The Determinants of Homebuilder Stock Price Exposure To Lumber: Production Cost Versus Housing Demand

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Abstract

We study the economic linkage between homebuilder stock market performance and commodity futures market information on a major component of building materials—lumber. The price of lumber plays a dual role in determining homebuilder profits: it represents a production input cost and serves as a future housing demand indicator. Using all US publicly listed homebuilder stocks, we show that the housing demand effect dominates the builder–lumber relationship. This effect is robust even after we control for the Federal Housing Finance Association (FHFA) housing price index (HPI). Our results further indicate that the slope of the lumber futures curve serves as a cross-market signal of future housing demand and thus of homebuilder stock market performance.

Keywords: Homebuilder, Lumber futures, Housing demand, Commodity exposure

JEL Classification: G14, R31

The Determinants of Homebuilder Stock Price Exposure To Lumber: Production Cost Versus Housing Demand

Housing development and home construction historically has been a risky process because housing prices and construction costs tend to be volatile. Unexpected events in the economy, variations in weather conditions, or outright natural disasters can cause shortages in lumber, steel, or other building materials, which can in turn severely diminish the financial viability of real estate investments that involve construction. Furthermore, because of the construction lag between the time of a development decision and the time of project completion, the financial performance of homebuilders depends heavily on the extent to which they can accurately predict future housing demand.

Despite its economic importance, very few studies have examined the housing market from the supply side by analyzing homebuilder performance and risk exposure. Examining the stock market performance of all publicly listed homebuilders in the United States, we address this issue from the perspective of the exposure of homebuilder stock prices to lumber pricing and availability. Most homebuilders are involved in only one line of business—home construction. Thus, the performance of these companies is directly contingent upon lumber prices based on the following two competing effects. First, one might assume that high lumber prices must be associated with negative returns on homebuilder stock shares because in terms of cost lumber is by far the largest component of housing construction materials (NAHB, 2012; Lowder and Biddle, 1997). Second, however, exogenous shifts in future housing demand typically bids up the price of all production input factors. As home construction consumes more than 60% of all lumber in the United States (Wood Use Report, 1983), positive housing demand shocks are likely to drive up lumber price. Since lumber futures contracts are actively traded on the Chicago

Mercantile Exchange, the lumber futures price curve may provide information pertaining to demand for housing production output. Therefore homebuilder stock returns may be positively associated with lumber prices.

Using the Dow Jones Home Builders index (DJHB), we first investigate the relationship between homebuilder stock performance and the lumber futures price in an aggregate time-series framework. Contemporaneous regressions show that homebuilder stock returns are positively associated with lumber futures returns and positively associated with the slope of the futures curve. This positive builder–lumber relationship is robust, even after we control for stock market returns, commodity index returns and housing price index (HPI) returns. Furthermore, a predictive regression shows that the slope of the lumber futures curve leads homebuilder stock returns. In other words, if the lumber futures price with longer maturity is higher than the price with shorter maturity, the homebuilder stock returns tend to be higher in the next period. This signal exists even after we control for exogenous housing demand shocks (HPI).

To measure homebuilder exposure to lumber across firms and time, we examine the determinants of the cross-sectional difference of the lumber beta. Utilizing a unique dataset from SNL Financial, we obtain substantial information on each homebuilding company, such as land inventory, the number of houses delivered, the average price of constructed houses, cost, and equity market data, which enables us to empirically test how observed exposures correspond to predicted exposures. Our cross-sectional results are consistent with the time-series regression: the lumber futures curve contains information about housing demand; the lumber futures slope is positively associated with homebuilder lumber exposures. Furthermore, builders who hold more land inventory have more positive betas than do those who specialize in merely transforming materials into physical buildings. Federal Housing Finance Agency (FHFA) HPI returns, which are positively associated with homebuilder stock returns, as expected, do not provide a sufficient statistical basis for predicting lumber prices. Instead, the lumber slope contains additional information about future housing demand, which is not contained in the HPI.

This paper offers three contributions to the literature. First, unlike other papers on commodity betas such as those of Tufano (1998) and Rajgopal (1999) that investigate only the single role that commodity prices have played in influencing firm performance as either inputs or outputs, we show that lumber prices play two roles in explaining homebuilder stock returns—production input costs and signals of output demand. Second, to the best of our knowledge, we have pioneered a link between the futures term structure, regarding both the level and the slope of the futures curve, and a firm’s risk exposure to commodities. Third, we have established that the slope of the lumber futures curve has significant predictive power regarding homebuilder stocks. In our sample, a one-standard-deviation increase in the slope of the lumber futures curve is associated with a 14–15% increase in annual return for homebuilders.

In the remainder of the paper, we review the prior literature and motivate our study in Section 2. We then describe the data in Section 3. In Section 4, Empirical methodology and results, we conduct an aggregate analysis of homebuilder stock performance and cross-sectional analysis of homebuilder exposure to lumber. Section 5 concludes the paper.

Motivation and Literature Review

Since lumber is a major component of construction material, one would reasonably expect homebuilder performance to be negatively correlated with the price of lumber, resulting in negative lumber exposure. However, we have found that exposure of stock prices in the homebuilding industry to lumber prices is positive. Prior empirical studies also suggest an ambiguous relationship between construction costs and construction activity. For example, Follain (1979) analyzes housing starts and construction material and finds that the sign of the coefficient depends on the model specification. DiPasquale and Wheaton (1994) find a positive effect of costs on housing starts. Poterba (1984) points out the endogeneity issue, which results in a positive relation between the lumber price index and construction activity. Somerville (1996) also studies the relationship between homebuilder profit and construction cost and the results suggest that homebuilder profits are more sensitive to variations in land costs than to variations in the cost of structures. These phenomena thus motivate us to search for alternative forces that might offset the ‘‘production input’’ effect.

In North America, lumber constitutes the largest component of the building material market. Demand for lumber is derived from housing demand. A boom in housing activity should trigger a price increase in lumber and other input factors. The positive relation between increases in construction costs and home-building activities has also been pointed out in prior studies. Poterba (1984) argues that if construction input factors, such as lumber or skilled construction labor, are in limited supply, then an increase in construction demand will increase input factor prices. Using annual time-series data, Topel and Rosen (1988) show that lumber prices and hourly wages of construction labor track both home prices and new construction closely. Somerville (1999) emphasizes that the implicit costs of switching subcontractors are also positively related to construction activity.

However, previous studies focus only on the contemporaneous relation between the current costs of factor inputs and construction activities. We, however, observe the full structure of future lumber prices—not merely, for example, the contemporaneous relation between the cost of labor and the cost of switching subcontractors. Lumber futures are actively traded, and the prices incorporate market expectations pertaining to construction activity such as housing stars and completions (see, for instance, Karali and Thurman, 2009). Taking advantage of the futures market, we are able to utilize the extra information contained in the term structure of the lumber futures price as an indicator of future housing demand. Since lumber futures prices are positively related to construction activity in the market, the slopes of the lumber futures term structure and futures returns serve as signals of the housing demand faced by homebuilders. Another strand of the literature studies how firms utilize the commodity futures market to effectively hedge their business risks. Corporate managers have always been concerned with exposure to interest rates, exchange rates, and commodity prices. They believe that by engaging in risk management they can hedge some of their risks. Furthermore, if certain commodities serve as either major components of a company's Cost of Goods Sold or as major output products, the company's stock performance can be traced to commodity price movements. For example, Tufano (1996, 1998) shows that gold mining companies are significantly affected by gold price risks. Specifically, using a sample of 48 companies, Tufano (1998) illustrates that the stock returns of gold mining companies have an average beta of 2.21 against returns on gold prices. Similarly, Rajgopal (1999) and Haushalter (2000) demonstrate that oil and gas producers' performance is highly sensitive to their respective commodity prices. Likewise, Géczy et al. (2006) and Carter et al. (2006) document significant stock exposures of natural gas pipeline firms and airlines to gas and fuel oil prices, respectively. While these studies focus on corporate hedging activities associated with either input or output commodities in the production process, our study presents new evidence on the dual role played by lumber relative to homebuilder performance: as a factor input cost and as output demand signals.

The Data and Descriptive Analysis

The sample used in this study comes from the SNL homebuilder module and Dow Jones Indexes. Table 1 summarizes the operation profiles and data coverage for each of the 21 publicly listed builders in the United States. Most of the builders focus on the construction of single-family detached or townhome-condo residential properties. Only three builders (Centex, KB Home, and Tarragon) involve commercial real estate construction in addition to their residential construction activities. In terms of the geographical distribution of homebuilding operations, while several of the listed builders focus on as few as two states, most publicly listed builders are licensed to build homes in more than a dozen states. D.R. Horton has home construction licenses in 27 states, the maximum number of operating states in the sample. The average number of homebuilder operating states is 12. Table 2 provides the descriptions of variables used in this study.

As a measure of the performance of the entire US home construction sector, we used DJHB returns for the period of 1992–2007. The components of this index are residential homebuilders, including manufacturers of mobile and pre-fabricated homes. A company must have float-adjusted market capitalization of $500 million or more to enter the index. If a company is already a component of the index, its float-adjusted market capitalization must meet minimum eligibility and liquidity requirements to remain in the index. The DJHB index, the most widely used index of its kind, has been tracked by several exchange-traded funds (ETF) and index funds. On May 1, 2006, Dow Jones Indexes announced that Barclays Global Investors

(BGI) licensed the indexes to serve as the basis of its ETFs. Shares in the Dow Jones US Home Construction Index Fund (ticker: ITB) have been traded on the New York Stock Exchange since May 5, 2006.[1]

The lumber cost data we use are obtained from the Chicago Mercantile Exchange.[2] Random-length lumber futures contracts are actively traded on the Chicago Mercantile Exchange,[3] and are settled in January, March, May, July, September, and November. Generic lumber futures prices, which include contracts of maturities ranging from one month to one year, are obtained from Bloomberg. As shown in Fig. 1, the lumber futures price is highly volatile. Moreover, the term structure of lumber futures varies substantially over time. Fig. 2 demonstrates four examples of lumber futures term structures indicating that at different time periods the lumber futures curve contains rich information on future lumber price trends. We develop the idea that the ‘‘housing demand’’ effect is related not only to lumber returns but also to the slope of the lumber futures curve, which is defined as the percentage difference between the two futures prices with the nearest maturity (1 month) and the second-nearest maturity (3 months) normalized by the nearest futures price. Intuitively, a positive lumber return suggests an increase in current lumber demand, which indicates that construction activity in the current period is higher than in the previous period. The homebuilding industry is likely to experience growth in this period. Likewise, an upward sloping futures curve indicates that the market expects construction activity to increase in the next few months. Therefore, both measures are

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[1] Another well-known homebuilder index is the S&P select industry index-homebuilders, which is the basis of the SPDR homebuilders ETF (ticker: XHB), advised by State Street Global Advisers (SSgA). Not surprisingly, the two indexes are highly correlated, with coefficients of 0.996. Even though XHB started trading on the NYSE on February 6, 2006, the data were incomplete.

[2] The merger between the Chicago Mercantile Exchange (CME) and the Chicago Board of Trade (CBOT) on July 12, 2007 created the world’s largest futures exchange, CME Group Inc. On March 17, 2008, CME announced its acquisition of NYMEX Holdings, Inc., parent company of the New York Mercantile Exchange (NYMEX).

[3] One contract of random-length lumber futures contains 110,000 board feet (about 260 cubic meters). The pricing unit is in dollars per 1000 board feet.

related to the housing demand faced by homebuilders. In particular, in the empirical analysis in Section 4.1, we demonstrate that the slope of the lumber futures curve can be used to predict homebuilder returns.

As controls for homebuilder exposure to overall market conditions and for exogenous shocks in the commodity market, we include S&P 500 index returns (Market) and S&P Goldman Sachs Commodity Index returns (GSCI). Components of the commodity index are selected on the basis of liquidity and weighted by their respective world production quantities. We also include the percentage change in the FHFA-HPI[4] as an additional control for housing demand. The HPI is constructed through a repeat-sales methodology and is available monthly. We use the seasonally adjusted index in the empirical analysis. Fig. 3 plots historical time series of lumber futures, the DJHB, the GSCI, the Market index, and the FHFA-HPI. Summary statistics as well as correlations among them shown are in Table 3.

To analyze the cross-sectional determinants of lumber exposure for homebuilding companies, we further obtain firm-level quarterly information on homebuilding operation profiles for each builder in the United States.[5] The operation profiles of the builders include detailed information on the number of new houses delivered, backlogged, canceled, and newly contracted during each quarter as well as the unit prices associated with them. On the expenses side, the operation profiles provide a breakdown of cost details ranging from construction expenses and sales to general and administrative expenses. Table 4 provides the simple summary statistics for each of the variables used in the time-series regressions as well as the correlations among them. The following variables along with lumber futures term structures are used in the cross-sectional tests:

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[4] The FHFA HPI is the former OFHEO-HPI.
[5] SNL Financial provides detailed construction information only for years since 2003.

Slope: The slope of the lumber futures curve is calculated as the difference between the second-nearest maturity lumber futures and the nearest maturity lumber futures, normalized by the nearest maturity lumber futures price. The slope for a period longer than one day is the average of the daily slope within that period. On average, the lumber futures curve is upward-sloping.

Size: Homebuilder market capitalization is used as a measure of homebuilder size.

BTM: The book-to-market ratio is defined as the ratio of the homebuilder's book value of equity to the market value of equity.

HPI: The percentage change in FHFA-HPI for each quarter is used to control for market-level demand shocks.

Land: Homebuilder land inventories vary considerably from firm to firm. Total land inventory for homebuilders ranges in value from $4.6 million to $7.2 billion with a mean of $4.1 billion for all homebuilders from 2003 to 2011 in our dataset.

Price: As a measure of the market price of output, we use the unit price of delivered homes, which averaged $321,600 per unit for 2003 Q1 through 2011 Q4, ranging from a minimum of $178,000 per unit to a maximum of $739,000 per unit in this period.

Quantity: As a measure of quarterly production quantity, we use the total number of delivered homes in the regression, which averaged 3173 units for 2003 Q1 through 2011 Q4, ranging from 6 units to 18,622 units per quarter.

Cost: Homebuilding companies usually report total expenses associated with construction, sales, general administration, and financial charges. We use total construction expenses to measure construction costs.

National: A dummy variable that equals 1 if the builder operates in more than 12 states. The average number of operating states in our sample is 12. Since most housing development and home construction contractors are local businesses, obtaining permits and licensing in other states represents significant operating commitments to homebuilders. Therefore, we refer to builders who have more than the average number of state licenses as ‘‘national builders’’.

Empirical Methodology and Results

Whether homebuilder performance is related to lumber prices depends on how homebuilders deal with the production risk related to changes in the price of lumber. If firms use futures to insure certain prices for their inputs and outputs, then their performance should not depend on price changes regarding their inputs and outputs (Dusak, 1973). As Tufano (1998) has documented, gold-mining firms tend to have varying exposures to gold prices depending on their hedging models. Thus, it is worthwhile first to consider whether homebuilders hedge the prices of their inputs (lumber) and outputs (houses). Until recently, there was no effective way to hedge against housing risks

In relation to corporate hedging activity on the input side, anecdotal evidence indicates that very few builders, if any, hedge lumber prices using lumber futures or options. To investigate the hedging behavior of input risks, we have examined all recent annual reports of homebuilders by searching for the keyword, ‘‘hedge’’. With the exception of several builders discussing the use of interest rate swaps to hedge their investments or holdings of mortgagebacked securities, none of the firms' annual reports mentioned hedging lumber price risk or other production risks. Without hedging the price risks of both outputs and inputs, homebuilders have been implicitly relying on the naturally offsetting effects—"production input" and "housing demand"—to attenuate their lumber exposure. Higher lumber futures returns indicate higher construction costs in the current period. In the meantime, higher lumber returns also reveal that the market expects housing prices to increase. Previous empirical studies suggest that these two effects counterbalance each other most of the time. As Rosenthal (1999) shows, the value of new buildings and construction costs are co-integrated. Using a micro-data set from a large homebuilder, Somerville (1996) also finds that unexpected variations in structure costs can generally be passed onto consumers in the form of higher prices. However, the two effects do not always counterbalance each other. For example, when a world commodity price rally occurred during 2008 Q3 in conjunction with a slowdown in the US housing market, the lumber beta was 1.6 (Casassus et al., 2012). In such cases, homebuilders are confronted with substantial lumber price risks. Examples of homebuilders' annual reports reveal that most managers of homebuilding firms have realized the importance of the potential risks of lumber price fluctuations, but none of them has mentioned the use of lumber futures to hedge the production risks. Consider the following two examples:

> *The homebuilding business has from time to time experienced building material and labor shortages . . . as well as fluctuating lumber prices and supply. . . . Significant increase in costs . . . could have a material adverse effect upon our sales, profitability, stock performance, ability to service our debt obligations and future cash flows*.—NVR 2008 Annual Report

> *Fluctuating lumber prices and shortages, as well as shortages or price fluctuations in other building materials or commodities, can have an adverse effect on our business. . . . The potential difficulties described above can. . . . incur more cost to build our homes. We may not be able to recover these increased costs by raising prices because of market conditions and because the price of each home we sell is usually set several months before the home is delivered, as our customers typically sign their home purchase contracts before construction begins.*—K.B. Homes 2008 Annual Report

These two examples imply that it is appropriate when analyzing the effect of lumber prices on homebuilders to assume that they do not hedge lumber risks. As we indicated in our introduction, if the lumber returns curve signals homebuilder housing demand, they must be able to predict future homebuilder stock performance.

Aggregate analysis of homebuilder stock performance

We first investigate the effect of lumber futures on aggregate measures of the home construction industry. We have chosen the DJHB as a proxy for the home construction industry. Table 5 shows the results obtained from the step-wise regressions of DJHB returns on various factors at daily, weekly, and monthly frequencies in the form of Eq. (1).

$$\mathrm{DJHB_t} = \beta_0 + \beta_M \mathrm{Market_t} + \beta_{LB} \mathrm{LB_t} + \beta_{\mathrm{GSCI}} \mathrm{GSCI_t} + \beta_{Slope} \mathrm{Slope_t} + \beta_{HPI} \mathrm{HPI_t} + \varepsilon_t \qquad (1)$$

where the dependent variable is the return on the DJHB index at time t. $\mathrm{Market_t}$ is the market return at time t, which et is the error term in the regression.

Panel A reports results from the contemporaneous regressions with returns and measures of the control variables in the same time period. The results indicate that market returns serve as a dominant factor in driving aggregate homebuilder returns. The DJHB index has a market beta slightly greater than 1 (model A). For each 1% increase in market returns, the homebuilder index returns increase 1.1%. Model B adds lumber futures returns. Our hypothesis regarding the exposure of DJHB returns on lumber is as follows: if supply shocks are the dominant force in determining lumber returns, then the exposure of the DJHB to lumber returns β_{LB} should be negative. However, if housing demand shocks are the dominant influence on lumber returns, β_{LB} should be positive. In model B, the lumber beta is small but significantly positive, which indicates that housing demand shocks are the primary determinant of lumber returns in the sample period we analyze. This result confirms previous studies which find that, when homebuilder returns and changes in production input factor prices are co-integrated, current housing demand will bid up the factor price. This positive builder–lumber relationship remains the same even if we control for market-level movements of the commodity with the GSCI (model C). This suggests that current lumber returns contain information on housing demand shocks.

Since lumber futures contracts with varying maturities are traded in the market, we continue to examine whether the lumber futures curve contains information about housing demand shocks that is not incorporated in the current lumber price. We construct the slope of the lumber futures curve and include it in model D. The lumber slope is defined as the percentage difference between two futures prices with the nearest maturity (1 month) and the second-nearest maturity (3 months) normalized by the nearest futures price. Intuitively, a positive lumber return suggests an increase in current lumber demand, which indicates that construction activity in the current period is higher than in the previous period. The homebuilding industry is likely to experience growth in such a period. Likewise, an upward sloping futures curve indicates that the market expects construction activity to increase in the future rather than that there will be a temporary lumber supply shortage. The daily (model D), weekly (model E), and monthly (model F) regressions shown in Panel A of Table 4 indicate that the lumber slope is an important factor influencing homebuilder returns. The results show that an upward-sloping lumber futures curve is associated with positive homebuilder index returns.

To check whether the housing demand effect is captured in the HPI, we include FHFA-HPI returns as an additional control for current housing demand shocks (model G).[6] Results indicate that HPI is the most important factor affecting builder stock returns: a 1% increase in HPI returns is associated with a more than 6% increase in the builder index return. However, HPI is not a summary statistic and the lumber futures curve still contains extra information on housing demand. To examine whether the additional information from the lumber futures curve can predict homebuilder returns, we perform additional predictive regressions.

Panel B of Table 5 shows the results developed from step-wise predictive regressions with model identifications that are similar to those in Panel A. The only difference in the regression setup is that we use a one-period lag measure of LB and Slope as the independent variables. The predictive regression results indicate that the lumber slope is significantly positively associated with homebuilder returns, even after controlling for the HPI. However, the lumber returns figure is no longer significant.

The overall results provided in Table 5 suggest that DJHB returns are positively and significantly related to stock market returns, HPI returns, and the lumber slope. After controlling for HPI, market-level shocks to the stock market, and the commodity market, a one-percent increase in the lumber futures slope is related to a 0.30% increase in DJHB returns and predicts a 0.27% increase in DJHB returns next month. The result is consistent with the hypothesis that the

[6] HPI data is available only at monthly and quarterly levels.

slope of the lumber futures curve contains extra information on expected future housing demand in addition to information on current housing demand shocks.

Cross-sectional analysis of homebuilder exposure to lumber

In addition to the effect on the aggregate homebuilder index (DJHB), the effect of lumber futures prices on homebuilder performance is likely to differ across market condition and homebuilding firms. To gain more insight on the effect of lumber futures prices on homebuilders' performance, we perform a cross-sectional analysis of homebuilder exposure to lumber across firms.

To estimate cross-sectional variation quantitatively, we adopt a multivariate test for the potential determinants of the homebuilder's lumber exposure with a two-stage approach.[7] In the first stage, we estimate a firm-specific quarterly lumber beta in the following two-factor market model using daily data for each firm i and each quarter q.

$$R_{i,t} = \alpha + \beta_{M,i}\mathrm{Market_t} + \beta_{LB,i}\mathrm{LB_t} + \varepsilon_t \qquad (2)$$

where $R_{i,t}$the daily return on stock i at time t and Market_t and LB_t are returns on the S&P 500 index and on the lumber futures price with nearest maturity, respectively. For each firm, the estimated coefficients $\beta_{M,i}$and $\beta_{LB,i}$measure the sensitivities of firm i's stock returns to market returns and lumber returns, respectively. After obtaining the lumber betas, we estimate the following pooled OLS regression as the second stage analysis:

$$\beta_{LB,i,q} = \alpha + \sum_{j=1}^{N} b_{j,i,q}\, X_{j,i,q} + \varepsilon_t, \qquad (3)$$

[7] The two stage approach has been used in studying foreign exchange exposures (Jorion, 1990), interest rate exposures (Flannery and Christopher, 1984), and commodity prices exposures (Strong, 1991; Tufano, 1998).

where $X_{j,i,q}$represents the jth factor for firm i at quarter q; $b_{j,i,q}$is the corresponding coefficient estimate.

From the first stage beta estimation, we can potentially obtain 2183 lumber betas. However, SNL provides detailed information on homebuilder operation beginning in 2003 Q1.Therefore, 1427 observations are completely eliminated. After further dropping observations with missing variables, our final sample of observations is reduced, finally, to 562 firm-quarter observations.

The estimates of the multi-variable OLS model (Eq. (3)), which examines the determinants of lumber risk exposure, are reported in Table 6. To evaluate the sensitivity of the estimated coefficients, four alternative specifications are estimated. Model I in Table 6 considers the lumber futures curve signal—Slope, market condition (i.e., Market, and HPI), and firm financial characteristics (i.e., Size, BTM) in the specification. Market and HPI control for overall stock market return and housing market demand, while Size (the natural logarithm of the homebuilder market cap) and BTM (the ratio of common equity to market equity) control for variations in homebuilder characteristics. The estimated coefficient on Slope is positive and statistically significant at the 5% level; while the coefficient on HPI is positive and significant at the 1% level. The results indicate that, on average, a positive housing market shock will increase homebuilder risk exposure to lumber. The slope of the lumber futures curve contains additional information signaling future housing demand.

The estimates reported for model II specification add a Land variable, which is the natural logarithm of the value of total land inventory hold by the homebuilder. The coefficient on Land is positive and significant at the 5% level, indicating that builders who hold more land inventory have more positive betas than do those who specialize only in transforming materials into physical buildings.

Model specification III in Table 6 includes additional home construction activity variables (i.e., Price, Quantity, and Cost) motivated by Tufano (1998)'s fixed-production model without hedging. After controlling for market-level housing demand shocks with FHFA-HPI returns and the slope of the lumber futures curve, housing demand at the individual firm level with unit price and quantity of construction as proxies is not significant for explaining the lumber beta. The coefficients on the previous variables remain the same qualitatively. Finally, in model IV, we include the national builder dummy to indicate whether the builder operates nationally. National homebuilders presumably should have lower lumber betas than local homebuilders due to economies of scale in lumber inventory and management. Results in model IV indicate that after, controlling for the size of the homebuilder, the national homebuilder dummy is negative but statistically insignificant.

The coefficient on the slope is positive, consistent, and robust across all four model specifications. The results indicate that the term structure of lumber futures is an important determinant of the exposure in the homebuilder industry to the price of lumber. Moreover, the lumber beta is significantly positively related to the percentage change in the FHFA-HPI and market returns. This suggests that the lumber beta tends to be negative when there is a negative housing demand shock or during economic downturns. This result suggests that hedging lumber price risk with futures contracts might be beneficial for homebuilders especially when they face significant downside risk in the housing market.

Conclusions

In this paper, we have examined the effect of lumber price changes on US homebuilders, and the determinants of the magnitude of this effect. On the one hand, as a major component of housing construction input, an exogenous negative shock to lumber production will lead to an increase in lumber prices or a positive change in the slope of the lumber futures curve. This in turn results in an increase in construction costs. Homebuilders are likely to experience declining profits. On the other hand, since demand for lumber as a production input is derived from housing demand, an increase in lumber prices, or a positive slope of the lumber futures curve indicates an upward trend in future housing demand, which will improve homebuilder stock performance. The net effect of lumber price risk depends therefore on which of the two abovementioned forces dominates the relationship. Utilizing time series of lumber futures prices and DJHB returns, we find that the housing demand effect is a dominant factor for the homebuilding industry. Taking into consideration firm characteristics across time, we find that homebuilder sensitivity to lumber price movements depends on the slope of the lumber futures curve, percentage change in the HPI, and firm-held land inventory.

Our study has several implications both academic and practical. First, the lumber futures curve contains additional information on future housing demand, even after controlling for FHFA-HPI returns. Moreover, exposure to lumber prices varies across different firms and time. The slope of the futures curve can be used to predict homebuilder stock performance in the next period. Furthermore, since the lumber beta is positively related to FHFA-HPI returns and market returns, the exposure of homebuilder returns to lumber returns tends to be negative during a slowdown in the housing market or a downturn of the entire stock market. Even though hedging lumber risk at the corporate level has not been a common practice in the home construction industry, our results suggest that the industry should re-consider the question whether “to hedge or not to hedge”.

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Table 1. List of publicly-traded homebuilders.

Company	Coverage		Construction focus			States of operation	Covered by SNL
	First year	Last year	Single-family residential	Multi-family residential	Commercial		
Avatar Holdings	1986	2008	Detached/Attached	Townhome/Condo	No	AZ FL	No
Beazer Homes	1994	2011	None	Townhome/Condo	No	AZ CA DE FL GA IN MD NC NJ NM NV PA SC TN TX VA	Yes
Brookfield Homes	2003	2011	Detached	Townhome/Condo	No	CA DC DE HI	Yes
Calprop	1986	1996	Detached/Attached	Townhome/Condo	No	CA CO	No
Centex	1986	2011	Detached/Attached	Townhome/Condo	Yes	AZ CA CO FL GA HI IL IN MD MI MN MO NC NJ NM NV OR SC TN TX VA WA	Yes
Champion Enterprises	1986	2008	Detached/Attached	None	No	AZ CA CO FL ID IN MN NE NY NC PA TN TX VA	No
Comstock Homebuilding	2004	2011	Detached/Attached	Townhome/Condo	No	DC GA MD NC VA	Yes
D.R. Horton	1992	2011	Detached/Attached	Townhome/Condo	No	AL AZ CA CO DE FL GA HI ID IL LA MD MN MS NC NJ NM NV OK OR PA SC TX UT VA WA WI	Yes
Dominion Homes	1994	2011	Detached	None	No	KY OH	Yes
Hovnanian Enterprises	1986	2011	Detached	Townhome/Condo	No	AZ CA DE FL GA IL KY MD MN NC NJ NY OH PA SC TX VA WV	Yes
KB Home	1986	2011	Detached/Attached	Condo	Yes	AZ CA CO FL NC NV SC TX	Yes
Lennar	1986	2011	Detached/Attached	Condo	No	AZ CA CO FL IL MA MD MN NC NJ NV NY PA SC TX VA	Yes
M.D.C. Holdings	1986	2011	Detached	Townhome	No	AZ CA CO DE FL IL MD NJ NV PA UT VA WV	Yes
M/I Homes	1993	2011	Detached/Attached	Townhome	No	DC FL IL IN MD NC OH VA	Yes
Meritage Homes	1988	2011	Detached	Condo	No	AZ CA CO FL NV TX	Yes
NVR	1993	2011	Detached	Townhome/Condo	No	DC DE MD MI NC NJ NY OH PA SC TN VA WV	Yes
Orleans Homebuilders	1986	2011	Detached	Townhome/Condo	No	FL IL NC NJ NY PA SC VA	Yes
Pulte Homes	1986	2011	Detached/Attached	Townhome/Condo	No	AZ CA CO CT DE FL GA IL IN MA MD MI MN NC NJ NM NV NY OH PA RI SC TN TX VA	Yes
Ryland	1986	2011	Detached/Attached	None	No	AZ CA CO DE FL GA IL IN KY MD MN NC NV OH SC TX VA	Yes
Standard Pacific	1987	2011	Detached/Attached	None	No	AZ CA CO FL NC NV TX	Yes
Tarragon	1986	2007	None	Townhome/Condo	Yes	CT FL NJ NY SC TN TX	Yes
Technical Olympic	1998	2008	Detached	Townhome/Condo	No	AZ CO DE FL MD NV PA TN TX VA	No
Toll Brothers	1986	2011	Detached/Attached	Townhome	No	AZ CA CO CT DE FL GA IL MA MD MI MN NC NJ NV NY PA RI SC TX VA WV	Yes
WCI Communities	2002	2011	Detached/Attached	Condo	No	CT FL MA MD NJ NY VA	Yes
William Lyon Homes	1991	2006	Detached/Attached	None	No	AZ CA NV	Yes

Table 2. Description of variables.

Variable	Definition and source of data
Panel A: Variables in time series regression	
DJHB	Dow Jones US Select Home Builder Index returns, which measure the performance of the US home construction sector. The components of this index are builders of residential homes, including manufacturers of mobile and pre-fabricated homes. A company must have float-adjusted market capitalization of $500 million or more to enter the index. If a company is already a component of the index, its float-adjusted market capitalization must meet minimum eligibility and liquidity requirements to remain in the index [Data source: Bloomberg]
LB	Lumber futures returns with the nearest maturity [Data source: Bloomberg]
Market	S&P 500 Index returns [Data source: Bloomberg]
GSCI	S&P Goldman Sachs Commodity Index returns. The index is a composite index of commodity sector returns. Components of the index are selected on the basis of liquidity and weighted by their respective world production quantities. Lumber is not a component of the index [Data source: Bloomberg]
Slope	Slope of the lumber futures curve, defined as the difference between the second-nearest-maturity lumber futures and the nearest-maturity lumber futures, normalized by the nearest-maturity lumber futures price. The slope for a period longer than one day is the average of the daily slope within the period [Estimated in the paper]
HPI	FHFA housing price index returns. The FHFA housing price index is the former OFHEO HPI. The index is constructed through a repeat-sales methodology [Data source: FHFA]
Panel B: Variables in cross-sectional regressions	
β_{LB}	Lumber beta, which is estimated from a two-factor market model for each firm-quarter, with daily homebuilder returns as the dependent variable, and daily market returns and lumber futures returns as independent variables [Estimated in the paper]
Size	The market capitalization of a homebuilder at the end of the quarter. We use the natural logarithm of market capitalization in the regression [Data source: SNL]
BTM	Ratio of the book value of common equity to the market equity of a homebuilder at the end of the quarter [Data source: SNL]
Land	The value of land inventory of a homebuilder at the end of the quarter. We use the natural logarithm of total land inventory in the regression [Data source: SNL]
Price	Unit price of delivered homes of a homebuilder. We use the natural logarithm of unit price in the regression. [Data source: SNL].
Quantity	Number of homes delivered. We use the natural logarithm of quantity in the regression [Data source: SNL]
Cost	Total expenses associated with construction, sales, general administration, and financial charges. We use the natural logarithm of cost in the regression [Data source: SNL]
National	National homebuilder dummy equal to one if a homebuilder operates in more than 12 states, which is the mean of the number of operating states in the sample [Data source: SNL]

Note: For brevity, Panel B does not include the variables that are described in Panel A.

Table 3. Summary statistics and correlation table for variables used in the aggregate analysis. Panel A reports descriptive statistics for the Dow Jones US Select Home Builder Index returns (DJHB), lumber futures returns with the nearest maturity (LB), S&P 500 Index returns (Market), S&P Goldman Sachs Commodity Index returns (GSCI), and the slope of the lumber futures curve (Slope) from 1991 to 2007 at a daily frequency. DJHB measures the performance of the US home construction sector. The components of this index are builders of residential homes, including manufacturers of mobile and pre-fabricated homes. Lumber return (LB) is lumber futures returns with the nearest maturity. Market returns is the S&P 500 index return. Commodity returns (GSCI) is calculated from the S&P Goldman Sachs Commodity Index, a composite index of the commodity sector. Components of this index are selected on the basis of liquidity and weighted by their respective world production quantities. Lumber commodity is not a component of this index. The slope of the lumber futures curve is defined as the difference between the second-nearest-maturity lumber futures and the nearest-maturity lumber futures, normalized by the nearest-maturity lumber futures price. Panel B shows the correlation between the returns of the four time series at a daily frequency.

Variable	Slope	Size	BTM	HPI	Land	Price	Quantity	Cost	National
Panel A: Summary statistics of factors affecting lumber exposures									
Number of Obs.	562	562	562	562	562	562	562	562	562
Mean	0.04	2359.70	1.01	201.50	1356.50	321.60	3173.00	108.80	0.58
Median	0.04	1648.00	0.73	200.40	717.50	286.00	2171.00	79.50	1.00
Minimum	−0.08	3.05	0.01	168.40	4.60	178.00	6.00	1.10	0.00
Maximum	0.11	11759.75	27.98	226.40	7233.50	739.00	18622.00	693.10	1.00
St. Dev	0.05	2398.91	1.56	17.20	1536.50	119.90	3272.40	105.10	0.49
Panel B: Correlation between factors affecting lumber exposures									
Slope	1								
Size	−0.21	1							
BTM	0.22	−0.22	1						
HPI	0.23	0.11	0.18	1					
Land	−0.01	0.74	−0.07	0.23	1				
Price	−0.01	0.02	−0.10	0.20	−0.08	1			
Quantity	−0.20	0.83	−0.15	0.10	0.75	−0.26	1		
Cost	−0.11	0.82	−0.12	0.23	0.80	−0.15	0.91	1	
National	0.03	0.54	−0.15	−0.05	0.44	−0.07	0.44	0.44	1

Table 4. Summary statistics and correlation table of factors affecting lumber exposures in the cross-sectional analysis. Panel A reports the summary statistics for the variables used in the cross-sectional regressions. The slope of the lumber futures curve is defined as the difference between the second-nearest-maturity lumber futures and the nearest-maturity lumber futures, normalized by the nearest-maturity lumber futures price. Slope used in the cross-sectional regressions is the average daily slope within the quarter. Size is the market capitalization of a homebuilder at the end of the quarter. BTM is the ratio of the book value of common equity to the market equity of a homebuilder at the end of the quarter. HPI is the percentage change of the seasonally adjusted FHFA housing price index level. Land is the value of land inventory held by a homebuilder at the end of the quarter ($ million). Price is the unit price of delivered homes of a homebuilder ($ thousand). Quantity is the number of homes delivered. Cost is the total expenses associated with construction, sales, general administration, and financial charges ($ million). The national homebuilder dummy is equal to one if a homebuilder operates in more than 12 states, which is the mean of the number of operating states in the sample.

Variable	Slope	Size	BTM	HPI	Land	Price	Quantity	Cost	National
Panel A: Summary statistics of factors affecting lumber exposures									
Number of Obs.	562	562	562	562	562	562	562	562	562
Mean	0.04	2359.70	1.01	201.50	1356.50	321.60	3173.00	108.80	0.58
Median	0.04	1648.00	0.73	200.40	717.50	286.00	2171.00	79.50	1.00
Minimum	−0.08	3.05	0.01	168.40	4.60	178.00	6.00	1.10	0.00
Maximum	0.11	11759.75	27.98	226.40	7233.50	739.00	18622.00	693.10	1.00
St. Dev	0.05	2398.91	1.56	17.20	1536.50	119.90	3272.40	105.10	0.49
Panel B: Correlation between factors affecting lumber exposures									
Slope	1								
Size	−0.21	1							
BTM	0.22	−0.22	1						
HPI	0.23	0.11	0.18	1					
Land	−0.01	0.74	−0.07	0.23	1				
Price	−0.01	0.02	−0.10	0.20	−0.08	1			
Quantity	−0.20	0.83	−0.15	0.10	0.75	−0.26	1		
Cost	−0.11	0.82	−0.12	0.23	0.80	−0.15	0.91	1	
National	0.03	0.54	−0.15	−0.05	0.44	−0.07	0.44	0.44	1

Table 5. Aggregate analysis of the homebuilder's performance. This table reports the effect of lumber return (LB) and the slope of the lumber futures curve (Slope) on Dow Jones U.S. Select Home Builder Index returns (DJHB) for the period of 1992–2007 after controlling for the market returns and commodity returns. The DJHB measures the performance of the U.S. home construction sector. The components of this index are builders of residential homes, including manufacturers of mobile and pre-fabricated homes. Market returns is the S&P 500 index returns. Lumber returns (LB) is lumber futures returns with the nearest maturity. Commodity returns (GSCI) is calculated from the S&P Goldman Sachs Commodity Index, a composite index of the commodity sector. Components of this index are selected on the basis of liquidity and weighted by their respective world production quantities. Lumber commodity is not a component of this index. The results in columns A–D are calculated using daily returns on the variables, with one additional explanatory variable for each model specification. The slope of the lumber futures curve is defined as the difference between the second-nearest-maturity lumber futures and the nearest-maturity lumber futures, normalized by the nearest-maturity lumber futures price. The slope for a period longer than one day is the average of the daily slope within the period. The results in columns E and F are calculated for the model with all independent variables using weekly returns and monthly returns, respectively. Column G used monthly returns of the seasonally adjusted FHFA housing price index (HPI) as an additional control. Standard errors are reported in parentheses and coefficients with ***, **, and * are statistically significant at the 1%, 5%, and 10% levels, respectively. Panel A reports the contemporaneous effect of lumber returns and slope on DJHB. The regression equation in column G is given as follows: $\mathrm{DJHB_t} = \beta_0 + B_M \mathrm{Market_t} + \beta_{LB} LB_{(t-1)} + \beta_{GSCI} \mathrm{GSCI_t} + \beta_{\mathrm{Slope}} \mathrm{Slope_{(t\text{-}1)}} + \beta_{\mathrm{HPI}} \mathrm{HPI_t} + \varepsilon_t$ Panel B reports the predictive regression results of the same models and data period as in the Panel A. The predictive

regressions differ from the previous contemporaneous regressions in that they use lumber returns and slope information in the previous period, instead of those in the same period as DJHB returns. The regression equation in column G is given as follows: $DJHB_t = \beta_0 + \beta_M Market_t + \beta_{LB} LB_{(t-1)} + \beta_{GSCI} GSCI_t + \beta_{Slope} Slope_{(t-1)} + \beta_{HPI} HPI_t + \varepsilon_t$

Independent variables	(A) Daily	(B) Daily	(C) Daily	(D) Daily	(E) Weekly	(F) Monthly	(G) Monthly
Panel A: Contemporaneous regressions							
Market	1.087***	1.084***	1.085***	1.084***	1.196***	1.099***	1.122***
	(0.025)	(0.025)	(0.025)	(0.025)	(0.061)	(0.132)	(0.126)
LB		0.020*	0.020*	0.022*	0.020	0.067	0.082*
		(0.011)	(0.011)	(0.011)	(0.025)	(0.050)	(0.048)
GSCI			0.012	0.013	−0.048	−0.005	−0.020
			(0.021)	(0.021)	(0.048)	(0.100)	(0.096)
Slope				0.011**	0.047*	0.206*	0.299***
				(0.005)	(0.027)	(0.117)	(0.114)
HPI							6.774 ***
							(1.505)
Intercept	0.000	0.000	−0.000	−0.000	−0.000	−0.001	−0.030***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.005)	(0.008)
Adj. *R*-square	0.311	0.312	0.312	0.312	0.319	0.261	0.325
Number of Obs.	4173	4173	4173	4173	834	208	208
Panel B: Predictive regressions							
Market	1.087***	1.087***	1.087***	1.087***	1.198***	1.124***	1.155***
	(0.025)	(0.025)	(0.025)	(0.025)	(0.061)	(0.132)	(0.126)
LB		0.004	0.004	0.005	0.012	0.015	0.031
		(0.011)	(0.011)	(0.011)	(0.025)	(0.049)	(0.047)
GSCI			0.013	0.013	−0.049	−0.008	−0.021
			(0.021)	(0.021)	(0.048)	(0.101)	(0.097)
Slope				0.010*	0.054*	0.159	0.271**
				(0.005)	(0.028)	(0.121)	(0.119)
HPI							6.798***
							(1.523)
Intercept	0.000	0.000	0.000	−0.000	−0.000	−0.001	−0.030***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.005)	(0.008)
Adj. *R*-square	0.311	0.311	0.311	0.312	0.319	0.255	0.318
Number of Obs.	4173	4173	4173	4173	834	208	208

Table 6. Cross-sectional analysis of homebuilder's exposure to lumber. The cross-sectional regression results for the factors affecting lumber exposures are reported in the following table. The dependent variable for all four models is the lumber beta, which is estimated from a two-factor market model for each firm-quarter between 2003 and 2011. The slope of the lumber futures curve is defined as the difference between the second-nearest-maturity lumber futures and the nearest-maturity lumber futures, normalized by the nearest-maturity lumber futures price. Slope used in the regressions is the average daily slope within the quarter. Size is the natural logarithm of a homebuilder's market capitalization at the end of the quarter. BTM is the ratio of common equity to market equity of a homebuilder at the end of the quarter. HPI is the percentage change in the seasonally adjusted FHFA housing price index level within the quarter. Market is the S&P 500 index returns during the quarter. Land is the natural logarithm of the value of total land inventory hold by a homebuilder at the end of the quarter. Price is the natural logarithm of the unit price of delivered homes of a homebuilder. Quantity is the natural logarithm of the number of homes delivered. Cost is the natural logarithm of total expenses associated with construction, sales, general administration, and financial charges. National is a dummy equal to one if a homebuilder operates in more than 12 states, which is the mean of the number of operating states in the sample. Standard errors are reported in parentheses and coefficients with ***, **, and * are statistically significant at the 1%, 5%, and 10% levels, respectively.

	Model 1	Model II	Model III	Model IV
Slope	0.651** (0.268)	0.644** (0.268)	0.650** (0.268)	0.654** (0.269)
Size	−0.010 (0.007)	−0.024** (0.010)	−0.011 (0.017)	−0.010 (0.018)
BTM	−0.010 (0.007)	−0.015** (0.007)	−0.012 (0.007)	−0.011 (0.007)
HPI	4.069*** (0.722)	4.177*** (0.722)	4.097*** (0.740)	4.078*** (0.746)
Market	0.277** (0.124)	0.293** (0.124)	0.284** (0.126)	0.282** (0.126)
Land		0.022** (0.011)	0.033** (0.013)	0.033** (0.013)
Price			0.038 (0.041)	0.037 (0.041)
Quantity			0.003 (0.027)	0.003 (0.027)
Cost			−0.030 (0.030)	−0.030 (0.030)
National				−0.005 (0.024)
Intercept	0.038 (0.053)	−0.151 (0.108)	−0.301 (0.246)	−0.303 (0.246)
Adj. R-square	0.079	0.084	0.087	0.086
Number of Obs.	562	562	562	562

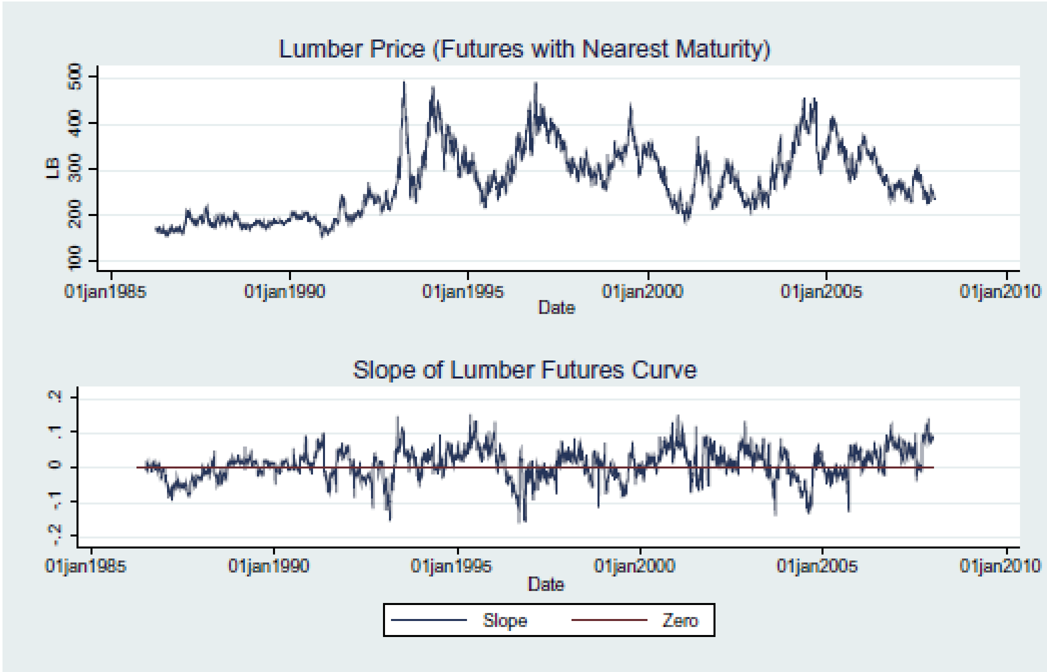

Figure 1. Time series of lumber futures prices with nearest maturity and the slope of the lumber futures curve. The top figure plots the lumber futures price with nearest maturity during the period July 1986 to December 2007. The bottom figure plots the slope of the lumber futures curve during the period July 1986 to December 2007.

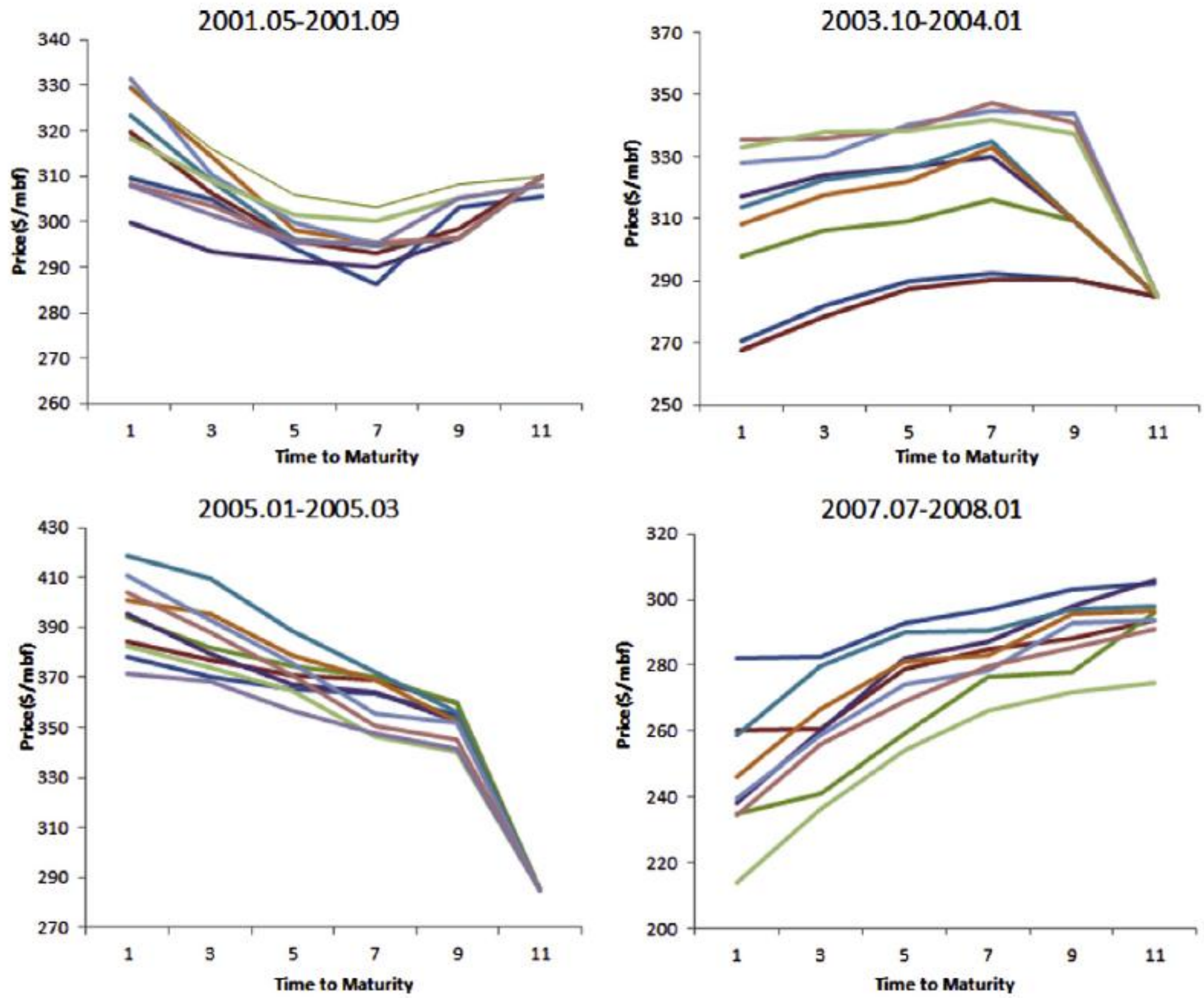

Figure 2. Examples of lumber futures term structures in different time periods. The four figures plot the lumber futures price with varying maturities against their respective time to maturity in different time periods. For example, as shown in the bottom left graph, the lumber futures curve exhibits contango (negative slope) during the period of January 2005 to March 2005. During the period of July 2007 to January 2008, the lumber futures curve exhibits backwardation (positive slope), as shown in the bottom right graph.

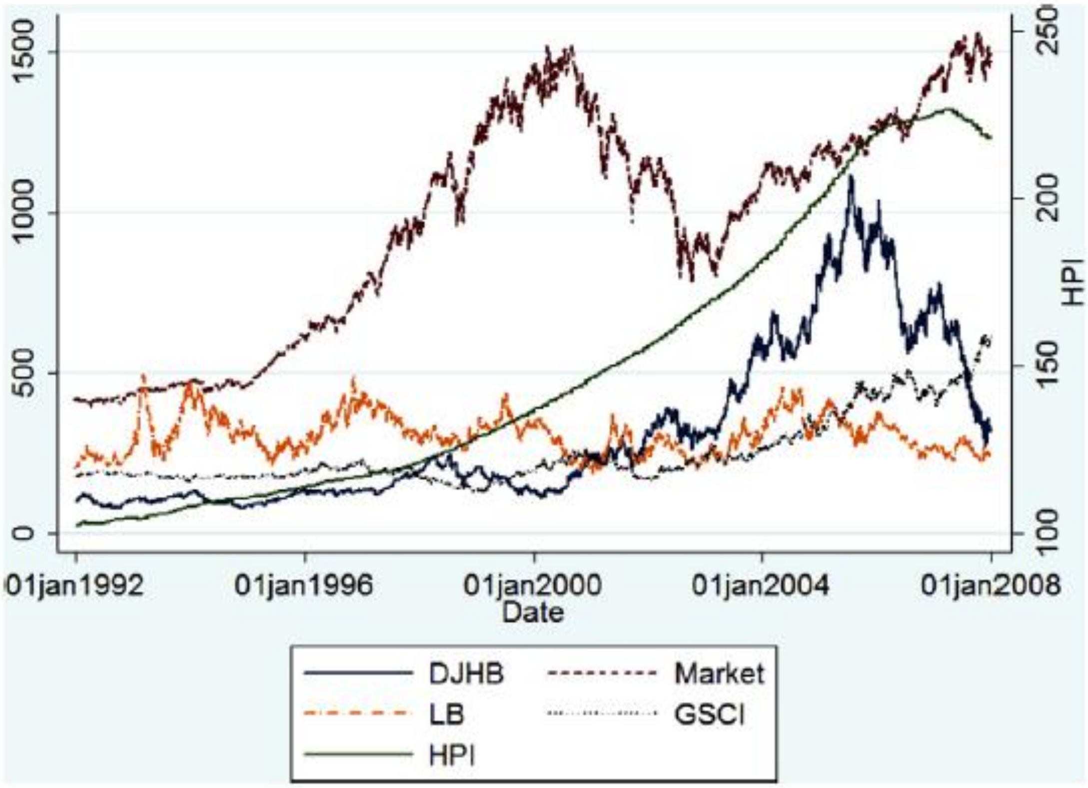

Figure 3. Time series of the Dow Jones US Select Home Construction Index (DJHB), the S&P 500 Index (Market), the Lumber Price (LB), the S&P Goldman Sachs Commodity Index (GSCI), and the FHFA Housing Price Index (HPI). DJHB measures the performance of the U.S. home construction sector. The components of this index are builders of residential homes, including manufacturers of mobile and pre-fabricated homes. LB is the lumber futures price with the nearest maturity. GSCI is a composite index of the commodity sector. Components of this index are selected on the basis of liquidity and weighted by their respective world production quantities. Lumber commodity is not a component of this index. The FHFA Housing Price Index (HPI) is the former OFHEO housing price index, which is one of the most widely used indexes of housing prices. This figure plots the five time series during the period of January 1992 to

December 2007. The level of DJHB, Market, LB, and GSCI are plotted on the left axis. The level of HPI is plotted on the right axis.