

## **Housing Futures Markets: Early Evidence of Return and Risk**

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## **Housing Futures Markets: Early Evidence of Return and Risk**

### **Abstract**

This paper examines risks and returns in the newly created market for housing futures traded on the Chicago Mercantile Exchange (CME). Our estimates of contract returns on housing futures average about 8.6 percent annually, with a standard deviation of 12.6 percent. Returns show little relationship to the movements in the corresponding housing price indexes. The results are consistent with the theory of “normal backwardation” first put forward by Keynes and Hicks in the 1930s. They suggest that housing futures prices are set by speculators who profit by buying futures when the futures price is below the spot price they expect to prevail in the future. The difference between the price that speculators expect to prevail in the future and the futures price represents the risk premium on futures contracts, or the speculator’s reward for risk.

When standardized for maturity and time, we find that risk premiums on housing contracts appear to be higher in Boston, Chicago, Denver, New York, and San Francisco and lower in Las Vegas, Los Angeles, Miami, San Diego, and Washington, DC. The level of risk premiums appears to have been falling since the trading in housing futures was initiated on the CME. Finally, we find evidence that risk premiums tend to be higher on contracts where the basis is low and the time to maturity is short.

## **Housing Futures Markets: Early Evidence of Return and Risk**

The value of residential real estate totaled \$22.4 billion in 2006, and housing comprises about a third of the combined value of all domestic assets. The enormous size of the housing market is evident by the 68.2 percent homeownership rate reported by the Census in the 2<sup>nd</sup> quarter of 2007. The rate has climbed about 3 percentage points during the past ten years. More insight into the influence of housing is apparent by examining the balance sheet of families. The *2004 Survey of Consumer Finances* by the Federal Reserve reports that financial assets constitute 37.2 percent of the assets of families. The remaining 64.3 percent is held as non-financial assets. Of the non-financial assets owned by families, 50.3 percent is held as an investment in a primary residence, while another 9.9 percent is classified as other residential property. These two housing categories represent 38.7 percent of the total wealth of families.

Although housing is frequently regarded as a dwelling for the buyer, this has changed as housing has come to be viewed increasingly as an investment vehicle. According to the National Association of Realtors, 37 percent of all housing purchases in 2006 represented a structure that was not the buyer's primary residence. The substantial run-up in housing prices in many metropolitan areas during the past few years has influenced many households to view a housing purchase as an investment. MacroMarkets LLC reports that over the ten year period ending in February 2007, the housing sector offered annualized returns of 10.93 percent and volatility of 2.07 percent, compared with an average annualized return of 7.63 percent and a volatility of 15.28 percent for stocks. Much of this gain occurred in the earlier part of the period, however, as housing values in many areas have decreased significantly in the past two years.

The enormous financial impact of housing on the economy and the widespread ownership of single-family houses have resulted in a pressing need to transfer the risks associated with the volatility of housing assets. Persistent problems with the development of a risk transfer mechanism have been the heterogeneity of housing, the relatively high transaction costs, and the

resulting lack of timely and accurate information related to housing market prices. Despite these problems, financial markets have been innovative. Over the counter (OTC) products that have been developed recently for housing include forward contracts, index-linked notes, index swaps, and total return swaps.<sup>1</sup> In addition to OTC products, standardized products are now trading. In May 2006, the Chicago Mercantile Exchange (CME) began trading housing futures contracts and options. Housing, thus, joined a long litany of other commodities and financial instruments on which hedgers and speculators can exchange standardized contracts for future delivery.

## **I. Housing Futures Contracts**

The CME housing futures contracts are based on the S&P/Case-Shiller<sup>®</sup> housing price indexes which are tabulated monthly for 10 major cities and a composite index for the nation.<sup>2</sup> The 10 cities for which contracts trade are Boston (BOS), Chicago (CHI), Denver (DEN), Las Vegas (LAV), Los Angeles (LAX), Miami (MIA), New York (NYM), San Diego (SDG), San Francisco (SFR), and Washington, DC (WDC). The national composite index trades under the symbol CUS.

The contract specifications for the CME housing futures are shown in Exhibit 1. The value of the futures contracts are set at 250 times the level of the S&P/Case-Shiller<sup>®</sup> indexes. Thus, if the level of the composite index (CUS), for example, is 250, the value of the associated futures contract is \$62,500 (250 x 250). At maturity, the contract's value is 250 multiplied by the average value of the index over the 3-month period ending two calendar months prior to the contract month. For example, the final settlement price for the August 2006 CUS index futures contract is the S&P/Case-Shiller<sup>®</sup> Composite Home Price Index as reported for the three-month period April 2006 through June 2006. The June 2006 index is released in August 2006. The

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<sup>1</sup> See <http://macromarkets.com> for an explanation of these products.

<sup>2</sup> The indexes are generated and distributed monthly by S & P, Fiserv, Inc. and MacroMarkets LLC; they based on the repeat-sales pricing methodology pioneered by Case and Shiller (1987). Sales pairs are screened to avoid foreclosed properties, non-arms length transactions, and suspected data errors. The repeat-sales pricing method is a quality-adjusted technique. Fluctuations in price because of remodeling, additions or extreme neglect are minimized by assigning a smaller weight to sales pairs with a large change in sales price relative to properties in the surrounding community.

scheduled release date for the reference S&P/Case-Shiller<sup>®</sup> indexes is the last Tuesday of the contract month.<sup>3</sup>

This paper explores the risk and return associated with housing futures. The next section explains the principles of the pricing of futures contracts and related existing literature. Section three develops a housing futures model. Section four explains the empirical data used to calculate returns and risks and lays out the tabulated results. Section five looks at the information content of futures prices. The final section summarizes the results and discusses possible avenues for future research.

## **II. The Theory of Futures Pricing**

A theory of futures prices which is often applied to financial futures is the cost-of-carry model (see, Fama and French, 1987). The cost-of-carry model suggests that the futures price will be equal to the spot price plus the cost of carry (storage, insurance, etc.). The linkage between the spot and futures price is thought to derive from the choice of either 1) buying the product on the spot market and carrying it into the future or 2) purchasing a contract for future delivery on the futures market. If the returns from one strategy are greater than another, arbitrageurs are assumed to act to close the gap by buying the spot and selling the future or visa versa. Such arbitrage is relatively easy in financial markets but can be difficult in housing markets especially when closing the gap involves selling the spot market. As a result, the linkage between spot and futures prices is assumed to be much looser in housing markets.

Almost 80 years ago John Maynard Keynes (1930) set forth a theory of commodity futures pricing in his *A Treatise on Money, Vol. II* (pp. 142-144).<sup>4</sup> According to Keynes, the price of a futures contract normally will be set below the expected future price of the commodity. The difference between the expected future price and the price of the commodity on the futures

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<sup>3</sup> Chicago Mercantile Exchange, *CME Rulebook, Chapter 419, CME Metro Area Housing Index Futures* (Chicago, CME, 2006).

exchange reflects a “risk premium” sufficient to induce speculators to assume the risk of future price fluctuations.

J. R. Hicks credits Keynes when he discusses futures markets in his classic work, *Value and Capital* (1939, p. 138). Hicks asserts that futures prices are nearly always set by speculators, “who seek a profit by buying futures when the futures price is below the spot price they expect . . .” Speculators will only be willing to buy futures contracts so long as the price is below the spot price they expect to prevail in the future. On the other hand, hedgers seek to lay off the risk of future price fluctuations. Therefore, hedgers are willing to accept a price which is below the expected future spot price in order to ensure a price certain in the future.

Keynes refers to the difference between the expected spot price and the futures price as “normal backwardation.” In market language, there is “backwardation” whenever the futures price is below the spot price. However, Keynes and Hicks assert that even when the spot price is not expected to change, the futures price will be below the spot price by an “an amount which hedgers have to hand over to speculators in order to persuade the speculators to take over the risks of the price fluctuations in question.”<sup>5</sup>

Exhibit 2 illustrates the case of “normal backwardation.” In Exhibit 2A, the spot price (P) is equal to the expected future price (E), but the futures price (F) is less than (P) and (E) by an amount which reflects the risk premium on futures contracts, or the speculator’s reward for risk.

In Exhibit 2B, the expected future price (E) is greater than the spot price (P), but the futures price (F) is still less than (E) by the amount of the risk premium. Likewise in a falling market, where (E) is less than (P), the futures price (F) will still be less than (E) by the amount of the risk premium, as shown in Exhibit 2C.

Keynes speculated that the level of “normal backwardation,” or the size of the risk premium, was about 10 percent in organized commodity markets.<sup>6</sup> Exhibit 3 lists three empirical

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<sup>5</sup> Hicks (1939), p. 138.

<sup>6</sup> Keynes (1930), p. 143.

studies that have examined the size of risk premium in commodity futures markets. The three studies report returns for portfolios of fully-collateralized futures contracts. The contracts are collateralized by investments in t-bills, thus, the reported returns include the interest on the t-bills as well as the gains or losses from the movements in prices. The reported returns and risks on commodity futures are close to the returns and risks on common stocks recorded for comparable time periods, suggesting that commodity futures and common stocks have about the same risk premiums and levels of risk. The positive return in excess of the risk-free rate lends support to the “normal backwardation” theory. A similar finding for housing futures would support the applicability of normal backwardation to housing futures, whose contracts terminate with cash-settlement, and more importantly, whose underlying value is based on an index constructed by a repeat sales sampling methodology unique to real estate.

### **III. Model**

While the theoretical aspects of housing futures pricing shares the underpinnings with commodity futures pricing, there are significant differences. Housing futures are settled in cash similar to financial index futures. That is, the underlying asset cannot be delivered to satisfy performance of a housing futures contract. The housing futures index is constructed based upon a pair of house sales, with all available sales pairs in the geographic market being aggregated into one index. Therefore, unlike a financial futures index, the actual underlying assets change in the computation of each price index, so the necessary condition of homogeneity used in futures pricing is achieved through statistical methods. A sufficient sample size is the primary means by which individual heterogeneous assets can be used to construct the index suitable for standardized futures pricing purposes. Also, statistical techniques are used to identify outliers and minimize their influence. Finally, a three month average serves to smooth index prices from one month to the next. A challenge of using housing for purposes of futures trading is limited disclosure of needed information. The index price is lagged by two months, and it is released only once a

month. While the release of information pertaining to the market such as housing starts, housing permits, NAR<sup>®</sup>, and OFHEO indexes occurs periodically, the paucity of information in the market contributes to inefficient pricing. Another significant difference of using housing versus financial instruments as underlying assets is the significant transaction costs associated housing. The normal high commission rates, loan fees, and other closing costs that occur with housing do not exist with stocks, treasury securities, etc. These high transaction costs make arbitrage more difficult to implement. This can be a significant problem because futures prices are often priced relative to the spot price of the underlying asset. To the extent that arbitrage is hindered, an efficient mechanism for the pricing of housing futures is impaired. But despite the limitations inherent in the development of housing futures contracts, the enormous size of the market, greater housing price volatility in recent years, the perceived need by hedgers, and the interest by speculators has led the CME to develop housing futures.

Assumptions are necessary to construct a housing futures pricing model. In this case, transactions costs and taxes are ignored. It is further assumed that a comparable portfolio of houses relative to the Case-Shiller<sup>®</sup> Home Price Index is available in the spot market to generate like returns to the index, and also produces a series of rental housing payments. With these assumptions, the housing futures model becomes:

$$P_m = P_s e^{(r - Q)T} \quad (1)$$

where  $P_m$  is the contract price at maturity,  $P_s$  is the spot price of the index,  $r$  is annual rate on t-bills,  $Q$  is the rental yield, and  $T$  is the time to maturity expressed as fractions of a year. The rental yield is defined as annual rentals from the houses divided by the market value of these houses. Note that equation (1) is very similar to the familiar futures pricing equation for stock indexes, with the exception that  $Q$  represents the rental yield instead of the dividend yield. Because  $Q$  changes monthly with new houses, the value of  $Q$  should represent the annualized

rental yield during the life of the contract. If  $P_m > P_s e^{(r - Q)T}$ , then in the absence of taxes and transactions costs, arbitrage profits are possible by buying houses on the spot market and selling the futures contracts. Conversely, if  $P_m < P_s e^{(r - Q)T}$ , futures contracts should be purchased and a short position should be taken in houses. However, because arbitrageurs cannot short a spot position in housing, the possibility arises that  $P_m$  will remain below the equilibrium level. The concept of traders using the equilibrium pricing of equation (1) is known as index arbitrage.

By dividing equation (1) by the purchase price of the futures contract, applying the natural logarithm to both sides of the equation, and simplifying the expression results in equation (2) as follows:

$$\ln(P_m/P_p) = \ln(P_s/P_p) + (r - Q) \cdot T \quad (2)$$

The empirical estimation of equation (2) permits an examination of returns on futures contracts as they are related to the ratio of the current spot and futures contract purchase prices as well as the risk-free interest rate net of the rental yield, for futures contracts held to expiry.

The LHS of equation (2) is the percentage return on the futures contract  $[\ln(P_m/P_p)]$ . The RHS of equation (2) includes the natural logarithm of the ratio of the spot price relative to the futures contract purchase price  $[\ln(P_s/P_p)]$  and the difference between the t-bill rate and the rental yield times the time to maturity expressed as fractions of a year  $[(r - Q) \cdot T]$ .

#### **IV. Returns and Risks in Housing Futures**

This section examines the risk premium on housing futures contracts. The data are taken from the Chicago Mercantile Exchange, DataMine, which shows the daily prices on all housing futures contracts trading from May 2006 through May 2007. On every day that a housing futures contract opened (the housing futures market is very thin and contracts do not always trade every day), a long contract was assumed to be purchased and held to maturity. The purchase price was

assumed to be the average of the open and settle price for the day. The contracts were assumed to be fully collateralized by an equivalent investment in t-bills, so that the total return to the investment includes the accumulated interest on the t-bills. The formula for the annualized return on the futures contracts is:

$$AR_{i,t} = [(P_m/P_p) - 1] + [(1 + r)^t - 1] \cdot (360/t) \quad (3)$$

where,

$AR_{i,t}$  = annualized return on the  $i$ th contract of duration  $t$  (days);

$P_m$  = contract price at maturity;

$P_p$  = purchase price of the contract;

$r$  = daily t-bill rate;

$t$  = duration of the contract in days.

Exhibit 4 shows the average returns on all long housing futures contracts traded on the CME from May 2006 that matured on or before May 2007.<sup>7</sup> The average return on all 1,018 contracts for the 11 areas was 8.57 percent with a standard deviation of 12.64 percent. The highest average returns were recorded in New York (NYM), Chicago (CHI), and Miami (MIA). The lowest returns were registered in Los Angeles (LAX) and Denver (DEN). The highest risk area when ranked on the basis of the coefficient of variation was LAX. San Francisco (SFR) and Chicago (CHI) had the lowest risk.

There is a large difference between the performance of the S&P/Case-Shiller housing price indexes and the returns on the collateralized housing futures contracts. Exhibit 4 shows the average annualized monthly percentage changes in the associated S&P/Case-Shiller house price indexes during the period May 2006 through March 2007. On average, across all 11 areas, the housing price indexes declined an average of -3.4 percent, while investments in fully

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<sup>7</sup> Contracts maturing in May 2007 were settled on the basis of the average price index in the Jan. 2007 – Mar. 2007 period.

collateralized housing futures returned an annualized average of 8.6 percent.<sup>8</sup> This result conforms to Keynes' theory of "normal backwardation," because speculators appear to earn substantial risk premiums even in a falling market (shown in Exhibit 2C above).

The results show that expected movements in housing prices are not a basis for returns to investors in futures. Futures investors earn above normal profits only when the spot price at maturity turns out to be higher than expected when they purchased the futures contract. A futures contract accordingly is a bet on the direction and magnitude of the future spot price, with holders of long futures contracts benefiting when spot prices exceed market expectations. Unless an investor has special knowledge of the future direction of spot prices, his expected returns in the long run should approach the risk free rate plus an appropriate risk premium.

## V. The Information Content of Futures Prices

There is little agreement about the information content of futures prices, or whether futures prices have the ability to forecast future spot prices. Using equation (2), we estimate the following the empirical model to examine this issue:

$$\ln(P_{m,t}/P_{p,t}) = \beta_0 + \beta_1 \ln(P_{s,t}/P_{p,t}) + \beta_2(r_t - Q_t) \cdot T_t + \beta_3 Time_t + \beta_{i,4} City_{i,t} + \varepsilon_{i,t} \quad (4)$$

where,

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<sup>8</sup> The average annualized housing futures returns were calculated assuming that contracts were held to expiry with no weighting by volume of contracts bought or sold. This approach is designed to examine the market return for futures contracts, avoiding any specific trading strategy approach which would be the focus of an individual investor. Alternative investment strategies could be employed such weighting portfolios by volume, opening or closing additional contracts prior to expiration, but this approach is less comparable to the average annualized monthly percentage change in the S&P/Case-Shiller Price Index shown in the last column. In any case, it is not possible to know the individual buy or sell decisions of individual investors in the market given aggregate volume and open interest data used in this study.

$\ln(P_{m,t}/P_{p,t})$  = the natural logarithm of the ratio of the contract price at maturity of the contract to the futures purchase price at the initiation of the contract, or the return from price appreciation on the contract at time  $t$ ;

$\ln(P_{s,t}/P_{p,t})$  = the natural logarithm of the ratio of the spot price at the initiation of the contract to the futures purchase price at the initiation of the contract;

$(r_t - Q_t) \cdot T_t$  = the interaction of the t-bill rate ( $r_t$ ) minus the rental yield ( $Q_t$ )<sup>9</sup> for the contract multiplied by the contract length  $T$  (expressed in fractions of a year);

$Time_t$  = a continuous time variable stated in the number of days since May 2006 before the purchase of the contract;

$City_t$  = a vector of dummy variables representing urban area of the contract;

$\varepsilon_{i,t}$  = stochastic error term.

$\beta_0, \beta_1, \beta_2, \beta_3$ , and  $\beta_i$  represent the coefficients for the explanatory variables.

The addition of the *Time* variable to the empirical model is designed to capture the effects of market maturation and participant learning. The expectation is that  $\beta_3$  is negative, as learning and competition reduces the average rate of return on housing futures contracts over time. The vector of city dummy variables (*City*) captures possible unexplained differences in returns among the 10 city contracts.

The results of estimating equation (4) are shown in Exhibit 5. Sample summary statistics are shown in Table A.1. The overall fit of the equation is high; the adjusted  $R^2$  is 0.997.

Equation (4) is estimated using the White (1980) procedure for heteroskedasticity consistent covariance estimates. The coefficient on  $\ln(P_{s,t}/P_{p,t})$  is statistically significant at the .01 level and above and the sign is positive. In the futures market, the difference between the futures price and the spot price is termed the “basis,” or  $(P_{p,t} - P_{s,t})$ . The positive sign on this variable

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<sup>9</sup> Data for this variable is obtained from the national income and product accounts maintained by the Bureau of Economic Analysis (BEA). It is estimated by dividing the space rent on owner-occupied non-farm dwellings by the current value of owner-occupied residences. See, <http://www.bea.gov/national/index.htm#gdp>

suggests that returns tend to be higher when the basis is small, that is when  $P_{s,t}$  is larger and  $P_{p,t}$  is smaller.

The sign on  $(r_t - Q_t) \cdot T_t$  is positive and statistically significant at the .01 level and above. If  $r_t - Q_t > 0$ , then the returns are higher for longer term contract. Alternatively, when  $r_t - Q_t < 0$ , then returns will be lower. In our sample,  $r_t - Q_t$  averages less than zero, so returns tend to be lower on longer term contracts.

The negative and statistically significant sign on the time variable ( $Time_t$ ) shows that returns have been secularly declining since the initiation of housing futures trading, indicating the perceived risk levels have been falling.

The city dummy variables show return differences relative to the national composite index contract (CUS). Contract returns for Boston, Chicago, Denver, New York, and San Francisco are significantly higher, while returns for contracts in Las Vegas, Los Angeles, Miami, San Diego, and Washington, DC are lower.

## **VI. Summary and Conclusions**

This paper provides an initial examination of the risks and returns in the newly created market for housing futures. The estimates of average contract returns presented here are all positive and show little relationship to the movements in the corresponding housing price indexes, which have been declining since housing futures trading was initiated in May 2006. These results are consistent with the theory of “normal backwardation” first put forward by Keynes and Hicks in the 1930s. They suggest that housing futures prices are set by speculators who profit by buying futures when the futures price is below the spot price they expect to prevail in the future. The difference between the price that speculators expect to prevail in the future and the futures price represents the risk premium on futures contracts, or the speculator’s reward for risk. Our results suggest that the risk premium on housing futures has been averaging about 8.6 percent annually, with a standard deviation of 12.6 percent.

When standardized for maturity and time, we find that risk premiums on housing contracts appear to have been higher in Boston, Chicago, Denver, New York, and San Francisco and lower in Las Vegas, Los Angeles, Miami, San Diego, and Washington, DC. Additionally, premiums have been secularly declining since the trading in housing futures was initiated. Lastly, we find evidence that premiums tend to have been higher on contracts where the basis is small and the time to maturity is short.

The evidence presented here is based on only the first year of futures trading. Whether these results continue to prevail in the future is a topic that merits additional study. As additional historical data accumulates, more research is warranted to compare the returns and risks on housing futures with other assets over time and over the business cycle.

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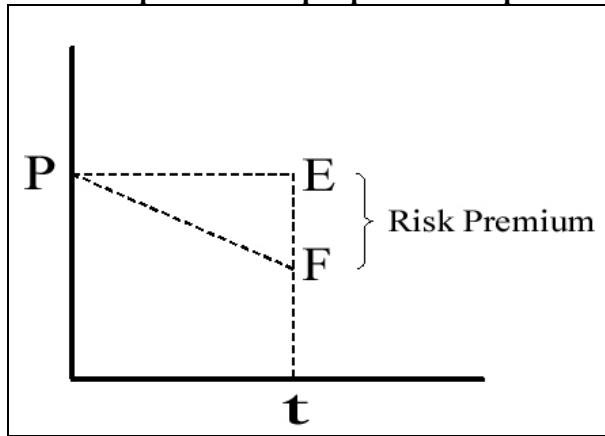
**Exhibit 1. CME Housing Futures Specifications.**

Contract Size	\$250 multiplied by the Case-Shiller <sup>®</sup> Home price Index
Minimum Price Fluctuation	Increments of 0.20 or \$50
Contract Months	February, May, August, November (February Cycle)
Cash Index Release Schedule	The last Tuesday of every calendar month at 8:00 a.m. CST
Last trading Day	Trading ceases at 2:00 p.m. CST on the business day preceding the index release day for the contract month.
Contracts Available	Boston, Chicago, Denver, Los Angeles, Las Vegas, Miami, New York, San Diego, San Francisco, Washington DC and the 10-city composite index
Type of Trading	Futures, options on futures, block trading (20 contract minimum), calendar spreads, regional spreads
Settlement	Contracts are settled against the spot value of the S&P/Case-Shiller <sup>®</sup> Home Price Index with a two-month lag using the index values for the previous three months (previous quarter).
Trading Hours	Offered exclusively on the CME Globex <sup>®</sup> electronic trading platform on Monday – Thursdays 5:00 p.m. – 2:00 p.m.(CST) the next day.
Minimum Performance Requirements	Depends on volatility of the housing market, purpose of the futures trade (speculative or hedging), and if the position is an outright position or a spread.
Position Limits	5,000 contracts

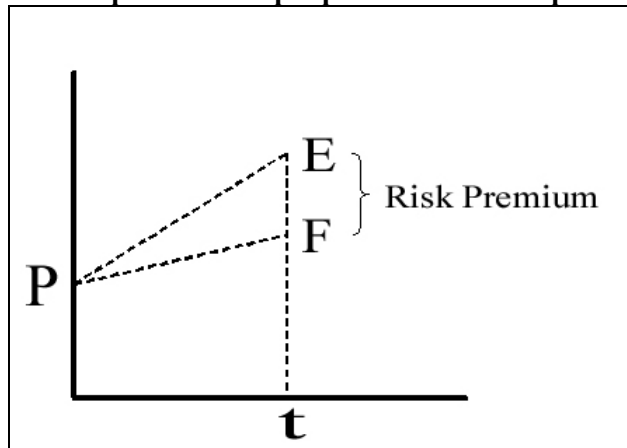
Source: Housing Futures and Options: Contract Specifications, CME, May 2006.

**Exhibit 2. Futures Pricing with “Normal Backwardation” under Alternative Spot Price Expectations**

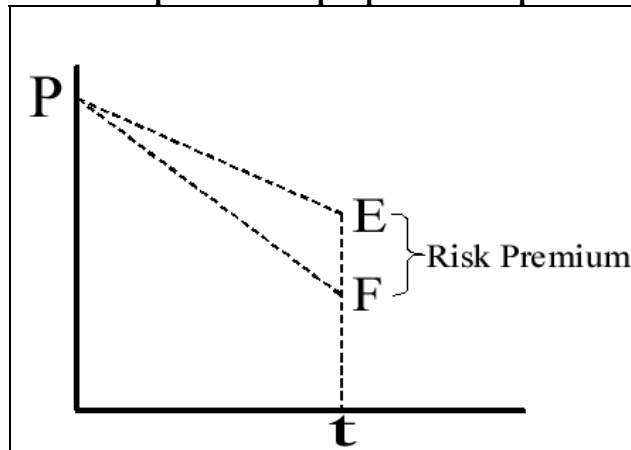
**Exhibit 2A: Futures price below spot price and expected future price**



**Exhibit 2B: Futures price above spot price but below expected future price**



**Exhibit 2C: Futures price below spot price and expected future price**



**Exhibit 3: Studies of Commodity Futures Returns and Risks**

<b>Study Author(s)</b>	<b>Bodie &amp; Rosansky</b>	<b>Gorton &amp; Rouwenhorst</b>	<b>Greer</b>
Time Period	1950-1976	1959-2004	1970-1999
No. of Commodities	23	36	18
Type of Return	Nominal	Real	Nominal
Ave. Return	13.8%	5.2%	12.2%
Std. Deviation	22.4%	12.1%	19.6%
Sharpe Ratio	1.6	2.3	1.6
<b>Comparable Stock Returns:</b>			
Ave. Return	13.1%	5.7%	14.9%
Std. Deviation	18.9%	14.9%	16.0%
Sharpe Ratio	1.4	2.6	1.1

**Exhibit 4: Returns and Risks on Housing Futures Contracts**

<b>City</b>	<b>No. of Contracts</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Coefficient of Variation</b>	<b>Average Annualized Monthly %Δ in S&amp;P/Case-Shiller Price Indexes (5/06 – 3/07)</b>
CUS	105	8.13%	4.62%	0.57	-2.67%
BOS	50	8.83%	12.96%	1.47	-5.70%
CHI	51	11.26%	4.62%	0.41	0.96%
DEN	46	6.57%	11.41%	1.74	-2.45%
LAV	61	8.57%	7.28%	0.85	-2.46%
LAX	188	5.36%	16.87%	3.14	-2.37%
MIA	187	11.00%	18.48%	1.68	0.22%
NYM	92	11.79%	7.69%	0.65	-1.53%
SDG	89	7.08%	7.87%	1.11	-7.23%
SFR	85	9.36%	3.05%	0.33	-3.26%
WDC	64	7.07%	11.66%	1.65	-5.89%
All Areas	1,018	8.57%	12.64%	1.47	-3.44%

**Exhibit 5: The Information Content of Futures Prices**  
(n = 1,018)

<b>Variable</b>	<b>Coefficient</b>	<b>Standard Error</b>	<b>t-Statistic</b>
Constant	0.13618	0.00138	99.06
$\ln(P_{s,t}/P_{p,t})$	0.82363	0.01273	64.70
$(r_t - Q_t) \cdot T_t$	2.99118	0.05145	58.14
$Time_t$	-0.00020	0.00001	-32.60
<b>City Dummy Variables</b>			
BOS	0.24717	0.00201	122.82
CHI	0.29837	0.00174	171.38
DEN	0.48148	0.00101	475.85
LAV	-0.03818	0.00076	-50.46
LAX	-0.18838	0.00071	-265.87
MIA	-0.20724	0.00086	-241.29
NYM	0.04690	0.00054	87.69
SDG	-0.09158	0.00155	-59.09
SFG	0.03956	0.00068	58.46
WDC	-0.09608	0.00169	-56.91
R-squared	0.99746		
Adjusted R-squared	0.99742		
S.E. of regression	0.00937		

**Table A.1: Sample Summary Statistics**  
(n = 1,018)

<b>Variable:</b>	<b>Mean</b>	<b>Median</b>	<b>Maximum</b>	<b>Minimum</b>	<b>Std. Dev.</b>
$\ln(P_{m,t}/P_{p,t})$	0.05264	0.00695	0.59750	-0.26944	0.18453
$\ln(P_{s,t}/P_{p,t})$	0.02052	0.01820	0.08010	-0.12713	0.02962
$(r_t - Q_t) \cdot T_t$	-0.01211	-0.01121	-0.00007	-0.02751	0.00765
$Time_t$	155.25050	140.00000	389.00000	21.00000	94.02327
BOS	0.05010	0.00000	1.00000	0.00000	0.21826
CHI	0.04912	0.00000	1.00000	0.00000	0.21622
DEN	0.04519	0.00000	1.00000	0.00000	0.20782
LAV	0.05992	0.00000	1.00000	0.00000	0.23746
LAX	0.18468	0.00000	1.00000	0.00000	0.38823
MIA	0.18369	0.00000	1.00000	0.00000	0.38742
NYM	0.09037	0.00000	1.00000	0.00000	0.28686
SDG	0.08743	0.00000	1.00000	0.00000	0.28260
SFG	0.08350	0.00000	1.00000	0.00000	0.27677
WDC	0.06287	0.00000	1.00000	0.00000	0.24285