opposed -- counteracted -- by the feedback loop.

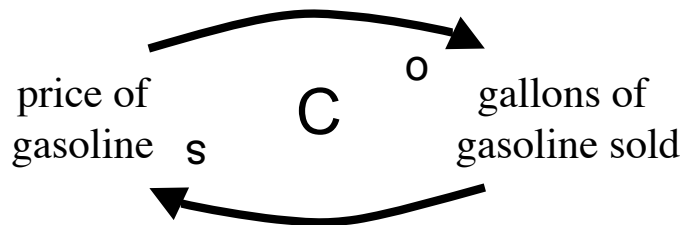
How to Determine if a Feedback Loop Has a Reinforcing or Counteracting Effect

- Start with one variable in the loop, and assume it changes.
- Take a “walk” around the loop to see the effects of that initial assumption.
- After a walk around the loop, identify the feedback effect on the first variable.
 - If the first variable continues in its *same* direction, the effect is *reinforcing*.
 - If the first variable moves in the *opposite* direction, the effect is *counteracting*.



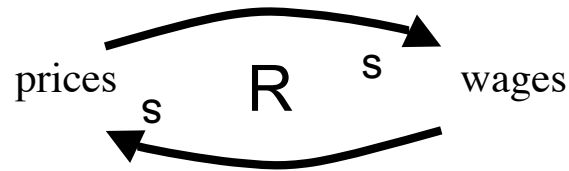
- Above, if prices increase then wages increase, and that causes prices to increase again. ==> Reinforcing Feedback Loop.

- Below, if prices increase, sales decrease. The decrease in sales causes prices to decrease. ==> Counteracting Feedback Loop.

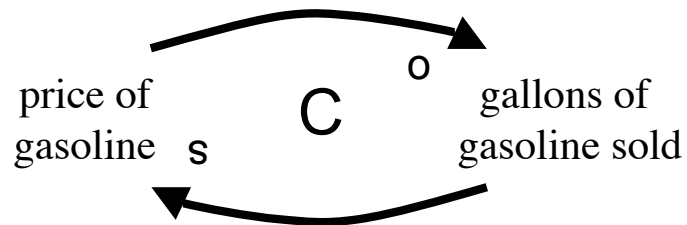


Reinforcing or Counteracting Loop? How to Confirm Your Conclusion

- If each link is labeled correctly as *same* (s) or *opposite* (o), here is a technique to confirm the “walk-around-the-loop” method:
- If a loop has an *even* number of “o” links (0, 2, 4, etc.), then the loop is a reinforcing loop (R). The *reinforcing* bank account loop has *zero* “o” links.



- If a loop has an *odd* number of “o” links (1, 3, 5, etc.), then the loop is a counteracting loop (C). The *counteracting* gasoline loop has *one* “o” link.

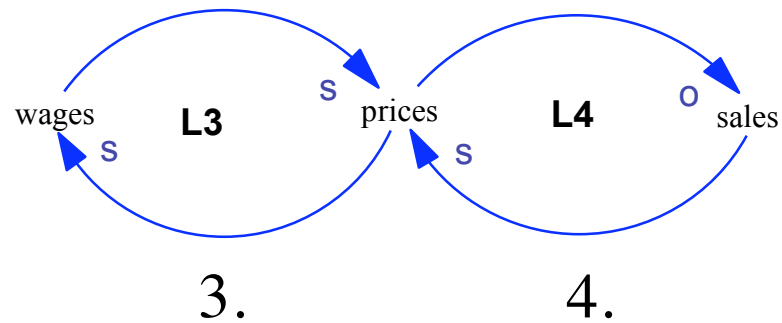
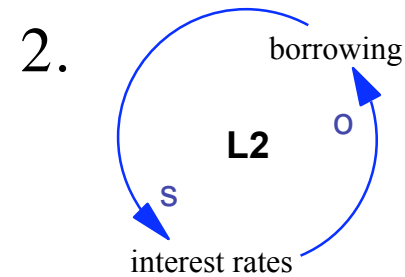
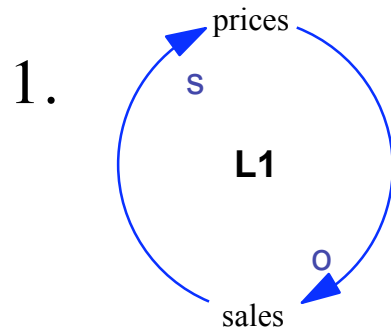


Time Delays in Feedback Loops

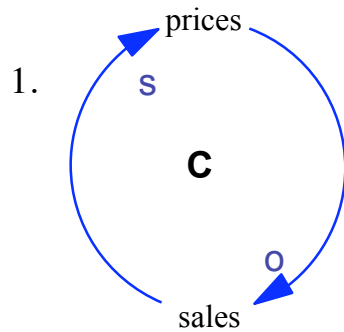
- The feedback effects of a loop do not all occur simultaneously. There must be some delay in at least one link.
- In the price & wage loop, for example, wages may be renegotiated every year or two. Thus, there would be a time lag between an increase in prices and the next round of current workers' wages. Starting wages for new workers might respond more quickly, but business managers would still have to think for a few weeks or months before deciding how to respond to price changes.
- In the gasoline loop, changes in driving habits require time. And, when sales decline, gasoline retailers may wait a while before cutting prices.
- *When delays are long, a feedback loop responds slowly to changes in its links. That means changes in the overall behavior of the system occur more slowly.*
 - If wages were renegotiated every five years, the price effect on wages would be less obvious.
 - If consumers waited years instead of weeks to adjust their driving habits when gas prices rose, gas prices would be slower to come back down.

Practice Exercise

Use the “walk-around-the-loop” method to determine if each loop is reinforcing or counteracting, and then confirm by using the “odd/even” test.

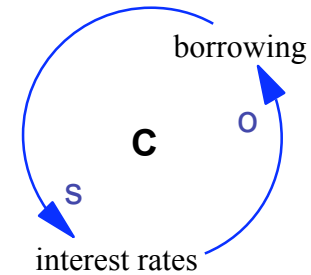


Answers to Practice Exercise

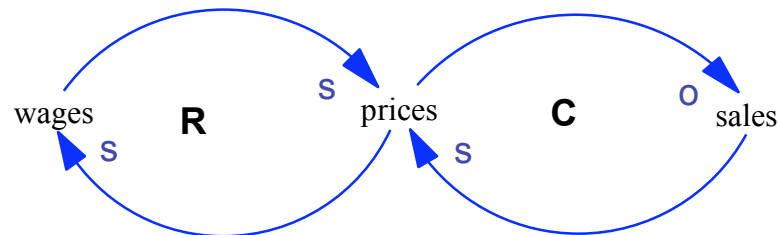


Assume prices increase. That causes consumers to cut back on purchases; thus, sales decline. When sales fall, business managers cut prices to stimulate demand. We started with prices increasing and, after one trip around the loop, found pressure to cut prices. L1 is counteracting loop, with one “o” link.

2. Assume interest rates increase. That causes borrowing to decrease. The decline in borrowing causes lenders to lower rates to attract more borrowers. L2 is a counteracting loop, with just one “o” link. (The supply of funds that could be loaned would also affect interest rates, but that requires another loop.)

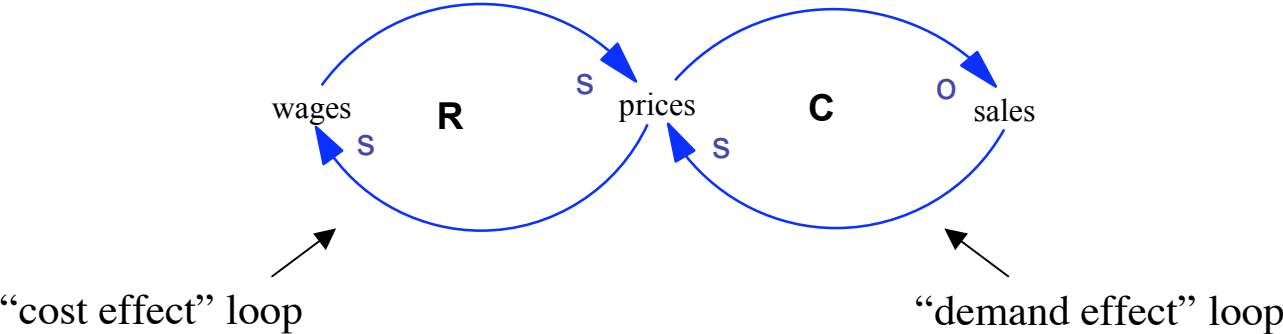


3. L3 (below, left) is the same loop as discussed in the tutorial. It is a reinforcing loop, with no “o” links.



4. L4 (above, right) is the same as L1 (above). It is a counteracting loop, with one “o” link.

Feedback Loop Application: Price Behavior



Prices are determined by both production *costs* (e.g., wages of workers) and by customer *demand*. When costs increase, prices also tend to rise, as the “cost effect” loop illustrates. When sales volume increases due to rising customer demand, that also puts upward pressure on prices, as the “demand effect” loop shows.

The reinforcing “cost effect” loop could set off an inflationary wage/price spiral. The counteracting “demand effect” loop, however, would exert pressure in the opposite direction since rising prices would reduce sales. Lower sales, in turn, would exert downward pressure on prices.

The actual level of prices cannot be predicted merely by looking at the two loops. We would have to know which loop exerts the stronger influence on prices, and that would depend, in part, on the delays in each loop. We will discover later that other things happening in the loops could cause short-run prices to fluctuate above and below some long-run trend, as illustrated below.

