

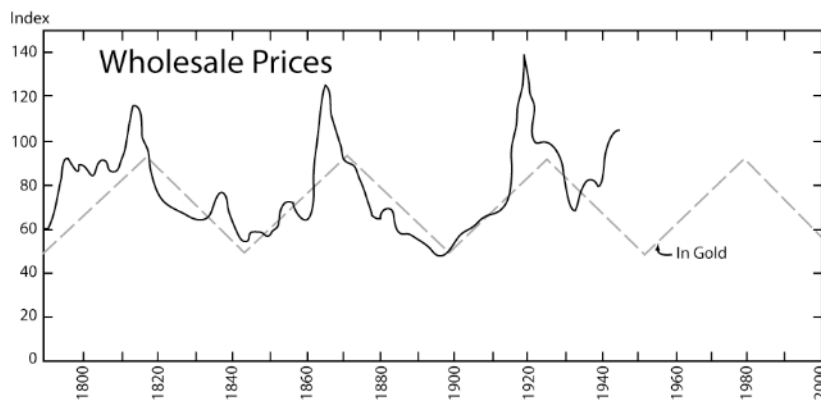
## Using Functions in Models and Decision Making: Cyclical Functions

### V.B Student Activity Sheet 6: Making Decisions from Cyclical Functions in Finance

Economists look for cycles to make predictions about the economy. Market traders also look for patterns in the prices of financial items such as stock, commodities, and currency value to make trades that yield the most money. In a cycle, prices rise and fall with a predictable regularity. If market traders can identify where in a cycle prices are, they can make decisions to increase their profit.

In 1947, economists Edward R. Dewey and Edwin R. Dakin published *Cycles—The Science of Predictions*, in which they identified a 54-year cycle in the wholesale price of goods. *Wholesale prices* are the prices that store owners pay the people who produce the goods (such as milk, gasoline, or chocolate chip cookies) to purchase the items to sell in their stores.

Dewey and Dakin presented a graph like the one shown below. The graph shows wholesale prices of goods in the United States in terms of a wholesale price index (WPI). The dashed line traces out the 54-year cycle that Dewey and Dakin describe.



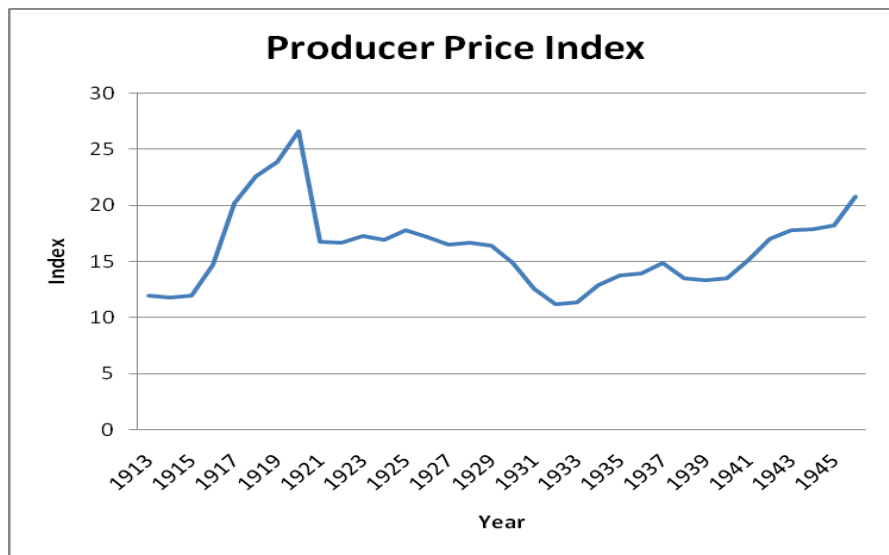
1. According to the graph, in what years do there appear to be *peaks*, or relative maximum values in the wholesale prices?
2. In what years do there appear to be *valleys*, or relative minimum values?
3. If there is a 54-year cycle between peaks and valleys, in what years should the next few maximum and minimum points occur?

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In 1978, the U.S. Bureau of Labor Statistics (BLS) reclassified the WPI that Dewey and Dakin used into the Producer Price Index (PPI). In 1982, the BLS reset the benchmark for the PPI to 100.0 for the annual value of the PPI. As a result, historical data had to be recalibrated to be used for comparisons over time.

4. The graph shows the PPI as it was recalibrated using an index of 100.0 to represent the value for 1982. How does this graph compare to the one used by Dewey and Dakin for their 1947 book?



5. The table at the right contains data from the BLS describing the commodity prices as measured by the PPI for certain years since 1940 (1982 = 100). Make a line graph of the PPI by year.

Year	PPI
1940	13.5
1944	17.9
1948	27.7
1952	29.6
1956	30.3
1960	31.7
1964	31.6
1968	34.2
1972	39.8

Year	PPI
1976	61.1
1980	89.8
1984	103.7
1988	106.9
1992	117.2
1996	127.7
2000	132.7
2004	146.7
2008	189.7

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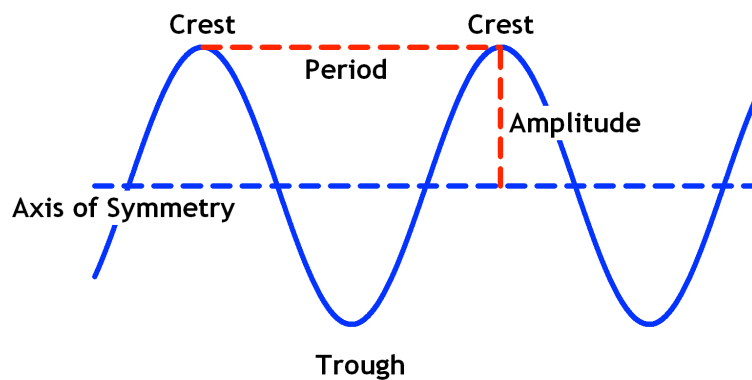
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6. Compare your scatterplot to the 54-year cycle described by Dewey and Dakin. Is there a maximum value where the Dewey and Dakin model predicts there to be one? Why or why not?

Is there a minimum value where the Dewey and Dakin model predicts there to be one? Why or why not?

7. Does the trend in your scatterplot reveal the cyclical pattern Dewey and Dakin described in 1947?

Businesses use other cyclical models to describe seasonal phenomena. They refer to key attributes in cyclical models as shown below.



The *crest* is the maximum height of a wave, and the *trough* is the minimum height of a wave. The *period* is the distance between two consecutive crests or two consecutive troughs. The *axis of symmetry* is a horizontal line that runs exactly halfway between the crests and troughs. The *amplitude* is the distance between a crest or trough and the axis of symmetry.

8. Suppose that a particular business owner has determined that the function

$$y = 200 \sin(0.524(x + 3.139)) + 400$$

can be used to determine the number of employees ( $y$ ) that he requires for month  $x$ , where  $x = 1$  corresponds to January 1.

Use your calculator to graph this function. Sketch your graph using the horizontal values from 1 to 12 and vertical values from 0 to 700.

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9. **EXTENSION:** Recall that sine functions can be represented using the general form  $y = A\sin(B(x - C)) + D$ , where

- $A$  represents the amplitude,
- $B$  represents the angular frequency,
- $C$  represents a factor of a horizontal translation, and
- $D$  represents the vertical translation.

For this function, determine the values of  $A$ ,  $B$ ,  $C$ , and  $D$ .

$A =$

$B =$

$C =$

$D =$

10. Find the length of one cycle by dividing  $2\pi$  by the frequency ( $B$ ).
11. What is the vertical translation? Graph the line  $y = D$  on your graphing calculator.
12. Determine the maximum and minimum values for number of employees. In what months do they occur?
13. How does the amplitude, combined with the vertical translation, describe the variation in number of employees needed for any given month?
14. When would you expect the next maximum value in the cycle to occur?
15. Change your viewing window so that you can see two full cycles of the graph, and determine the next maximum value. How does this compare with your prediction?
16. Suppose the economic conditions change, and the business owner needs between 300 and 900 employees during the seasonal cycle. Which parameters should change? What should the new numbers be?
17. **REFLECTION:** What other types of employment might be cyclical in nature?