Macroeconomics: an Introduction

Chapter 4

The Cost of Living And Living With Inflation

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Outline

Preview

Jane heard the good news on the first work day of 1999: she was receiving a raise of $4,000. This brought her annual salary to $44,000, up 10% from $40,000 in 1998. Her boss congratulated her on a job well done. Now it is the end of 1999 and Jane is wondering how well she *really* did during the past year and how big that raise *really* was. Jane's salary rose by 10%, but how much did her standard of living change?

The answer depends on what happened to her cost of living during 1999. That is what it cost her to buy the market basket of goods and services that she typically purchases. If her cost of living rose by less than 10%, then the purchasing power of Jane's salary rose and her standard of living improved. But if her cost of living rose by more than 10%, then her standard of living fell in spite of that raise.

In fact, if Jane represents a typical American household her cost of living actually rose by a about 2% during 1999. So the good news is that Jane did get a raise, but the bad news it that it was less than 10%. Inflation occurs when the cost of living rises persistently. Because inflation is a fact of modern life, it is important to understand how the cost of living is measured and how to use that information to adjust salaries and other dollar values in order to see them in terms of their purchasing power. We will also learn how to adjust interest rates to reveal the real rate of interest.

4.1 The Consumer Price Index

It would be too expensive to keep track of the cost of living for every household, so the U.S. Department of Labor's Bureau of Labor Statistics estimates the cost of living for a representative American household. The result is the Consumer Price Index, usually abbreviated CPI.

The CPI is an index because the cost of living is not expressed in dollars but rather as a percentage of what the market basket cost in a base period. An index is a measure of relative magnitude rather than absolute amount and therefore is expressed as a percentage rather than in units of measure like dollars or meters or tons. It makes sense to express the cost of living as an index because what we want to know is whether the cost of living rose, and by what percentage.

The amount spent by an actual household will depend on factors such as family size, income, age, and other characteristics that vary widely from one family to another. A large and affluent family will have a larger and more expensive market basket than a small family of modest income. The mixture of items in the market basket will also vary from family to family according to individual tastes. However there is enough similarity in buying habits and in movements in prices that percentage changes in the CPI give a useful indication of percentage changes in the cost of living for most households.

How the CPI Is Constructed

Here is how the CPI is calculated. The Bureau of Labor Statistics (often abbreviated BLS) has constructed a representative market basket that includes almost all of the items purchased by a typical American family: food, energy, housing, entertainment, travel, medical services, and so forth. The amount of each item in the CPI market basket is based on a study of the actual spending patterns of urban American households during the base period 1982-84. The BLS employs sample shoppers who actually go into stores monthly in cities all over the U.S. and record the prices of items on their list: hamburger @ $2.05/lb., head of lettuce @ $1.10, and so on for thousands of items.

From this mountain of data the BLS calculates the cost of the representative market basket for that month. The CPI for a given month is the cost of the market in that month as a percentage of the cost of the market basket in the base period. It is announced a couple of weeks after the end of the month.

For example, the CPI for June 1999 was 166.2%. The BLS got that number by making the calculation:

$$\text{CPI for June 1999} = \frac{\text{Cost of Basket in June 1999}}{\text{Cost of Basket in 1982-84}} \bullet 100\% = 166.2\%$$

This means that the market basket of the representative consumer cost 66.2% more in June 1999 than it had in the base period 1982-84.

Economists also use the term price level to refer to the cost of living, so one might read in an article on the business page that "the price level rose more than 66% from 1983 to 1999." The BLS has also reconstructed the value of the CPI for years prior to the base period, so we can also use the CPI to compare the cost of living in 1990 with what it was in 1970.

The base period is updated occasionally to reflect the changing composition of the representative market basket. The quantities of items in the market basket change over time because of changes in tastes, because consumers will respond to changes in relative prices, and because new products are introduced. The previous base period was 1967. The 1982-84 market basket reflects not only changes in buying patterns since 1967 but also added products to the market basket that simply did not exist in 1967. Clearly, the 1982-84 market basket is now woefully out of date.

Now let's get back to Jane's salary and the question: did her standard of living increase in 1999? The CPI was 166.2 in June 1999, while it had been 163.0 a year earlier. The cost of living for the typical family therefore rose in percentage terms by:

CPI Percent Change in 1999 = (166.2-163)/163) = .02 = 2%.

We could have used averages of the CPI for each year, or year-end readings to make this comparison, but there would be little difference in the result. This is the best estimate we have of the increase in Jane's cost of living during 1999.

It is obvious now that Jane's standard of living did rise, because her salary increased faster (10%) than did the cost of living (2.9%).

Biases in the CPI

It is generally acknowledged that the CPI overstates the amount by which the cost of living has risen. One source of bias is that changes in relative prices among goods will induce consumers to alter their spending decisions. For example, if the price of oranges doubles because of a freeze in California, consumers will not buy the same quantity as before, but rather will substitute other fruits like grapefruit from Florida. The ability of consumers to substitute away from goods whose prices rise the most means that their standard of living does not fall as much as the CPI , based on a fixed market basket, implies.

Second, new products are constantly being introduced which tend to be superior to the products they replace. Prices of new product tend to fall as producers realize economies of scale and because these tend to benefit the most from technological change. The market basket of 1982-84 did not include many of the electronic products, such as PCs, CD and DVD players, and cellular phones that have seen the rapid price declines.

Third, the CPI does not fully capture the improvements in quality that result from technological advances. Many of these have been dramatic. While the cost of a hospital room per night has risen sharply in recent years, that change overstates the increase in the cost of hospital services. New surgical techniques are often far safer with much more rapid recovery, so the patient stays fewer nights. The BLS does make some adjustments for quality changes, but is unable to fully capture all of them.

The combination of all of these factors is an upward bias in the measured rate of inflation that economists estimate at about one percentage point on an annualized basis. Efforts are already being made to reduce the bias from the latter two sources, and we can expect a new base period to be established in the near future.

Exercises 4.1

A. Construct a market basket for a typical undergraduate. What will be the main differences between it and the market basket for the Jones family of four?

B. If the BLS were to construct a new base-period market basket today, what important changes would you expect to see in it compared to the 1982-84 market basket?

C. The BLS attempts to adjust prices for changes in quality. Give an example of a product whose quality has changed significantly in the last decade. What effect has this quality change had on the CPI if it has not been adequately recognized by the BLS? Did your product exist in the base period?

D. At the end of this chapter you will find a table showing supermarket prices advertised in The Seattle Times on January 29, 1948 and the prices of the same items in 1993. Choose quantities of these items to make up a family market basket. Price this basket at 1948 prices and at the 1993 prices provided or your own supermarket survey of prices today. Which items have risen the most in price? Which the least? What is the value for 1993, or now, of this "supermarket price index" using 1948 as the base year?

4.2 Jane's Real Income

To see just how much Jane's standard of living rose in 1999 we use the concept of real income which is the purchasing power of Jane's income. How much more goods and services did Jane's 1999 income buy than her 1998 income?

If the only good in Jane's market basket were coconuts then the purchasing power of Jane's income would simply be the number of coconuts that her income can buy, which is her salary divided by the price of coconuts. In a complex economy with many goods and services we can think of the purchasing power of Jane's income as how many "market baskets" it can buy. Of course we do not know what is in Jane's actual market basket or its exact cost, but we can use the CPI as an index of the cost of a representative market basket.

Calculating Real Income

This suggests that to find out what Jane's real income was in 1999 we divide her salary by the CPI. Taking the mid-year the CPI of 163% for 1998, we divide her 1998 income of $40,000 by 1.63 and we get

Jane's 1998 real income = $40,000/1.63 = $24,540

Making the same calculation for 1999, using the June CPI of 166.2%, we have

Jane's 1999 real income = $44,000/1.662 = $26,474

Notice that we express real income as a dollar amount, but what sort of dollars are they? Certainly they are not the dollars Jane received in 1998 or 1999; the amounts are far smaller. These are dollars that have the purchasing power that a dollar had in the 1982-84 base period. That is because we have *deflated* the dollars she was paid in 1998 and 1999 by the increase in the cost of the market basket since the base period. Such dollars are called constant dollars of the base period. The dollars Jane was actually paid are called current dollars. When economists wish to distinguish clearly between current dollar amounts and constant dollar amounts they refer to current dollar amounts as *nominal*. What we have done here, then, is deflate Jane's nominal income by the CPI to get her real income in constant dollars of 1982-84.

Now we calculate the change in Jane's real income from 1995 to 1996 as follows:

$$\text{Percentage Change in Real Income} = \frac{(\$26{,}474-\$24{,}540)}{\$24{,}540} \bullet 100\% = 7.9\%$$

We have shown that the net result of her raise and inflation was an increase of 7.9% in real income.

A Useful Approximation

Notice that the 7.9% change in Jane's real income is roughly, but not exactly, the 10% change in her nominal income *minus* the 2% change in the CPI, since 10% - 2% = 8%. This suggests a short cut approximation to calculating rates of change in real amounts, namely

% Change in Real Income *equals*
% Change in Nominal Income *minus* % Change in the CPI

The reason why this approximation works can be seen from the relation between Jane's incomes in nominal and real terms. Her 1999 nominal income can be expressed as:

$$(\text{1999 nominal income}) = (\text{1999 real income}) \bullet (\text{1999 CPI}/100)$$

But the 1999 amounts are just the 1998 amounts incremented by the fractional increases that occurred during 1999, so

$$(\text{1999 nominal income}) = (\text{1998 nominal income}) \bullet (1.10)$$

and

$$(\text{1999 real income}) = (\text{1998 real income}) \bullet (1.079)$$

and, finally,

$$(1999\ \text{CPI}/100) = (1998\ \text{CPI}/100)\bullet(1.02).$$

Using the equivalent amounts to replace the 1999 amounts in the first equation we obtain the following relationship between nominal income, real income, and the CPI:

$$(\text{'98 nominal income})\bullet(1.10) =$$
$$[(\text{'98 real income})\bullet(1.079)]\bullet[(\text{'98 CPI}/100)\bullet(1.02)]$$

Now, divide the left hand side of this equation by 1998 nominal income and the right had side by its equivalent, ('98 real income)•('98 CPI/100), and what we have remaining is 1.10 = (1.079) • (1.02). Notice that (1.079) • (1.02) is

$$(1+.079) \bullet (1+.02) = 1+(.079+.02) + .0016 = 1 + \text{sum} + \text{cross-product}$$

Since the cross product of .079 times .02 is very tiny, the sum of .079 plus .02 is very close to the exact answer, .099 verses .10.

This is why the 10% change in nominal income is approximately the *sum* of the 7.9% change in real income and the 2% change in the CPI. Equivalently, the 7.9% change in real income is *approximately* the 10% change in nominal income *minus* the 2% change in the CPI.

This approximation works well only for small changes since only then is the cross-product small, being a small fraction of a small fraction. For very large changes the cross product will not be small (try a 50% change in the CPI along with a 70% change in nominal income!). But the formula is fine for calculating real changes in the low inflation environment found in most countries today if the time period is not too long. It comes in very handy because we all need to compute real changes in many economic variables in our lives besides income, for example the real change in the value of a stock, or the size of the federal budget, or that tuition bill.

Exercises 4.2

A. During summer vacation in 1998 George delivered pizzas for $5.50 an hour. When he went back to see if the job was open for the summer of 1999 his employer told George that because he had done such a great job the previous summer, his hourly wage would go up $.16 an hour if he would come back. What was the percentage change in George's real wage from 1998 to 1999? Show that there are two ways to calculate this change. Should George feel that his employer had paid him a big compliment?

B. The national minimum wage was $3.35 per hour in 1996 and had not changed for several years. Was the minimum wage constant? How much did the minimum wage change in 1996?

C. A portfolio of stocks that cost $10,000 at the beginning of 1993 was worth $11,044 at the end of the year. During that year the CPI rose from 141.9% to 145.8%. Calculate the amount by which the real value of this portfolio changed during 1993 by two methods. Why do you get slightly different answers?

D. Consider the situation where there are three variables, say y, x, and z, and they are linked by the relation $y = x \bullet z$. Show that for small changes it is approximately true that

$$\% \text{ change in } y = \% \text{ change in } x + \% \text{ change in } z$$

4.3 Inflation: the American Experience

Inflation, we have learned, is a continuing increase in the cost of living which we measure using the Consumer Price Index. When we look at the chart of the CPI since 1952 in Figure 4.1, we see that inflation has been a feature of American life for the past half century. We start in 1952 because war-time price controls and their removal distort the data during the WWII and Korean War. The CPI has increased steadily since, never declining for more than a month or two and them by a small amount. The CPI is 100 in 1983, the mid-point of the base period, and all changes are relative to that benchmark. Values before that date were reconstructed by the BLS for purposes of historical comparison.

From a level of 26 in 1952 the level of prices has increased seven fold to 180 in 2002. This means that a basket of goods that cost $26 in 1952 was priced at $100 by 1983 and by 2002 the cost had escalated to $180. This also tells us that a salary of $18,000 in 1999 was equivalent in purchasing power to a salary of $10,000 in 1983, but it took only $2,600 to have the same purchasing power in 1952. Why has inflation been so severe during the past three decades? That is subject of Chapters 7 through 9.

The rate of inflation is the percentage change in the price index expressed at an annual rate. In Figure 4.2 we chart the inflation rate as the percent change in the CPI from the corresponding month a year earlier.

The period through 1966 was a period of low very inflation, averaging only about 1%. But then inflation rose in successive waves to a peak of over 14% by 1980. It subsided dramatically in the 1980s and by 1999 was down to only about 2%. How this roller coaster ride occurred, and whether we need be concerned that it may continue in the future, are important questions to keep in mind as we move through the book.

Figure 4.1:

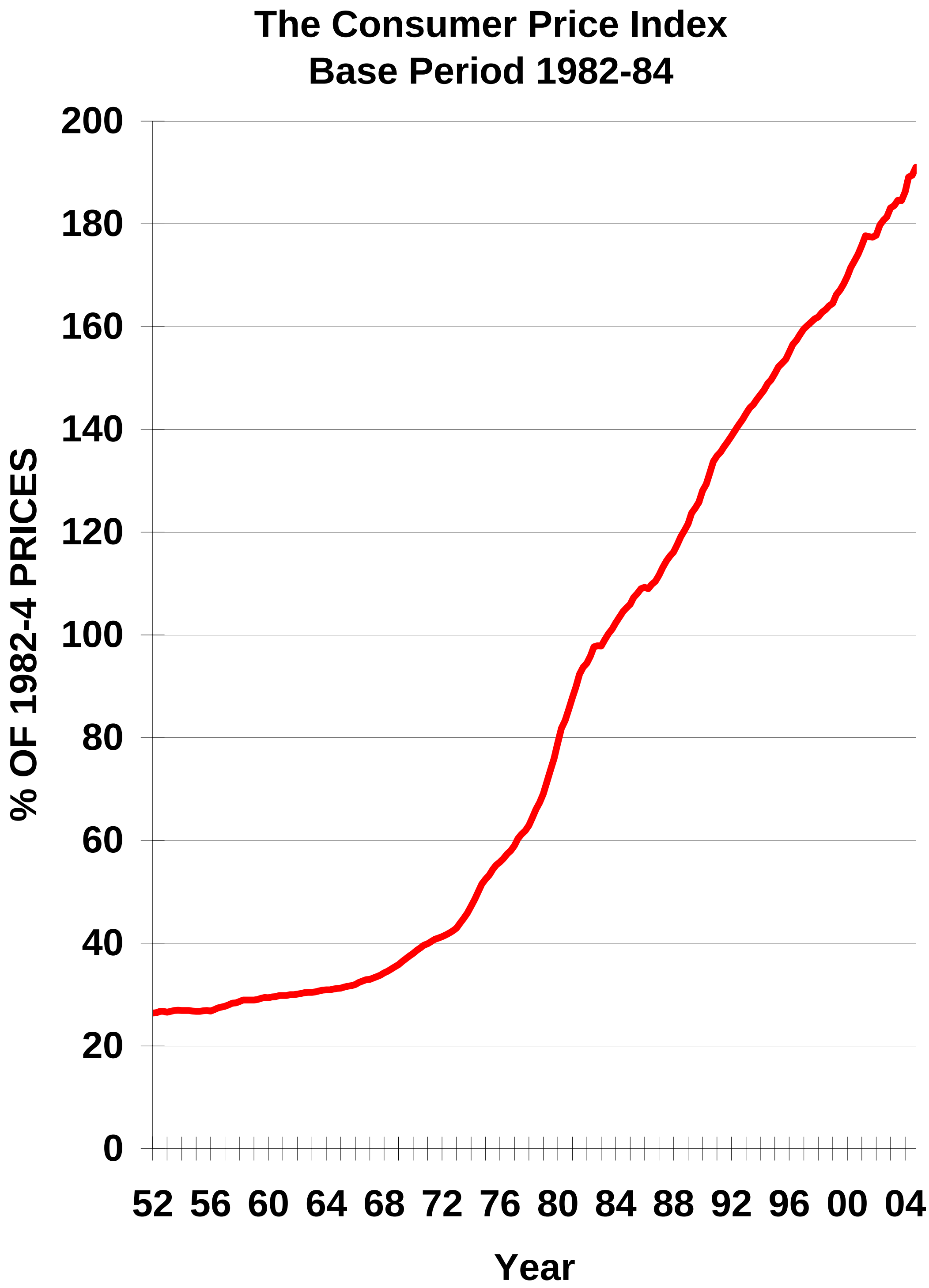
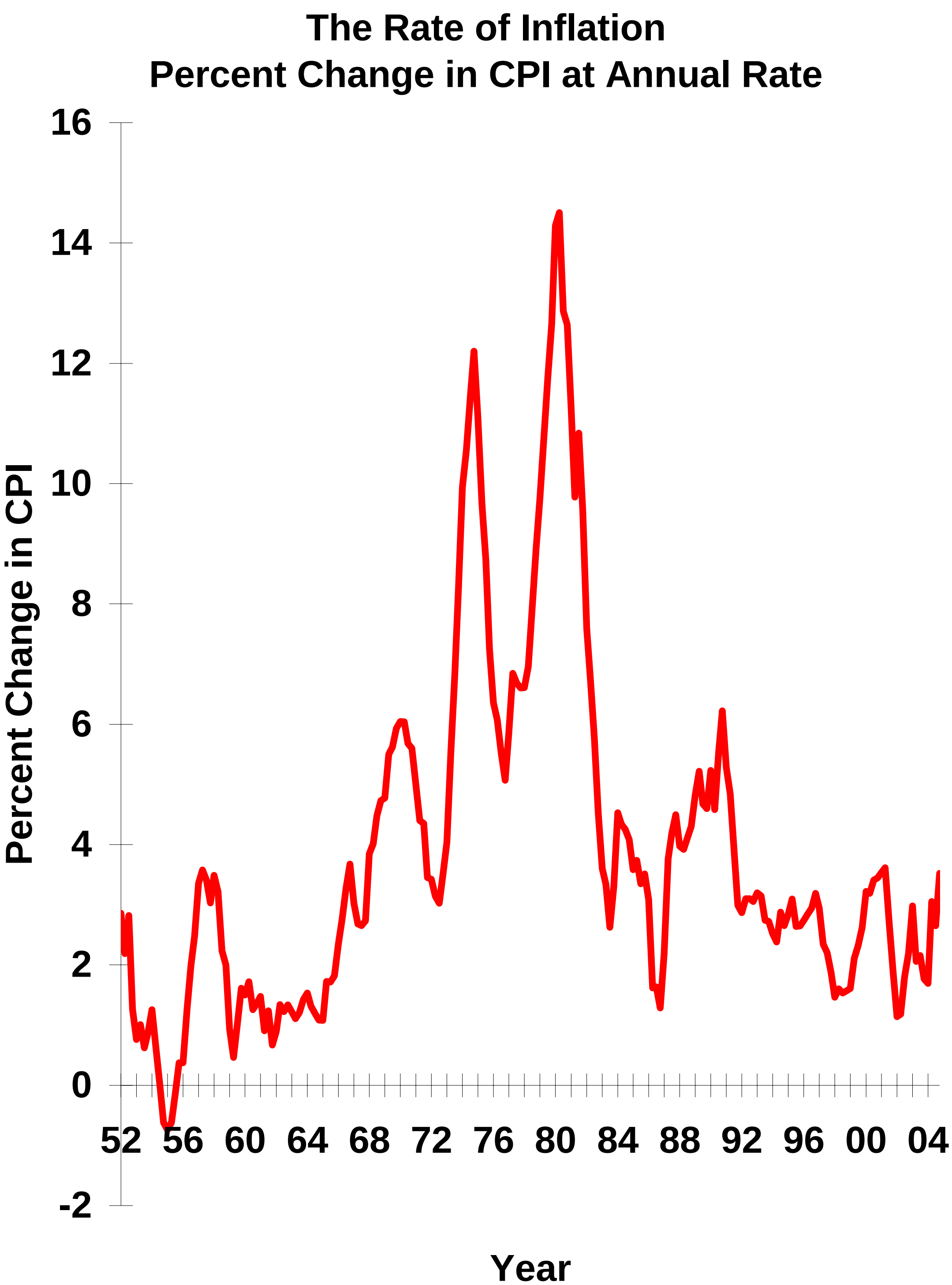

The Consumer Price Index
Base Period 1982-84
200
180
160
140
120
100
80
60
40
20
0
% OF 1982-4 PRICES
52 56 60 64 68 72 76 80 84 88 92 96 00 04
Year

Figure 4.2:



The Rate of Inflation
Percent Change in CPI at Annual Rate
Percent Change in CPI
16
14
12
10
8
6
4
2
0
-2
52
56
60
64
68
72
76
80
84
88
92
96
00
04
Year

Inflation and Politics

Inflation became a hot political issue during the 1980 election in which President Carter ran for reelection against Ronald Reagan. The surge in inflation during the Carter administration (1977-1980), along with the Iranian hostage crisis, put President Carter in a very vulnerable political position and contributed importantly to his defeat. Evidently, the American public does not like inflation.

The new Reagan administration advocated a vigorous anti-inflation policy, executed by the Federal Reserve Board under the chairmanship of Paul Volcker. Ironically, Volcker had been appointed by President Carter. We have seen that inflation declined sharply through the mid 1980's but was rebounding by the end of the decade.

A second anti-inflation program was then put into place by Volcker's successor Alan Greenspan who took over in 1986. By 1993 inflation had again subsided to levels not seen for three decades, and it has remained at low levels since.

The Purchasing Power of $1

As inflation pushes the cost of living upward, the purchasing power of a dollar, the amount of goods and services it buys, falls. The purchasing power of a dollar in terms of pizzas is 1 divided by the price of a pizza. If pizzas cost $5 in 1980 and $10 in 2000, then the purchasing power of $1 fell from .2 pizzas to .1 pizzas during that decade. Since we do not live by pizzas alone (though some come pretty close), a more meaningful measure of the purchasing power of the dollar would be $1 divided by the price of our whole market basket.

The CPI is not exactly the price of the market basket, but it is an index of the price of the market basket expressed relative to prices in the base period. We can therefore calculate an index of the purchasing power of the dollar as (100/CPI)•100%. This makes sense because the CPI is 100 in the base period, so our index of purchasing power will be 100% in the base period. Otherwise, it gives us the purchasing power of $1 relative to what it was in the base period.

The purchasing power of the dollar is charted in Figure 4.3. Notice that the purchasing power is 100% in 1982-84. That is our reference point since it is the base period for the CPI. According to this chart, a dollar in 1952 had almost 400% of the purchasing power that a dollar had in 1983. By 2002 a dollar retained only 55% of the purchasing power that it had in the 1982-84, and one seventh of its purchasing power in 1952! Our dollar has been a shrinking yardstick of value, and we must keep this in mind when comparing dollar values between one year and another. For example, how have wages *really* changed over this period?

The Real Wage

We know that during the half century the growth in people's real incomes must have been much less that the growth in their nominal incomes since the inflation depicted in these charts has greatly diminished the purchasing power of the dollar being earned. But how do real and nominal incomes really compare? In Figure 4.4 we see charted the average wage of hourly production workers in U.S. manufacturing, both in current dollars (dashed line) and in constant 1982-84 dollars after deflation by the CPI.

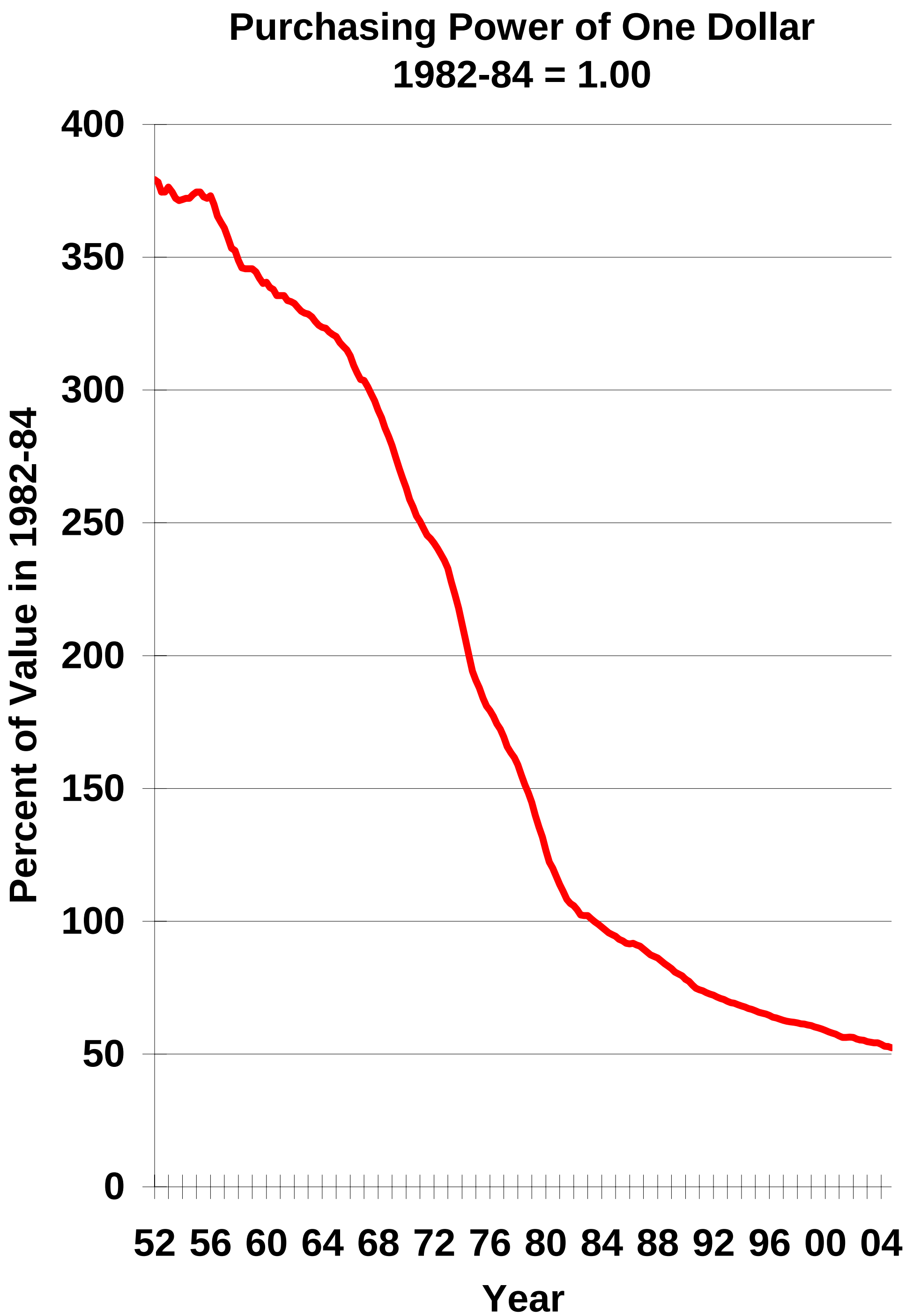
The *nominal wage* rose from about $1.65 per hour in 1952 to nearly $16 today, a ten fold increase. While this might seem like a very large increase, you now know that the cost of living rose almost as much over the same period. Indeed we see in the chart that the real wage is about the same today as it was in the 1960s, having reached a modestly higher level in the 1970s. Clearly, hourly factory workers did not participate in the general prosperity of the U.S. during the 1990s.

One factor behind the erosion of the manufacturing wage in the U.S. has been *globalization* - increased competitiveness of markets internationally that the U.S. once dominated. For example, the market for structural steel was dominated until the 1960s by a few large American firms, particularly U.S. Steel Corp. The fact that they all employed workers belonging to a single unified labor union put those workers in a strong bargaining position in wage negotiations. As European economies rebuilt their steel industries and as developing countries became steel producers, the world market for structural steel became very competitive. Today, an office building in St. Louis might contain steel from any of many countries, such as Korea, Japan, Brazil, and India which are all major producers.

Another, perhaps more important, factor in the decline in the real wage is the shift in technology away from the use of manual labor and toward the use of more educated workers in manufacturing processes. The ability to work with computers is often more important on the shop floor than is physical strength. The gap between the earnings of college educated workers and hourly workers with less education has widened dramatically in recent decades and continues to widen. The flexibility that technology brings to manufacturing, with its ability to substitute microprocessors for humans in repetitive tasks, suggests that the bargaining position of organized labor will remain much weaker than it was.

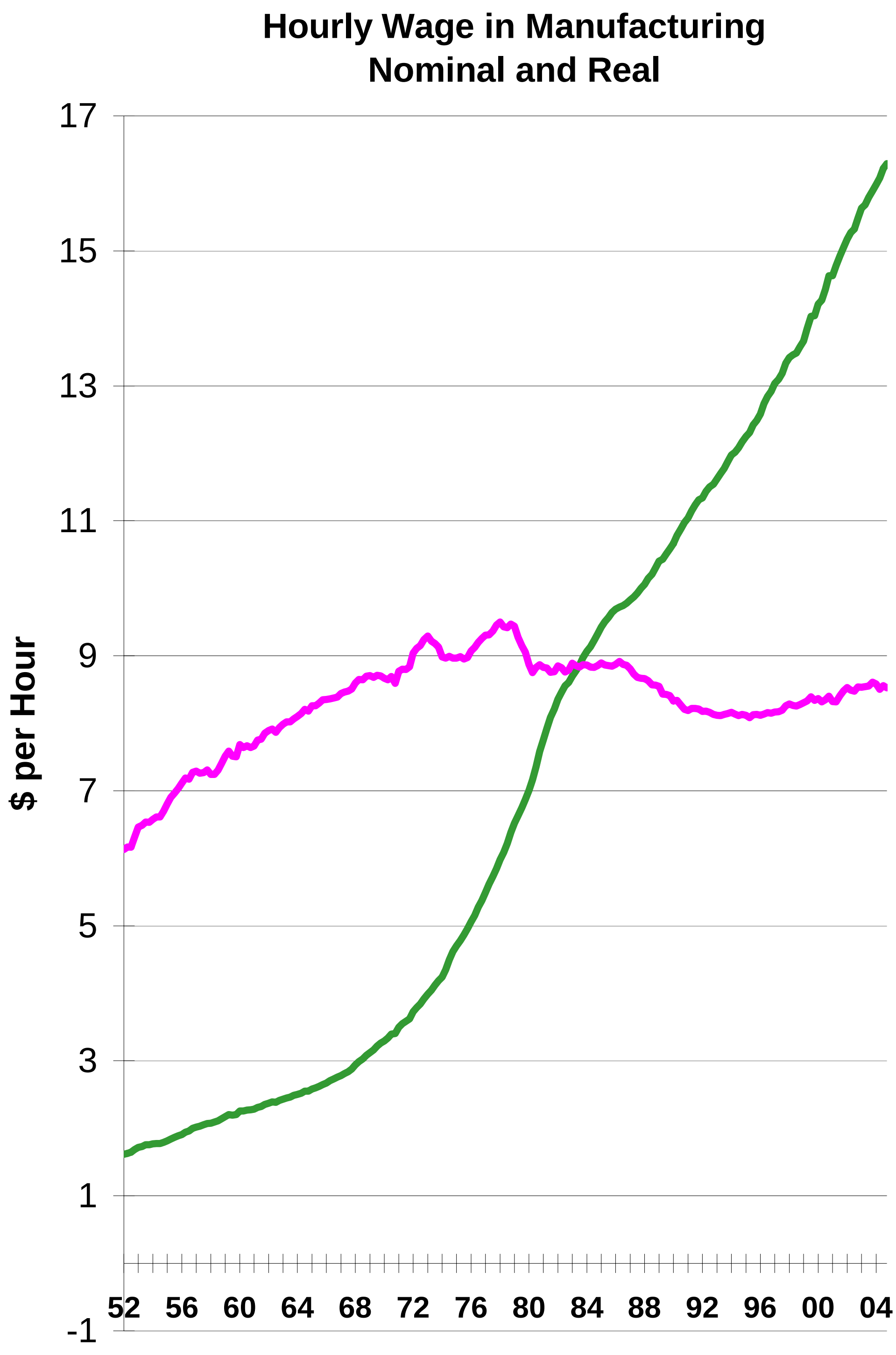
It is important to understand that nothing about adjusting wages for inflation implies that real wages have stagnated *because* of inflation. Rather what we have learned is that only by adjusting for inflation can we see changes over time in the actual standard of living, and that is what really matters to people.

Figure 4.3:



Purchasing Power of One Dollar
1982-84 = 1.00
Percent of Value in 1982-84
400
350
300
250
200
150
100
50
0
52 56 60 64 68 72 76 80 84 88 92 96 00 04
Year

Figure 4.4:


Hourly Wage in Manufacturing
Nominal and Real
$ per Hour
17
15
13
11
9
7
5
3
1
-1
52
56
60
64
68
72
76
80
84
88
92
96
00
04

Exercises 4.3

A. Using Figure 4.1 and a ruler, read off and write down the value of the CPI in 1968 and 1988. Obviously your readings from the chart will be very approximate. What was the percentage change in the cost of living over that 20 year period?

B. In 1988 the Boeing 747 was 20 years old. The first ones had cost $18.5 million in 1968, and by 1988 the latest model, which carried more passengers twice as far, was priced at $125 million. (1) What was the percentage increase in the nominal price of a 747 over the 20 years? (2) Now express the two prices in 1982-84 dollars. (3) What was the percentage increase in the real price of a 747 over the 20 years? (4) Why might this be an over estimate of the increase in the real price in view of the evolution of the 747 during its lifetime?

C. Heard at the dinner table: "I can't believe how expensive things are these days. I can remember filling up my gas tank when I was in high school in the early 1960s for 32 cents a gallon. Today I paid $1.51! On top of that, I can remember that then three hamburgers, fries, and a small cola cost $.71 at a drive in, and yesterday I paid $3.48!"

Can you set dad straight on how much the *real* cost of gas and drive-in food have changed in the last thirty years?

4.4 The Inflation Game: Who Are the Winners and the Losers?

Imagine that you belong to a union that has just negotiated a wage contract with your employer that entitles you to a 6% raise in each of the next three years. The way you will feel about this settlement three years down the road will depend very much on what the inflation rate turns out to be. You are playing the inflation game and your wage is the lottery ticket!

When the contract was signed everybody involved had some expectation of what inflation would be over the three years. Let's say that the union and the employer pretty much agree that inflation can be expected to average around 4%, so they both anticipate that the wage in real terms will be going up about 2% per year. But what if inflation speeds up to 6% unexpectedly? Then the real wage will not rise at all; the union and you are losers and the employer is the winner. If it jumps to above 6% you will actually suffer a reduction in buying power. On the other hand, if inflation slows down to 1% your wage will increase at a sprightly 5% per year in real terms and you and your fellow employees will be winners at the expense of your employer.

Inflation creates winners and losers whenever people make contractual agreements in dollars and inflation turns out to be different than what someone expected. If we knew what the inflation rate was going to be for certain over the next three years then your union and employer could simply agree on the increase in the real wage, which is what matters to both sides, and then just add on the rate of inflation that they know will happen. Unfortunately, inflation is subject to unexpected changes and it is obvious from Figure 4.2 that no one could have anticipated the extent to which it accelerated in the 1970s and how quickly it would subside in the 1980s. Inflation certainly created a lot of winners and a lot of losers in those decades.

The 1970s Inflation Game

Who were the big winners of the 1970's? They were people who had agreed to pay a certain amount of dollars in the future, for example the couple who borrowed $18,000 in 1971 to buy a $20,000 house. That probably seemed like a large mortgage in 1971, but as the rapid inflation of the 1970s eroded the value of those dollars the mortgage payments got smaller and smaller in real terms. While the homeowners' income grew along with inflation, the monthly mortgage payments remained the same for the life of the mortgage, often 30 years.

Meanwhile, the market value of the house tended to rise with inflation, so the homeowners' equity in the house, its value less the mortgage owed, grew rapidly. People who borrowed to buy real estate in the 1970s were big winners in the inflation game.

For every winner in the inflation game there is a loser. One of the losers in the 1970s was the lender of that $18,000 which was probably a savings and loan. S&Ls are much like banks, they are financial intermediaries that take in deposits from savers and make loans. Until recent years they specialized in mortgage lending. It is not surprising that many S&Ls were bankrupted by the inflation of the 1970s since the mortgage payments they received turned out to be much less valuable than they had expected.

Lenders in general were losers in the 1970s. The teenager who had received a US savings bond from her grandmother in 1970 became a lender to the US Treasury. The value of that bond was far less at maturity in 1980 than grandma ever imagined. The winner in that instance was the US Treasury which found the bond much cheaper to pay off than it had expected when it issued the bond. Owners of bonds were losers, whether the bonds were issued by the Treasury, by local government, or by private firms, because those bonds had promised only to pay a fixed amount of dollars in the future regardless of inflation.

Retirees on fixed pensions were big losers in the inflation game in the 1970s and the winner was their former employer whose burden of meeting pension obligations became ever lighter as those pension payments became cheaper in real terms. The sad plight of the elderly suffering erosion of their living standard helped to push Congress to change the Social Security system to provide for automatic adjustment of monthly benefit payments once a year by the amount of the increase in the CPI. This has greatly reduced the exposure of the elderly to the whims of the inflation game. So why not build inflation adjustments into other kinds of contracts and laws?

Protecting Yourself Against Inflation

The adjustment of Social Security benefits payments for the increase in the CPI is one example of indexation. As inflation became more rapid and more unpredictable in the last twenty years people looked for ways to isolate themselves from its effects, to find a way to avoid playing the inflation lottery.

Wage contracts more commonly today include a cost of living adjustment, or COLA for short, that is based on the CPI. Long-term leases on commercial property, for example a retail store sight, often provide for an annual adjustment of the rental based on the CPI. Mortgages increasingly carry an adjustable monthly payment with the amount changing annually according to current interest rates that, as we will see, reflect the current inflation rate.

Exercises 4.4

A: Looking again at the wage contact example at the beginning of this section, what do you think the settlement would have been if inflation were generally expected to average 10% for the next three years? How would you suggest the two parties rewrite their agreement using a COLA?

B. You are a lawyer and a client is rewriting her will. She wants to be sure that an elderly aunt will receive $10,000 per year for life in the event of your client's demise. How would you suggest that your client make this bequest so as to achieve its objective, the care of her aunt?

C. Suppose that as a result of taking this course you became convinced that inflation was going to be much more rapid in the 1990s than most people expect. How would you position yourself to benefit from your hopefully superior foresight?

D. Suppose instead that you saw that inflation was going to be very low in the 1990s, that in fact prices might be falling. How would you position yourself to benefit from a *deflation* that will come as a surprise to others?

4.5 Real and Nominal Interest Rates

You will recall that in Chapter 3 we looked at quotes on Treasury bonds, notes and bills of various terms to maturities and learned that the yield is the interest rate for that maturity. For example, if the one-year T bond has a yield of 5% today, then for every $100 you invest in one-year T bonds you will earn $5 in interest over the next year. Your $100 will grow to $105.

But how much will you *really* earn on your investment? Just as in the case of a raise in salary, it depends on how rapidly the cost of living rises during that year. If the CPI increases by 5%, then your $105 will have no more buying power when the bond matures than your $100 did a year earlier. In that case you clearly earn nothing in terms of purchasing power. But if the CPI rises by only 3%, then your investment grows faster than inflation, resulting in a gain in purchasing power.

How much of a gain? To see how much, we convert both your original investment of $100 and the $105 you will receive a year later into constant dollars, and then calculate the change in the real quantities.

Calculating the Real Rate

Suppose that the CPI today is 165 and one year from now it will be 170, so the inflation rate for that 12 month period is 3%. In terms of constant 1982-84 dollars you invest $100/1.65 or $60.61 today, and you receive $105/1.7 or $61.76 in a year, a gain of 1.9%.

Notice that this percentage gain is approximately the nominal rate of 5% minus the inflation rate of 3%. That is not a coincidence but just another application of the general formula we developed in Section 4.2: the % change in a real quantity is approximately the difference between the % change in the nominal quantity and the % change in the CPI. Using this short cut to calculating the real gain on the bond we would get 5% - 3% = 2% which is close to the exact result of 1.9%.

It is natural to call the quoted bond yield or interest rate the nominal interest rate and to call the difference between the nominal interest rate and the inflation rate the real interest rate. Putting the definition in the form of an equation we have

The Real Interest Rate ***equals***
The Nominal Interest Rate ***minus*** **The Rate of Inflation**

Ex Ante & Ex Post Real Interest Rates

Of course, someone who purchases a one year bond today does not know what the inflation rate will turn out to be during the year. It is only after the fact, a year later, that we can say that the real interest rate turned out to be 2% or whatever is implied by how much the CPI grew. However, the buyer of a bond starts out with some *expectation* of what inflation will be during the period until the bond matures. If your expectation is that the CPI will rise by 2%, then your expected real interest rate is 5%-2%=3%. The expected real rate is also called the ex ante real interest rate, where *ex ante* means “from before.” When the rate of inflation turns out to be 3%, more than you had expected, then the realized real interest rate is only 5%-3% = 2% which is less than you expected. The realized real rate is also called the ex post real interest rate, where ex post means “from after.”

This illustrates the fact that when you own a bond or issue a bond you become a player in the inflation game. If inflation is worse than expected, bond issuers win and bond owners lose, but if inflation is lower than expected, it is the bond issuers who lose and the bond owners who win. Recall that inflation surged in the 1970s and subsided in the 1980s. Since few people anticipated these sharp swings in inflation, the 1970s were years when bond owners realized lower real interest rates than they had expected, while the 1980s were years when they realized higher real interest rates than they had expected. It will almost always be true that the ex post real interest rate will differ from its ex ante counterpart, since inflation will almost never turn out exactly as we expect.

It is easy to calculate the ex post real interest rate after the fact. But how can we tell what the ex ante real interest rate is today? We observe the nominal interest rate directly, but where do we find the expected inflation rate? Each of us has our own expectation of inflation and ex ante real interest rate, but it would be interesting to measure these for the economy. One approach is to take a survey and average the result. Another is to use recent inflation, say over the past year, as a proxy for expected inflation on the assumption that many people will look at the recent past as a guide to the near future.

In Figure 4.5 the T bill yield minus the rate of inflation over the prior year is plotted as a measure of the expected or *ex ante* short term real interest rate.

The T bill rate minus the actual inflation rate over the three month life of the bill is the realized or *ex post* real short term interest rate and that is plotted in Figure 4.6.

We see in comparing Figures 4.5 and 4.6 that the realized rate fluctuates more than the expected rate, but the two show a similar pattern over long periods. After the wild swings of the immediate post-WWII period, the short term real rate of interest was fairly steady during the 1960s, averaging a bit under 2% (at an annual rate). In contrast, the mid 1970s through 1980 was a period of very low and even negative real rates, so the nominal interest rate on bills was not sufficient to make up for the rapid inflation of that period. Then in the 1980s we see a third distinct period in which real rates were sharply higher but gradually diminished towards the end of the decade. In the 1990s we have seen the real interest rate rebound to levels more typical of the early period.

Figure 4.5: The Ex Ante Real T Bill Rate

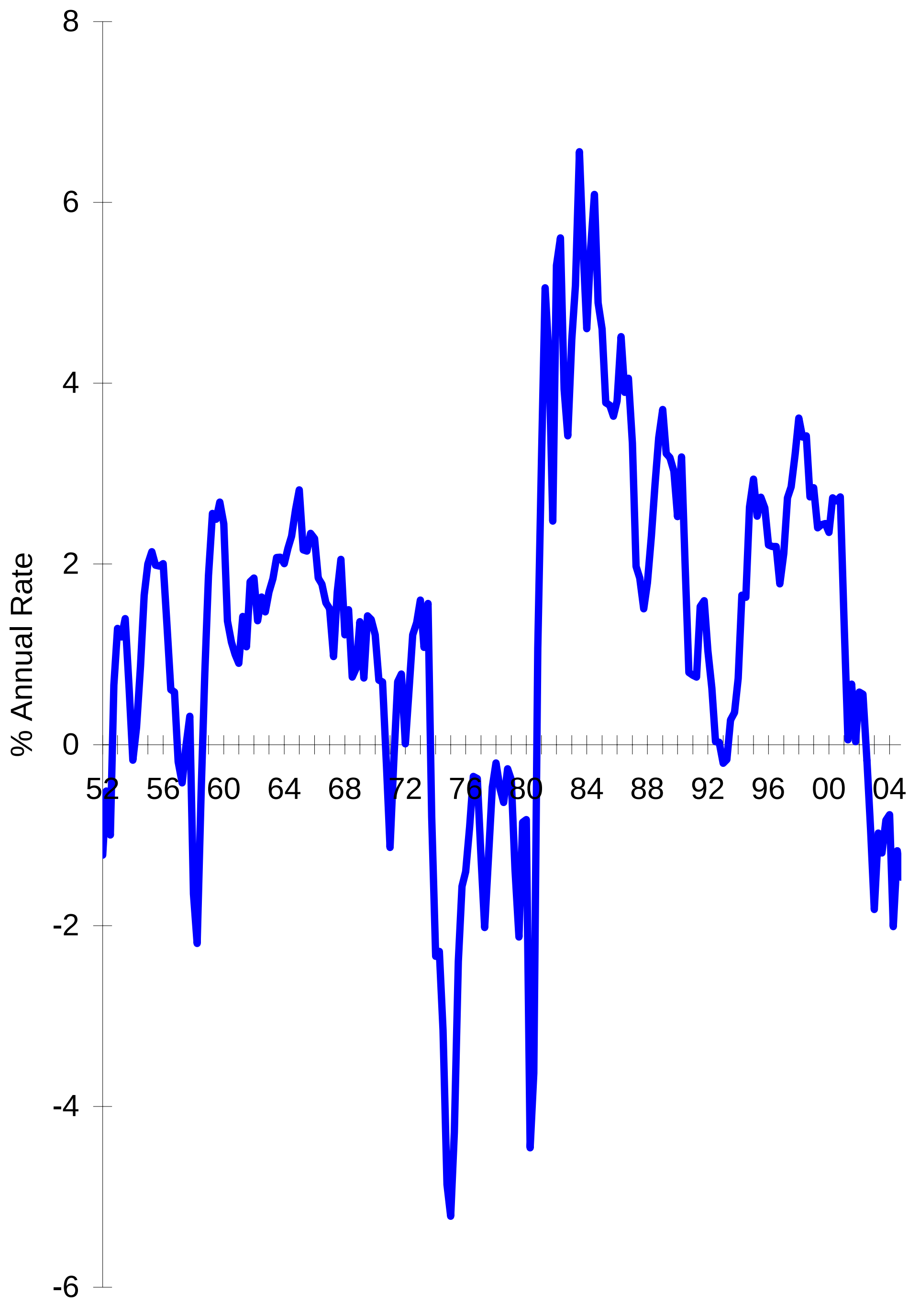
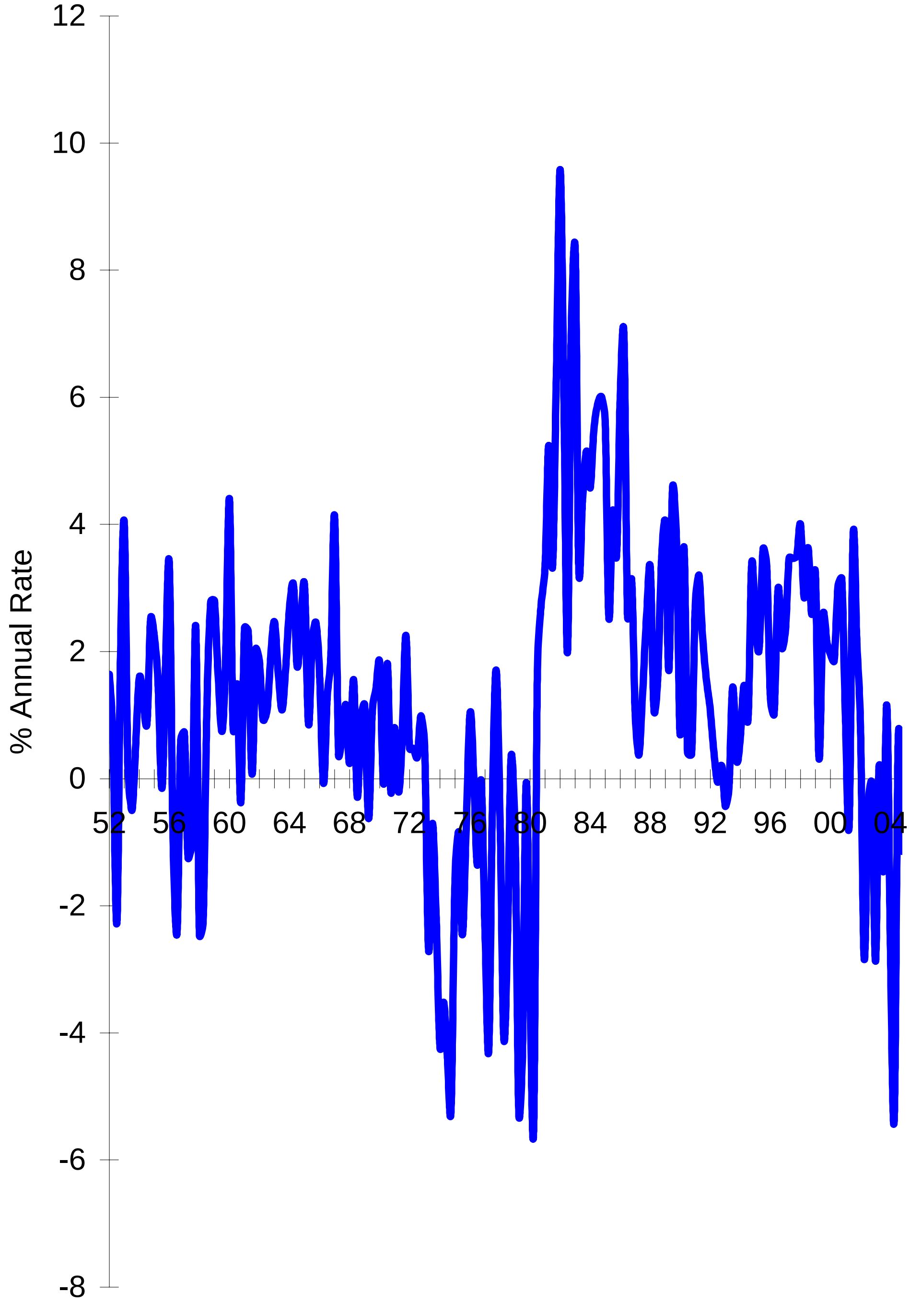


Figure 4.6: The Ex Post Real T Bill Rate



The fact that the real rate of interest is quite different from the nominal rate is apparent in Figure 4.7 where we see plotted the nominal T bill rate along with the ex ante real T bill rate. Notice that while the nominal rate was soaring in the 1970s, the real rate was declining and actually becoming negative! Then as the nominal rate fell sharply in the 1980s, the real rate moved to the highest levels in recent U.S. experience. With inflation more stable the last decade, the two rates have largely moved together.

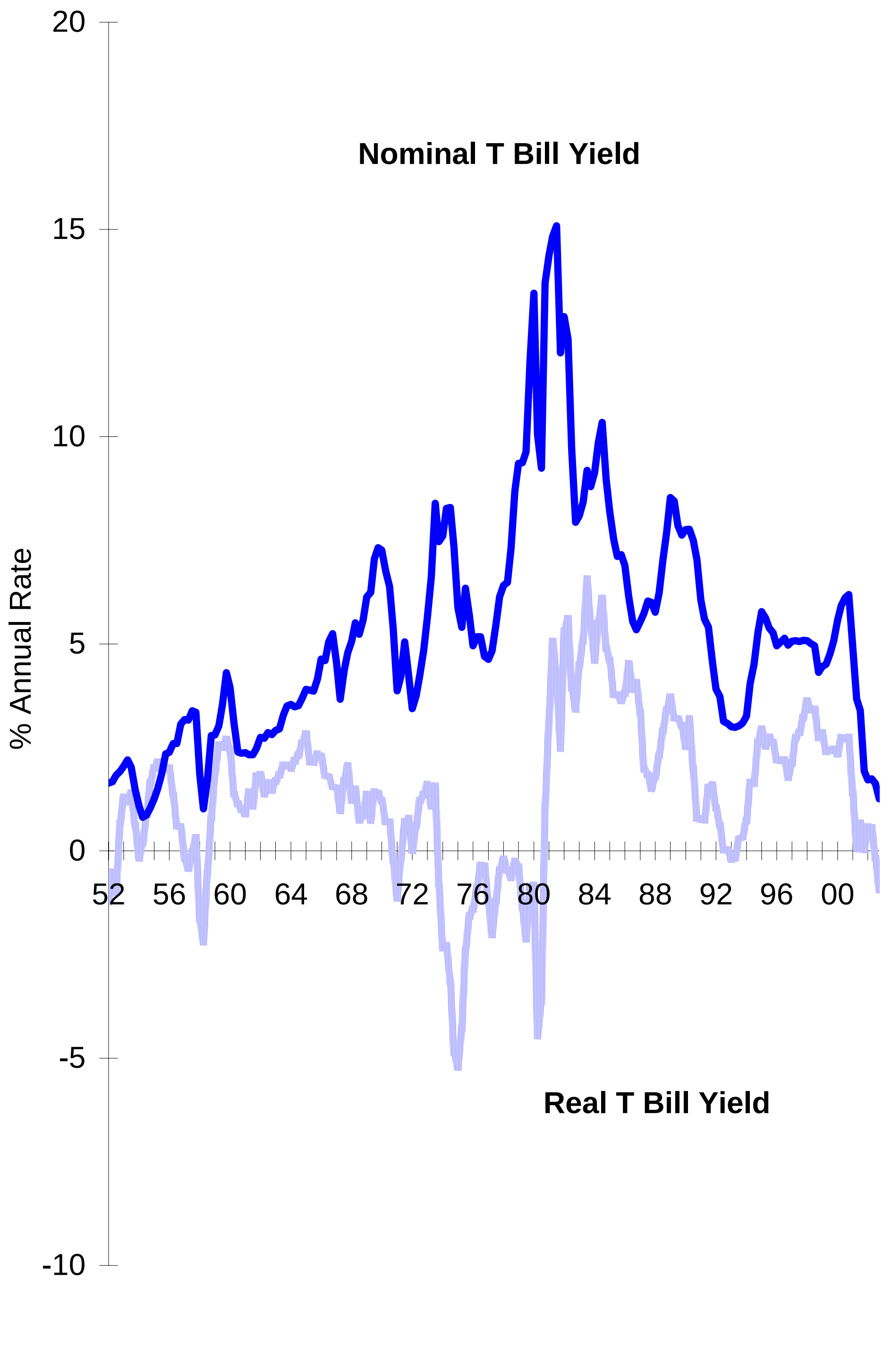
Indexed Bonds – Real Interest Rates in the Marketplace

An exciting development of the last few years is the issuance of indexed bonds by the U.S. Treasury. The bonds pay a coupon and face value that is adjusted fully by the change in the CPI, so these are payments in real terms, in constant dollars. The yield on these bonds is a real interest rate. Unlike the *ex ante* real interest rate on a nominal bond, which is only an expectation, the real interest rate on an indexed bond is known for certain at the time of purchase. The following table lists the indexed T bonds that were available at mid-1999, their maturity year and real yield, as well as the yields on ordinary nominal T bonds of the same maturity, and then the difference between the nominal and real yields that is the implied inflation premium:

Maturity Year	Yield (real)	Nominal Bond	Expected Inflation
2002	3.7	5.2	1.5
2007	3.9	5.4	1.5
2008	3.9	5.4	1.5
2009	3.9	5.6	1.7
2028	3.9	5.8	1.9
2029	3.9	5.7	1.8

Notice that the real yield is quite high relative to the historical real yield on T bills, suggesting that real interest rates in 1999 were relatively high. When we subtract these real yields from the nominal bond yields of the same maturity we get the implied value of expected inflation, the inflation premium that is contained in the nominal rate. Thus we get to observe expected inflation at the level of the market directly!

Figure 4.7: Nominal and Real T Bill Rates



What surprised many economists was how low the expected inflation rate really is, a mere one and a half percent, even when the market looks out over the next three decades. Evidently, the market expected the very low inflation rates of the late 1990s to persist indefinitely (supporting our assumption above that recent inflation is a reasonable proxy for expected inflation!). These are not simply opinions from a survey, these are numbers you can bet money on! If you thought that inflation was likely to be much greater than the 1.5% that is implied by the indexed bond yield, you could act on that opinion by purchasing the real rather than the nominal bond. This is a particularly important calculation for managers of pension portfolios since they are large purchasers of bonds and the risk of inflation is a very important consideration.

How is the real rate of interest determined?

The real rate is what lenders earn and what borrowers pay in real, purchasing power terms. If you think about it for a minute, it is real interest rates and not nominal interest rates that really matter to these economic agents, just as real and not nominal salaries are what really matter to both employees and employers.

It may be helpful in this discussion to think of bond buyers as suppliers of "loanable funds" to the bond market and issuers of bonds as “purchasers” of those loans. The supply of loanable funds will depend in part on the real rate. The higher the real rate the greater will be the supply of savings from U.S. households and from the rest-of-the-world (ROW) flowing into the bond market.

The demand for loanable funds by issuers of bonds - firms undertaking capital spending projects, households building houses, and governments financing deficits - will also depend on the real interest rate. The lower the real rate the greater will be their demand for loanable funds. The prevailing real interest rate will be the one that equates the supply of loanable funds in the bond market with the demand for funds.

A shift in the demand for loanable funds will cause the real interest rate to change. For example, if the federal government spends more than it receives in taxes, then the U.S. Treasury is obliged to go to the bond market as a purchaser of loanable funds. Many economists see the high level of the real interest rate through the 1980s as the result of the large and persistent federal budget deficit of that decade.

When the Treasury started borrowing about $200 billion per year in the early 1980s, the real rate had to rise to induce savers, primarily households and the ROW, to buy more bonds, that is, supply more loanable funds.

Some observers expect the aging baby boomers who were the yuppies of the 1980s to become the middle aged big savers of the 1990s as they contemplate college expenses and retirement. This would increase the supply of loanable funds to the bond market in the decade ahead, thereby tending to push real interest rates down.

Exercises 4.5

A. Based on Figures 4.5 and 4.6, make an estimate of the average real rate on T bills over the past three decades. If your crystal ball told you that the rate of inflation is going to average 4% over the next ten years, what then would be your forecast of the average T bill yield over the same period?

B. Interest income is subject to federal income tax in the US. Suppose your tax rate is 33% and T bills are yielding 6%. Further, assume that the inflation rate is 5%. Calculate the following to the nearest whole percentage point:

1) Nominal yield on T bills.
2) After-tax nominal yield.
3) Before-tax real yield.
4) After-tax real yield.
5) After-tax real yield on a $100 bill.
6) Opportunity cost of holding that $100 bill for one year.

C. Now suppose that the T bill yield increases to 9% and the inflation rate increases to 8%. Recalculate the answers to items (1) through (6) above. Why does an increase in inflation reduce the real after-tax yield on T bills even though the increase in inflation is matched by the increase in the nominal interest rate? In general, what happens to real after-tax yields as the rate of inflation rises, taking into account that nominal interest rates tend to rise with inflation? How could the tax law be changed to eliminate this effect of inflation?

D. Find the indexed bonds section of the Treasury Bonds table in the Wall Street Journal and compare those yields with the yields on the ordinary bonds of roughly corresponding maturities. What are the implied expected rates of inflation? How does expected inflation compare with recent actual inflation. Do you think this expected inflation is realistic or optimistic or pessimistic? Which type of bond would you buy for a pension fund client, and how would you justify that judgement?

4.6 The Fisher Hypothesis: Inflation and Interest Rates Go Together

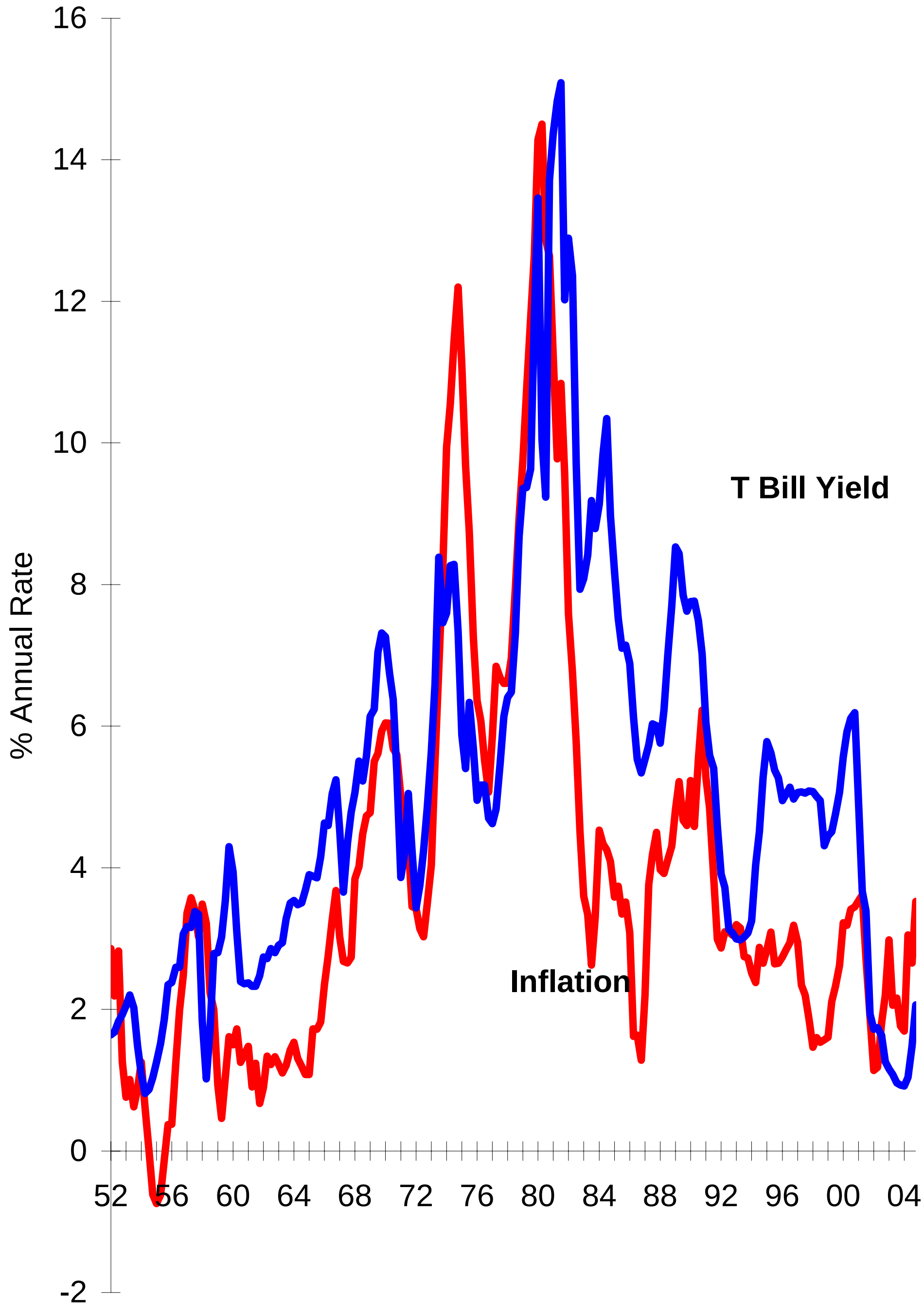
Recall our observation from Figure 4.7 that the real interest rate does not fluctuate as much as the nominal interest rate. Given that the difference between the two is inflation, that observation would seem to imply that much of the fluctuation in the nominal rate corresponds to fluctuation in inflation. The fact that the nominal interest rate and inflation do move together is strikingly apparent in Figure 4.8 where the T bill yield and the CPI inflation rate are plotted together. This phenomenon is not peculiar to the U.S. or to recent experience. The strong correlation between nominal interest rates and inflation is one of the most firmly established empirical regularities in economics and one that has been documented over long periods of history and across many countries.

This relationship between interest rates and inflation was first noticed by the American economist Irving Fisher who in the early decades of this century articulated the theory of interest rates as we know it today. What Fisher discovered is that the real interest rate is relatively stable, and that large changes in the rate of inflation will be reflected primarily in corresponding changes in the nominal interest rate.

The idea that variations in nominal interest rates across time and across countries are largely due to differences in inflation is known as the Fisher Hypothesis.

The relative stability of the real interest rate goes along with the idea, discussed above, that the real rate will be determined in the market for loanable funds where savers come together with borrowers. Recall that what matters to both lenders and borrowers is the real interest rate; they will be indifferent to a rise in the nominal rate if it only reflects a difference in inflation rates. While changes in the supply and demand for loanable funds will cause some change in the real interest rate, the main sources of savings (households saving for retirement) and borrowing (government deficits, firms building factories) are relatively stable. Further, the balance between supply and demand will not be sensitive to a change in the inflation rate as long as it is reflected in a corresponding change in the nominal interest rate.

Figure 4.8: The T Bill Rate and Inflation



For example, suppose that with inflation at a rate of 5% and an interest rate of 7% the supply and demand for loanable funds are in balance. Evidently, a real rate of 2% is agreeable to both sides. Then it becomes apparent that inflation has sped up to 10%. Both borrowers and lenders can agree that a jump in the nominal rate to 12% leaves them in the same position they were before, since inflation has no large direct effect on either saving or borrowing. Households are still saving for retirement, the government still has a budget deficit. Doesn't it make sense that the primary effect of a change in the inflation rate will just be a corresponding change in the nominal interest rate that leaves the real rate the same?

Does the Fisher Hypothesis explain the interest rates we see in the world today? Indeed it does. Figure 4.9 is a "x-y scatter plot" of points representing the short term interest rate and the inflation rate in each of nine industrial countries. Similarly, Figure 4.10 is the same scatter plot for eight developing countries. The line in each is the predicted relationship between these variables based on the Fisher Hypothesis and assuming a real interest rate of 2%. Specifically, it is the plot of the function:

Interest Rate = Inflation Rate+2%

Although developing countries have much higher inflation rates than industrial ones, a range in all from negative inflation (deflation) to another with inflation above 100%, the Fisher Hypothesis does a remarkable job of explaining nominal interest rates.

Why doesn't the Fisher equation fit the data exactly? One reason is that the real interest rate is not the same in all countries, it is just less variable than is inflation. Second, the Fisher Hypothesis is a statement about ex ante real interest rates; the theory discusses agents' expectations of what inflation will be. As in Figure 4.6, we are using past inflation as a proxy for agents' expectations, but it is an imperfect proxy. It also seems likely that it will not be a very good proxy in a country experiencing very rapid and variable inflation, such as Russia which is the highest point in Figure 4.10. Another example would be Turkey. In situations where the monetary environment is volatile, past inflation may be less important than the results of the latest election in influencing expectations.

Figure 4.9: The Fisher Relation Across Industrial Countries

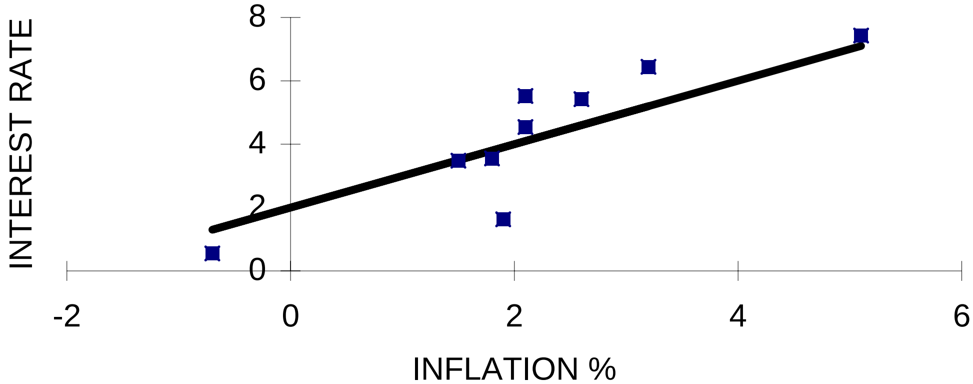
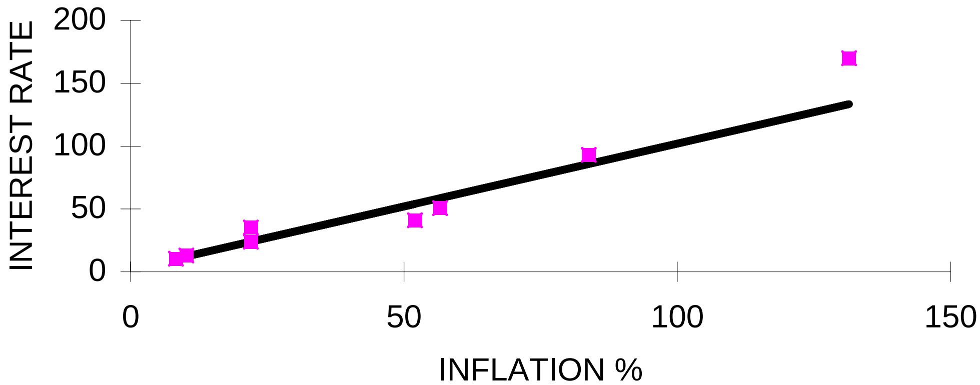


Figure 4.10: The Fisher Relation in Developing Countries



Exercises 4.6

A. You get off the plane in a country you know little about, and you notice that banks are advertising that they will pay 25% per year for savings deposits. Language is no problem, interest rates are universal! What is a reasonable estimate of the local inflation rate? How likely is it that the inflation rate is 5%?

B. Now you make the next leg of your trip and disembark in Zurich, Switzerland. You have read that inflation is unheard of in that country, noted for its sound banks. What range of interest rates do you expect to see advertised there? How likely is it that banks will be offering to pay 25% to savers?

C. What is your relative level of confidence about the two predictions you have just made? Explain any difference.

D. Turkey is a country that has experienced rapid inflation during the 1990s, about 100% per year. What do you suppose is the level of interest rates there, approximately? Now we hope that Turkey can somehow get this inflation under control. If it does so, and we were to check back several years later after inflation had settled down to 5%, what would expect to find had happened to interest rates there?

APPENDIX

Prices from supermarket ads in THE SEATTLE TIMES, Jan. 29, 1948 and comparable prices in 1993.

Subject of personal advice column: "Elderly Men Regret Divorcing First Wife'" by Dorothy Dix.

END.

Item	price in 1948	unit	price in 1993
Roasting chickens	.55	lb	1.39
Bacon	.82	lb	2.99
Beef rib roast	.65	lb	4.99
Swift's Premium ham	.65	lb	3.33
Peanut butter	.53	25 oz.	3.79
Palmolive soap	.15	bath size	.80
Clorox bleach	.27	half gal.	1.29
Libby beef hash	.32	can	1.69
Grapefruit juice	.20	46 oz can	2.59
Wesson oil	.90	qt	2.32
Canned salmon	.47	1 lb. can	3.46
Grapefruit	.07	lb	.79
Oranges	.07	lb	1.69
Lettuce	.10	lb	.67
Avocados	.13	per	.79
Apples, Rome beauty	.08	lb	1.29
Fisher's flour	2.29	25 lb	7.89
Hill's coffee	.50	lb	2.62
Eggs, AA large	.59	dozen	.65
Baby Ruth	.04	bar	.45
Milk, whole	.19	qt	.95
Camels	.16	pack	2.39
Rainier beer	2.89	case (24)	13.98