“Real” Assets

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DOI:10.1093/acprof:oso/9780199959327.003.0011

Abstract and Keywords
Many “real” assets, including inflation-indexed bonds (linkers), commodities, and real estate, turn out not to be that “real.” While a single linker provides a constant real return by definition, linkers as an asset class have almost no correlation with inflation. Among commodities, only energy has been a decent inflation hedge. Gold, surprisingly, has been a poor inflation hedge. Real estate has some but certainly far from complete inflation-hedging ability. Boring Treasury bills, in contrast, are the best at hedging inflation.

Keywords: inflation hedge, TIPS, commodities, gold, real estate, T-bills, real rate, break-even inflation, contango, backwardation, spot, cash, roll

Chapter Summary
Many “real” assets, including inflation-indexed bonds (linkers), commodities, and real estate, turn out not to be that “real.” While a single linker provides a constant real return, linkers as an asset class have almost no correlation with inflation. Among commodities, only energy has been a decent inflation hedge. Gold, surprisingly, has been a poor inflation hedge. Real estate has some, but certainly far from complete, inflation-hedging
ability. Boring Treasury bills (T-bills), in contrast, are the best at hedging inflation.

1. How Real Is Real Estate?
Carole was a consultant to a mid-sized pension fund holding a traditional portfolio of 60% equities and 40% bonds.¹ For a long time the fund was too small to consider direct real estate investments, but recently, thanks to large employer contributions, the fund had swelled. The trustees, worried about the threat of inflation, believed that investing in real estate could offer some protection against its ravages.

Were the trustees right? Is direct real estate a good inflation-hedging asset? Carole knew this was not only about number crunching. Real estate seemed to differ from the other asset classes—equities and bonds—in the fund’s portfolio. Although direct real estate could have a static allocation, it requires active management, typically by a professional. What’s more, bricks and mortar require ongoing capital spending if the asset is to remain competitive. The fund already had a passive allocation to traded real estate investment trusts (REITs), which had underlying real estate exposure. Are REITs different from direct real estate? Carole had to consider these additional challenges as well.

(p.347) The fund’s liabilities increased when inflation was high and, to minimize the variation in the difference between assets and liabilities (which is surplus, see chapter 1), the trustees wanted some assets that have high returns when inflation is high. In fact, the trustees’ top concern was finding assets whose returns correlated highly with inflation. If real estate turned out not to provide adequate inflation protection, then what other real assets should Carole consider?

In this chapter, we cover the properties of assets traditionally thought to hold their value during times of high inflation, especially the “real” assets of real bonds, commodities, and real estate. I distinguish between inflation hedging—the correlation of returns and inflation—and the long-run returns of assets. An asset having a long-run return much higher than inflation can be a very poor inflation hedge; inflation hedging is a statement about a co-movement, while the latter is a statement about a long-term mean. As we shall see, most real assets turn out not to be so “real.”
2. Inflation

2.1. Rising and Falling Inflation

Figure 11.1 plots inflation measured by year-on-year changes in the Consumer Price Index (CPI; for all urban consumers, all items) from January 1952 to December 2012. The U.S. inflation experience since the second half of the twentieth century is marked by an increase in inflation through the 1960s and 1970s, which the economic historian Allan Meltzer (2005) calls the Great Inflation, and then a low inflation experience after the mid-1980s. Inflation reached a peak of over 14% in 1980. Meltzer calls the Great Inflation “the climactic monetary (p. 348) event of the last part of the 20th century” and its effect was devastating: it contributed to the destruction of the world’s system of fixed exchange rates (known as Bretton Woods for the town in New Hampshire where the system was agreed), it bankrupted much of the savings and loan industry, and it was an experience shared by all developed countries to greater or lesser degrees.

The United States had high inflation after World War II, and a bout of inflation during the Korean War in the early 1950s, but in both cases policymakers quickly brought it under control. In fact, in 1954 and 1955, inflation was actually negative. Thus the Great Inflation erupted in the mid-1960s from a time of stable and low inflation. Why did rising prices get so out of hand in the 1960s and 1970s, and how did policymakers bring inflation under control again in the 1980s?²

Three things caused inflation to get out of control.

First, policymakers used the wrong models. In the 1960s, economists believed in the Phillips (1958) curve, which plotted a tradeoff between unemployment and inflation. Economists believed unemployment could be reduced by raising inflation, but over time it became clear that there was no such tradeoff.
During the 1960s and 1970s, both unemployment and inflation rose. The *Rational Expectations* revolution in economics in the 1970s spearheaded by Friedman and Lucas (who won Nobel Prizes in 1976 and 1995, respectively) explained that the Phillips curve was unstable and could not be effectively exploited by policymakers.

Second, economists were divided on how to respond to higher inflation. They recognized it was a problem, but some thought the Fed was not responsible. *Cost push inflation*, which arose in the price of natural resources such as oil, was thought to be outside the Fed’s control, whereas *demand pull inflation*, caused by an overheating economy, was thought to be under the Fed’s control. Most economists believed the era’s underlying inflation was of the cost push variety. Even some economists who thought the Fed could control inflation did not recommend that the Fed embark on disinflation because of the large *sacrifice ratios*—the reductions in GDP required to bring down inflation—and advocated instead that society learn to live with high inflation because of the unacceptably high costs of unemployment. Unfortunately, high unemployment happened anyway in the late 1970s hand in hand with inflation (*stagflation*), and unemployment would have been lower had the inflation problem been tackled earlier.

The third reason was the intense political pressure on the Fed, which was not as independent as it is today. “Inflation continued,” Meltzer writes, “because of the unwillingness of policymakers to persist in a political and socially costly policy of disinflation. During the 1960s and after, there was little political support for an anti-inflation policy in Congress and none in the administration.” This last point is especially relevant: if there is little political consensus on how to end inflation, *(p.349)* it will persist. Inflation can be as much a political risk as it is an economic one (see also chapter 7 for inflation risk and political risk as factors).

Inflation was finally brought under control by Fed Chairman Paul Volcker, who was appointed by President Jimmy Carter and served from August 6, 1979, to August 11, 1987. When Volcker took office, the public was ready to endure the pain required to cure the inflation disease. Volcker brought inflation under control by jacking up the Fed funds rate above 19% in the early 1980s. The economy careened into recession, but inflation was brought under control. This period is the
Volcker disinflation. There are several lessons for asset owners in this experience: committed monetary policy can control inflation, doing so can be painful, and inflation risk is intertwined with monetary policy risk (see chapter 9 on fixed income).

Figure 11.1 shows that not only has the level of inflation varied considerably, but the volatility of inflation has also changed over time, exhibiting high and low volatility periods. This sort of volatility clustering is described well by Engel’s (1982) popular model of GARCH volatility. In fact, although GARCH models are now overwhelmingly applied on financial returns (see chapter 8), his first application was inflation! From the mid-1980s to the early 2000s, the volatility of inflation declined dramatically, especially compared to the very high inflation volatility of the 1960s and 1970s. Economists dubbed the later, quiet period the Great Moderation. The fall in volatility was not only observed in inflation; volatility declined in all macro series: GDP growth, investment, consumption, sales, unemployment, and so on. (Volatility of asset returns, however, did not fall.)

The decline in inflation and other macroeconomic volatility was accepted by many as a permanent regime change. In 2003, at the Fed’s rarefied Jackson Hole symposium—an annual retreat of central bankers, policymakers, and academics—conference delegates debated whether the Great Moderation was due to structural changes in the economy, good monetary policy, or plain good luck. All three played some role.³ Central bankers gave themselves a hearty round of congratulations for a new era of successful monetary policy, but the uptick in volatility since the financial crisis has shown how wrong most economists were. Inflation volatility, like other macroeconomic volatilities, changes over time, and asset owners must be prepared to live with it. The worst thing is to become complacent.
2.2. There Is No Single Inflation Rate

While prices of all goods and services generally rise and fall together, inflation means different things to different investors because investors do not consume the same basket of goods and services. Two especially important inflation rates (p.350) for individuals are for medical care and higher education. The former is part of the CPI bundle and is separately tabulated by the Bureau of Labor Statistics; clearly the elderly and sick consume more medical care than the average consumer. The latter is measured by the Higher Education Price Index and is distributed annually by Commonfund, a nonprofit institution specializing in asset management for endowments and foundations. (Higher education expenses do enter the CPI bundle, but I use the Higher Education Price Index for this analysis as it is more relevant for university endowments.) Figure 11.2 plots both series, together with CPI, from 1984 to 2008.

Figure 11.2 shows that both medical care costs and higher education expenses have been increasing faster than the overall rate of inflation as measured by the vanilla CPI. From 1984 to 2008, the average annual CPI increase has been 3.1% while the average inflation rate for medical care and higher education has been 5.3% and 4.0%, respectively. Due to the effect of compound interest, a 1% difference over twenty to thirty years can really kill you (literally, in the case of inadequate medical care). A basket of $10,000 worth of general goods and services at the beginning of 1984 would cost $21,600 at the end of 2008, but $10,000 worth of medical care in 1984 would cost $36,100 in 2008.
The difference between the CPI and an investor’s own consumption basket is called basis risk, and Figure 11.2 shows that it can be substantial. There are ways to hedge against basis risk, but the most important is to first hedge against a general rise in all prices. Then an investor can tilt her portfolio to assets that may have higher exposures to medical care risk, for example, if her liabilities or (p.351) considerations reflect that risk. To accomplish this, she might invest in health care companies. Like factor investing in general (see chapter 14), finding assets that hedge inflation risk is specific to the inflation index that is relevant to the investor.

Let’s examine some assets usually considered to have some value as a hedge against inflation. We start with one that is not normally considered an inflation hedge and is ignored by many textbooks and investors.
3. Treasury Bills

Figure 11.3 is the same CPI inflation series as Figure 11.1, except it overlays the year-on-year returns of cash, or T-bills, in the dotted line. From 1952 to 2012, T-bills have returned 4.8% per year, about 1% above average inflation for the period, which was 3.7%. Crucially, the correlation of T-bill returns and inflation has been high, at 70.1%. We have seen high correlations of T-bill returns and inflation before—chapter 8 portrayed equity as a poor inflation hedge and in passing presented evidence that T-bills hedge inflation marvelously. Of all the “real” assets considered in this chapter—real bonds, commodities, and real estate—T-bills have had the highest correlation with inflation.

Of course, the long-term return of T-bills has been much lower than other asset classes. But inflation hedging is all about the co-movement of asset returns with inflation, not the average return. T-bills are highly correlated with inflation because monetary authorities respond to inflation in setting the short-term interest rate—technically the Fed funds rate, but the T-bill rate moves almost one for one with the Fed funds rate (see chapter 9).

Furthermore, according to the Fisher (p.352) Hypothesis, the T-bill rate reflects expected inflation. Movements in expected inflation account for a large part of overall movements in total inflation because of inflation’s persistence—if inflation is high today, it is likely to be high next month.

Investors need to be concerned about two things in holding cash as an inflation-hedging tool. First, Figure 11.3 shows that cash returns lag inflation. This is most clearly seen in the huge spike in inflation in the late 1970s; the increase in T-bill yields did not come until the early 1980s. It is impossible for a policy authority to respond with perfect foresight to contemporaneous inflation shocks given that all our macro data is collected with a lag. 4 But once inflation shocks occur,
inflation is persistent. Inflation shocks are thus reflected in T-bill yields with a lag. Unless inflation is extraordinarily high (hyper-inflation has never occurred in the United States and is extremely unlikely despite the doomsayers), this lag is inconvenient and modestly costly, but it is not a reason to avoid cash as a real asset.

The second reason is. At the time of writing and at end of the sample in Figure 11.3, T-bill returns were effectively zero. This is exactly where the Fed wanted short-term interest rates to be at this time: the economy was still tender after the global financial crisis of 2008 and 2009 and the Great Recession that followed. Inflation was 3.0% at December 2011 and thus lay square in the middle of the Fed’s preferred 2% to 4% policy range. The real interest rate, which is the difference between the T-bill yield and inflation, was negative, and significantly so. Reinhart and Rogoff (2011) and Reinhart and Sbrancia (2011) label this financial repression. It is effectively a tax imposed on bond (and cash) investors by policymakers who channel the benefits to other purposes and people (like shoring up the financial system and subsidizing managers and owners of large financial institutions). Given the ocean of government debt sloshing around worldwide, financial repression is likely to stay a while. This second reason is a statement about the relatively low long-run return of T-bills and that an investor may desire other assets with higher long-run average returns, not that T-bills are not a good inflation hedge.

4. Real Bonds
A real bond is a bond whose principal or coupon is indexed to inflation. In this way the investor is protected against inflation because the payouts grow as inflation increases. Bond payments, therefore, remain constant in real terms. Real bonds are called linkers.

The U.S. version of linkers is Treasury Inflation-Protected Securities (TIPS), which have been issued by Uncle Sam since 1997. As of December 31, 2011, the Treasury has issued $739 billion of TIPS, which represents 7.5% of all outstanding marketable Treasury securities. Officially, these bonds are now referred to as Treasury Inflation Indexed Securities, but market participants and all the literature, except for official government publications, continue to use the name TIPS.
Many sovereigns have issued real bonds. The first linker was issued by Massachusetts in 1780 to raise money for the Revolutionary War. Inflation was extremely high while patriots were fighting the British, and the bonds were invented partly to allay the anger of soldiers in the revolutionary army who were dismayed by the declining purchasing power of their (already meager) pay. An important linkers market is in Great Britain, where the Bank of England first issued *Inflation-Linked Gilts* in 1981. This market was immediately successful because of high inflation in the United Kingdom during that time (significantly higher than U.S. inflation, and the Great Inflation lasted longer in the United Kingdom than in the United States). The U.S. market, in contrast, was highly illiquid for the first few years (see below). Linkers now account for approximately a quarter of all outstanding debt issued by the U.K. government.

TIPS pay a fixed coupon payment that is indexed to CPI with a lag of three months. The interest rate on TIPS is fixed, but the bond’s principal is regularly adjusted for inflation, with the result that investors receive increasing interest payments when inflation rises. The principal can also fall with inflation, but it can never go below the original face value of the bond. This *deflation put* usually has little value for a long-maturity TIPS bond that has a high principal balance. Such a bond has already experienced a period of high inflation. For this bond, deflation would have to be extremely severe for its principal to fall back to par. In contrast, during times of low inflation and deflation, the deflation put is valuable for short-maturity TIPS. These bonds have low principal balances, and, when deflation occurs, their principals cannot go below par. Such a period occurred during 2008 and 2009. Inflation during parts of 2009 was actually negative (see Figure 11.1 and 11.3), and newly issued TIPS during that time were extra valuable because of the high value in their deflation puts.
4.1. Real Bonds for Retirement?

An investor buying and holding a TIPS bond when it is first issued receives a constant real yield due to the inflation indexation. If the TIPS bond is held to pay off a liability coming due at the maturity of the bond, the investor purchasing the TIPS has eradicated inflation risk. (This is an example of immunization; see chapter 4.) If a retired person can purchase a series of TIPS maturing in different years, then she has locked in a stream of payments that are constant in real terms. This allows her to meet her living expenses in the future, impervious to the effects of inflation. Thus it seems that TIPS are an ideal retirement savings mechanism for retail investors. Zvi Bodie, a professor at Boston University specializing in investment management and pensions, advocates that retail investors should hold close to 100% TIPS in their retirement portfolios.

There are several problems with Bodie’s advice.

First, purchasing a single TIPS bond provides an inflation hedge for future cash flows immunized at a moment in time—subject to the small indexation lag and the important caveat that the CPI is the right inflation measure for that investor. But perfect cash flow matching assumes that the investor can predict all her future liabilities to immunize them today. Often, she can’t really know for certain what liabilities she will face down the road, and some of those retirement expenses are the result of choices about where she works, how long she works, her health, and other considerations along the way.

Second, most investors do not save a lump sum at a moment in time for retirement. Instead, an investor saves a portion of his income at a time over many years. The real yield curve changes across time. As real yields change, the value of the TIPS portfolio also changes, and it changes in such a way such that the TIPS portfolio returns have low correlations with inflation, as I show below. This wouldn’t matter if the investor could perfect forecast his retirement liabilities and he cares only about hedging them using TIPS, but in many situations we care about wealth today as well as wealth at retirement: taking out a mortgage, having a financial cushion to start a business, or even splurging on vacation are all decisions that are impacted by investors’ total wealth today.
The third problem with retail investors holding only real bonds for retirement is that at the time of writing in 2013, TIPS are paying negative real yields. If real yields are negative, to secure a payment of $100 that is immune from inflation risk in five years requires an investor to put away more than $100 today. Negative real rates mean that TIPS subtract wealth, instead of adding wealth, from investors. In a world of negative real rates, investors investing in risk-free real assets must be prepared to see safe investments decline, not increase, in purchasing power. This critique applies not only to individuals saving for retirement but for all endowments, foundations, and sovereign wealth funds wishing to preserve spending in real terms. While real rates on risk-free bonds may be negative, there are positive expected real risk premiums in other asset classes and strategies (see chapter 7).

A final consideration is that TIPS have sovereign risk. Sovereign risk includes both the risk of a government explicitly defaulting on a real bond—which may be minimal for the United States but is not negligible for other markets—but also the risk that the government implicitly defaults by changing the definition of inflation. The Argentinian government, for example, took direct control of its statistics institute in 2007 and since then the discrepancy between its official inflation figures and those reported by independent economists has been up to 15%. Up to 2013, this doctoring has saved the Argentinian government $2.5 billion in linkers payments.11 The United States periodically changes its inflation basket. While these changes are geared towards keeping the basket relevant for the typical consumer, the basket can change in a way that makes it less relevant for you. This is time-varying basis risk. In some countries, however, governments have redefined inflation to the detriment of all consumers. I consider sovereign credit risk in chapter 14 as part of factor investing.

This is not to say that real bonds are not good investments. I recommend that they be used as part of an overall portfolio, rather than constituting the majority of individuals’ retirement savings. And whether and how much an investor should hold must be a factor decision, not a decision based on the false notion that real bonds are “real,” which I now show.

4.2. Real Bonds Are Lousy Inflation Hedges
Almost all investors investing in TIPS hold a portfolio of TIPS, and the composition of that portfolio changes over time (unlike a perfectly immunized bond portfolio). Investors often hold a fixed proportion of their portfolio in TIPS, treating TIPS as an asset class, or as part of an overall bond portfolio. Investing in TIPS this way, as opposed to using individual TIPS bonds to immunize (usually partially unknown) future cash flows, results in TIPS being a poor inflation hedge. Real bonds, unfortunately, are not so real.

Table 11.4 reports means and standard deviations of TIPS and nominal Treasuries from March 1997 to December 2011. The bond portfolios are the BarCap U.S. Treasury and U.S. TIPS benchmarks. The full sample statistics are listed in the top panel of Table 11.4. TIPS show a mean return of 7.0%, exceeding the average Treasury return of 6.2%. TIPS volatility of 5.9% is also higher than the Treasury volatility of 4.7%. TIPS and Treasuries tend to move together, with a correlation of 64%, and the correlations of both TIPS and Treasuries with inflation is low. Far from offering good inflation protection, TIPS’ correlation with inflation is just 10%.
### Table 11.4

**TIPS and Treasury Returns Mar 1997 to Dec 2011**

<table>
<thead>
<tr>
<th></th>
<th>TIPS</th>
<th>Tsys</th>
<th>Tsys-TIPS</th>
<th>Monthly Inflation</th>
<th>TIPS-Infl</th>
<th>Tsys-Infl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>7.02</td>
<td>6.24</td>
<td>-0.78</td>
<td>2.35</td>
<td>4.67</td>
<td>3.89</td>
</tr>
<tr>
<td>Stdev</td>
<td>5.89</td>
<td>4.70</td>
<td>4.65</td>
<td>1.33</td>
<td>5.90</td>
<td>5.16</td>
</tr>
<tr>
<td>Mean/Stdev</td>
<td>1.19</td>
<td>1.33</td>
<td>-0.17</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Correlations with:

- **Tsys**: 64%
- **Inflation**: 10% -22% -35%

**TIPS and Treasury Returns Jul 2007 to Dec 2011**

<table>
<thead>
<tr>
<th></th>
<th>TIPS</th>
<th>Tsys</th>
<th>Tsys-TIPS</th>
<th>Monthly Inflation</th>
<th>TIPS-Infl</th>
<th>Tsys-Infl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>8.44</td>
<td>7.25</td>
<td>-1.65</td>
<td>1.79</td>
<td>6.65</td>
<td>5.46</td>
</tr>
<tr>
<td>Stdev</td>
<td>7.71</td>
<td>5.17</td>
<td>7.10</td>
<td>1.71</td>
<td>7.63</td>
<td>6.02</td>
</tr>
<tr>
<td>Mean/Stdev</td>
<td>1.09</td>
<td>1.40</td>
<td>-0.23</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Correlations with:

- **Tsys**: 45%
- **Inflation**: 16% -37% -44%
The first few years of the TIPS market during the late 1990s and early 2000s were characterized by pronounced illiquidity (as I detail below), so the second panel of Table 11.4 takes data from when the TIPS market was mature and starts at July 2007. In this sample the same stylized facts hold: TIPS have higher average returns than Treasuries (8.4% vs. 7.2%, respectively), TIPS and Treasuries have a relatively high correlation of 45%, and TIPS are poor at hedging inflation with a correlation between TIPS and inflation of only 16%. To understand why TIPS covary so little with inflation even though they are indexed to inflation, let us examine the different factors driving real bond returns.

4.3. Real Yields

Real yields are surprisingly volatile. I say “surprisingly” because before real bonds were issued, many economists believed that real yields set in traded markets would be like the real interest rates theories in textbooks at that time. In simple economic models, real rates should reflect demographic trends, the growth of economic output, savers’ time preferences and attitudes toward risk, and the opportunity costs of firms investing in real production. All of these change smoothly, if at all, over time. Thus, before linkers were issued, many economists believed linkers would be the most boring of markets! The father of modern empirical asset pricing, Eugene Fama, argued in 1975 that the real rate was constant. He wrote the paper at a time when linkers were not available. Now that we have linkers, he was obviously wrong; Table 11.4 shows that real rates are volatile, and in fact approximately as volatile as nominal rates.

In Panel A of Figure 11.5, I plot real yields of five- and ten-year TIPS from the St. Louis Federal Reserve Bank from January 2003 to December 2011. On average, the real term structure is slightly upward sloping, but the real term spread between ten- and five-year maturities TIPS was approximately zero from 2006 to 2008 and was negative in 2008. The figure shows that real rates move around quite a bit: the five-year real rate moved from close to zero at the beginning of 2008 to over 4% that same year during some of the worst months of the financial crisis.
Panels B to D of Figure 11.5 graph the nominal Treasury yield and the TIPS yield for the five-, ten-, and twenty-year maturities, respectively. TIPS yields soared during the financial crisis as Treasury yields fell at the end of 2008. At this time there was a flight to quality as many investors flocked to safe Treasuries and sold other risky assets, including TIPS. Since both TIPS and Treasuries are backed by the full faith and credit of the U.S. government, both have the same near-zero default risk. Why would TIPS have sold off? Treasuries are the traditional tried-and-true, and Treasuries have roles in many places where TIPS do not (or where TIPS are rarely used) such as for collateral, meeting margin calls and, most of all, guaranteeing good liquidity. I discuss liquidity risk as a factor in TIPS below.

Panels A and B of Figure 11.5 show that the five-year real rate was negative and around --1% at December 2011. The ten-year TIPS yield (Panel C) was slightly below zero at this time. A negative real rate may seem surprising. Why would anyone want to buy a security and see it lose value in real terms over time? It is not a surprise from an economic point of view, however. While the older generation of models, which predate modern linkers markets, had trouble explaining the volatile...
real rates we see in the real world (newer models generate volatile real rates as investors’ assessments of risks change and firms’ financing and production opportunities change), they did accommodate the possibility of negative real rates.

In production models, the real rate represents how much future output is worth today: a real rate of 2% means that one widget today is worth 1.02 widgets next year. Usually this is positive because consumers are willing to forego output today for greater output in the future. The economy expands, on average, and there are positive production opportunities. With negative real rates, consumers want to consume today because output in the future is expected to be lower. Thus negative real rates can reflect shrinking future output opportunities—and a negative real rate is the ultimate bearish signal. This is the production interpretation of the real rate.

*(p.358) (p.359) (p.360)* A related consumption explanation is that the real rate is a price that investors use to gauge how expensive it is to shift consumption today to the future. It reflects the cost of foregoing eating today and instead eating tomorrow. Usually, consumption today is preferred, so eating one fruit today is equivalent to eating 1.02
fruits next year. But with a negative real rate, consumers prefer to save: eating tomorrow is actually better than eating today. This reflects extreme precautionary saving. Consumers are willing to shift consumption to later from today because they believe very bad times are a-coming—taxes will be high, economic growth will be low, there will be even more undue regulatory burdens, and even greater political uncertainty than today.

Periods of negative real rates are not uncommon. In Ang, Bekaert, and Wei (2008), I estimate real yields since 1952. Even though real yields were not traded in the United States prior to 1997, I can estimate real rates using a term structure model (see chapter 9), which ties together inflation and nominal yields, with assumptions on time-varying risk premiums, to infer the term structure of real rates. I find pronounced negative short-term real rates in the late 1950s and a second period extending over the late 1970s and early 1980s. Both periods were associated with accelerating inflation. I also find very long-maturity real rates have not turned negative. This is consistent with the TIPS data in the more recent sample where the twenty-year TIPS yield has not turned negative: on December 2011, the twenty-year TIP had a yield of 0.53% even though the five-year TIP had a negative yield.

The variability of real rates is one reason TIPS are a weak hedge against inflation. Over the sample for the data in Figure 11.5, the correlations of five-, ten-, and twenty-year TIPS yields with inflation are negative, at –23%, –12%, and –13%, respectively. As inflation increases, real yields tend to fall: unfortunately at the time investors most desire high real yields —when inflation is high—they are not forthcoming. Due to time-varying real rates, real bond portfolios are not so real.

4.4. Break-Even Inflation Compensation

In Figure 11.5, Panels B through D, Treasuries always have higher yields than TIPS and the distance between Treasuries and TIPS is fairly constant, except for the 2008 and 2009 financial crisis. The difference between nominal and real bond yields is labeled break-even inflation or inflation compensation (I use the two terms interchangeably, as the literature does):

\[(11.1)\]
(p.361) Break-even inflation in Panels B to D of Figure 11.5 is represented by the distance between the TIPS yield (solid line) and the Treasury yield (dashed line). Taking out the financial crisis in 2008 and 2009, break-even inflation is fairly stable. For example, for the ten-year maturity TIPS and Treasury bonds in Panel C, break-even inflation was 2.44% from July 2004 to December 2007, and from January 2010 to December 2012, it was 1.79%. For the twenty-year maturity bonds in Panel D, the corresponding numbers for the two periods are 2.66% and 2.35%.

TIPS yields are set by the market relative to Treasuries yields, for reasons that are not entirely clear, such that break-even inflation is fairly stable. During and after the financial crisis, the nominal yield on long-term bonds was pushed down partly by quantitative easing and other nonconventional monetary policies (see chapter 9) and partly as a flight-to-quality response by investors seeking the safety of Treasuries versus risky European and other sovereign debt. Except for the 2008 to 2009 period, the market prices TIPS yields at an approximately constant discount to Treasuries. Since Treasury yields are very low, this leads to negative real yields.

Break-even inflation, or inflation compensation, can be decomposed into two terms:

\[
(11.2) \quad \text{Break} - \text{EvenInflation} = \text{ExpectedInflation} + \text{RiskPremium}.
\]

If the risk premium is constant, then break-even inflation moves one-for-one with expected inflation. But since risk premiums vary over time, break-even inflation cannot be used directly as a measure of future expected inflation. When the variation in the inflation risk premium is small, changes in TIPS yields relative to the benchmark Treasury curves are statements of the market’s expectations about future inflation.\(^{13}\) Inflation risk premiums, however, change. Ang, Bekaert, and Wei (2008) show they were especially large during the Great Inflation of the 1960s and 1970s, during the late 1980s when the economy was booming, and during the mid-1990s (see also chapter 9 on fixed income).

Using the decomposition of break-even inflation in equation (11.2), we can interpret the negative break-even inflation rates
during the financial crisis as the market pricing in negative future inflation, or negative risk premiums, or both. Can we say which it is?

Inflation surveys turn out to be one of the best methods of forecasting inflation and beat many economic and term structure models, as Ang, Bekaert, and Wei (2007) show. Inflation expectations have been fairly stable for the sample considered in Figure 11.5, except in the financial crisis. At December 2008, the median (p.362) forecast from the Survey of Professional Forecasters predicted current CPI headline inflation during that quarter to be −2.6%, coming back to 2.0% during 2009. Thus the negative break-even inflation rates over 2008 and 2009 were consistent with market participants forecasting dire, Japan-like deflation scenarios during that time. At the same time, the flight to safety in Treasuries, which forced up Treasury prices and drove down Treasury yields, was consistent with Treasuries having a negative risk premium. Investors so desperately wanted Treasuries that they were willing, on a risk-adjusted basis, to pay to hold them (there was a negative risk premium) rather than demanding to be paid to hold them (the normal positive risk premium). So both the deflation scenario and the negative risk premiums were important.

4.5. Illiquidity

An important factor in TIPS markets is illiquidity risk. The TIPS market was illiquid during the first few years after TIPS were introduced, up to around the early mid-2000s, and is still much less liquid than Treasuries. Since many of the investors preferring TIPS are pension funds and retail investors, Sack and Elasser (2004) predict the TIPS market will remain more illiquid than the Treasuries market, where there is a larger concentration of active fund managers.

Researchers estimate the TIPS illiquidity risk premium was around 1.0% for the five-year TIPS and between 0.5% and 1.0% for ten-year TIPS up until around 2003 and 2004. In 2004, illiquidity risk premiums fell substantially to well below 0.5% for both the five- and ten-year TIPS. They dramatically spiked to above 2.5% during the financial crisis, and after 2009 have gone back to below 0.5%.
The illiquidity risk premium makes TIPS yields higher than what they would be if they had the same liquidity as Treasuries. That is, liquidity-adjusted real yields would be lower, and thus even more negative at December 2011, than what we observe in TIPS markets. Liquidity-adjusted inflation compensations would be also higher than the raw inflation compensations. Thus if negative real rates reflect investors’ expectations of very bad times in the future, the bad times are predicted to be even worse after adjusting for liquidity risk.

4.6. TIPS and Taxes

Interest payments on TIPS, like the interest paid on conventional Treasury bonds, are subject to Federal income tax. Any inflation-adjusting increases in the principal of TIPS are also taxable. The tax code does not differentiate between real and nominal income—it is just income—so the investor’s after-tax yield is exposed to inflation risk. During periods of high inflation, the tax levied on the increased inflation-adjusted principal constitutes a loss of purchasing power; investors lose out on an after-tax basis when inflation is high. But during periods of deflation, the TIPS principal shrinks (at least until it reaches par value). This deflation adjustment is tax-deductible and is an offset to the TIPS interest income. Thus there is an after-tax benefit of deflation but an after-tax inflation penalty. Inflationary periods are much more common than deflationary ones, so the net tax effect, on average, is negative.

Because of this, TIPS are best held in tax-deferred accounts. (Taxes are discussed in chapter 12.) The retail version of TIPS is the I Savings Bond (I-Bond, for short). I-Bonds are real zero-coupon bonds. The interest and principal adjustments are paid at maturity or upon redemption by the investor. While interest on I-Bonds is subject to federal income tax, that tax is paid only at redemption. The interest paid is added back to the bond value, so there is a benefit from tax-deferred growth. The indexed principal is not taxed. Accordingly, individual investors should hold I-Bonds—rather than TIPS—in after-tax accounts. Individuals, however, can purchase only $10,000 of I-Bonds per year. I-Bonds also are not tradeable in secondary markets—if you want to cash out, you must redeem them.

4.7. Summary

1. The TIPS asset class is a poor inflation hedge.
The correlation of TIPS returns with inflation is close to zero. One reason “real” bonds are not so real is that real yields are volatile. The result is that TIPS are poorly correlated with inflation. While a single TIPS can be an inflation hedge, an investment strategy based on a rebalanced portfolio of TIPS is not.

2. Real yields can be negative for extended periods of time. Negative real yields mean a loss of purchasing power. You need to put aside a larger sum of money today than the cash flows you need to meet in the future.

3. An individual’s portfolio for retirement should not hold only TIPS. The exception is when the individual knows her future cash flow needs exactly and can immunize them immediately. Otherwise, the need to save over time opens up the investor to time-varying real rates, and then TIPS have little ability to hedge inflation risk. Even when you know your future cash flows exactly, you bear basis risk if your price basket of goods and services is not the CPI basket.

4. Liquidity is an important factor in TIPS markets. During bad times, you will have much less liquidity than traditional Treasury securities. Liquidity-adjusted real rates are lower than observed real rates.

5. Hold TIPS in tax-deferred accounts. If you want to hold linkers in an after-tax account as an individual, buy I-Bonds.

5. Commodities
Commodities are touted as natural hedges for inflation risk, especially because commodity prices enter many inflation indices. Commodity prices affect many items in the CPI basket. For example, oil prices directly affect gasoline, which has its own category in the CPI basket. Agricultural commodities, including wheat and corn, enter the price of food, which is another category in the CPI basket.

Commodities have become quite popular among institutional investors since the mid-2000s. Many institutions were attracted to them by the research of Erb and Harvey (2006) and Gorton and Rouwenhorst (2006), who showed that commodities had attractive returns and low correlations to stocks, bonds, and other traditional asset classes. These authors noted the good inflation-hedging ability of commodities. Yet, as we’ll see, only certain commodities—those linked with energy—have positive correlations with inflation, and those correlations are far from perfect.
5.1. Commodity Futures

Despite the popular belief that commodities are good for hedging inflation, the baseline case in economics is that in perfect markets with no extraction costs, prices of exhaustible commodities like gold and oil should have no correlation with inflation. Actual prices of exhaustible commodities should follow random walks, and forward prices should rise at the risk-free rate. The intuition is that in this perfect world, producers can costlessly adjust their production to shocks and all demand shocks—whether permanent or transitory—have permanent effects on the remaining supply of these commodities. For nonexhaustible commodities, new supplies are always being created, so the normal demand and supply mechanisms, which may not involve the general price level, are at play. There is no underlying economic foundation that says commodities must be (automatically) linked with inflation. Perhaps it is no surprise, then, that most commodities turn out not to have any relationship with inflation.

In the real world, of course, gold and oil prices do not follow random walks. The perfect-world case is still useful because it allows us to see the effect of production frictions and how the behavior of investors and producers causes commodity prices to change in a predictable fashion. Today’s economic models show that commodity prices reflect production costs. These vary over time, and, once you start production, you can’t get your money back (they are irreversible investments), which impart an option value to delay production in the presence of uncertainty. Commodity prices also are driven by supply shocks to current and future substitutes, technological change—for example, a clean energy breakthrough that makes oil obsolete—and time-varying storage costs. Some papers emphasize the role of speculators and other types of investors. Speculators, for example, can cause commodity prices to temporarily swing away from fundamentals. Many of these factors do not have a direct bearing on inflation.

That many factors influence commodity prices means plenty of scope for active management in commodity investments. Commodity markets exhibit the same value and momentum effects, and other cross-sectional predictability phenomena, as equities and bonds. Commodity Trading Advisors (CTAs), in fact, are often a byword for momentum-style trading. These value and momentum effects are manifestations of standard
investment factors (see Chapter 7). In addition, commodity prices respond to hedging pressure, relative scarcity, and demand and supply imbalances, as predicted by economic models.\textsuperscript{22} Open interest and other asset prices, including exchange rates, also forecast commodity prices.\textsuperscript{23}

5.2. Commodity Factors

Commodities are usually not held physically by financial investors because of storage costs. Instead, investors gain commodity exposure through futures markets. An exception is the small group of investors who directly hold precious metals, but even in this case most investors seeking precious metal exposure (directly or indirectly through intermediated funds) invest through futures. Even for producers, the storage costs of some commodities, like electricity, are close to infinity.

Table 11.6 lists the performance of various commodity futures investments from the Goldman Sachs Commodity Index (GSCI) along with their correlations (p.366) (p.367) to stocks, bonds, and various macro factors. The overall GSCI is a weighted combination of various commodities. With an approximate exposure of 80\% to various types of oil and gas, this index heavily weights energy.
### Table 11.6

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>8.92</td>
<td>7.77</td>
<td>7.25</td>
<td>9.53</td>
<td>12.65</td>
<td>6.68</td>
<td>5.41</td>
<td>2.37</td>
<td>2.80</td>
</tr>
<tr>
<td>Stdev</td>
<td>20.71</td>
<td>15.99</td>
<td>15.39</td>
<td>32.95</td>
<td>32.90</td>
<td>14.30</td>
<td>12.55</td>
<td>18.35</td>
<td>1.12</td>
</tr>
<tr>
<td>Sharpe [raw]</td>
<td>0.43</td>
<td>0.49</td>
<td>0.47</td>
<td>0.29</td>
<td>0.38</td>
<td>0.47</td>
<td>0.43</td>
<td>0.13</td>
<td></td>
</tr>
<tr>
<td>Correlations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>with Inflation</td>
<td>29%</td>
<td>2%</td>
<td>1%</td>
<td>23%</td>
<td>26%</td>
<td>25%</td>
<td>8%</td>
<td>-4%</td>
<td></td>
</tr>
<tr>
<td>with Ind Prod</td>
<td>11%</td>
<td>-7%</td>
<td>-9%</td>
<td>3%</td>
<td>9%</td>
<td>12%</td>
<td>9%</td>
<td>9%</td>
<td></td>
</tr>
<tr>
<td>with Bonds</td>
<td>-9%</td>
<td>0%</td>
<td>4%</td>
<td>-13%</td>
<td>-10%</td>
<td>-9%</td>
<td>-5%</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>with Stocks</td>
<td>14%</td>
<td>-3%</td>
<td>-10%</td>
<td>4%</td>
<td>7%</td>
<td>24%</td>
<td>30%</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>with VIX</td>
<td>-18%</td>
<td>-4%</td>
<td>-1%</td>
<td>-11%</td>
<td>-13%</td>
<td>-23%</td>
<td>-21%</td>
<td>-12%</td>
<td></td>
</tr>
</tbody>
</table>
From January 1986 to December 2011, the GSCI has returned 8.9% with a standard deviation of 20.7%. The raw Sharpe ratio, without subtracting a risk-free rate, is 8.9%/20.7% = 0.43. For comparison, the raw Sharpe ratios on stocks and bonds were 0.66 and 0.94, respectively, during this period. The low correlations of commodity future returns with stocks and bonds (at 14% and –9%, respectively) make commodities compelling investments. There is tremendous diversification potential in adding commodities to traditional stock and bond portfolios (see chapter 3).

Commodities offer some inflation protection, but they certainly are not a perfect hedge. The overall GSCI correlation with inflation is 29%. This reflects the relatively good inflation-hedging performance of energy futures. The correlations of crude oil and energy overall (which lumps crude oil, Brent crude oil, unleaded gas, heating oil, gas oil, and natural gas together) with inflation are 23% and 26%, respectively. Nonenergy futures are poor inflation hedgers. Agriculture, for example, has only a –4% correlation with inflation. Precious metals, which include gold, and gold on its own have low correlations of only 2% and 1%, respectively, with inflation.

Table 11.6 also lists correlations of commodities with industrial production growth (measured year on year) and the VIX volatility index. Commodity returns, especially energy and agriculture, are higher when economic growth is high. The correlations with economic growth are around 10% and so are lower than the correlations with inflation. It is notable that precious metals have slight negative correlations with growth —indicating that precious metals have some value as insurance when the economy performs poorly, but the correlations are below 10% in absolute value. Volatility is also a factor: the correlation of GSCI with VIX is –18%, which comes through energy and agricultural commodities performing poorly when volatility is high. Precious metals, in contrast, have almost no correlation with inflation.

In summary, only energy commodities have hedged inflation and even then the correlations are far from one. Energy and agricultural futures tend to perform badly when growth is low and volatility is high. Precious metals, in contrast, move fairly independently of macro factors.

5.3. Spot, Cash, and Roll Returns
Commodity futures returns have three parts and all of them are important:

1. **Spot return**
   This is the return earned by changing physical commodity prices in spot markets.

2. **Cash or collateral return**
   The cash return is the interest earned on the collateral (or the margin) investors are required to post to trade futures contracts.

3. **Roll return**
   Investors desiring constant exposures to commodities must roll over their exposures to new futures contracts as the old ones expire. As they sell futures contracts that are about to expire and buy new ones, they incur capital gains or losses.

Table 11.7 breaks the average total returns of the GSCI into spot, cash, and roll return components. Figure 11.8 plots the rolling two-year average of these return components over time. From January 1970 to December 2011, the average 11.3% GSCI total return included a spot return of 6.4%, a cash return of 5.6% and a −0.7% roll return. During the 1980s, however, the spot return was negative, at −0.4%, but overall commodity futures returns were still positive because the losses in commodity spot markets were offset by high interest earnings on collateral, with a cash return of 9.1%, and a positive roll return of 2.4%. In the 2000s, the roll return was −7.5%, but spot commodity markets did well, at 13%, so the total GSCI return was positive.
Table 11.7
### Average Returns of GSCI Commodities Index

<table>
<thead>
<tr>
<th></th>
<th>Spot</th>
<th>Cash</th>
<th>Roll</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970s</td>
<td>11.1%</td>
<td>6.6%</td>
<td>4.0%</td>
<td>21.6%</td>
</tr>
<tr>
<td>1980s</td>
<td>-0.4%</td>
<td>9.1%</td>
<td>2.4%</td>
<td>11.1%</td>
</tr>
<tr>
<td>1990s</td>
<td>0.8%</td>
<td>5.0%</td>
<td>-0.5%</td>
<td>5.3%</td>
</tr>
<tr>
<td>2000–2011</td>
<td>13.0%</td>
<td>2.3%</td>
<td>-7.5%</td>
<td>7.8%</td>
</tr>
<tr>
<td>1970–2011</td>
<td>6.4%</td>
<td>5.6%</td>
<td>-0.7%</td>
<td>11.3%</td>
</tr>
</tbody>
</table>
Figure 11.8 shows that the variation in the spot return is much larger than the variation in the roll and cash returns. We can decompose the variation of total GSCI returns into:

\[
\text{var(total return)} = \text{var(spot)} + \text{var(cash)} + \text{var(roll)} + 2\text{cov(spot, roll)} + 2\text{cov(spot, cash)} + 2\text{cov(roll, cash)}
\]

The cash and the roll components play important roles in the overall return of commodities, but the variance in the commodity future return is almost entirely due to movements in underlying spot markets. Thus all the risk is coming from spot markets. But to understand the expected returns, you need to understand all the factor drivers of all three spot, cash, and roll components.

Spot commodity markets are affected by production factors and investor behavior discussed in Section 5.1.

Interest rate factors determine the cash return (see chapter 9). Because you do not earn negative interest rates on collateral (at least not yet), the cash return is always positive.

The roll return depends on the slope of the futures curve. When the futures curve is upward sloping, called contango, there is a negative roll return. When markets are in contango, an investor must replace the currently expiring futures contract with the next-maturity contract that is more expensive. This involves selling low and buying high, and so the roll loses money. A downward-sloping futures curve is called backwardation. When markets are backwardated, the investor sells the expiring futures at a high price and is able to buy the next-maturity contract at a low price. Selling high and buying low in backwardated futures markets makes money. But not always, because commodity markets can quickly change between backwardation and contango.

Whether the futures market is in contango or backwardated depends, among other things, on the usual elements of supply and demand plus the cost of storage, inventory imbalances, and convenience yield. The latter refers to the reward producers receive for storing a commodity, which investors do not receive: being able to keep production on schedule, the ability to profit from increasing production at
short notice, and the ability to profit from temporary shortages in the commodity.

Returns on commodities depend crucially on the behavior of long-dated futures, so commodity investors need to keep an eye on the shape of the futures curve. In Table 11.7, the negative roll return in the 2000s was due to highly backwardated oil markets in 2008. The movement of the oil futures from contango in 2007 to backwardated in 2008, causing negative roll returns, was a double whammy for many investors who were already hurt by falling oil prices (negative spot returns) during that period. Most other commodity markets at that time were in contango.

Investors expecting positive commodity returns when commodity prices are increasing in spot markets will be in for a nasty surprise when their investments in futures turn out to be quite different from the spot returns. The United States Oil Fund is one of the largest exchange-traded funds (ETFs) with approximately $1.3 billion net assets as of July 2012 (see chapter 16 for details on 40-Act funds) and is designed to track the price of oil.

The USO doesn’t hold physical oil: it holds oil futures and is forced to roll every thirty days. Figure 11.9 plots the one-year moving average of USO returns versus crude oil spot returns from April 2007 to December 2012. There are pronounced discrepancies between the crude oil spot return and the USO return; on average, the USO return is 1.4% lower. This is due to the roll, as the cash return during this span was close to zero. The shape of the futures curve—contango or backwardation—determines the sign of the roll return. In addition, large investors forced to roll on pre-determined schedules have to pay large transactions costs. Bessembinder et al. (2012) estimate that ETFs pay about 30 basis points on average per roll, or approximately 4.4% per year in oil futures markets. ETFs need liquidity for the roll, and this is the premium they must pay for it in the futures markets.
5.4. Gold

Gold is not a good inflation hedge. A case can be made for gold in an investor’s diversified portfolio, but it cannot be made on the basis that gold is a real asset.

There are two popular misconceptions about gold: first, that gold is an inflation hedge in terms of how gold moves with inflation (the correlation of gold with inflation); and second, that the long-run performance of gold handily beats inflation (the return of gold, on average, is greater than inflation). Let’s examine both. Using data from Global Financial Data, I plot the real price appreciation of gold in Panel A of Figure 11.10 from September 1875 to December 2011. The real price appreciation is defined to be the price of gold divided by CPI. I normalize the index to be 1.0 at the beginning of the sample. The correlation of annual returns of gold and inflation is 23% in Figure 11.10. To repeat: gold is far from a perfect inflation hedge.
If the long-run returns of gold were exactly the same as inflation, then the graph of gold’s average real return over time should be exactly a horizontal line. From 1875 to the early 1930s, the price of gold declined in real terms. In 1933 real gold prices suddenly jumped upward when President Franklin Roosevelt signed Executive Order 6102 forbidding the private holdings of gold—one of many attempts to stabilize the financial system during the Great Depression. In 1934 the United States defaulted. The 1934 Gold Reserve Act changed the value of a U.S. dollar from $20.67 per troy ounce to $35. This was an economic default but not legal default. Reinhart and Rogoff (2008) label it an explicit default: the United States reduced the value of its debt payments relative to an external measure of value (at that time, all major currencies were backed by gold).

Real gold prices started rising dramatically in the early 1970s, when the Bretton Woods system of fixed exchange rates broke down. In 1979 and 1980, the real price of gold skyrocketed from below 0.5 to above 3.0 as Fed Chairman Volcker jacked up interest rates to end the Great Inflation. Once inflation stabilized, gold lost much of its value in real terms. Since 2000, however, real gold prices have relentlessly marched upward. At the end of the sample at December 2011, the real price was above 2.0.

Figure 11.10
The time variation in real gold prices in Panel A of Figure 11.10 unequivocally rejects the hypothesis that gold returns are driven only by inflation. Gold has not been an inflation hedge over the past 130 years. Erb and Harvey (2013), however, document that over the extremely long run, gold may have a higher return than the inflation rate (the mean effect), even though gold does not correlate highly with inflation (the inflation hedging ability). Erb and Harvey compare the pay of a U.S. Army private today with that of a legionary during the reign of Augustus (27 BC to 14 AD), the first emperor of the Roman Empire. Erb and Harvey find the pay of U.S. army privates and Roman legionnaires very similar when stated in ounces of gold. They also find the pay of a U.S. army captain approximately the same as that of a Roman centurion, when expressed in gold. So, over centuries, gold tracks inflation, at least in preserving the long-run level of military pay. If only we could live so long.

Sadly, these extremely long horizons are not relevant for most investors. Only a few institutions—the Catholic Church, the Padmanabhaswamy Temple in Kerala, India (founded in the sixteenth century and possessor of $22 billion in gold), and certain universities such as the University of Bologna (the world’s first, founded in the eleventh century)—have survived for many centuries. But having survived for centuries does not mean these institutions’ planning horizons are centuries-long. The long-term investors of today—pension funds, endowments, family offices, sovereign wealth funds—do not plan 1,000 years ahead.

Gold may serve valid roles in an investor’s portfolio, but being an inflation hedge is not one of them (at least for horizons less than a century). So why invest in gold?

Ray Dalio, a superstar hedge fund manager who popularized risk parity (which is a special case of mean-variance investing; see chapter 3), makes an argument that gold “is a very under-owned asset” and that if many investors move to increase their
Holdings of gold to the level reflective of gold’s market capitalization in a world wealth portfolio, the gold price should increase. At first glance, this is a silly argument. All the gold in the world—whether in the ground, stored in a vault, or even resting in a shipwreck on the seabed—is already owned by someone. Dalio’s argument can work only if there are market participants who buy to increase their holdings of gold to market capitalization weights and are completely insensitive to the price they pay. That is, some investors must have perfectly inelastic demand curves. There may be some institutions like this—some central banks, the growing rich and middle-class populations in emerging markets, and perhaps some pension funds that (mistakenly) believe gold is an inflation hedge. Erb and Harvey (2012) estimate that the market weight of gold as a fraction of total wealth ranges between 2% and 10%, depending on whether you count only the gold held by investors or the entire gold supply, which includes gold yet to be mined and gold held by central banks.

When I look at Panel A of Figure 11.10, I am struck by the very long-term mean reversion exhibited by the real price of gold. The correlation of twenty-year real returns of gold with lagged twenty-year real returns of gold is −63%—a staggering number in absolute value terms. When the real price of gold has been high, the subsequent long-term performance of gold has been low. This should be a warning to all asset owners adding to their gold holdings now. The classic error of an investor chasing returns is to invest after past returns have been high, while current prices are high. Subsequent returns often end up disappointingly low.

I close with a look at the real performance of gold relative to equities in Panel B of Figure 11.10. The line for gold is exactly the same as in Panel A, except the scale on the y-axis has been drawn to be logarithmic. Panel B overlays the real price of equities also starting at 1.0 at September 1875. The equity market simply clobbers gold in real terms.

6. Real Estate
Real estate is all about space. To be more specific, real estate investing is about creating and maintaining structures to remove physical space between people and institutions. There are two core models in urban economics that articulate the fundamental sources of demand and supply for real estate. Central to both is the concept of spatial equilibrium, which states that people and firms invest in real estate in such a way that they are indifferent about where they locate.\(^{28}\) Agents’ utility and, ultimately, real estate values, are affected by the amenities provided by real estate—which include proximity to customers and suppliers, human capital spillovers, and the innate advantages of geography, including gorgeous views and nice weather. Real estate values are also affected by workers’ income, housing costs, and transportation costs.

The Alonso (1964), Mills (1967), and Muth (1969) model explains real estate prices \emph{within} a given city in terms of distance to centers of production: as transportation costs increase, real estate prices fall. The second workhorse model, Rosen (1979) and Roback (1982), explains how real estate prices differ \emph{across} different cities and metropolitan areas because of different incomes, amenities, and productivity levels. Higher land values are the price of entry to metropolitan areas with more productive firms or better amenities (which includes more cultural activities, less crime, better schools, and more comfortable weather).

The realtors’ mantra of “location, location, location” gets it only half right. Location certainly is the primary driver in the Alonso-Mills-Muth model, but it matters because of transportation costs. The Rosen-Roback model emphasizes that it is not location per se but the interaction of location’s advantages (enabling trade or production, for example) with the productive capabilities of firms and workers and other macro factors.

\textbf{(p.375)} Asset owners with real estate investments should start with urban economics as their foundation (no pun intended). Urban economics allows us to:
1. Understand macro factors
Economic models are especially good at explaining how endogenous variables—which in this context are real estate prices, where people live, and how much housing they consume—are determined from exogenous variables, like geography, or slow-moving conditions like productivity levels. Economic models give insight into the fundamentals behind prices, including aggregate demand factors and supply restrictions. The emphasis on the macro drivers is especially important because real estate holdings are long-horizon investments, with a median holding period for individual institutional properties of over a decade.29

2. Place real estate in its context
Real estate prices, like all prices, are determined in equilibrium. I live in New York City where real estate prices are high, average wages are high, and the cost of living is high. From the point of view of a worker, the high wage is good. From the point of view of an employer, the high wage is bad. Why don’t firms shift away from New York and lower their wage bill? In equilibrium real estate prices can be high and wages can be high only if the city enables all workers and firms to be jointly more productive. What creates this productivity? What sustains it? What will cause the productivity to disappear? Real estate can only be understood as part of an economic whole.
3. Evaluate policy

Government policy matters in equity and fixed income markets (see chapters 8 and 9, respectively), but in real estate, policy is crucial. The value of real estate cannot be divorced from the regulations governing its use. Economic models are especially good at measuring the effects of exogenous policy changes (through *comparative statics* exercises). An extremely important determinant of real estate prices is the supply of real estate. In the “superstar cities,” which include San Francisco, Boston, and the like clustered on the coasts, the supply of new housing and office space is more tightly restricted by regulation. This creates scarcity, which drives up prices. Atlanta, on the other hand, has few supply restrictions, and real estate prices are low compared to cities on the coasts. Government policy matters from city to city, but it is as important in determining real estate prices within cities. If policy regarding supply is changed, all else equal, economic models allow us to predict which areas benefit and which areas suffer and by how much.

(p.376) 6.1. Direct or Indirect?

I concentrate my analysis on institutional direct real estate investment and indirect real estate investment through REITs. REITs are mutual fund-like vehicles allowing broad ownership of real estate assets. Many REITs are publicly traded. REITs have to satisfy many restrictions: most notably, they are required to distribute at least 90% of their taxable income each year to shareholders as dividends. REITs are one of the few ways retail investors can access commercial real estate markets and were created by Congress in 1960 through the Real Estate Investment Trust Act. Congress did not have the high-minded intention of allowing the masses access to the diversification benefits of commercial real estate; the REIT Act was originally a rider attached to An Act to Amend the Internal Revenue Code with Respect to the Excise Tax on Cigars and was passed after adept lobbying by the real estate industry so that developers could tap the equity market for additional funds.

Since direct real estate and REITs both involve buildings and land that generate cash flows, one would think the returns of
these two approaches would be highly correlated. Surely direct and indirect physical holdings of real estate must be driven by common fundamentals in the long run. But they are not, and this is called the REIT puzzle.

Table 11.11 reports means, standard deviations, autocorrelations, and cross-correlations of direct and indirect real estate returns along with equity returns from the beginning of 1978 to the end of 2011 at the quarterly frequency. The direct property returns are from the National Council of Real Estate Investment Fiduciaries (NCREIF), which collects property data from its members. NCREIF computes a value-weighted index based on appraisals on a quarterly basis. The indirect property returns are the FTSE NAREIT All Equity returns, also at the quarterly frequency. I compare these property returns with S&P 500 equity returns.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Stdev</th>
<th>Autocorrelation</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCREIF</td>
<td>0.0221</td>
<td>0.0225</td>
<td>0.7806</td>
</tr>
<tr>
<td>REIT</td>
<td>0.0347</td>
<td>0.0918</td>
<td>0.1070</td>
</tr>
<tr>
<td>S&amp;P 500</td>
<td>0.0301</td>
<td>0.0823</td>
<td>0.0711</td>
</tr>
</tbody>
</table>

**Correlation Matrix**

<table>
<thead>
<tr>
<th></th>
<th>NCREIF</th>
<th>REIT</th>
<th>S&amp;P 500</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCREIF</td>
<td>1.0000</td>
<td>0.1520</td>
<td>0.0900</td>
</tr>
<tr>
<td>REIT</td>
<td>1.0000</td>
<td>0.6265</td>
<td></td>
</tr>
<tr>
<td>S&amp;P 500</td>
<td></td>
<td>1.0000</td>
<td></td>
</tr>
</tbody>
</table>

Table 11.11 shows that NCREIF returns are very smooth (the quarterly autocorrelation is 78% and volatility is just 2.2%) compared to REIT and equity returns, which have autocorrelations close to zero and volatilities around 8% to 9%. Notably, the correlation between REIT and equity returns is high, at 63%, while the correlation between NCREIF and REIT returns is low, at 15%. Thus REITs resemble equities more than they resemble direct real estate. Hartzell and Mengden, who were industry practitioners at Salomon Brothers, were the first to document this phenomenon in 1986,
and they generated substantial discussion about the underlying nature of real estate returns. Was real estate indeed a separate asset class, or was it just a different version of equity (and debt)?

This debate continues in real estate economics today. My takeaways for asset owners from this long literature are:

**Direct Real Estate Returns Are Not Returns**

The NCREIF series (and the corresponding widely used Investment Property Databank series in Europe) have many data biases because the values are not based on market transactions. REIT returns, in contrast, are investable returns. There are two important and large biases:

1. **Smoothing bias**
   Using appraisals (done at most once or twice a year) artificially induces smoothness, which is why the autocorrelation of the NCREIF series is so much higher than REITs or equities in Table 11.11.

2. **Selection bias**
   The properties that you see sold are not representative of the entire stock. For example, perhaps only the best properties are sold because those are the ones a developer is sprucing up, while the foreclosed crummy ones are not being sold.

(p.378) In addition, REITs are levered while NCREIF returns are reported on an unlevered basis. Researchers have developed many methods to move from appraisals to transaction-level (and repeat-sales) indices, to desmooth real estate returns, to take into account selection bias, and to remove other illiquidity biases. The effects of these biases are enormous. Lin and Vandell (2012), for example, report that for a one-year holding period, the variance of direct real estate returns should be three times higher than the raw variance reported in Table 11.11. Pagliari, Scherer, and Monopoli (2005) argue that there is no difference in direct and indirect real estate returns after adjusting for leverage and sector composition and also adjusting direct real estate returns for appraisal smoothing.

Smoothing and selection biases are shared by all illiquid assets—including private equity—and I discuss methods of...
dealing with them in chapter 13. I use NCREIF returns for now, but you've been warned: these are not actual returns.
In the Long Run, Direct and Indirect Real Estate Returns Move Together

Direct and indirect real estate returns are linked in the long run. Figure 11.12 graphs the correlation of long-horizon log NCREIF returns with long-horizon log REIT returns. At the one-quarter horizon, the correlation is around 0.22, which reflects the low correlation between NCREIF and REIT returns in Table 11.11. (Quarterly returns in Table 11.11 are arithmetic returns but I use log returns in Figure 11.12; see the appendix.) After twelve quarters, the correlation tapers to around 0.43. Thus there are some long-horizon common components in NCREIF and REIT returns. Econometric studies also document strong evidence that public real estate markets lead private real estate markets, which is to be expected since price discovery should happen in markets that are liquid.36

The astute reader will be wondering at this point, if direct and indirect real estate do move together in the long run, is real estate a separate asset class given that the correlation between REITs and equities is so high (63% in Table 11.11)? CPPIB, the manager of the CAN$162 billion Canada Pension Plan, does not consider real estate a separate asset class; CPPIB practices factor investing when it invests in real estate and thinks of real estate as comprising equity and debt characteristics.37 In chapter 10, we also found that real estate did not seem to yield additional returns in excess of stocks, bonds, and REITs in factor benchmarks. But CPPIB is an exception: most investors regard real estate to be a separate asset class (or even factor). REITs cannot be the basis for this statement, given the high correlation of REIT returns with equities in Table 11.11. The statement is usually made using
direct real estate returns—but as we know, direct real estate returns are not returns.\textsuperscript{38} Although REIT and NCREIF returns do exhibit some commonality in the long run, the long-horizon correlations are far from one as Figure 11.12 shows. Thus:

**Direct and Indirect Real Estate Are Different**

Listed REITs seem to have one major advantage over direct real estate: they are liquid. But as of June 30, 2012, there were only 150 REITs traded on the New York Stock Exchange with a collective market capitalization of $545 billion. This is an average market capitalization of $3.6 billion for each REIT—smaller than many big real estate developments in the world’s leading cities. The FTSE NAREIT All Equity REITs Index had a total market capitalization of $562 billion. In contrast, Florance et al. (2010) estimate that the (direct investment) commercial real estate market in the United States totaled over $9 trillion at the end of 2009, even though the market lost over $4 trillion from 2006 to 2010.

If REITs have such a big liquidity advantage, why is the amount of money invested through REITs well below one-tenth of the total commercial real estate market? Why aren’t REITs more popular?

Structurally, REITs are different from direct real estate. Prior to the early 1990s, the REIT industry was very small because REITs were forced to retain external advisors to select and execute investment strategies. In 1986, REITs were allowed to select and manage their own assets and during the early 1990s many (p.380) reorganized to bring these roles in-house.\textsuperscript{39} The post-1990s is called the new REIT era for this reason.

Even today, however, the legal structure of REITs makes them different from direct real estate investment. Graff (2001) persuasively argues that there are still large agency costs associated with REITs imposed by their legal requirements.\textsuperscript{40} (See Part III of this book for agency problems in delegated asset management.) The 75% income test (relaxed somewhat in 1986) requiring that proportion of REIT income to be derived from real estate investments gives REIT managers greater incentives to commit capital to overpriced acquisitions than managers of private real estate partnerships. In addition, REIT managers collect a perpetuity in the form of management fees, while closed-end funds are usually...
scheduled to liquidate after a prespecified term and open-ended funds are supposed to liquidate after requests from investors. The 5–50 test to preserve the exemption of REITs from double taxation where each group of five or few investors cannot own more than 50% of the voting stock means that REITs cannot be taken over to remove poorly performing incumbent management. That REITs have higher average returns than NCREIF returns in Table 11.11 is consistent with the notion that REITs are riskier than direct real estate, and their higher returns compensate for the extra risk.

The legal structure of REITs can also lead to differences with direct real estate even when there are no agency considerations. The requirement that REITs pay out 90% of their income each year means REIT managers gravitate to properties already generating quality cash flows rather than investing in developments that require cash today to create cash flows in the future. On the other hand, there has been tremendous innovation in REITs recently with an abundance of issues in many new sectors, like health care, data centers, and storage. NCREIF is traditionally wedded to the “core” sectors of apartment, retail, office, and industrial partly because these new sectors are small—the markets for self-storage centers and server farms are tiny compared to the office market.

Overall, however, I believe these agency and legal differences are secondary. There are more similarities, especially over the long run, between REITs and direct real estate. This is as expected from economic theory, where underlying both are buildings and land, and this is borne out in empirical tests. The large divergences in short-run returns between direct real estate and REITs are mostly due to direct real estate returns not being returns.
6.2. Real Estate and Inflation

The literature is sharply divided on whether real estate is a good hedge for inflation. Fama and Schwert (1977) were the first to state that real estate was a perfect hedge for both expected and unexpected inflation. Fama and Schwert, however, used the housing component in the CPI, as they lacked direct real estate return data. For direct real estate, the results seem to be inconclusive. On the one hand, Goetzmann and Valaitis (2006) argue that direct real estate is a good inflation hedge. On the other hand, Huang and Hudson-Wilson (2007) find “that the conventional wisdom that real estate, as an asset class, is an effective inflation hedge is overly generous.” It is clear from the literature that REITs do not hedge inflation in the short run. Gyourko and Linneman (1998), for example, note that REITs are perverse inflation hedges.

I believe real estate offers some inflation protection but is far from an effective inflation hedge. That is, real estate is only partially real.

In Figure 11.13, I plot correlations of direct and indirect real estate returns with inflation over various horizons. I also overlay correlations of equity returns with inflation for comparison. We saw in chapter 8 that equity was a poor inflation hedge. Panel A plots classical (Pearson) correlations. REIT return correlations with inflation are slightly higher than equity correlations, but only just, and these increase from just above 0.1 at the one-quarter horizon to around 0.4 at the five-year horizon. NCREIF correlations are around 0.4 at the one-quarter horizon and decrease slightly to 0.3 at the five-year horizon. NCREIF returns, as I emphasized before, should not be trusted at short horizons due to illiquidity biases. It is comforting, though, that at long horizons, where the illiquidity biases are mitigated, the correlations for both REIT and NCREIF returns are both around 0.3 to 0.4. Real estate provides a partial inflation hedge at long horizons but not at short horizons.
Panel A of Figure 11.13 is an overly generous representation. In Panel B, I graph robust (Spearman) correlations. These are lower than the Pearson correlations in
Panel A. Both the REIT and stock correlations with inflation are negative at short horizons, with correlations around –0.1. (This is consistent with the findings for equities in chapter 8.) After one year, REIT correlations with inflation are a little higher than stock correlations. At the five-year horizon, the correlation of REIT returns with inflation is approximately 0.4, very similar to the number in Panel A. The robust calculations in Panel B for the NCREIF series have brought down the correlations with inflation significantly. Now the NCREIF correlations with inflation are around 0.2 at the one-quarter horizon, have a hump-shaped pattern increasing to around 0.3, and end at the five-year horizon back around 0.2.

In Panel C of Figure 11.13, I graph correlations of inflation with a common real estate factor from June 1980 to December 2011. I construct this real estate factor in Ang, Nabar, and Wald (2013), where I extract common movements in real estate returns from REITs and two direct real estate indices based on the NCREIF database (one is an appraisal-based property index and one is a transaction-based index). All the indices are adjusted to have the same sector composition and leverage (delivered REIT returns). The goal is to capture joint movements in an overall real estate cycle while allowing specific real estate sectors freedom to move up and down relative to that overall cycle. Panel C, not surprisingly, shows that the correlation of the real estate cycle with inflation is between the NCREIF and REIT correlations in Panels A and B. The robust correlations are close to zero at short horizons. They peak around 0.3 at the three-year horizon and end at 0.2 at the five-year horizon.

In summary, real estate is not that real. It provides some inflation protection at long horizons but not at short horizons.

7. How Real Is Real Estate? Redux
I’ve shown that real estate is partly, but far from completely, real.

Carole has several considerations in writing her report in addition to just the inflation-hedging ability of direct real estate. In particular,

(p.384) 1. Idiosyncratic risk is large.
Since there are no return series for direct real estate, benchmarking a single real estate investment or a portfolio of real estate properties is an important problem. Moreover, the “return” from the fund’s real estate portfolio can differ significantly from a benchmark index—and neither represents true returns. This is also related to ...

2. Heterogeneity across properties.
Carole’s fund is likely buying only a few properties, and in an extreme case only one. While we have talked about property at an “index” level, there can be large differences across property sectors and even across properties within a given sector. Different property sectors offer different inflation-hedging abilities. Huang and Hudson-Wilson (2007) find that office is the best property sector at hedging inflation risk and retail one of the worst.

3. Investment vehicles typically involve high leverage.
Real estate investment is more than just a real estate play. Most real estate investment vehicles bundle fixed income factors as well. This is all the more reason for thinking about factors and looking through the “real estate” label.

4. Active management.
Bond and stock investments can be passive. But direct real estate investment can be done actively only to maintain and enhance returns. Active management requires selecting a manager, which in turn means agency issues. I take up these considerations in Part III of the book.

If real estate is not that real, what drives real estate returns? We circle back here to the baseline models in urban economics—property market fundamentals matter, and movements in consumer or producer prices are just one of many factors affecting spatial equilibriums. Other macro factors, including interest rates and economic growth, also play a role.42

The micro level matters, too. Direct real estate returns comprise both income components and capital gains, but cash components matter more in the short run due to the illiquid nature of direct real estate. A long-term lease that has inflation-indexed rents and is triple net (where all operating
expenses such as taxes, insurance, utilities, and maintenance are paid by the tenant) is a perfect income inflation hedge. The worst income inflation hedge is a long-term contract with a fixed rent where the landlord is responsible for all expenses.

So what is a real asset? The best one in this chapter turns out to be cash (T-bills), in terms of moving together with inflation. Cash is too often underestimated as an inflation hedge. But T-bill returns are lower than the expected returns of other asset classes. Carole should note that real bonds are definitely not that real, and gold is badly overrated as an inflation hedge. It is challenging to find assets that deliver steady real returns—but that is exactly why these assets have risk premiums in the long run. Factor theory says that these assets carry risk premiums because they do not pay off during bad times, when investors most desire cash flows. Times of high inflation are bad times. That most risky assets, including “real” assets, are not perfect inflation hedges is why these assets have long-run risk premiums.

Notes:

(1) This example is based on the case “Is Real Estate Real?” CaseWorks ID#111704.

(2) In particular see DeLong (1997), Sargent (1999), Meltzer (2005), and Nelson (2005).


(4) “Forecasting” current economic conditions is called nowcasting, and econometricians have developed sophisticated models to do this. See Giannone, Reichlin, and Small (2008).


(7) Since CPI is released with a two-week delay, there is actually a two and a half month lag between the actual release of CPI and the indexation adjustment.

(8) Jacoby and Shiller (2008) show that the value of the deflation put can be large.
“Real” Assets

(9) Well, not quite. There is still the reinvestment risk associated with the coupons of the bond. One would technically need to buy and hold a TIPS zero-coupon bond to receive a constant real yield. The text ignores this consideration.

(10) Bodie makes his case in a series of papers and books, most recently in Bodie and Taqqu (2012).


(12) Ramsey (1928) was the first to characterize the real rate as a function of consumers’ preferences and output growth. Another early contribution was Fisher (1930), who derived that the real interest rate should reflect the marginal benefits of real firm investments.

(13) Fleckenstein, Longstaff, and Lustig (2010) argue that TIPS and Treasuries are mispriced relative to each other with TIPS being cheap and Treasuries being expensive. They claim this is the “largest arbitrage ever documented in the financial economics literature.”

(14) See D’Amico, Kim, and Wei (2009), Gürkaynak, Sack, and Wright (2010), and Pflueger and Viceira (2011).

(15) If you use I-Bonds to pay for education expenses and you meet certain income limits and other restrictions, you will not pay any tax.

(16) See Bodie (1983) and many others.

(17) The Commodity Futures Modernization Act of 2000 also made it easier for institutional investors to take commodity positions.

(18) Hotelling (1931) was the first to show this. Weinstein and Zeckhauser (1975) and Pindyck (1980) show this under uncertainty.

(19) Carlson, Khokher, and Titman (2007) show that these effects give rise to stochastic volatility and determine the shape of the forward curves.
“Real” Assets

(20) Keynes (1923) and Hicks (1939) developed the first model of this type. Another seminal paper is Deaton and Laroque (1992).


(22) An important paper in this literature is Bessembinder (1992). Relative scarcity or demand in one commodity also spills over into other commodities, as Casassus, Liu, and Tang (2013) show.


(26) Perhaps Norway is an exception. The Norwegian sovereign wealth fund pays out approximately 4% of the fund to the Norwegian government each year (the Handlingsregel). The Norwegian government fully funded the construction and is meeting a large part of the operational costs, of the Svalbard Global Seed Vault, which seeks to preserve seeds of plants around the world in a remote, secure underground cavern near the North Pole. It is insurance for the world in case of a global catastrophe.


(29) Fisher and Young (2000) report a median sale period of eleven years for the properties in the National Council of Real Estate Investment Fiduciaries (NCREIF) database.


(32) For a theoretical basis of this proposition, see Carlson, Titman, and Tiu (2010).

(33) There are two minor biases in addition to these two main ones. The first is an index construction bias, which is that repeat-sales indexes, which are developed to deal with appraisal bias, are equal-weighted cross-sectional estimators. But returns of equal-weighted portfolios are arithmetic averages of cross-sectional individual asset returns. I warned you that this was technical! The second is that the time a property is on the market differs in “hot” versus “cold” real estate markets. A paper that deals with all four biases is Fisher et al. (2003).


(40) See also Sagalyn (1996) who documents agency problems in REITs.

(41) Glascock, Lu, and So (2002) argue that this is because the observed negative relation between REIT returns and inflation is statistically spurious and explained by other macro factors, especially monetary policy shocks. This is similar to Fama’s (1981) argument on why equities are a poor hedge to inflation (see chapter 8). Case and Wachter (2011) take a contrary view and argue that REITs are good inflation hedges, but they do not define inflation-hedging ability as a correlation (or beta) with inflation.

“Real” Assets

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