Calculating the Candy Price Index: A Classroom Inflation Experiment

July 27, 2002

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Support for this work was provided by the National Science Foundation's Course, Curriculum and Laboratory Improvement Program under grant DUE-9950688. Denise Hazlett is grateful to Jim Shepherd of Whitman College for letting her run this experiment in his class, and to the following people for beta-testing the experiment: Michael Haupert of the University of Wisconsin-LaCrosse, Gail Heyne Hafer of St. Louis Community College at Meramec, Melissa Binder of the University of New Mexico, Helen Roberts of the University of Illinois at Chicago, Anthony Becker of St. Olaf College, and Earl Adams of Allegheny College.

Abstract

In this classroom experiment, students develop a price index based on candy-purchasing decisions made by members of their class. They use their index to practice calculating inflation rates and to consider the strengths and weaknesses of the Consumer Price Index (CPI). Instructors can use the experiment as an introduction to the topic of inflation and how we measure it. The exercise also provides a concrete example of the sources of bias in the CPI, promoting discussion of the measures the Bureau of Labor Statistics has taken recently to reduce bias. The experiment, including follow-up discussion, fits into a 50 minute class period. The authors and other professors have used the exercise in their introductory and intermediate macroeconomics courses, in classes of 10 to 135 students.

Introduction

Inflation plays a central role in economic policymaking, as well as influencing decisions made by individuals. Consumers, economists, and policymakers commonly use the Consumer Price Index (CPI) as a measure of inflation. However, critics such as the 1996 Boskin Commission have suggested that several sources of bias in the CPI cause it to overestimate changes in the cost of living. This classroom experiment has students develop a simple price index in order to explore the strengths and weaknesses of the CPI. The experiment gives students a concrete example of how a price index like the CPI measures inflation. The exercise also makes clear the distinction between the level of a variable (the CPI) and the rate of change in the variable (the inflation rate), two concepts students often confuse. Finally, the experiment actively promotes consideration of the sources of bias in the CPI, including the substitution, new product, and quality biases. Follow-up discussion includes how the Bureau of Labor Statistics has changed the CPI to address recent criticisms.

Print-outs of all of the materials for running the exercise, as well as follow-up discussion questions, can be accessed online by going to http://people.whitman.edu/~hazlett/econ/.

Description of the Experiment

Students develop a Candy Price Index by purchasing three kinds of candy brought to class by the instructor: Hershey's Kisses, miniature Reeses Peanut Butter Cups, and individually wrapped Lifesavers. The instructor gives each student thirty cents in credit with which to purchase the candy at specified prices. The exercise consists of seven periods. In the initial period, each type of candy costs five cents. This period serves as the base for calculating the Candy Price Index. The prices change over the course of the six subsequent periods. Given the prices and the thirty cents they can spend each period, students fill in information sheets to indicate their desired purchases in each of the periods. In the last two periods, a new product, miniature Snickers bars, also becomes available for purchase. The instructions and information sheet appear in Appendix A.

Before students make their choices, the instructor announces that students will actually receive the candy from only one period's purchases. That one period will be randomly selected by a die roll at the end of the experiment. Knowing that they will receive candy for only one period's purchases forces students to consider each period as if it stood alone. Otherwise, a student who, for instance, bought mainly Reeses in the first few periods could become tired of buying Reeses and switch to Lifesavers simply for variety.

Calculating the Candy Price Index

After students have marked their desired purchases for all seven periods, the class uses the base period purchases to establish the fixed-weight basket for calculating the Candy Price Index. As a group, the class roughly estimates what a typical student purchased in the base period. This estimate relies on a show of hands in response to a series of questions from the instructor: "How many students bought six Reeses? How many students bought five Reeses?" and so forth. Based on a quick series of such questions, the class comes to an agreement about what constitutes a typical student's purchases.

From our experience, a typical student basket seems to be weighted fairly heavily towards Reeses, for instance, 3 Reeses, 2 Kisses, and 1 Lifesaver.

Students next calculate the Candy Price Index in each of the seven periods, and the inflation rate between each consecutive pair of periods. See Appendix A for the worksheet assigning these calculations. The instructor should ask students to bring a calculator if the students will work these problems in class.

The worksheet leads students through calculating the cost of the basket in the base period. It then presents the formula for the Candy Price Index: 100 times the cost of the basket in the current period, divided by the cost of the basket in the base period. Instructors may want to demonstrate how to calculate the Candy Price Index, especially for classes doing this exercise as an introduction to inflation measurement. In Appendix B we provide an example of the Candy Price Index calculation, for the instructor's reference. Instructors should emphasize here that in every one of the Candy Price Index calculations, the quantities remain constant. That is, students must always use the quantities of candy from the basket established in the base period. Students then work their assigned problems, possibly in small groups during class so that the instructor can immediately follow up with a discussion. After students finish their worksheets, the instructor rolls the die and distributes the candy purchased during the period selected by the die.

We have found that some students confuse the CPI with the inflation rate. That is, they confuse the concepts of price level and percentage change in the price level. To help reduce this confusion, we suggest preceding the experiment with some brief information about recent levels of the CPI in the United States. For example, the instructor could note that the CPI was 177.1 in January 2002, 175.1 in January 2001, and that the change in the CPI was 1.1 percent over this 12 month period. This information gives students an idea of what the CPI looks like, as well as the distinction between the CPI and the inflation rate.

When they reach the point of calculating the Candy Price Index in Periods 5 and 6, students will almost certainly ask how they should deal with the introduction of the Snickers bars. The instructor then points out that new products enter the basket only after a new set of surveys is conducted. The Candy Price Index in Periods 5 and 6 uses the old survey, which established the basket in the base period when Snickers did not exist. So, the Candy Price Index initially ignores the introduction of new products, just as the CPI does.

Because prices sometimes decline between periods, students will most likely calculate a negative inflation rate at some point. For example, consider a base period basket containing 3 Reeses, 2 Kisses, and 1 Lifesaver. The Candy Price Index and inflation rates for this basket are shown in Table 1. With Reeses weighted so heavily in the basket, the fall in the price of Reeses between Periods 1 and 2 produces a 22 percent decline in the price level. Thus, this exercise also provides fodder for a discussion of deflation.

TABLE 1: Candy Price Index and Inflation Rates for a Basket of 3 Reeses, 2 Kisses, and 1 Lifesaver

Period	Candy Price Index	Inflation Rate (%)
Base	100	NA
1	150	50
2	117	-22
3	133	14
4	150	13
5	167	11
6	183	10

Note that the Candy Price Index recorded in Table 1 changes between every period. This result comes from having a basket that contains unequal quantities of each of the three items. In contrast, a basket that contained equal quantities (2 Reeses, 2 Kisses, and 2 Lifesavers) would have a Candy Price Index that changed only between Periods 0 and 1 (when the price of one item becomes 10 cents) and between Periods 3 and 4 (when the prices of two items become 10 cents). The Candy Price Index and associated inflation

rates for this basket of equal quantities are shown in Table 2. These results would produce a less interesting discussion than do the results from the unequal basket shown in Table 1. Fortunately, when faced with the choice of Reeses, Kisses, and Lifesavers, students as a group do seem to generate a basket in which no two quantities are the same.

TABLE 2: Candy Price Index and Inflation Rates for a Basket of 2 Reeses, 2 Kisses, and 2 Lifesavers

Period	Candy Price Index	Inflation Rate (%)
Base	100	NA
1	133	33
2	133	0
3	133	0
4	167	25
5	167	0
6	167	0

Discussion

Class discussion covers the substitution, new product, and quality biases in the CPI. See Appendix C for a set of follow-up discussion questions regarding these biases. The 1996 Boskin Commission, charged to study the effect of these biases, concluded that the Consumer Price Index overestimated cost-of-living changes by about 1.1 percent per year because of the biases. So, if the CPI measured inflation to be 3.3 percent, the Boskin Commission findings suggested that the inflation rate absent the biases would be approximately 2.2 percent. The Bureau of Labor Statistics (BLS) has since taken measures to reduce these biases.[1] Reducing the biases in the CPI provides policymakers and the public with better information about inflation. Moreover, a more accurate CPI generates less expensive cost-of-living adjustments in social security payments and government pensions. Finally, the more accurate CPI produces smaller adjustments in tax brackets, generating more government tax revenue.

[1] Information on the Boskin Commission and BLS responses comes from the BLS (1997) report "Measurement Issues in the Consumer Price Index" available from the BLS web cite.

Substitution Bias

The last question on the worksheet leads to a discussion of the substitution bias by asking students to consider how the price changes in the experiment affected individual consumers. The substitution bias exists when a fixed-basket price index overestimates the effects of inflation by neglecting the fact that consumers sometimes substitute away from items that have become relatively more expensive, without suffering much loss in utility. Thus, maintaining a constant standard of living would not require spending the full cost of the basket. Before recent changes (discussed later in this article) reduced the bias estimate, the Boskin Commission had estimated the substitution bias at 0.4 percent per year.

As an example of the substitution bias, consider the price changes between Periods 4 and 5. Using the basket of 3 Reeses, 2 Kisses, and 1 Lifesaver, the inflation rate would be 11 percent, as shown in Table 1. However, with the price of Kisses going down while the price of Reeses goes up, many students simply switch to Kisses without suffering much loss in welfare. Thus, for most of the consumers in our experiment, the cost of maintaining their standard of living does not rise by 11 percent.

Of course, in this case true peanut-butter lovers cannot find a cheap substitute for their candy of choice. So for them, the index does not overestimate the welfare effect of the rise in the price of Reeses. In fact, because they like Reeses so much, for them the Candy Price Index could well underestimate the welfare effect of a rise in the price of Reeses.

Similarly, those who dislike chocolate can find no adequate substitute when Lifesavers go up in price, as they do in Period 2. The person who wants only Lifesavers sees a higher cost of living. However, the simultaneous fall in the price of Reeses pulls the price level down between Periods 1 and 2. Thus, for the typical consumer, maintaining one's standard of living becomes cheaper. The Lifesavers fan resembles a person living

during a period of generally declining prices who spends a large proportion of his budget on a particular item, such as medicine, that rises in price.

Interestingly enough, we also had some students who exhibited complete flexibility in their preferences. These "I'm starving and I just need something to put in my stomach" students would simply buy as much as possible of the cheapest type of candy. For them, the amount rather than the type of candy mattered. (In fact, these students actually wanted to see inside the bags of candy for proof that these were not hypothetical purchases.) These students could maintain a constant standard of living by buying whatever candy cost five cents. So for them, the Candy Price Index displayed a significant substitution bias. Thus, the experiment shows that the relative price changes aggregated in the CPI affect consumers differently, depending on the flexibility of their preferences.

At this point in the discussion, students will wonder how the government's inflation calculations deal with the issue of substitution. So, the instructor explains how the Bureau of Labor Statistics recently revised its method of calculating the CPI to reduce the substitution bias.[2] Since January 1999, the BLS has assumed that consumers do in fact make substitutions at the level of product categories, such as apples. The BLS assumes that consumers maintain constant expenditures on apples, but substitute between types of apples. Consumers would buy, for instance, 20 percent more golden delicious apples when their price falls by 20 percent, and 15 percent fewer Granny Smiths when their price rises by 15 percent. In contrast, the pre-1999 method assumed that consumers bought the same quantity of golden delicious and Granny Smiths regardless of how the relative prices changed. The BLS estimates that this changed treatment of expenditures within product categories trims the annual CPI by about 0.2 percent.

[2] For details, see Wallace and Motley (1999). We recommend having students read this three-page article for background information.

New Product and Quality Bias

New product bias occurs when the CPI does not adequately account for the value to consumers of newly available goods and services. Quality bias comes from the failure to adequately account for changes in the quality of goods and services. Together, they produced a 0.6 percent annual bias in the CPI, according to the Boskin Commission.[3] The BLS counters the claim about quality bias by noting that they do adjust the CPI for quality changes. In fact, such adjustments in 1995 "amounted to 1.7 percentage points over the course of a single year." (1997, 5) To reduce the bias that comes from ignoring new products, the BLS now revises the CPI basket every two years rather than every ten years.

To introduce the concept of new product bias, the instructor asks students to consider their purchases in Periods 5 and 6, when they suddenly had the additional option of buying the miniature Snickers bar. Several of our students purchased this new item, and many more purchased it once its price fell to 10 cents in Period 6, from 15 cents in Period 5. However, the Snickers bars did not exist in the base period when the survey was conducted. Snickers therefore did not make it into the basket, and so do not show up in the Candy Price Index. Thus, calculations of the inflation rate ignore the price of this new candy. In particular, the Candy Price Index ignores the fact that the fall in the price of Snickers in Period 6 potentially offsets some of the simultaneous rise in the price of Kisses. The Snickers bar resembles a technological innovation such as the cell phone, which did not enter the CPI until 1998. (Motley 1997, 3) By ignoring the falling price of cell phones throughout most of the 1990s, the CPI overestimated inflation. Students find the Snickers analogy helpful in illustrating the new product bias.

To introduce quality bias, the instructor notes that when examining a change in the price of a particular type of candy, the class assumed that the quality of the candy remained constant. Examples of changes in the candy quality could include changes in the inputs

or even changes in the size of the product. The instructor asks the class to suppose that as Lifesavers doubled in price between Periods 3 and 4, they also doubled in size. Then, the instructor asks how students could adjust for this quality change in order to provide an accurate measure of inflation between these two periods. In response, students would note that the price per ounce of Lifesavers stayed constant. With the prices of Kisses and Reeses unchanged between Periods 3 and 4, an adjusted measure would show zero inflation.

For a more typical example of the quality bias, the instructor could ask students to suppose that the quality of chocolate in the Kisses vastly improved between Periods 2 and 3, at the same time that the price doubled. Then, the class could discuss the difficulty of measuring subjective changes in quality and incorporating them into the CPI. As an example of the difficulty of adjusting for quality changes, see Schwartz and Scafidi's (2001) estimates of quality-adjusted net price indices for college education. These quality changes come from changes in college facilities, course offerings, and faculty. The BLS does not currently adjust the CPI for changes in the quality of college education. However, Schwartz and Scafidi's study was partially funded by the BLS, which might mean that the BLS will eventually begin making such adjustments.

Suggestions for More Advanced Students

Making the many calculations assigned on the worksheet will help beginning students understand how the CPI aggregates price changes. However, students who are already familiar with the CPI and inflation measurement may need less practice with these calculations. We suggest having these more advanced students work in small groups, with each making only two of the Candy Price Index calculations, plus one inflation rate calculation from the worksheet. Then, the groups report their results to the class as a whole, so that everyone can refer to this information during the following discussion.

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[3] The Boskin Commission's 1.1 percent estimate also includes an outlet bias component. They estimate that the CPI exaggerates inflation by 0.1 percent per year because the BLS underestimates the amount of

Suggestions to Reduce Candy Expense

Even with a die roll selecting only one period for actual purchases, the instructor might still find the candy expense too great. To reduce the cost, we recommend that the instructor have the die roll select only among periods 1-6, and not the base period. This restriction eliminates the possibility of having to distribute the large quantities purchased at the low base period prices. Offering students 20 cents in credit rather than 30 would also reduce the cost. However, instructors should not offer 25 cents, as this might force students to purchase a five cent item that they would not otherwise want, simply to spend their entire budget. An alternative way to reduce the candy expense would be to distribute the candy the following day. Then, the instructor brings to class only the candy students actually purchased, rather than the larger quantities necessary to cover any of the potential purchases in periods 1 through 6. Finally, the instructor could reduce costs by eliminating Snickers bars. The instructor could instead introduce the topic of new product bias in the follow-up discussion by asking students what *would* have happened if they had had the option of buying miniature Snickers bars in Periods 5 and 6. However, we strongly recommend using the version with Snickers, if possible.

Conclusion

In this exercise, students generate data that they then use to develop a simple fixed-weight price index. Their hands-on experience devising the index and using it to calculate and interpret inflation rates makes them more knowledgeable about how the Consumer Price Index aggregates price changes. Through a follow-up discussion, they become better-informed about the biases in the CPI, and about the measures that the Bureau of Labor Statistics has taken recently to reduce these biases.

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shopping consumers do at newly opened outlet stores.

References

Bureau of Labor Statistics. 1997. The experimental CPI using geometric means. http://stats.bls.gov/cpigmsum.htm.

Bureau of Labor Statistics. 1998. Future schedule for expenditure weight updates in the consumer price index. Dec. 18, http://stats.bls.gov/cpiupdt.htm.

Bureau of Labor Statistics. 2002. Get detailed statistics, http://data.bls.gov/cgi-bin/surveymost?cu.

Bureau of Labor Statistics. 1997. Measurement issues in the consumer price index. June, http://stats.bls.gov/cpigm697.htm.

Bureau of Labor Statistics. 1998. Planned changes in the consumer price index formula. April 16, http://stats.bls.gov/cpigm02.htm .

Motley, B. 1997. Bias in the CPI: "Roughly right or precisely wrong." Federal Reserve Bank of San Francisco's *Economic Letter*, Number 97-16, http://www.frbsf.org/econrsrch/wklyltr/el97-16.html.

Schwartz, A. E. and B. P. Scafidi. 2001. What's happened to the price of college? Quality-adjusted net price indices for four year colleges. Working paper, Wagner School of Public Service, New York University, and Andrew Young School of Policy Studies, Georgia State University.

Wallace, A. and B. Motley. 1999. A better CPI. Federal Reserve Bank of San Francisco's *Economic Letter*, Number 99-05, http://www.frbsf.org/econrsrch/wklyltr/wklyltr99/el99-05.html.

Appendix A: Instructions and Worksheet for the Candy Price Index Experiment

For <u>each</u> of the <u>seven</u> periods listed below you have $0.30 in credit to spend how you choose on any combination of the candies listed. The prices of the candies vary from period to period. Make your choices with regard to these prices, *spending no more or less than thirty cents in each period*. Note that in every period you have the option of buying Kisses, miniature Reeses and Lifesavers. However, in Periods 5 and 6, you also have the option of buying miniature Snickers bars. You should assume that the Snickers bars are not actually invented until Period 5. Please make your choices for all seven periods now.

*At the end of this experiment, I will roll a die to determine which **one** of the periods will actually provide candy.*

	Base Period	
Candy	Price	Amount of Candy
Kisses	5 cents	
Reeses	5 cents	
Lifesavers	5 cents	

	Period 1		Period 2	
Candy	Price	Amount	Price	Amount
Kisses	5 cents		5 cents	
Reeses	10 cents		5 cents	
Lifesavers	5 cents		10 cents	

	Period 3		Period 4	
Candy	Price	Amount	Price	Amount
Kisses	10 cents		10 cents	
Reeses	5 cents		5 cents	
Lifesavers	5 cents		10 cents	

	Period 5		Period 6	
Candy	Price	Amount	Price	Amount
Kisses	5 cents		10 cents	
Reeses	10 cents		10 cents	
Lifesavers	10 cents		5 cents	
Mini Snickers	15 cents		10 cents	

We will now determine as a class what amounts of candy a typical student bought in the base period. We use the term "basket" to refer to these base period amounts purchased by the typical consumer.

	Basket (from Base Period)	
Candy	Price	Amount of Candy
Kisses	5 cents	
Reeses	5 cents	
Lifesavers	5 cents	

The cost of the basket in the base period is
(# of Kisses × 5 cents) + (# of Reeses × 5 cents) + (# of Lifesavers × 5 cents)

Cost of the Basket in the Base Period = _____

You will now calculate the Candy Price Index (CaPI) for each of the periods in the experiment. You calculate the CaPI by taking the cost of the basket in the current period, dividing by the cost of the basket in the base period, and then multiplying by 100. (Remember to use only the amounts from the base period basket in your calculations, and not the amounts from your particular purchases!)

CaPI in the base period = _____ × 100 = _____

CaPI in Period1 = _____ × 100 = _____

CaPI in Period 2 = _____ × 100 = _____

CaPI in Period 3 = _____ × 100 = _____

CaPI in Period 4 = _____ × 100 = _____

CaPI in Period 5 = _____ × 100 = _____

CaPI in Period 6 = _____ × 100 = _____

You will now calculate inflation rates. To determine the inflation rate between one period and the next, you calculate the percentage change in the CaPI. A percentage change is the new value minus the old value divided by the old value. As a hypothetical example, suppose the CaPI increases from 120 in Period 3 to 150 in Period 4. Then, you would find the inflation rate between Periods 3 and 4 by taking (150-120)/120, which equals 0.25. Thus, prices rose on average by 25 percent in this example.

Inflation Rate Between Base Period and Period 1 = _____

Inflation Rate Between Period 1 and Period 2 = _____

Inflation Rate Between Period 2 and Period 3 = _____

Inflation Rate Between Period 3 and Period 4 = _____

Inflation Rate Between Period 4 and Period 5 = _____

Inflation Rate Between Period 5 and Period 6 = _____

Examine the ways in which **you** specifically were affected by the price changes in the various periods. How did your purchases and your satisfaction change as the prices changed? Does consumer inflation have different effects on people with different preferences?

Appendix B: Example Calculation of the Candy Price Index

Suppose the basket contains 3 Reeses, 2 Kisses, and 1 Lifesaver. The Candy Price Index is found by taking the cost of the basket at current prices, dividing by the cost of the basket at base period prices, and then multiplying this ratio by 100.

The cost of the basket at base period prices is 30 cents:
$(3 \times 5 \text{ cents}) + (2 \times 5 \text{ cents}) + (1 \times 5 \text{ cents})$.

The cost of the basket at current prices varies according to these changing prices.
For instance, in Period 4, the cost of the basket is
$(3 \times 5 \text{ cents}) + (2 \times 10 \text{ cents}) + (1 \times 10 \text{ cents}) = 45 \text{ cents}$.
Thus, the Candy Price Index in Period 4 is $(45 \text{ cents}/ 30 \text{ cents}) \times 100 = 150$.

Appendix C: Follow-up Discussion Questions

1. The substitution bias exists when a price index with a fixed basket overestimates the effects of inflation by neglecting the fact that consumers sometimes substitute away from items that have become relatively more expensive, without suffering much loss in utility. What types of individual preferences would lead to significant substitution bias? What types of individual preferences would lead to a much smaller substitution bias?

2. Between Periods 1 and 2, Lifesavers became more expensive, and Reeses became cheaper. For a typical student, what happens to the cost of maintaining a particular standard of living between Periods 1 and 2? Now consider an individual with atypical preferences. This student loves Lifesavers and dislikes Reeses. What happens to the cost of maintaining a particular standard of living for this person? How accurately does the Candy Price Index track the cost of living for this person?

3. The new product bias exists when a price index does not adequately account for the value to consumers of newly available goods and services. For instance, in our experiment Snickers bars did not become available until Period 5, and so they never appeared in the consumer basket used to measure inflation. How do you think the falling price of Snickers bars between Periods 5 and 6 *should* have affected the measurement of the inflation rate? How did it actually affect our measurement of the inflation rate?

4. The quality bias exists when a price index does not adequately account for changes in the quality of goods and services. Suppose that when Lifesavers doubled in price between Periods 3 and 4, they also doubled in size. How could we adjust for the change in Lifesavers so that the Candy Price Index provides an accurate measure of inflation between Periods 3 and 4? Suppose further that the quality of chocolate in the Kisses vastly improved between Periods 2 and 3, at the same time that the price of Kisses doubled. How difficult do you suppose it would be to measure this change in chocolate quality and incorporate the change into the Candy Price Index?

5. Consider the percentage change in the Candy Price Index between Periods 3 and 4. How would wages have to have changed on average between Periods 3 and 4 for consumers' purchasing power to have stayed constant? If the prices of all of the goods had increased to 10 cents in Period 4, how would wages have to have changed on average between Periods 3 and 4 for consumers' purchasing power to have stayed constant?

6. The Bureau of Labor Statistics provides detailed information about the Consumer Price Index (CPI) and general categories contained within the CPI at www.bls.gov/cpi/. From this web site, go to "Get Detailed Statistics" and look at "All Urban Consumers (Current Series)". Examine the "All Items CPI" and the "Medical Care Services" category of the CPI for the period of September through December of 2001. By what percentage do average consumer prices change over this period, according to the "All Items CPI"? By what percentage does the cost of medical care services change over this same period? Describe the accuracy with which the "All Items CPI" tracks the cost of living for an individual who spends a large proportion of his or her income on medical services.