# TRADING HOUSE PRICE RISK WITH EXISTING FUTURES CONTRACTS

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**Abstract**

This paper examines the use of futures contracts to hedge residential real estate price risk. We examine whether existing futures contacts can effectively be used to offset volatility in national house prices. Little evidence of any simple systematic relation between national prices and futures prices is found. Since house prices are not easily replicated with a portfolio of existing futures contracts, a further implication is that the Chicago Mercantile's introduction of a financial asset whose value reflects house prices will help complete the market.  Nevertheless, the success of the CME's new derivative contracts may be limited in light of state and regional house price correlations.

**INTRODUCTION**

In examining the use of derivatives contracts to manage risk, the typical consideration involves hedging strategies for commodities or financial assets. We examine the feasibility of using existing futures contracts to trade a different type of asset, residential real estate. Until now, there have been few options for individuals to reduce the risk of their real estate ownership.[1] While homeowners can insure themselves in movements in interest rates with derivatives on fixed income securities, there remains the problem of reducing the risk associated with general movement in house prices.

Individuals expecting to move to a new area also face house price risk. For example, individuals transitioning between jobs might be concerned about rising prices of homes in their new area of residence. Anticipating their move and purchase of a new home, an individual could enter a hedge position to profit from unexpected price increases. In addition to the anticipatory hedge, investors wishing to diversify their portfolio might also be interested in a long position that gains with an increase in house prices.

The potential for buying and selling house price risk is substantial. By the end of 2005, the value of residential homes equaled $21.6 trillion, comparable in size to the $17.0 trillion in domestic equities and $25.3 in fixed income assets. In addition to the magnitude of the market, house price volatility has been considerable. Quarterly changes of more than 8% (annualized) have been observed in U.S. aggregate house prices in 1 out of 10 quarters in the last 20 years. This masks the severe volatility in regional prices such as the 28% (annualized) increase in Seattle house prices in the late 1990s and the 12% (annualized) decrease in Houston house prices in the mid 1980s reported by Case et al. (1993).

Whether house prices are tied to one or a small number of futures prices is largely an empirical issue. If there is high correlation between house prices and a portfolio of futures prices, it should be possible to effectively hedge house price risk with existing futures contracts. Our initial analysis includes estimation of minimum variance regressions and is similar to the empirical work of Herbst (1985), who considers the efficacy of hedging inflation risk with traded futures.

In the following analysis, the hedge portfolio includes an inflation futures contract. If, as is frequently believed, housing is a hedge against inflation, the reverse should also be true. While a futures contract on the Consumer Price Index began trading on the Chicago Mercantile Exchange in 2004, we develop a synthetic futures price series for our sample period based on inflation forecast data to consider the efficacy of hedging house price risk with the CPI futures contracts.[2]

As a practical matter, our hedging analysis also yields implications for market completeness. If a portfolio of futures contracts replicates or nearly replicates changes in house prices, then the Chicago Mercantile Exchange's introduction of a new housing security would not further complete financial markets. Putting aside transaction costs, anyone wishing to buy or sell house price risk could do so through the trading of existing derivatives. If, on the other hand, the empirical evidence finds that currently traded derivatives do not effectively hedge house price risk, the analysis would further motivate the CME's introduction of housing futures and option contracts.

The S&P/Case-Shiller® home price index provides the basis for the underlying value of the different CME housing derivatives that began trading on May 22, 2006. Initially, the CME listings include 10 different U.S. cities plus a "national" contract based on a composite index of the 10 metropolitan areas.[3] Futures trading occurs on the Globex, the CME's electronic market futures contracts, while futures options trade via open outcry in the Goldman Sachs Commodity Index (GSCI) pit.

The CME's new derivatives are not the first examples of house price securities. Previous cases of financial assets based on real estate include stocks and bonds that began trading on the New York Real Estate Securities Exchange in 1929. Unfortunately, with the collapse of real estate security prices and capital markets in general, the SEC decertified the NYRESE as a national market in 1941. More recently, residential and commercial real estate futures contracts traded for a few months on the London Fox Property Futures Market. Case et al. (1993) attribute the failure of the contracts in 1991 to the public's lack of appreciation and understanding of such markets.

Whether such appreciation for housing markets now exists remains to be seen. However, the ultimate success of the housing futures contracts depends upon whether they serve the needs of hedgers as well as speculators. In a second part of our investigation, we examine the correlation between local house prices and both national and regional figures. While institutions may hold a diversified portfolio of real estate assets that span the country, the individual investor likely owns a house in one or two areas so that price risk is a localized issue. Thus, the last part of our analysis considers the question of how effective hedging of local real estate would be using a futures contract based on either a national index or regional index. Specifically, we first examine hedging state housing prices with a U.S. house price futures contract and then look at the correlation between state and regional indices. The hedging effectiveness results in part two yield further implications for the likely success of the CME's housing contracts.

## DATA AND METHODOLOGICAL CONSIDERATIONS

In the first part of our analysis, we investigate the effectiveness of hedging real estate prices with existing futures contracts. Table 1, Panel A lists the 31 futures contracts that we consider as possible hedging instruments. The list covers both commodity and financial futures and includes important contracts on interest rates, foreign currencies, equity indices, energy, metal, food, grain, and meat. These are the futures contracts that have been continuously traded since the introduction of equity index futures in the early 1980s.

To measure house prices, we initially consider two indices. The first is the House Price Index (HPI) produced by the Office of Federal Housing Enterprise Oversight (OFHEO). The HPI is a weighted-repeat sales index for single-family detached residential properties. To be included in the index calculations, property must have a conventional mortgage originated and purchased by the Federal Home Loan Mortgage Corporation (Freddie Mac) or the Federal National Mortgage Association (Fannie Mae). The national sample had approximately 29 million transactions as of 2005. OFHEO produces quarterly estimates of the HPI for states, U.S. Census divisions, and the United States.

The HPI is similar in concept to the S&P/Case-Shiller® home price index used by the CME.[4] Both methods calculate the index value based on repeat home sales. However, there are important differences that for our purposes favor the use of the HPI for our analysis. The first difference is that the HPI data goes back further than the S&P/Case-Shiller® home price index and allows us to analyze a longer time series that matches up with the futures data. The second advantage is that the HPI exists for all 50 states, 9 geographic regions and a national index based on the entire country. (States and their

OFHEO regions appear in Table 1, Panel B.) This enables us to make inferences concerning how effective futures hedging might be for investors in local markets.

For completeness, we also initially consider the constant-quality new home price index calculated by the Bureau of the Census (hereafter the Census Index). This index compares the sales price today to the base year price for the same quality house. Quality means not only adjusting for size and house amenities, but also standardizes for the location of the house. If existing homes appreciate at a similar rate to new houses, then this index can be used to approximate the inflation rate for all one family homes.

There are a number of idiosyncrasies that differentiate the Census index from the repeat sales HPI. In computing the HPI, OFHEO relies on transaction data for single family unattached houses and the methodology has not changed over time. The Census Index, on the other hand, uses survey data. As it is a Laspeyres price index, the Census Index only changes the "representative house" every few years. This implies that the index may overstate the rate of housing inflation. An upward inflation bias occurs because the index does not allow for the substitution of features in a home, for example less expensive carpeting or hardware, or even a smaller house. Moreover, the index assumes that the distribution of housing prices remains the same. However, as prices rise, sales activity may migrate from relatively high priced areas to lower priced regions.

Despite their different methodologies, Figure 1 reveals that generally the HPI and CPI Housing index move together, although the correlation is not perfect. Moreover, both exhibit similar volatility measures. Given some differences in their design and concept, we initially analyze both indexes to make sure that our hedging results are not a function of the housing price series chosen.

Since OFHEO and the Census report the housing indexes on a quarterly basis, the analysis uses end of quarter prices to construct futures returns. It can be argued that the appropriate time horizon for an individual hedging house prices should be measured in years rather than months. This can be accomplished by simply rolling over maturing futures contracts. As a practical matter, for many futures contracts, there is little volume in contracts with more than 6 months to expiration. In addition, it should be noted that the real estate market is characterized by boom and bust cycles that may last for short periods of 1 to 3 years. This activity can also be seen in the aggregate house price series exhibited in Figure 1.

For each futures contract, we obtain end of day prices from Price-data.com for the period 1983:Q2 to 2005:Q4. We base each return on the nearby futures contract that expires after the quarter of interest. For example, the 2000:Q1 return for the S&P 500 index uses the last trading day price in December 1999 and March 2000 for the futures contract that expires in June 2000. The 2000:Q1 price change does not use the prices of the March 2000 futures contract since this contract expires before March 31, 2000.

Given the potential importance of inflation on housing prices we would also like to examine the relation between futures contracts on the Consumer Price Index (CPI) and house prices. The Chicago Mercantile Exchange (CME) only launched a CPI futures contract in early 2004, and so we must produce a synthetic inflation futures contract for our sample period. To see the effect of including inflation futures in our hedge portfolio, we create a proxy for our sample period using data from the Philadelphia Fed's Survey of Professional Forecasters. We measure the change in the CPI futures as the difference in the mean inflation forecast from the middle of the previous quarter to the middle of the current quarter. Our proxy differs from the actual CPI futures contract in that 1) a quarter for the CPI contract would cover, for example, December to February, while the Philadelphia Fed would use January to March as a quarter and 2) the CME contract uses the non-seasonally adjusted CPI while the Philadelphia Fed survey uses the seasonally adjusted index. This proxy is designed specifically to pick up changes in inflationary expectations rather than simply the inflation rate. However, to more fully examine the relation between inflation and housing prices, we also consider the actual CPI growth rate in the analysis below.

To test for hedging efficiency, we use the method described in Kolb and Overdahl (2003) and estimate the following regression for each geographic region:

$$I_{s,t} = \alpha_s + \Sigma\, \beta_{s,j}\, F_{j,t} + \varepsilon_t \qquad (1)$$

where, $I_{s,t}$ = the percentage change in the HPI for geographic region s in quarter t,

$F_{j,t}$ = the return on futures contract j in quarter t,

$\alpha_s$= the constant regression parameter,

$\beta_{s,j}$ = the slope coefficient for the risk minimizing hedge for region s using futures contract j, and

$\varepsilon_{s,t}$ = an error term with 0 mean.

Ederington (1979) shows that $\beta_{s,j}$ is the risk minimizing hedge ratio for region s using futures contract j, and the regression's $R^2$ represents the percentage of the dependent variable's risk eliminated by holding the futures portfolio.[5] Ultimately it is the regression's coefficient of determination that indicates how effective futures contracts are in hedging housing price volatility.

Without a theory for selecting futures contracts to hedge income, we begin the analysis by regressing U.S. HPI changes on the returns of all 31 futures contracts (including the inflation futures proxy) in our dataset. From a statistical standpoint, the greater the number of futures contracts used in the regression, the higher the $R^2$, and therefore, the more effective the hedge. However, this ignores transaction costs as well as the monitoring costs of maintaining the hedge with numerous futures contracts.

To mitigate these costs, we select a portfolio of futures contracts that maximizes the adjusted $R^2$ of the hedging equation. This criterion adjusts for degrees of freedom, and in this way, futures contracts are only added to the hedge portfolio if they contribute in a significant way. This methodology tries to achieve the simultaneous goals of selecting a portfolio that has a small number of futures contracts that also effectively hedges HPI. We then repeat the above analysis using the Census housing index to measure house price changes.

In the final part of our analysis, we examine whether it would be practical to hedge state HPI against a national HPI contract. Thus, we estimate the risk minimizing hedge ratio for each state. We use the same regression technology as before, only now the dependent variable is quarterly percentage changes in the state's HPI and the independent variable is the quarterly percentage change in the U.S. HPI. We end the empirical analysis by estimating the relation between state and (own) region house returns.

**EMPIRICAL RESULTS**

Columns 1 and 2 in Table 2 display the hedging regression results for all 31 futures contracts. The $R^2$ for the U.S. HPI is 0.403, indicating that 40% of the variation of house prices can be explained by changes in futures prices. For nearly half of the futures contracts, the slope coefficient is negative and implies that these assets move inversely with the U.S. HPI. Taken as a whole, the results suggest that hedging national HPI with existing futures contracts may not be very effective.[6]

The hedging results for the Census index appear in columns 3 and 4 and are little different than the HPI results. The 31 futures contracts explain approximately 48% of the variation in Census housing returns. Again, a number of futures contracts have negative coefficients, and only two, the British Pound and Platinum are statistically significant.

To see if a smaller number of futures contracts can form a hedge portfolio without any loss in hedging effectiveness, we select those futures contracts that maximize adjusted $R^2$. With potentially fewer futures contracts, we reduce transaction and monitoring costs in trading our hedge portfolio. Additionally, a smaller number of contracts should mitigate the usual problems associated with multicollinearity.[7] Table 3 reports the regression results that select the hedge portfolio using adjusted $R^2$ criterion. The selection process yields a HPI hedge portfolio that includes 11 futures contracts. The $R^2$ of 0.279 is a little lower than the $R^2$ found for the hedge regression with all 31 futures contracts included in the portfolio. What is notable about the results in Table 3 is that the CPI futures contract is not selected for inclusion in the HPI hedge portfolio. This is, perhaps, a surprising result since housing is an important component in the consumer price index. The Census index regression in Table 3 also finds 11 contracts chosen to maximize the adjusted $R^2$. The overall coefficient of determination has fallen only slightly to .433. Inflation futures is now a selected explanatory variable for Census housing prices, however, it enters the equation with a negative and statistically insignificant coefficient.

Given the conventional wisdom that housing provides a hedge against inflation, it is perhaps surprising that the CPI futures proxy is not a positive and statistically significant coefficient in any of the hedge portfolios. One possibility is that the positive relation between house prices and the general price level appears over longer hedging horizons. To first examine the relation between house price changes and changes in our hypothetical inflation futures contract, Panel A of Figure 2 graphs annual growth rates of the HPI against annual changes in inflation expectations as measured by the Survey of Professional Forecasters. Even over a longer hedge period, the correlation coefficient is -0.09 and the two do not appear to be positively correlated. The results are little different if we compare annual changes in the HPI to annual changes of the actual CPI. The scatter diagram appears in Panel B, and the correlation coefficient between annual rates equals -0.34. The end result is that house prices as measured by the HPI do not appear to be positively correlated with inflation or inflation expectations. From a risk management perspective, trying to hedge house prices with any financial instrument linked to the CPI would be ineffective.

Given that residential real estate represents a large portion of U.S. wealth, it is important to next consider whether it would be feasible for investors to use a national futures contract to hedge house price risk. We examine this possibility in light of the recent launch of the CME's housing futures and options contracts. For the individual investor, the relevant market for house price risk is local and we consider the relation between a state's (or region's) house price index and the aggregate U.S. index. Rather than use the Case Shiller set of indexes, we continue to examine the HPI. We do so for at least two reasons. First, the HPI goes back further than the reported Case Shiller time series. Second, with the HPI, we may consider house prices in all 50 states rather than only the 10 cities followed by Case Shiller and traded on the CME. Despite some differences in the construction of the HPI and Case Shiller indexes, both are based on resale data, and it is likely that our results will hold for the CME contracts that have recently begun trading.

In regressing a state's HPI growth rate on the return to the national index, the beta coefficient again stands for the appropriate hedge ratio for the risk minimizing portfolio. A beta less than one suggests that a state's HPI moves more slowly relative to the nation's, whereas a beta greater than one implies a state's HPI changes more rapidly than the country's. The results in Table 4 show that state betas range from Utah's low of -0.034 to California's high of 2.039. In terms of hedging effectiveness, the results are somewhat mixed. Virginia is the state with the highest $R^2$ (equal to 0.801) and has a beta equal to 1.459. At the other extreme are Alaska, Colorado, Montana, South Dakota and Wyoming, each with an $R^2$ close to 0, a result that suggests a simple hedging program with a national house price futures contract would not be useful for these states.

Since in a simple linear regression, the equation's $R^2$ is inversely related to the slope coefficient's standard error, it is useful for hedging purposes to examine the relation between beta and its standard error. If we look at Pennsylvania, whose beta is nearly equal to 1, the coefficient's standard error implies that the true beta is likely between 0.939 and 1.303. In other words, if trying to hedge a dollar of Pennsylvania's HPI, it is not clear whether to sell as little as \$0.94 or as much as \$1.31 of a national HPI futures contract. For West Virginia, the possible range for the hedge ratio is even larger, with the optimal hedge ratio somewhere between -0.022 and 1.448. In other words, for every dollar owned of West Virginia real estate, hedgers may need to *buy* 2 cents of the national futures or sell as much as \$1.49 of the national contract. Thus, for many states, the optimal hedge ratio is noisy and may indicate that beta is unstable over time.

If state real estate price cannot be effectively hedged with a national futures contract, the final question is whether state prices closely follow the region that they are in. Table 5 compares state HPI returns to the HPI returns in its own region (See Table 1, Panel B for OFHEO geographic regions). In addition to examining the state and regional relation, the regression results may also yield insights as to whether investors can effectively hedge their local real estate portfolio with one of the city real estate contracts listed on the CME.

The regression statistics in Table 5 yield mixed results regarding hedge effectiveness. At one extreme, California, Texas and Massachusetts house prices are highly correlated with their regional index, and all have $R^2$ statistics greater than .95. Thus, for these areas, if a regional futures contract were to exist, investors could effectively hedge a diversified state portfolio. That these three state real estate markets can be effectively hedged and have hedge ratios close to one is not surprising in light of the fact that they have the greatest weight in each of their respective regions.

In contrast, Alaska, South Dakota and North Dakota have small weights in their regional index, and all three have virtually 0 correlation between state and regional housing returns. For these areas, state real estate portfolios could not be hedged with a regional futures contract. Again, these results are not particularly astonishing. It is unlikely that the Alaska real estate market is at all similar to the California market, even though both are in the same OFHEO region. Perhaps what is remarkable is that the median $R^2$ measure is .359 (Kansas) which means that for the typical state, only 36% of the variation of real estate prices can be explained by regional changes.

Taken as a whole, Table 5 results imply that it is difficult to hedge a real estate portfolio. Unless the investor's portfolio looks similar to the real estate make-up of the futures contract, hedge performance statistics are likely to be low. Going one step further, Table 5 results suggest that if an investor tries to hedge a local real estate portfolio, poor results will obtain unless the portfolio mirrors the construction of the relevant CME futures contract.

**CONCLUSION**

Traditional derivatives hedging involves the risk inherent in commodity or financial asset prices. Current innovations in derivatives contracts and risk management practices are extending the spectrum of hedging toward macroeconomic and other risks. In light of this, we investigate a different use for derivatives – their potential to mitigate the house price volatility faced by individuals.

Our empirical examination based on 23 years of data suggests that hedging of house price risk with existing futures contracts would be largely ineffective for the U.S. as a whole. Given our results and the need for real estate risk management, the CME has launched a set of housing price futures contracts. However, the initial response has been tepid and daily volume has been small.

Ultimately the success of any futures contract depends on the ability to attract hedgers as well as speculators to enter the market. Shiller believes that many home owners will be concerned about falling prices, and therefore hedgers will be net short. This implies normal backwardation of futures prices. Whether this will occur remains to be seen. What our analysis suggests is that hedgers, short or long, may not be able to effectively manage risk unless their geographic portfolio weights largely replicate those in the futures index that they are using.

Even at a local level, price changes may vary dramatically from one part of the metropolitan area to another. As an example, suppose that an investor owned residential property in San Francisco County and wished to hedge their risk with the San Francisco futures contract listed on the CME. In an April 2006 San Francisco Chronicle chart, the annual price appreciation of homes in San Francisco County varied dramatically by zip code. In one county zip code, the median home price fell 36.50% for the year, while in another county zip code, the median home price rose 38%. The median across zip codes in the county was a 1.5% price increase for the year. With such a wide dispersion of home price appreciation, it is unlikely that any single city index can effectively hedge real estate portfolios from the same metropolitan area.

In addition to location issues, an investor's real estate portfolio may have idiosyncrasies that differentiate the properties from the representative house implicit in the relevant futures index. The idiosyncrasies may reflect differences in age, size, style or property depreciation. In other futures markets, potential differences between the spot and futures assets can lead to premiums or discounts in the delivery invoice price. For example, corn and wheat can be graded and conversion factors can adjust for coupon and maturity differences in Treasury notes and bonds. However, there is no simple adjustment factor to housing futures prices, and hedgers may be subject to additional basis risk. This implies ineffective hedging, and individuals will not use these contracts to manage house price risk. Ultimately, a lack of hedgers in the marketplace may lead to failure of the CME housing futures contracts.

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**Notes**

1. One possibility has been for individuals to invest in Real Estate Investment Trusts (REITs), investment companies that own commercial real estate and/or mortgage backed securities. However, historically the correlation between REITs and house prices is low. The correlation for the sample period from 1983 to 2005 between the OFHEO House Price Index growth rate and the return on the National Association of REITs (NAREIT) Total REIT Index is 0.05. For the NAREIT Top 50 REITs Index the correlation is -0.14, and for the NAREIT Equity REIT Index, the correlation coefficient equals 0.05.

2. A CPI-W futures contract originally traded on the Coffee, Sugar, and Cocoa Exchange in the mid-1980s. The contract drew little trading interest and eventually the CSCE discontinued listing it. Petzel (2003) attributed the contract's failure to a lack of arbitrage opportunities with inflation indexed cash instruments.

3. The ten cities plus their initial weighting in the composite index are: Boston (7.4122%), Chicago (8.8868%), Denver (3.6825%), Las Vegas (1.4802%), Los Angeles (21.1620%), Miami (4.9862%), New York (27.2390%), San Diego (5.5134%), San Francisco 11.7879% and Washington, DC (7.8500%).

4. In fact, the correlation coefficient between OFHEO's HPI and the S&P/Case-Shiller® national home price index is .809 for the period 1990-2000 and equals .858 for 2000-2005.

5. Moosa (2003) shows that model specification in terms of levels or changes rather than percent changes makes little difference with respect to hedging effectiveness. It should also be noted that from the regression equation, the risk minimizing number of futures contracts to use is equal to $\beta_{s,j}$ times the dollar value of the dependent variable (HPI) relative to the value of a futures contract j.

6. According to FAS rule 133, firms may receive hedge accounting treatment if their derivatives transaction is deemed to be a highly effective hedge. As part of FAS 133, the hedge must satisfy the 80/125 rule that says the derivative's change in value relative to the item being hedged must be between 80% and 125%. Under these guidelines, our results would have almost certainly been considered ineffective hedges.

7. An alternative selection method uses principal components to choose variables for the subsequent regression analysis. This is the approach taken by Herbst (1985) who selects a subset of futures contracts to form an inflation hedge portfolio. This method first estimates a factor matrix and then chooses the futures contract with the highest factor loading as a surrogate for each factor. Since factors are orthogonal to each another, this selection process mitigates any multicollinearity problem that might exist.

   Few additional insights emerge if our selection criterion uses principal components analysis. Five futures contracts are common to the hedge portfolio using principal components or adjusted $R^2$ selection criteria. In either case, the CPI futures contract is not chosen as part of the hedge portfolio. A copy of the principal components analysis is available from the authors.

## References


Bureau of Labor Statistics. 2002. Consumer Price Indexes for Rent and Rental Equivalence. Bureau of Labor Statistics. http://www.bls.gov/cpi/cpifact6.htm (accessed February 28, 2005).

Calhoun, C. 1996. OFHEO House Price Indexes: HPI technical description. Manuscript (Office of Federal Housing Enterprise Oversight, Washington, D.C.).

Case, K., R. Shiller, and A. Weiss. 1993. Index-based futures and options markets in real estate. *Journal of Portfolio Management* 19: 83−94.

Croushore, D. 1993. Introducing: The Survey of Professional Forecasters. *Federal Reserve Bank of Philadelphia Business Review* November: 3−13.

Ederington, L. 1979. The hedging performance of the New Futures Market. *Journal of Finance* 34: 157−170.

Herbst, A., 1985. Hedging against price index inflation with futures contracts. *Journal of Futures Markets* 5: 489−504.

Kolb, R. and J. Overdahl. 2003. *Financial Derivatives*, 3rd ed. New York: John Wiley and Sons.

Labuszewski, J. 2006. Introduction to CME Housing Futures and Options, *Chicago Mercantile Exchange Strategy Paper*, 1-28.

McCarthy, J. and R. Peach. 2004. Are home prices the next "bubble"? *Federal Reserve Bank of New York Economic Review* December: 1−17.

Moosa, I. 2003. The sensitivity of the optimal hedge ratio to model specification. *Finance Letters* 1: 15−20.

Petzel, T. 2003. Elusive liquidity. @*Markets Magazine* January/February.

Shiller, R. 2003. *The New Financial Order: Risk in the 21st Century*. Princeton, N.J.: Princeton University Press.

Figure 1

Growth rates of housing price indexes

Quarterly growth rates of the OFHEO U.S. House Price Index and the Bureau of the Census constant-quality new home price index. Data are quarterly from 1980:Q1 to 2005:Q4.

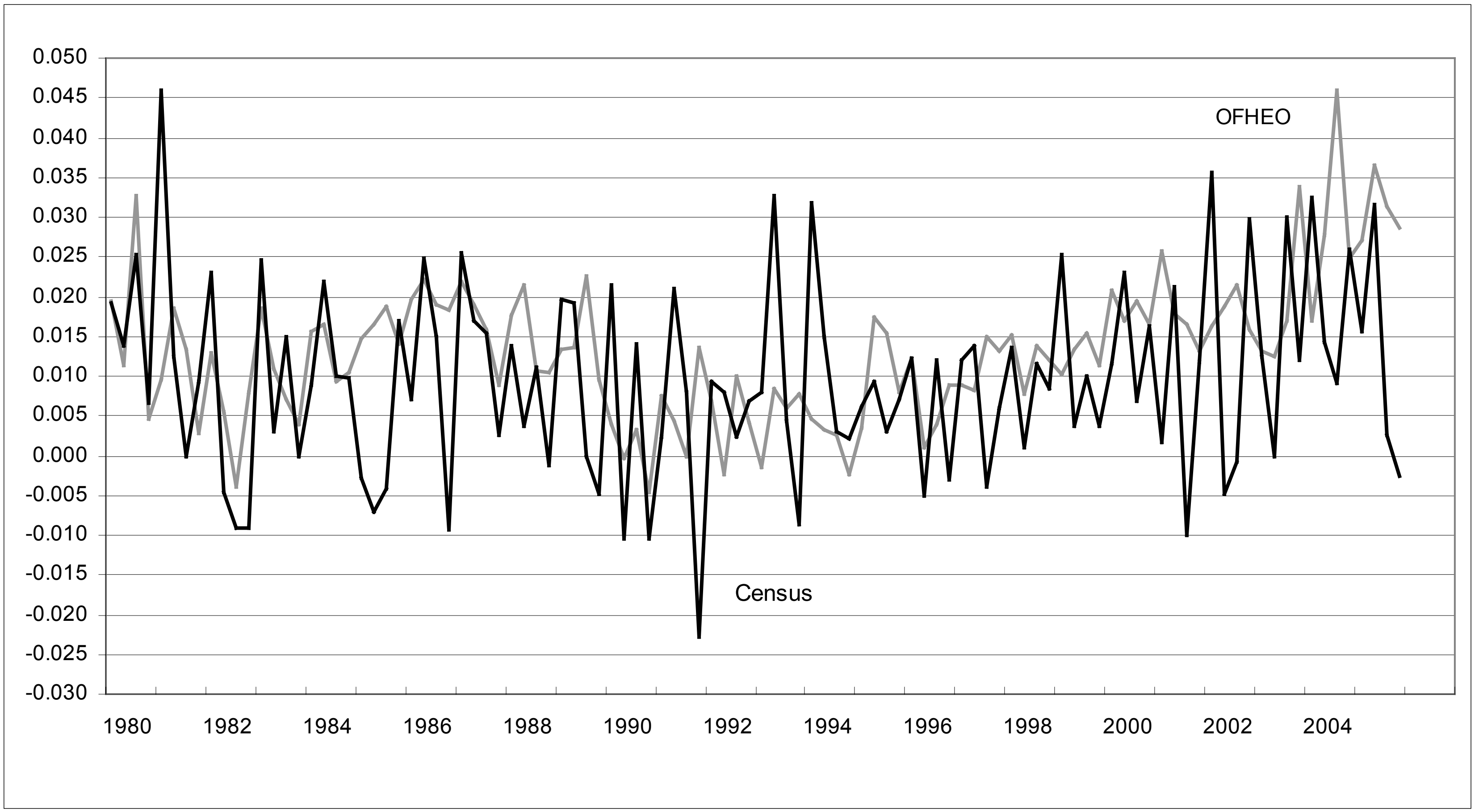
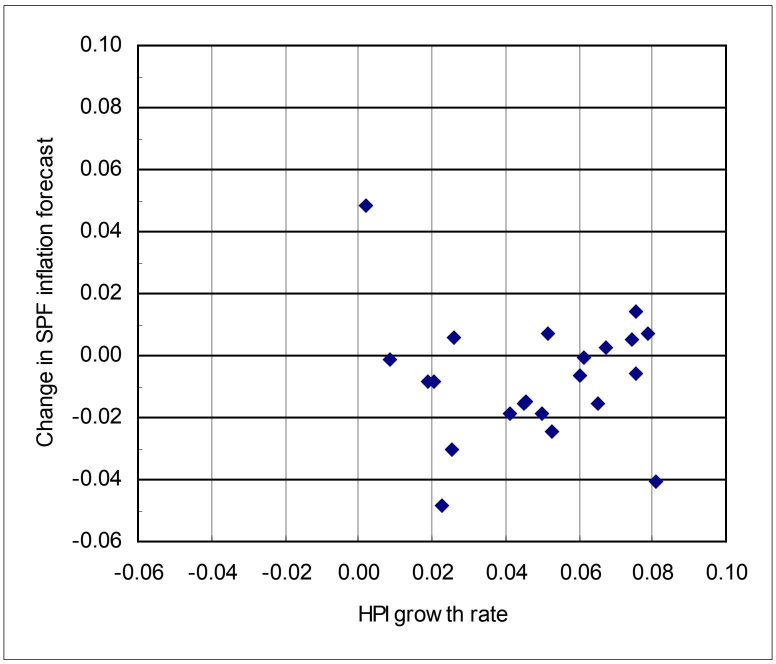


Figure 2

Inflation and growth rates of the House Price Index

Annual growth rates of the OFHEO U.S. House Price Index. Inflation is measured as the annual percentage change in the Consumer Price Index or the cumulative annual percent change in the quarterly inflation expectations from the Philadelphia Fed's Survey of Professional Forecasters. Data are annual from 1983 to 2005.

Panel A




Panel B

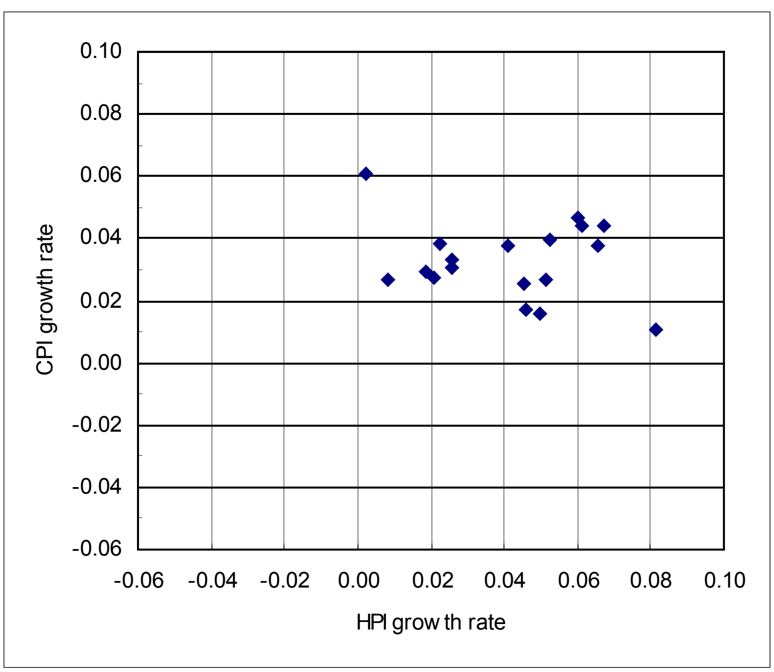


Table 1
Data classifications

Panel A: Futures contracts

**Currency**
- British Pound
- Canadian Dollar
- Japanese Yen
- Swiss Franc

**Energy**
- Crude Oil
- Heating Oil

**Interest Rate**
- Eurodollar
- 30 Year T-bond

**Food**
- Cocoa
- Orange Juice
- Coffee
- Sugar #11

**Grain**
- Soybean Oil
- Corn
- Kansas City Wheat
- Oats
- Soybeans
- Soybean Meal
- Wheat

**Metal / Fiber**
- Cotton
- Gold
- High Grade Copper
- Lumber
- Platinum
- Silver

**Meat**
- Feeder Cattle
- Live Cattle
- Live Hogs
- Pork Bellies

**Equity Index**
- S&P 500

Panel B: OFHEO geographic regions

**New England**
- Connecticut (CT)
- Maine (ME)
- Massachusetts (MA)
- New Hampshire (NH)
- Rhode Island (RI)
- Vermont (VT)

**Mid-Atlantic**
- New Jersey (NJ)
- New York (NY)
- Pennsylvania (PA)

**South Atlantic**
- Delaware (DE)
- District of Columbia (DC)
- Florida (FL)
- Georgia (GA)
- Maryland (MD)
- North Carolina (NC)
- South Carolina (SC)
- Virginia (VA)
- West Virginia (WV)

**East North Central**
- Illinois (IL)
- Indiana (IN)
- Michigan (MI)
- Ohio (OH)
- Wisconsin (WI)

**West North Central**
- Iowa (IA)
- Kansas (KS)
- Minnesota (MN)
- Missouri (MO)
- Nebraska (NE)
- North Dakota (ND)
- South Dakota (SD)

**East South Central**
- Alabama (AL)
- Kentucky (KY)
- Mississippi (MS)
- Tennessee (TN)

**West South Central**
- Arkansas (AR)
- Louisiana (LA)
- Oklahoma (OK)
- Texas (TX)

**Mountain**
- Arizona (AZ)
- Colorado (CO)
- Idaho (ID)
- Montana (MT)
- New Mexico (NM)
- Nevada (NV)
- Utah (UT)
- Wyoming (WY)

**Pacific**
- Alaska (AK)
- California (CA)
- Hawaii (HI)
- Oregon (OR)
- Washington (WA)

Table 2
OLS estimates of hedge ratios using all futures contracts

Coefficient estimates for a regression of percentage changes in the OFHEO U.S. House Price Index and the Bureau of the Census constant-quality new home price index on percentage changes in futures contract prices. Data are quarterly from 1983:Q2 to 2005:Q4. Futures contract price changes are calculated using the nearby futures contract that expires after a quarter. * denotes statistical significance at the 10% level.

| | OFHEO HPI | | Census Index | |
|---|---|---|---|---|
| | Coefficient (1) | Standard error (2) | Coefficient (3) | Standard error (4) |
| Intercept | 0.0136* | 0.0014 | 0.0086* | 0.0017 |
| British Pound | -0.0258 | 0.0320 | -0.0962* | 0.0388 |
| Canadian Dollar | 0.0404 | 0.0447 | 0.0010 | 0.0543 |
| Japanese Yen | -0.0244 | 0.0212 | 0.0109 | 0.0257 |
| Swiss Franc | 0.0068 | 0.0280 | 0.0189 | 0.0340 |
| Crude Oil | -0.0205 | 0.0176 | 0.0160 | 0.0214 |
| Heating Oil | 0.0215 | 0.0184 | -0.0099 | 0.0223 |
| Eurodollar | -0.0941 | 0.1726 | -0.1408 | 0.2096 |
| 30 Year T-bond | 0.0160 | 0.0258 | -0.0061 | 0.0313 |
| Cocoa | 0.0033 | 0.0089 | -0.0017 | 0.0108 |
| Orange Juice | 0.0071 | 0.0083 | -0.0056 | 0.0101 |
| Coffee | -0.0088* | 0.0051 | -0.0002 | 0.0062 |
| Sugar | -0.0105* | 0.0062 | -0.0036 | 0.0075 |
| Soybean Oil | -0.0133 | 0.0173 | -0.0080 | 0.0210 |
| Corn | -0.0299* | 0.0146 | -0.0284 | 0.0177 |
| KC Wheat | 0.0198 | 0.0269 | -0.0135 | 0.0326 |
| Oats | 0.0018 | 0.0073 | -0.0146 | 0.0089 |
| Soybeans | 0.0394 | 0.0421 | 0.0848 | 0.0512 |
| Soybean Meal | -0.0053 | 0.0287 | -0.0219 | 0.0349 |
| Wheat | -0.0044 | 0.0332 | 0.0057 | 0.0404 |
| Cotton | -0.0122 | 0.0084 | -0.0131 | 0.0102 |
| Gold | -0.0034 | 0.0251 | -0.0124 | 0.0304 |
| Copper | 0.0100 | 0.0089 | 0.0098 | 0.0109 |
| Lumber | -0.0046 | 0.0084 | -0.0159 | 0.0102 |
| Platinum | 0.0305* | 0.0161 | 0.0368* | 0.0195 |
| Silver | 0.0131 | 0.0134 | 0.0115 | 0.0162 |
| Feeder Cattle | 0.0145 | 0.0316 | 0.0185 | 0.0383 |
| Live Cattle | -0.0528* | 0.0317 | -0.0084 | 0.0385 |
| Live Hogs | 0.0061 | 0.0142 | 0.0278 | 0.0172 |
| Pork Bellies | 0.0043 | 0.0100 | -0.0125 | 0.0122 |
| S&P 500 | 0.0054 | 0.0165 | 0.0003 | 0.0200 |
| CPI | 0.1960 | 0.1567 | -0.1991 | 0.1904 |
| $R^2$ | 0.403 | | 0.476 | |
| Adjusted $R^2$ | 0.090 | | 0.201 | |

Table 3
OLS estimates of hedge ratios using futures contracts that maximize adjusted $R^2$

Coefficient estimates for a regression of percentage changes in the OFHEO U.S. House Price Index and the Bureau of the Census constant-quality new home price index on percentage changes in futures contract prices. Data are quarterly from 1983:Q3 to 2005:Q4. Futures contract price changes are calculated using the nearby futures contract that expires after a quarter. The futures contracts are selected to maximize the adjusted $R^2$ for the regression using data from 1983:Q3 to 2005:Q4. * denotes statistical significance at the 10% level.

| | OFHEO HPI | | Census Index | |
|---|---|---|---|---|
| | Coefficient (1) | Standard error (2) | Coefficient (3) | Standard error (4) |
| Intercept | 0.0132* | 0.0009 | 0.0090* | 0.0011 |
| British Pound | | | -0.0728* | 0.0196 |
| Japanese Yen | -0.0368* | 0.0139 | | |
| Eurodollar | | | -0.1727 | 0.1183 |
| Orange Juice | 0.0095 | 0.0068 | | |
| Coffee | -0.0083* | 0.0040 | | |
| Sugar | -0.0091* | 0.0048 | | |
| Soybean Oil | -0.0122 | 0.0102 | | |
| Corn | -0.0253* | 0.0115 | -0.0392* | 0.0123 |
| KC Wheat | 0.0133 | 0.0091 | | |
| Oats | | | -0.0180* | 0.0062 |
| Soybeans | 0.0288* | 0.0139 | 0.0587* | 0.0139 |
| Copper | 0.0102 | 0.0063 | | |
| Lumber | | | -0.0153* | 0.0070 |
| Platinum | 0.0384* | 0.0106 | 0.0246* | 0.0129 |
| Silver | | | 0.0172 | 0.0115 |
| Live Cattle | -0.0251* | 0.0134 | | |
| Live Hogs | | | 0.0291* | 0.0133 |
| Pork Bellies | | | -0.0123 | 0.0095 |
| CPI | | | -0.2104 | 0.1317 |
| $R^2$ | 0.279 | | 0.423 | |
| Adjusted $R^2$ | 0.180 | | 0.344 | |

Table 4
Relation between state/regional and U.S. OFHEO House Price Index growth

Estimates from an OLS regression of the respective state or U.S. Census division OFHEO House Price Index growth rate on the OFHEO U.S. House Price Index growth rate. Data are quarterly from 1983:Q3 to 2005:Q4.

| | β | Standard error | $R^2$ | | β | Standard error | $R^2$ |
|---|---|---|---|---|---|---|---|
| AL | 0.493 | 0.126 | 0.145 | MT | 0.240 | 0.272 | 0.009 |
| AK | 0.142 | 0.469 | 0.001 | NE | 0.055 | 0.097 | 0.004 |
| AZ | 1.577 | 0.185 | 0.446 | NV | 1.563 | 0.214 | 0.373 |
| AR | 0.317 | 0.117 | 0.076 | NH | 1.586 | 0.198 | 0.417 |
| CA | 2.039 | 0.143 | 0.692 | NJ | 1.723 | 0.152 | 0.587 |
| CO | 0.064 | 0.154 | 0.002 | NM | 0.507 | 0.180 | 0.081 |
| CT | 1.753 | 0.189 | 0.488 | NY | 1.370 | 0.167 | 0.429 |
| DE | 1.263 | 0.115 | 0.572 | NC | 0.319 | 0.078 | 0.156 |
| DC | 1.850 | 0.198 | 0.492 | ND | 0.471 | 0.455 | 0.012 |
| FL | 1.519 | 0.107 | 0.691 | OH | 0.176 | 0.058 | 0.094 |
| GA | 0.498 | 0.088 | 0.263 | OK | 0.193 | 0.162 | 0.015 |
| HI | 1.744 | 0.340 | 0.226 | OR | 0.273 | 0.179 | 0.025 |
| ID | 0.457 | 0.211 | 0.050 | PA | 1.121 | 0.093 | 0.617 |
| IL | 0.593 | 0.060 | 0.519 | RI | 1.862 | 0.227 | 0.429 |
| IN | 0.217 | 0.069 | 0.100 | SC | 0.543 | 0.140 | 0.143 |
| IA | 0.154 | 0.092 | 0.030 | SD | -0.020 | 0.946 | 0.000 |
| KS | 0.241 | 0.089 | 0.076 | TN | 0.400 | 0.142 | 0.081 |
| KY | 0.199 | 0.066 | 0.091 | TX | 0.364 | 0.134 | 0.076 |
| LA | 0.257 | 0.148 | 0.032 | UT | -0.034 | 0.194 | 0.000 |
| ME | 1.267 | 0.176 | 0.365 | VT | 1.422 | 0.198 | 0.363 |
| MD | 1.649 | 0.091 | 0.786 | VA | 1.459 | 0.077 | 0.801 |
| MA | 1.353 | 0.211 | 0.314 | WA | 0.591 | 0.159 | 0.132 |
| MI | 0.286 | 0.147 | 0.040 | WV | 0.713 | 0.375 | 0.039 |
| MN | 0.699 | 0.118 | 0.280 | WI | 0.323 | 0.089 | 0.128 |
| MS | 0.301 | 0.170 | 0.034 | WY | 0.160 | 0.310 | 0.003 |
| MO | 0.432 | 0.073 | 0.281 | | | | |
| New England | 1.500 | 0.187 | 0.416 | East South Central | 0.343 | 0.072 | 0.203 |
| Mid-Atlantic | 1.431 | 0.125 | 0.594 | West South Central | 0.352 | 0.129 | 0.077 |
| South Atlantic | 1.124 | 0.045 | 0.874 | Mountain | 0.729 | 0.133 | 0.250 |
| East North Central | 0.341 | 0.054 | 0.303 | Pacific | 1.676 | 0.119 | 0.686 |
| West North Central | 0.450 | 0.057 | 0.409 | | | | |

Table 5
Relation between state and regional OFHEO House Price Index growth

Estimates from an OLS regression of the state OFHEO House Price Index growth rate on the respective regional OFHEO House Price Index growth rate. Data are quarterly from 1983:Q3 to 2005:Q4.

| | $\beta$ | Standard error | $R^2$ | | $\beta$ | Standard error | $R^2$ |
|---|---|---|---|---|---|---|---|
| AL | 0.800 | 0.158 | 0.221 | MT | 0.601 | 0.176 | 0.115 |
| AK | 0.062 | 0.232 | 0.001 | NE | 0.439 | 0.130 | 0.112 |
| AZ | 1.266 | 0.106 | 0.612 | NV | 1.037 | 0.149 | 0.349 |
| AR | 0.543 | 0.077 | 0.358 | NH | 1.002 | 0.035 | 0.901 |
| CA | 1.195 | 0.022 | 0.972 | NJ | 1.168 | 0.034 | 0.929 |
| CO | 0.681 | 0.078 | 0.460 | NM | 0.846 | 0.093 | 0.480 |
| CT | 0.957 | 0.053 | 0.786 | NY | 1.011 | 0.052 | 0.807 |
| DE | 1.015 | 0.100 | 0.534 | NC | 0.260 | 0.065 | 0.151 |
| DC | 1.568 | 0.162 | 0.511 | ND | 0.766 | 0.646 | 0.015 |
| FL | 1.385 | 0.066 | 0.829 | OH | 0.414 | 0.088 | 0.198 |
| GA | 0.410 | 0.073 | 0.258 | OK | 1.045 | 0.067 | 0.733 |
| HI | 1.021 | 0.158 | 0.317 | OR | 0.211 | 0.087 | 0.062 |
| ID | 0.838 | 0.119 | 0.354 | PA | 0.636 | 0.046 | 0.685 |
| IL | 0.771 | 0.114 | 0.336 | RI | 0.939 | 0.083 | 0.590 |
| IN | 0.722 | 0.089 | 0.423 | SC | 0.498 | 0.114 | 0.174 |
| IA | 0.637 | 0.114 | 0.257 | SD | 0.927 | 1.343 | 0.005 |
| KS | 0.745 | 0.105 | 0.359 | TN | 1.445 | 0.120 | 0.616 |
| KY | 0.343 | 0.084 | 0.157 | TX | 1.013 | 0.024 | 0.954 |
| LA | 0.926 | 0.068 | 0.676 | UT | 0.878 | 0.095 | 0.485 |
| ME | 0.722 | 0.057 | 0.641 | VT | 0.451 | 0.096 | 0.197 |
| MD | 1.374 | 0.075 | 0.788 | VA | 1.234 | 0.059 | 0.828 |
| MA | 1.014 | 0.024 | 0.953 | WA | 0.462 | 0.069 | 0.331 |
| MI | 1.773 | 0.156 | 0.591 | WV | 0.603 | 0.312 | 0.040 |
| MN | 1.520 | 0.116 | 0.655 | WI | 0.842 | 0.125 | 0.334 |
| MS | 1.121 | 0.194 | 0.270 | WY | 1.059 | 0.182 | 0.274 |
| MO | 0.722 | 0.096 | 0.388 | | | | |