Risk Management with Residential Real Estate Derivatives:
Strategies for Home Builders

by

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ABSTRACT

This paper examines *why* and *how* publicly-traded home builders might use index-based residential property derivatives to manage risk. After describing a number of alternative reasons for hedging, I argue for a paradigm for risk management proposed by Kenneth Froot, David Scharfstein and Jeremy Stein and augmented by Antonio Mello and John Parsons. According to this paradigm, the objective of hedging is to increase a firm's financial flexibility by maximizing its liquidity – slack in the form of cash or unused debt capacity – when falling output prices reduce income and make it difficult to raise external financing, but do not reduce the firm's need for funds. An important implication of this paradigm is that attempting to eliminate volatility in the value of a firm is not an optimal hedging objective, and attempting to do so can, in fact, reduce the value of the firm. To illustrate how this paradigm might be used by public home builders it is applied to two hypothetical firms, each with a different capital structure and regional focus, and the potential benefits of hedging for each firm is discussed.

The discussion then turns to the available real estate derivative products and how they can be employed as hedging vehicles. Key issues pertaining to the design of hedging vehicles are examined, including 1) how to choose a derivative contract, 2) how to choose an index or indices to use as the asset underlying the hedging vehicle and 3) how to address misalignment between the time to expiration of available derivatives contracts and the development time frames of residential communities. Evidence is presented that suggests hedging vehicles based on multi-market composite indices will probably have too much basis risk to effectively hedge against downturns in the prices of some builders' homes. Finally, I describe a methodology for determining whether and how much a firm should hedge.

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Finally, I would like to thank my family and close friends who I neglected while writing my thesis but without whom I would not have made it this far.
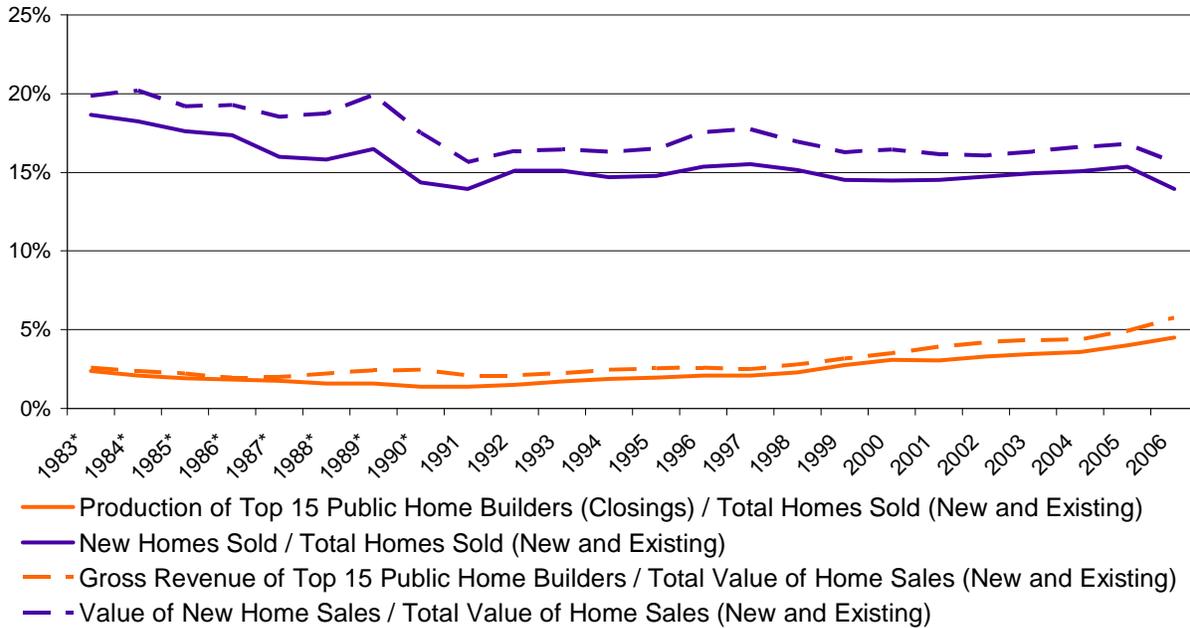
PART ONE

Derivative contracts based on S&P/Case Shiller Home Price Indices began trading on the Chicago Mercantile Exchange on May 22, 2006 and derivatives based on Radar Logic, Inc's Residential Property Indices began trading over the counter on September 17, 2007 (Krasny 2006 and Luthra 2007). Before they hit the market, these products were touted as revolutionary new tools for managing risks associated with shifting home prices, speculating on the movement of housing markets, reducing transaction costs and circumventing regulatory restrictions, taxes and accounting rules associated with trading and owning physical properties. Yet since their debut, the markets for housing derivatives have remained largely illiquid as trading volumes have grown modestly and unevenly. The lackluster pace of development is commonly attributed to a paucity of demand by "end-users," the corporations, investment managers and investors who enter into derivative contracts to manage risk, speculate, remove costs, or avoid a rule or regulation (Naylor and Mansour). Educating end-users in the real estate field is now deemed essential to the evolution and development of well functioning property derivatives markets in the U.S.

The objective of this thesis is to assist in the development of housing derivatives markets by educating a particular class of end-users about a particular use for residential property derivatives. The class is publically-traded home builders and the use is risk management. I have chosen to focus on risk management because, if the history of other derivatives markets can serve as a precedent for the way real estate derivatives markets will develop, then risk managers will play a seminal role in that development. Few derivatives markets have taken off without substantial and early interest from risk managers. I have chosen to focus on home builders because their industry entails inherent risks that lend themselves to hedging with real estate derivatives. Specifically, there is a substantial lag between the time home builders acquire land for development and the time they can bring their communities to market and sell homes. As a result, they are exposed to the risk that demand for housing will decrease during this period and they will not be able to dispose of developed properties or undeveloped land at expected prices.

I have chosen to focus on publicly-traded home builders in particular because a relatively small number of these firms are responsible for a significant proportion of annual US home sales, as illustrated below by Figures 1.1 and 1.2. Moreover, public home builders' share of both new home sales and total home sales (including new and existing homes) has been increasing for over a decade. Thus, by focusing on public home builders, I am tailoring my analysis to a concentrated group of decision makers with the

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FIGURE 1.1
New Home Sales and Public Home Builder Production
as a Percentage of Total Home Sales, 1983-2006

Production of Top 15 Public Home Builders (Closings) / Total Homes Sold (New and Existing)
New Homes Sold / Total Homes Sold (New and Existing)
Gross Revenue of Top 15 Public Home Builders / Total Value of Home Sales (New and Existing)
Value of New Home Sales / Total Value of Home Sales (New and Existing)

* Production for these years measured in housing starts rather than closings.
Sources: NAR, U.S. Census Bureau, NAHB, Quinn Eddins

potential to trade residential property derivatives in volumes measured in hundreds of billions of notional dollars.

Figure 1.1 shows that while the ratio of new home sales to total home sales decreased between 1983 and 2006, the contribution of large public home builders increased over that period as a percentage of total value and quantity of home sales in the United States. The chart combines data on new home sales from the U.S. Census Bureau with data on existing home sales from the National Association of Realtors (NAR) and compares these to the annual production and gross revenues of the top 15 public home builders, as reported by the National Association of Home Builders (NAHB). New homes gradually fell from 18.64% of total units sold and 19.85% of the total value of U.S. home sales in 1983 to 13.96% and 15.62%, respectively, in 2006. Over the same period, the annual production of the top 15 publicly-traded home builders increased from 2.37% of all units sold in 1983 (including new and existing homes) to 4.53% in 2006. Likewise, the combined gross revenues of the top 15 public home builders increased from 2.57% of the total value of all U.S. home sales in 1983 to 5.76% in 2006.

FIGURE 1.2
Production of Top 15 Public Home Builders
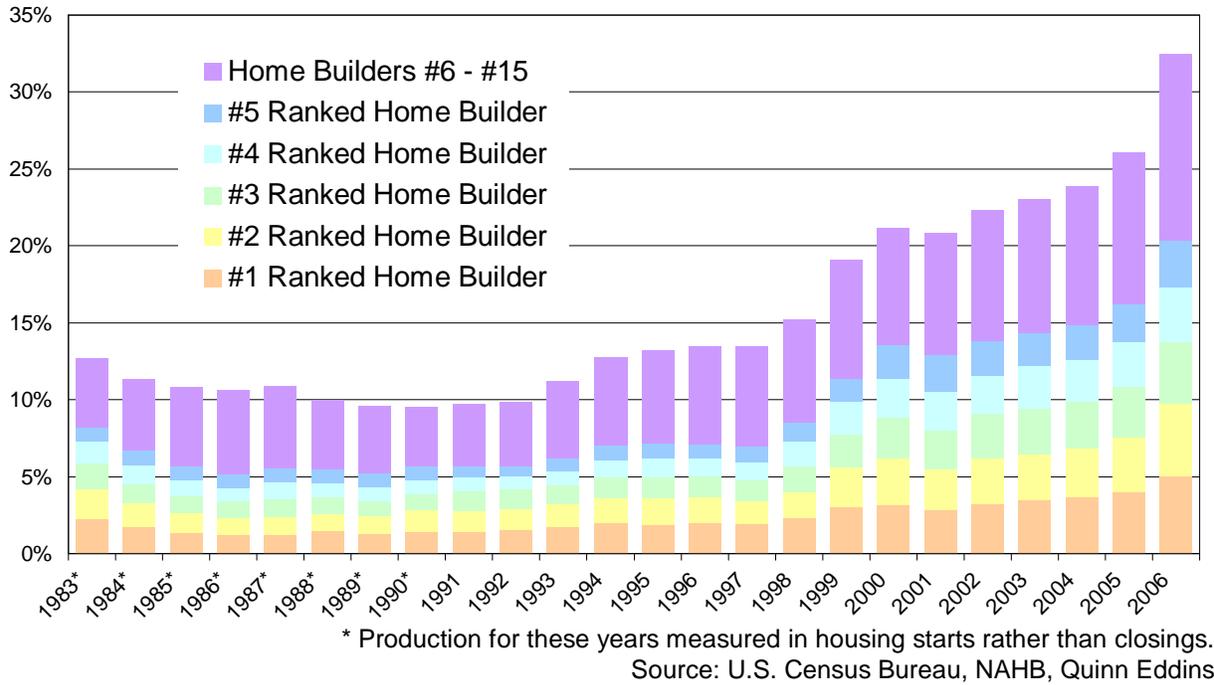**as a Percentage of New Home Sales, 1983-2006**

* Production for these years measured in housing starts rather than closings.
Source: U.S. Census Bureau, NAHB, Quinn Eddins

Figure 1.2 illustrates the largest home builders' increasing share of new home sales, measured by the quantity of units sold. In 1990, the top five home builders accounted for 5.65% of new homes sold. In 2006, the top five home builders accounted for 20.37% of new homes sold and the single home builder with the most U.S. closings, D. R. Horton, Inc., accounted for 5.08% of new homes sold in the United States. The top 15 public home builders in 1990 accounted for 9.51% of the homes sold, whereas the top 15 home builders in 2006 produced 32.42%. The top 15 home builders in 2007 are listed in Table 1.1, along with their gross revenues and U.S. closings for that year.

This paper makes an original contribution to the existing literature on real estate derivatives by approaching derivatives-based risk management *from the perspective of the home builder*. In Part Two I examine *why* home builders should manage risk. After discussing a number of alternative reasons for hedging I focus on a paradigm for risk management proposed by Kenneth Froot, David Scharfstein and Jeremy Stein and augmented by Antonio Mello and John Parsons. According to this paradigm, the objective of hedging is to increase a firm's financial flexibility by maximizing its liquidity – slack in the form of cash or unused debt capacity – when the firm needs it most: when falling output prices reduce income and make it difficult to raise external financing, but do not reduce the firm's need for funds. An important implication of this paradigm is that attempting to eliminate volatility in the value of a firm is not an optimal hedging objective, and attempting to do so can, in fact, reduce the value of the firm. The

paradigm is then put to work in a discussion of two hypothetical home builders, each with a different capital structure and regional focus, and the potential benefits of hedging for each firm is discussed. In Part Three I focus on the *how* of hedging with residential property derivatives. I examine key decisions pertaining to the design of hedging vehicles, including 1) choosing a derivative contract, 2) choosing which index or indices to use as the asset underlying the hedging vehicle and 3) determining how to deal with misalignment between the time to expiration of available derivatives contracts and the development time frames of residential communities. Finally, in Part Four, I bring the *why* and the *how* together and describe a methodology that home builders can use to determine whether and how much they should hedge.

TABLE 1.1

Top 15 Publicly-Traded Home Builders, 2007

Rank	Company	U.S. Closings	Portion of U.S. New Home Sales	Gross Revenue (millions)	Home Builder Gross Revenue / Total Value of U.S. New Home Sales
1	D. R. Horton	37,717	4.86%	10,171	4.20%
2	Lennar Corp.	33,283	4.29%	10,187	4.20%
3	Centex Corp.	30,684	3.95%	9,732	4.02%
4	Pulte Homes	27,540	3.55%	9,263	3.82%
5	KB Home	23,743	3.06%	6,417	2.65%
6	Hovnanian Enterprises	14,928	1.92%	5,334	2.20%
7	NVR	13,513	1.74%	5,129	2.12%
8	Beazer Homes USA	11,366	1.46%	N/A	N/A
9	The Ryland Group	10,319	1.33%	3,033	1.25%
10	M.D.C. Holdings	8,195	1.06%	2,933	1.21%
11	Standard Pacific Corp.	8,051	1.04%	3,369	1.39%
12	Meritage Homes Corp	7,687	0.99%	2,344	0.97%
13	Toll Brothers	6,687	0.86%	4,646	1.92%
14	Taylor Morrison	5,343	0.69%	2,477	1.02%
15	Weyerhaeuser R E	4427	0.57%	2,359	0.97%

Source: NAHB, Quinn Eddins

PART TWO

Section 2.1: Why Companies Manage Risk

Why would a publicly-traded home builder, or for that matter any corporation, want to hedge? Corporations are generally owned by many small investors, each of whom bears only a small part of the risk. In fact, Adolf A. Berle, Jr., and Gardiner C. Means argue in their book, *The Modern Corporation and Private Property*, that the modern corporate form of organization was developed to enable entrepreneurs to disperse risk among many small investors. If that is true, it is difficult to say why corporations themselves also need to reduce risk – investors can manage risk on their own.

Until the 1970s, finance specialists accepted this logic. The standard view was that if an investor does not want to be exposed to the risk of a particular market or industry, she can hedge for herself. For example, she can offset any loss that might come from a decline in oil prices by holding stocks of companies that generally benefit from oil-price declines, such as petrochemical firms. There is thus no reason for a corporation to hedge on behalf of its investors.

Another argument against hedging derives from the Modigliani and Miller theorem, which was developed in the 1950s and became the foundation of modern finance. The key insight of Franco Modigliani and Merton Miller, each of whom won a Nobel Prize for his work in this area, is that value is created on the left hand side of the balance sheet when companies make good *investments* that ultimately increase operating cash flows. How companies finance those investments on the right-hand side of the balance sheet - whether through debt, equity or retained earnings – is largely irrelevant. These decisions about financial policy can affect only how the value created by a company's real investments is divided among its investors. In an efficient and well-functioning capital market, they cannot affect the overall value of those investments.

It follows almost as a corollary of Modigliani and Miller's views that risk management strategies are also of no consequence. They are purely financial transactions that do not affect the value of a company's operating assets. In fact, once the transaction costs associated with hedging instruments are factored in, a strict interpretation of Modigliani and Miller would suggest that risk management result in a net decrease in corporate value.

Since the 1970s, however, different views of financial policy have emerged that allow a more integral role for risk management. The following is a brief sketch of some potential rationales for corporate risk management in light of Modigliani and Miller that have been proposed over the past 30 years.

A. Managerial Motives

Corporate hedging is, in part, an outgrowth of the risk aversion of managers (Smith and Stulz). While outside stockholders' ability to diversify will effectively make them indifferent to the amount of hedging activity undertaken, the same cannot be said for managers, who may hold a relatively large portion of their wealth in the firm's stock. Thus mangers can be made strictly better off (without costing outside shareholders anything) by reducing the variance of total firm value through hedging.

However, matters are not necessarily that straight forward because managers are often compensated in ways that encourage them to take more risk. For example, options given to managers as compensation are more valuable, all else equal, when the firm's stock price is riskier. Thus, a manager's risk aversion may be offset by compensation that is more valuable if the firm is riskier. This argument for hedging assumes that managers face significant costs when trading hedging contracts for their own account – otherwise, they would be able to adjust the risks they face without having to involve the firm directly in any hedging activities.

Another managerial motive for hedging is based on the notion of asymmetric information in the labor markets (Breeden and Viswanathan, DeMarzo and Duffie). If labor markets revise their opinions about the ability of managers based on their firms' performance, then some managers might undertake hedges in an attempt to influence the labor market's perception.

B. Taxes

If taxes are a convex function of earnings, reducing the variability of a firm's pre-tax value through hedging can reduce its tax liability (Smith and Stulz). The structure of a tax code is convex if effective marginal tax rates on corporations are an increasing function of the corporation's pretax value, as illustrated by the curved line in Figure 2.1.

In Figure 2.1, V_1 and V_2 represent the unhedged pre-tax value of a single firm in two different circumstances, one in which the firm's pre-tax value is low and the other in which the firm's pre-tax value is high. E(V) is the average of the values of the firm in these two circumstances, which is the expected pre-tax value of the firm over many time periods in a world in which the firm can only have values V_1 and V_2 and is equally likely to have one value as the other. If the firm is unhedged, it's tax liability over time will be the average of its tax liability when its pre-tax value is low, which is represented by the point on the curved line above V_1, and its tax liability when its pre-tax value is high, which is represented by

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FIGURE 2.1

Corporate Tax Liability as a Function of Pre-Tax Firm Value
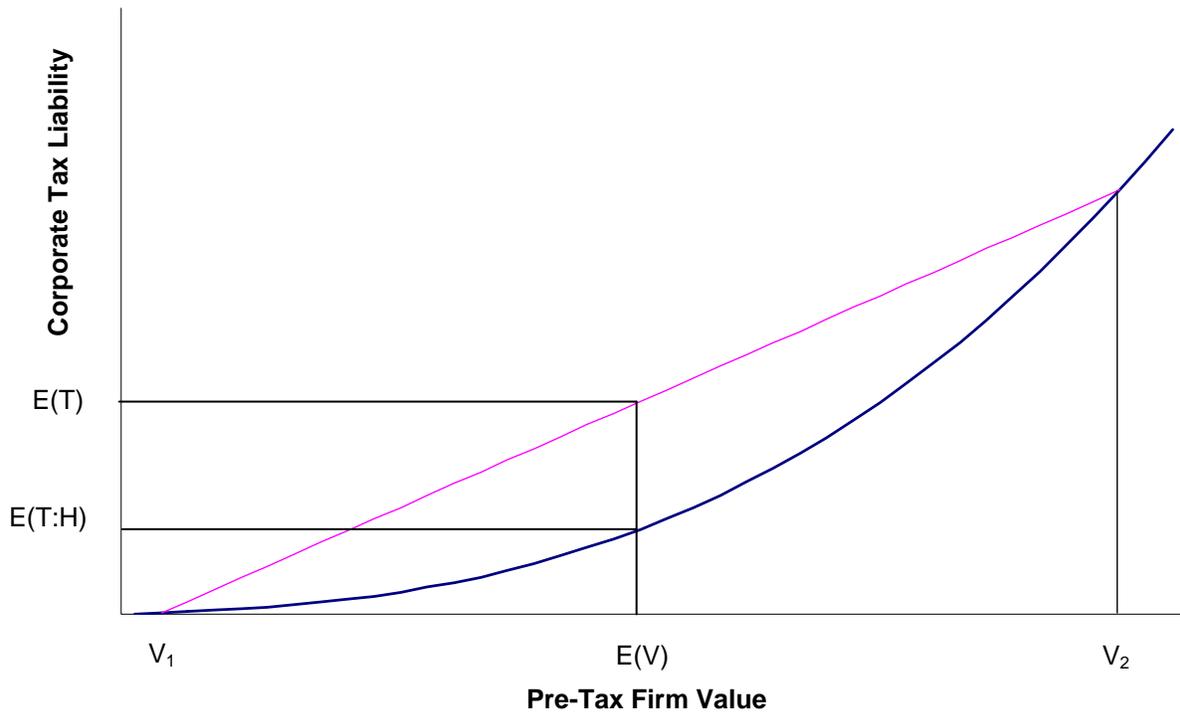
V1 :	Pre-tax value of the firm without hedging if state 1 occurs
V2:	Pre-tax value of the firm without hedging if state 2 occurs
E(V):	Expected pre-tax value of firm without hedging
E(T):	Expected corporate tax liability without hedging
E(T:H):	Corporate tax liability with costless, perfect hedge

Source: Smith and Stulz (1985)

the point on the curved line above V_2. The resulting expected tax liability, E(T), is represented by the point on the straight line above the expected value of the firm E(V).

Hedging reduces the volatility of the firm's pre-tax value. If the firm perfectly hedges its operating cash flows it will earn enough money on its hedge to raise its pre-tax value to E(V) when its cash flow is low. Likewise, when its cash flow is high it will lose enough money on its hedge to lower it's pre-tax value to E(V). When a convex tax function is applied to the firm's expected pre-tax value the resulting tax liability is E(T:H), which is represented by the point on the curved line above E(V). Thus Figure 2.1 illustrates the proposition that the expected value of a convex function of random variables is greater than the value of the convex function of the expected value of random variables. This is an instance of the mathematical principal know as Jensen's Inequality.

A convex tax function implies that a more volatile earnings stream leads to higher expected taxes than a less volatile earnings stream. Convexity in the tax function is quite plausible for some firms, particularly those who face a significant probability of negative earnings and are unable to carry forward 100 percent

of their tax losses to subsequent periods. Even if a tax system does allow a loss to be fully offset against the profit from a different year, in present value terms, the loss will have a lower effective tax rate than that applied to profits. Either way, taxes generate a motive for corporations to hedge.

C. Increased Debt Capacity

Because of the deductibility of interest expense for tax purposes, firms may find debt to be a tax-advantaged way to raise funds. However, lenders, fearful of bankruptcy, may be unwilling to lend to firms with risky cash flows. The amount that a firm can borrow is its debt capacity.

A firm that credibly reduces the riskiness of its cash flows should be able to borrow more, since for any given level of debt, default is less likely. Such a firm is said to have raised its debt capacity. To the extent debt has a tax advantage, such a firm will also be more valuable (Smith and Stulz).

D. Bankruptcy and Distress Costs

An unusually large loss can threaten the survival of a firm for a couple of reasons. First, a money-losing firm may be unable to meet fixed obligations, such as debt payments and wages. Second, if a firm appears to be in distress, customers may be less willing to purchase its goods due to fears that the firm will not be able to honor its warranties or service contracts. Thus, actual or threatened bankruptcy can be costly; a dollar of loss can cost the company more than a dollar. As with taxes, this is a reason for a firm to hedge using derivatives products that transfer income from states in which it is profitable to states in which it takes a loss. By reducing the variability of the future value of the firm, hedging lowers the probability of incurring bankruptcy costs (Smith and Stulz).

E. Costly External Financing

Suppose a home builder wants to purchase land for a new residential community. If the company has enough retained earnings to pay for the land, it will use those funds to purchase it. If the company does not have the cash, it will need to raise capital from one of two sources: the debt market (perhaps through a bank loan or bond issue) or the equity market.

It is unlikely that the company would decide to issue equity. On average, less than 2% of all corporate financing comes from the external equity market (MacKie-Mason). The aversion to equity arises from the fact that it is difficult for stock market investors to know the real value of a company's assets. Investors get the stock price right on average, but they sometimes price it too high and sometimes price it too low. Naturally, companies will be reluctant to raise funds by selling stock when they think their equity is undervalued, and if they do issue equity, it will send a strong signal to the stock market that they think their shares are overvalued. When companies issue equity, the stock price tends to fall by about 3%

(Asquith and Mullins). As a result, most companies perceive equity to be a costly source of financing and tend to avoid it.

The information problems that limit the appeal of equity are much less of a concern when it comes to debt. Most debt issues – particularly those of investment-grade companies – are easy to value even without precise knowledge of the company's assets. As a result, companies are less concerned about paying too high an interest rate on their debt than about getting too low a price on their equity. Thus it is not surprising that most external financing takes the form of debt.

However, debt too has a cost. Taking on too much debt limits a company's ability to raise funds in the future. Lenders will not lend to a company with a large preexisting debt burden because the company may use some of the new funds to pay off old debts instead of investing in productive assets. In the extreme, large amounts of debt can trigger distress, defaults and bankruptcy. So while companies often borrow to finance their investments, there are limits to how much they can or will borrow.

Moreover, the cost of debt often increases just when firms need it most. If a firm is seeking to borrow because it is in decline, or otherwise unable to generate sufficient cash flows to fund its operations, the lender will raise the interest rate on the loan they offer the firm because they perceive a heightened probability of default. In fact, this can occur even when a firm is not in distress. The very act of borrowing can send a signal to the lender that all is not well in the firm, which will cause the lender to raise the interest rate of the loan. As mentioned above, the same problem arises even more severely with equity issues.

The bottom line is that financial markets do not function as efficiently as they do in the imaginary world in which the assumptions of the Modigliani and Miller theorems hold true. The costs outlined above make external financing of any form, debt or equity, more expensive than internally generated funds. Given those costs, companies prefer to fund investments with retained earnings if they can. In fact, Stewart C. Myers (1984) proposed that companies follow a financial pecking order in which they rely first on retained earnings, then on debt and then, as a last resort, on outside equity. Companies see external financing as so costly that they cut investment spending when they lack the internally generated cash flow to finance all their investment projects. One study found that companies reduced their capital expenditures by roughly 35 cents for each $1 reduction in cash flow (Fazzari, Hubbard and Petersen). These financial frictions thus determine not only how companies finance their investments but also whether they are able to undertake those investments in the first place. Internally generated cash is therefore a competitive weapon that effectively reduces a company's cost of capital and facilitates investment.

This insight forms the theoretical foundation for the view, expounded by Froot, Scharfstein and Stein (1993), that the role of risk management is to ensure that companies have the funds available to make

value-enhancing investments. In general, the supply of internally generated funds does not equal the investment demand for funds. Sometimes there is an excess supply; sometimes there is a shortage. Because external financing is costly, this imbalance shifts investments away from the optimal level. Risk management can reduce this imbalance and the resulting investment distortion. It enables companies to better align their demand for funds with their internal supply of funds. That is, risk management lets companies transfer funds from situations in which they have excess supply to situations in which they have a shortage. "In essence, it allows companies to borrow from themselves" (Froot, Scharfstein and Stein 1994).

By hedging, the company reduces supply of internally generated funds when there is excess supply and increases supply when there is a shortage. This helps align the internal supply of funds with the demand for funds, as I will describe below. Of course, the average supply of funds doesn't change with hedging, because hedging is a zero-net-present-value investment: it does not create value by itself. What it does is ensure that the company has funds precisely when it needs them. Because value is ultimately created by making sure the company undertakes the right investments, risk management adds real value.

Mello and Parsons (2000) make an important contribution to the paradigm introduced by Froot, Sharfstein and Stein. While Froot et al treat the cost of external financing as exogenous to a firm's hedging strategy, Mello and Parsons make it endogenous, arguing that the cost of external financing depends on the effectiveness of the firm's hedge. They point out that, in addition to influencing the supply of internal funds, hedging affects a firm's supply of *external* funds. As noted above, hedging can help make external financing more accessible by reducing the variability of internal cash flows, and thereby reducing the likelihood that the firm will not be able to meet its financial obligations. So while external financing is more expensive than internal financing, its cost, and therefore the amount a firm should have, is a function of its hedging strategy. Thus Mello and Parsons take the view of Froot, Scharfstein and Stein one step further: The primary aim of risk management is to ensure that the internal and external supplies of funds are sufficient to cover the investment demand for funds, and to do so in a manner that minimizes the deadweight costs of external financing (negative market signals, financial distress costs, capital market illiquidity, etc.).

The discussion of risk management strategies in this thesis builds on the strand of research that justifies hedging on the basis of costly external financing. While the other work on hedging has mostly focused on why hedging can make sense, the work in the vein of Froot, Scharfstein and Stein and Mello and Parsons focuses on how much and what sort of hedging is optimal for a particular firm.

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A Paradigm for Strategic Risk Management[*]

Fluctuations in macroeconomic variables create volatility in each of the key factors in the risk management equation: the demand for funds, the internal supply of funds and the external supply of funds. In certain circumstances, this volatility may threaten the firm's ability to supply the funds it needs to execute its investment strategy, forcing it to pass up value-enhancing investments. To design a hedging strategy that will protect the firm's supply of funds, it is necessary to understand how each of these three factors is exposed to risk:

Internal Supply of Funds - Fluctuations in the price of a company's products or in the cost of its inputs have an immediate effect on its internal supply of funds.

Demand for Funds - A sharp and lasting increase in the price of a company's product may encourage expansion and spur investment. Conversely, permanent increases in the cost of a company's inputs may force a cutback in planned expansions.

External Supply of Funds - If the price of a company's output is depressed or its costs are running high then turning to outside sources for capital by issuing new debt or equity can become very expensive. If, however, the price of a company's output is high, lenders would be much more eager to lend to them and one would expect the price of financing to be lower.

Furthermore, a firm needs to understand how the risk exposures of these factors interact with one another. Does the company's supply of funds match its demand? If prices fall, does the supply of funds drop faster than demand? How big is the gap? If a company has financial capacity to cover the gaps there may be little cause for concern. If not, the company may not be able to execute its investment strategy.

Figure 2.2 illustrates how a firm's internal supply of funds and demand for funds might vary as the price of the firm's output changes in the future. The horizontal axis shows the relative price of a firm's output at the end of a given period of time in each of a number of alternative scenarios, while the vertical axis shows the cumulative cash flow over the period. The steeper line records the cumulative supply of funds generated by the firm corresponding to each different possible price scenario. The greater the price

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[*] The following is discussed in Froot, Scharfstein and Stein (1994) and Mello and Parsons (1999).

FIGURE 2.2

**Exposure of Internal Supply and Demand for Funds to Changes in Output Prices**
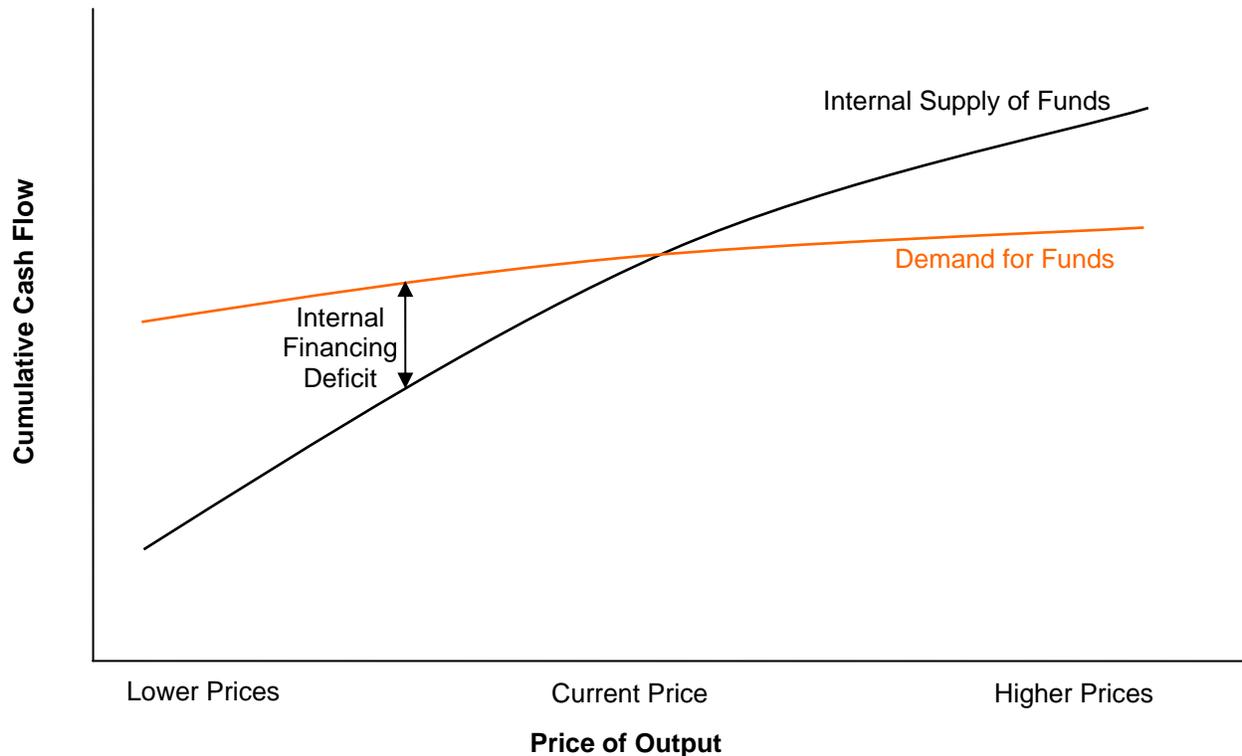
Source: Adapted from Mello and Parsons (1999) by Quinn Eddins

increases within the period, the higher the supply of funds accumulated. The slope of this line measures the exposure of the firm's internal supply of funds to changes in output price. The flatter line shows the demand for funds as a function of the different possible price scenarios. Like the firm's internal supply of funds, the demand for funds is affected by the risks and uncertainties facing the firm. The lower the output price, the lower the demand for funds. The slope of this line measures the exposure of this demand to changes in output price. Note that there is an internal funding deficit for low price scenarios: the internal supply of funds generated by the firm over this period is inadequate to meet the demand for funds in the company's strategy. At high price scenarios there is an adequate internal supply.

In Figure 2.2, the company's demand for funds is *inelastic*: short-term changes in price have little impact on new investments and other capital expenses. If, however, new investments can be delayed when output prices fall, then the company's demand for funds can be very *elastic* – that is, highly sensitive to price changes. The exposure of the demand for funds differs dramatically across companies and the exposure of any given company could also shift dramatically over time as its growth prospects develop and change.

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FIGURE 2.3

Exposure of Internal Supply and Increased Elastic Demand for Funds to Changes in Output Prices
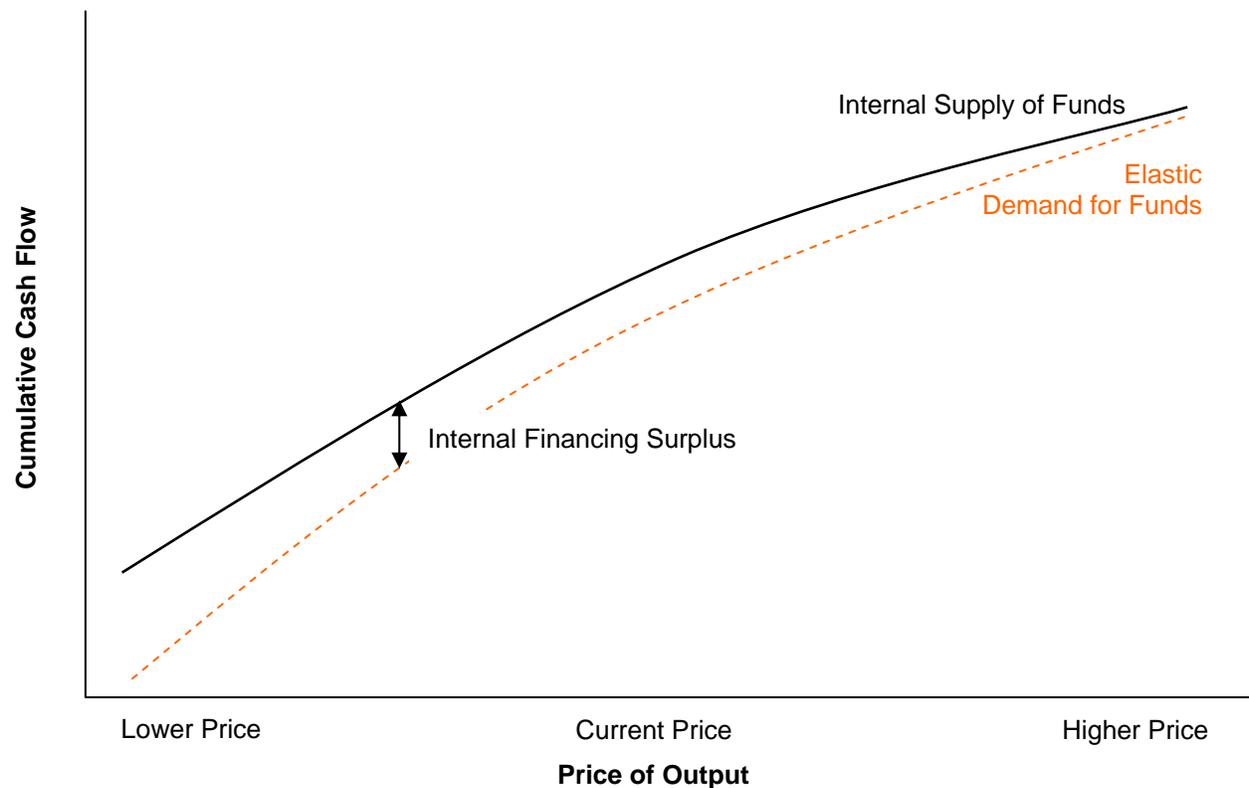
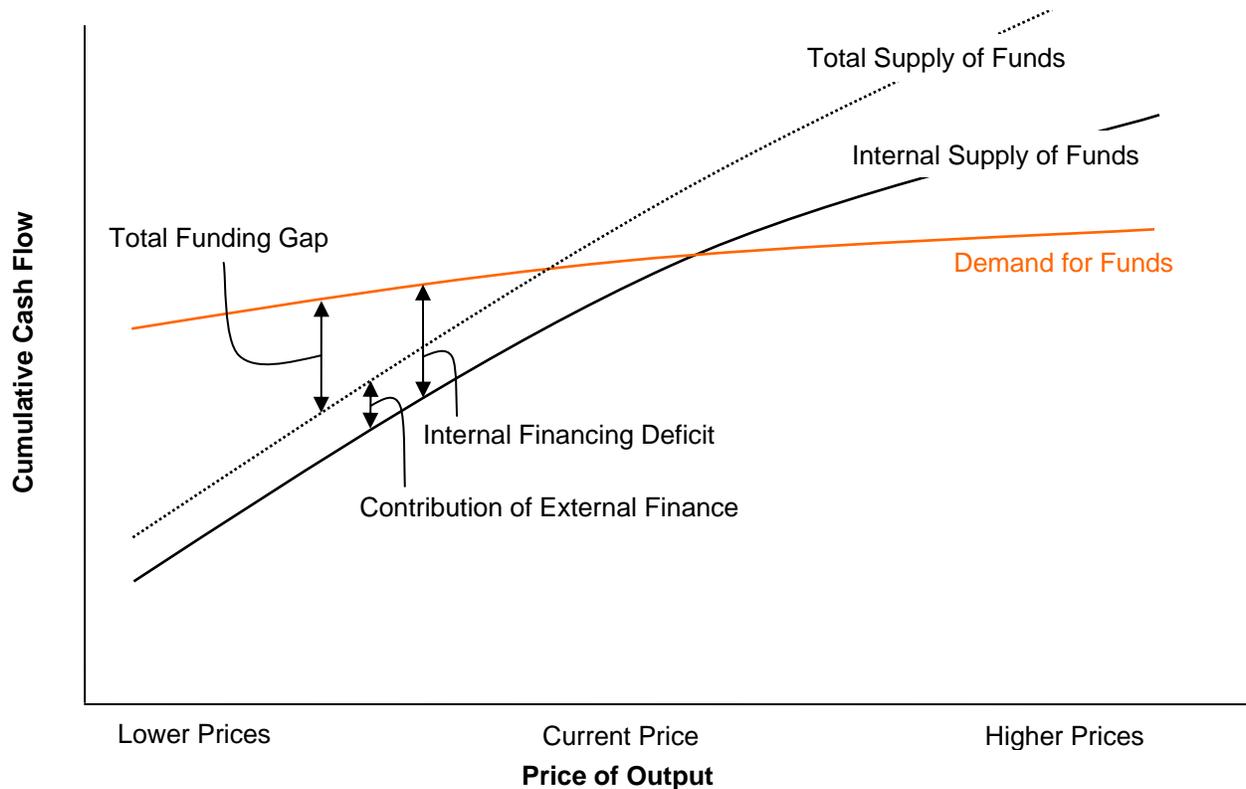Source: Adapted from Mello and Parsons (1999) by Quinn Eddins

Figure 2.3 shows the same internal supply schedule as Figure 2.2, but superimposes a more elastic demand schedule. Although the firm's internal supply of funds has significant exposure to price risk, it does not have an internal funding deficit under any price scenario. As prices decline and the supply of funds is reduced, the demand for funds is also reduced. Volatility in the internal supply of funds does not disrupt this firm's investment strategy and the firm will not benefit from reducing this volatility.

There are a number of ways the firm can meet an internal funding deficit. For example, it can issue more debt to finance new capital expenditures. A proper evaluation of the firm's total supply of funds must include these external financing sources. Figure 2.4 shows how external financing sources augment the internal supply of funds.

Many firms have significant reserves in the form of unused debt capacity and a shortfall in the internal supply of funds will not disrupt the investment strategy of these firms. However, like the internal supply and demand for funds, external financing capacity is likely to change under alternative price scenarios. In Figure 2.4, for example, the contribution of external financing decreases as the price of the company's output decreases. It may be easy to float additional debt when output prices are high, but it is much more difficult when margins are squeezed over a long period of time. Since the supply of external

FIGURE 2.4

Contribution of External Financial Activity to Total Supply of Funds and the Total Funding Gap

Source: Adapted from Mello and Parsons (1999) by Quinn Eddins

financing may also be exposed to price risk, identifying the true sensitivity of available financing to the company's price risk is a difficult task requiring a good degree of judgment.

Combining the internal supply of funds and the external funds available from financing gives a total supply of funds. This is compared with the demand for funds schedule to reveal the total funding gap. The total funding gap is significantly smaller than the internal financing deficit. However, the firm's available financing capacity still falls short of its demand for funds in some price scenarios. In these cases the company may be forced into an untimely sale of stock or a cutback of its investment program. Both are costly and reduce shareholder value.

Hedging can address the disparity when a firm does not have sufficient financial slack in the form of excess cash or unused debt capacity. There is a wide range of price movements for which the company's demand for funds exceeds its supply. There is an even wider range over which the supply of funds substantially exceeds demand. Hedging enables the firm to use surplus cash in one range of price movements to cover a deficit of cash over another range. In effect, the firm sells some of its "upside" surplus of funds in exchange for a cash infusion on the "downside." If the downside cash infusion enables

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FIGURE 2.5

Effect of Hedging on Financial Stack
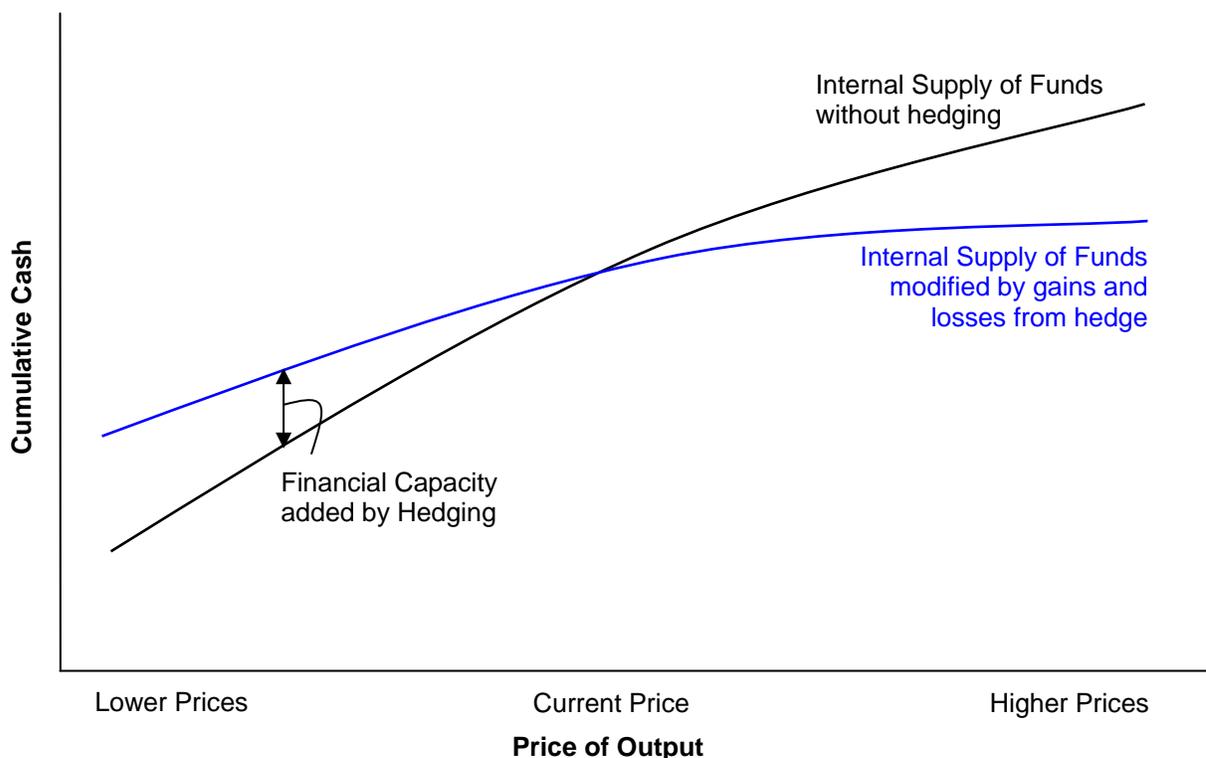
Source: Adapted from Mello and Parsons (1999) by Quinn Eddins

the company to make positive NPV investments it would otherwise have to forego, the exchange can raise shareholder value overall.

The simplest hedge is a sale of a set of forward contracts. The seller earns hedge gains in the event of a price fall and records hedge losses in the event of a price increase. The company's financial slack is adjusted as a result of the hedge. This is shown in Figure 2.5, where the previous estimate of financial slack is revised to incorporate the result of adding a hedge of forward contracts with various maturities. As a result of the hedge, the company's financial slack is raised when the price declines and lowered when the price increases. Since there is no funding gap at high prices, this reduction in financial slack is not costly to the firm. At the same time, it buys a very valuable increase in financial slack at those critical low price levels, enabling the firm to cover the remaining gap and avoid costly cutbacks to valuable investments.

The risk management paradigm discussed in this section has implications for what and how much a firm should hedge. According to the paradigm discussed in this section, a proper risk management strategy ensures that companies have the cash when they need it for investment. It does not seek to insulate a firm completely from risks of all kinds (Froot, Scharfstein and Stein 1994). If a home builder

hedges only enough to guarantee that it has sufficient funds available for its investment needs, it will only be partially hedged. As a result, its stock price, earnings, return on equity and any number of other performance measures will fluctuate with home prices. When home prices are low, a public home builder will be worth less: the company's existing inventory is less valuable, and it will invest less. It is simply less profitable to be in the home building business at such times and this will be reflected in the firm's performance measures. But there is nothing a risk management program can do to improve the underlying bad economics of low home prices. The goal of risk management is not to insure the investors and corporate managers per se. It is to ensure that companies have cash they need to create value by making good investments.

In fact, attempting to insulate investors completely from home price risk could destroy value. If a home builder were to hedge fully it could put itself in a situation where it would have an excess supply of funds when home prices fall. When home prices are high the opposite would be true: the home builder would lose so much money on its hedging position that it would have a shortage of funds for investment. While the increase in the price of homes would raise the value of the home builder, only a small portion of this increase in value would be reaped as an immediate cash flow. Meanwhile, the full matching loss incurred on the hedge would have to be paid in cash immediately. Thus hedging fully would reduce liquidity and prevent the company from making value-enhancing investments.

One might argue that completely hedging a firm's value would create its own liquidity. A hedge that successfully locks in the firm's value offsets the short-term losses on the hedge with an exactly matched increase in anticipated future cash flows. Consequently lenders and external investors would be willing to finance the losses. However, Mello and Parson (2000) find that, in general, this is not the case. A hedge creates its own liquidity only if the firm is able to perfectly hedge all its different sources of risk. Otherwise, unhedged risk will decrease the firm's debt capacity and increase the cost of its external financing.

Section 2.2: A Discussion of Two Hypothetical Home Builders

To build intuition about how this risk management paradigm can be applied to the home building industry, consider the case of two hypothetical home builders, Alpha Homes and Omega Communities. Both firms are widely held with shares traded on the New York Stock Exchange.

Alpha Homes

Alpha Homes earns one hundred percent of its revenues from building and selling residential

communities. The majority of Alpha's communities are in Arizona, Florida and Texas. Alpha has focused its recent land acquisitions in markets where land is widely available and approvals are relatively easy to acquire. Since it is relatively easy for home builders to enter these markets, the supply of houses is high and margins are thin. Alpha compensates for these thin margins by building and selling very large volumes.

Alpha's demand for funds is driven by its need to pay operating expenses and fund several different types of investments. These uses of funds include:

- ❖ acquisition of land for new communities,
- ❖ entitlement and improvement of land,
- ❖ construction of residential communities,
- ❖ payment of interest, taxes and direct overhead related to development and construction,
- ❖ repayment of debt,
- ❖ repurchasing stock.

The acquisition of land is Alpha's single largest expense. It acquires land through direct purchases, land purchase options and participation in land and development joint ventures. Unlike commercial real estate developers and privately-held residential developers, who create separate capital structures for each acquisition, Alpha and other publicly-traded home builders fund the lion's share of their land purchases from their central corporate treasury.

Whenever possible, Alpha acquires land using purchase options. Under option contracts Alpha has the right without obligation to buy home sites at predetermined prices on a predetermined takedown schedule. The contracts generally require the payment of a cash deposit or the posting of a letter of credit, which is typically less than 20% of the underlying price. They may also require monthly maintenance payments. Contracts are generally non-recourse, thereby limiting Alpha's financial exposure for non-performance. They allow Alpha to control land without taking on the risks associated with owning it. While the land is optioned Alpha can perform due diligence to determine whether its development plans will be profitable on the site and obtain the governmental approvals it will need to commence development.

In addition to purchasing land directly and using purchase options, Alpha enters into joint ventures that acquire and develop land for their home building operations and for sale to other firms. Alpha's partners in these land development joint ventures are generally other home builders, land sellers, financial investors or other real estate entities. Alpha's management believes these joint ventures help them control

attractive land positions, mitigate and share the risk associated with land ownership and development and extend their capital resources.

Debt service obligations, property taxes and overhead related to development and construction all contribute to the Alpha's inventory costs. These costs create a substantial demand on Alpha's operating cash flows. In the event inventory costs create too great a demand on Alpha's funds, management can take the following steps to reduce its inventory of land and unsold homes:

❖ limit new arrangements to acquire land,

❖ engage in bulk sales of land and unsold homes,

❖ reduce the number of homes under construction,

❖ abandon or re-negotiate land purchase options,

❖ sell underperforming assets, communities, divisions or joint venture interests.

Though these actions may increase Alpha's liquidity, many of them may also reduce future earnings and thus reduce the value of the firm.

There is a lag between the time Alpha acquires land for development and the time that it can bring the communities to market and sell homes. Lag time varies on a project by project basis; however, historically, Alpha has experienced a lag time of up to three years. As a result, Alpha is exposed to the risk that demand for housing may decline or costs of labor or materials may increase during this period and that it will not be able to dispose of developed properties or undeveloped land at expected prices or within anticipated time frames or at all.

In order to reduce its exposure to downward movements in the housing market, Alpha generally begins construction of its detached homes only after executing an agreement of sale and receiving a down payment from a buyer. Once a sales contract with a buyer has been approved, Alpha classifies the transaction as a "new sales order" and includes the home in its "backlog". Such sales orders are usually subject to certain contingencies, such as the buyer's ability to qualify for financing. At closing, title passes to the buyer and a home is considered "delivered" and is removed from the backlog. The average period between execution of a sales contract for a home and closing is approximately four months to over a year for pre-sold homes; however, this varies by market.

Though most of the homes Alpha builds are under sales contracts, inevitable contract cancelations on the part of buyers mean that a certain number of houses in Alpha's inventory will be unsold. Given high costs for carrying inventory and thin margins in many of its markets, Alpha can sustain substantial losses if it is unable to sell homes or other property in its anticipated time frame. Thus Alpha quickly adjusts the prices of unsold houses to meet market demand in order to remove these houses from its balance sheet as

quickly as possible. As a result, prices for unsold houses are highly variable and can drop precipitously in soft markets.

Alpha is also exposed to changes in prices for inputs and labor. It is generally unable to pass on any unexpected increases in construction costs to those customers who have already entered into sales contracts since those contracts generally fix the price of the house at the time the contract is signed. In an effort to reduce these exposures Alpha hires subcontractors to perform substantially all of its home construction and land development work on a fixed-price basis.

Historically Alpha's income has been its most significant source of operating cash flow. Recently, however, operations have used more cash than they have generated as Alpha has responded to strong demand for homes by making significant investments in inventory. To fund its acquisition of additional inventory, Alpha has taken on a significant amount of debt. As a result, Alpha's debt is currently 57% of its total capital, which exceeds its long-term target level of 45 – 55% of total capital. Covenants accompanying Alpha's debt obligations impose restrictions on its operations and financing activities. They limit Alpha's ability to incur additional debt, pay dividends, sell assets (other than in the ordinary course of business) and invest in joint ventures. Should Alpha fail to comply with these restrictions and covenants, Alpha's lenders could cause its debt to become due and payable prior to maturity or demand that Alpha compensate them for waiving instances of noncompliance

Home Price Changes and Alpha Homes' Liquidity

Figure 2.6 illustrates how Alpha Homes' supply of funds and demand for funds might vary across different home price scenarios. As noted previously, most of Alpha's residential communities are located in markets with low barriers to entry. As a result, the margins between Alpha's internal supply of funds and its internal demand for funds are very thin. When increasing demand for homes increases the market price for homes, Alpha can increase these margins. But when market demand decreases Alpha's margins quickly disappear and then become negative.

When demand for houses decreases Alpha sells fewer homes and the internal supply of funds decreases. Also, the number of sale contract cancelations increases, increasing the proportion of unsold homes in Alpha's inventory. In an effort to reduce inventory, Alpha lowers the prices of its unsold houses to meet the reduced market demand. As a result, the exposure of Alpha's supply of funds to home prices increases when demand and market prices are low.

To offset the decrease in its internal supply of funds, Alpha can reduce its demand for funds by temporarily halting the acquisition of new land (be it through direct acquisitions, options or joint

FIGURE 2.6

Alpha Homes' Total Funding Gap
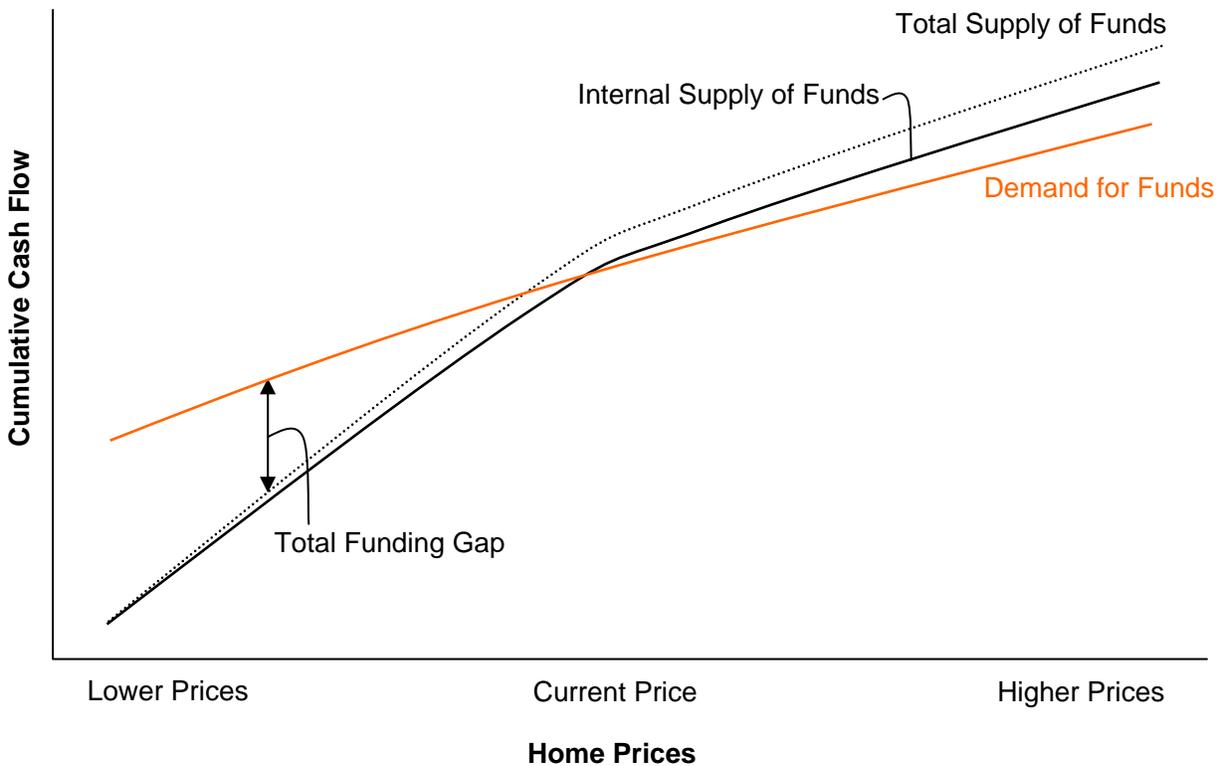
Source: Quinn Eddins

ventures) and reducing the number of homes under construction. As a result, Alpha's demand for funds is elastic with regard to downward movements in home prices.

However, decreasing market demand also prompts Alpha to redouble its sales effort, which in turn increases its demand for funds in the form of broker commissions, advertising expenses and incentives to homebuyers. If market demand drops significantly, the increases in these selling costs can become substantial. Thus Alpha's demand for funds is not as elastic to downward changes in price as it would be if it did not need to bear such selling costs.

Some costs of carrying inventory, such as interest and land taxes, cannot be avoided even if the rates of land acquisition and construction are slowed. Alpha can reduce these costs and its demand for funds by selling off land in its inventory. These land sales also benefit Alpha by increasing its internal supply of funds. However, Alpha's ability to sell land is severely restricted by covenants associated with its extensive debt obligations.

Alpha's external supply of funds can be defined as its debt capacity minus its current debt. Alpha's current high debt ratio and the covenants associated with its current debt will limit the amount of additional debt it can take on in the future. Thus, the contribution of external capital will be small, even if

prices are high. When prices are low, the reduction in the value of Alpha's assets will further reduce its debt capacity and thus its external supply of funds.

As Figure 2.6 illustrates, Alpha Homes has a funding gap in scenarios when home prices are low. Its combined internal and external supply of funds is not sufficient to meet its demand for funds in these cases. If the funding shortfall prevented Alpha from meeting its debt obligations, the resulting financial distress could generate significant costs for Alpha's shareholders. These costs could take the form of legal fees, write-downs or other deadweight costs associated with bankruptcy and financial restructuring. But even if Alpha were able to pay its debt obligations, simply having to curtail its land acquisition strategy could generate substantial opportunity costs. First, Alpha could lose out on economies of scale generated by building new communities on parcel adjacent to its current development sites. Second, it could lose market share in the markets where it currently builds communities. Third, it could be forced to pass up opportunities to purchase land in premier locations within its current markets. Fourth, it could be forced to forego opportunities to expand into new markets with growing populations and strong economic fundamentals. The cost of these lost opportunities could substantially reduce the value of the firm and, given the fierce competition for land in the home building industry, they could even threaten Alpha's prospects for the future.

Omega Communities

Omega Communities is a home builder similar to Alpha Homes in its business model and the value of its assets. It differs from Alpha, however, in two key areas: the markets in which it builds its communities and its capital structure.

Omega Communities seeks to build its communities in markets where land for new residential communities is limited and approvals are difficult to achieve, primarily in California and the Northeast. Omega's top managers believe these communities have substantial potential value that will be realized in the future and that this value should not necessarily be sacrificed in a soft housing market. They argue that as the process for acquiring governmental approvals becomes more difficult as the political pressure from low- and no-growth proponents continues to increase, Omega's expertise in taking land through the approval process and their current stockpile of approved land positions will allow it to grow in the years to come.

Omega owns several years' supply of home sites and management believes that, should the company's business decline significantly, its current inventory would be sufficient to meet the requirements of their current backlog as well as any new sales contracts. Thus they would be able to delay or curtail their acquisition of additional land, which would reduce their demand for cash.

Omega's debt is currently 27% of its total capital and over the past several years it has invested a significant amount of cash in short-term cash equivalents and short-term interest bearing marketable securities. Omega's management believes their access to reliable capital and their low leverage ratio give them a competitive advantage during downturns in the national housing market. Based on their experience during previous downturns, they believe that difficult times can bring unexpected opportunities for firms that are well prepared. With $900 million of cash and cash equivalents and approximately $1.22 billion available under their bank revolving credit facility, they believe they have the resources available to fund these opportunities.

Figure 2.7 illustrates Omega's supply and demand for funds under different home price scenarios. The high demand and constrained supply in Omega's markets allow it to have significantly wider margins than Alpha. Home prices can fall much lower before Omega's internal supply of funds drops below its demand for funds. Moreover, Omega's low debt levels and large cash reserves give it access to far more external funding than Alpha. As a result, Omega has a total funding surplus even in scenarios where the price for homes is very low.

FIGURE 2.7
Omega Communities' Total Funding Surplus

Source: Quinn Eddins

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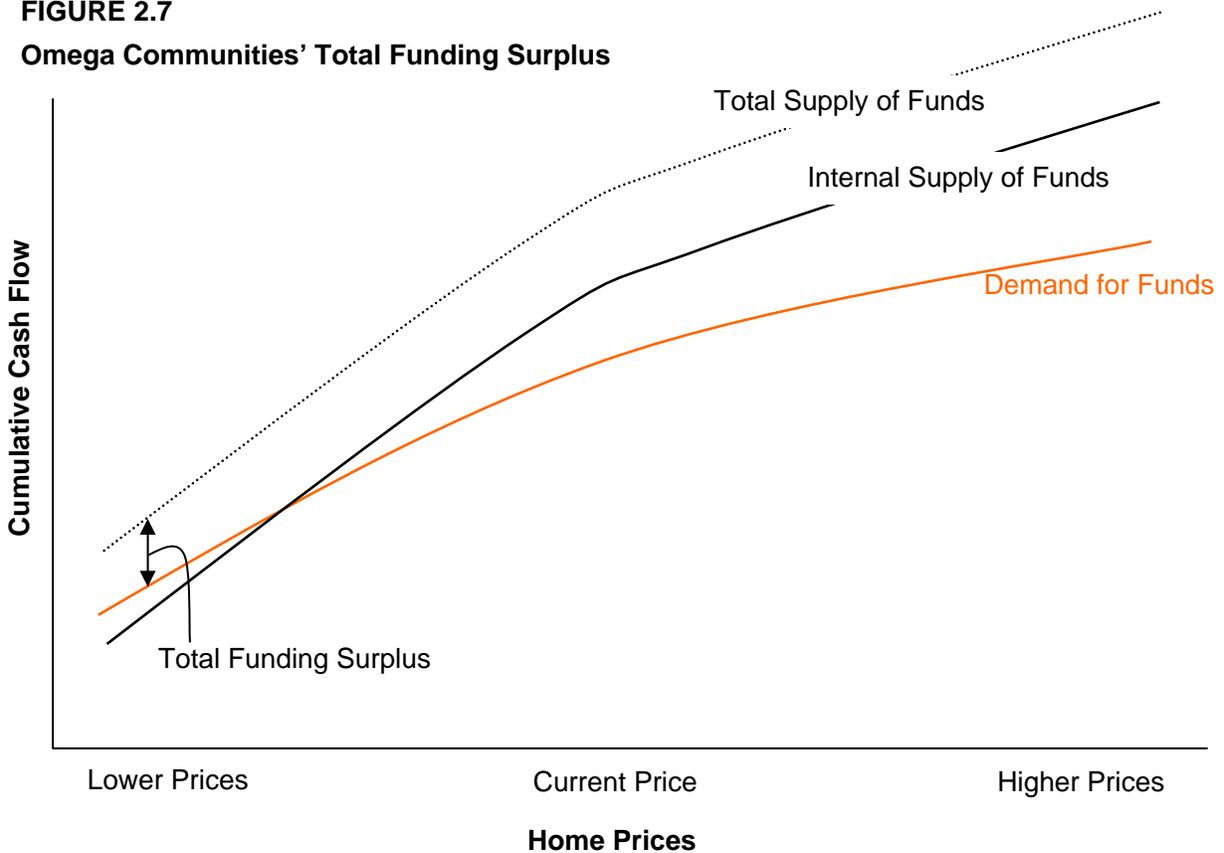
Case Discussion

Different Firms Need Different Hedging Strategies

The cases of Alpha Homes and Omega Communities illustrate an important point: not all home builders should adopt the same hedging strategy. Even though all home builders are exposed to home price risk, some may be exposed more than others in both their operating cash flows and their investment opportunities. For instance, Alpha's strategy of financing land acquisitions with large amounts of debt creates large debt service obligations that are inelastic to changes in home prices levels. As a result, Alpha is unable to significantly reduce its operating expenses during periods of low home prices by scaling down its operations. If home prices fall dramatically, Alpha may need to sell off land in its inventory and thereby sacrifice economies of scale, market share and important future sources of cash flow. If debt covenants restrict Alpha's ability to sell land, and it is unable to secure additional debt due to its high debt ratio and depressed home values, Alpha may be forced into bankruptcy. Conversely, Omega's strategy of maintaining a low leverage ratio provides it with modest debt service obligations. As a result, Omega has the ability to reduce a much higher proportion of its operating expenses when home prices are low by scaling down its building and selling operations. Alpha has more to gain from hedging than Omega does because its demand for funds is less in sync with its supply of funds.

Similar logic applies if we consider the investment opportunities the two firms face. Limited supplies of land and difficult approvals processes make purchasing and developing land more expensive in Omega's markets than in Alpha's markets. Thus, when home prices drop, it may no longer be worthwhile for Omega to acquire additional land, while it may still be worthwhile for Alpha to do so. Thus, even if, for the sake of argument, we assume that the drop in home prices affected both companies' operating cash flows equally, Omega's investment opportunities are reduced by more than Alpha's. Again, since Omega's demand for funds is more in line with its supply of funds, Omega has less incentive to hedge than Alpha does.

To develop a coherent risk-management strategy, home builders must carefully articulate the nature of their operating cash flows and their investment opportunities. Once they have done this, their efforts to align the supply of funds and the demand for funds will generate the right strategies for managing risks.

Should Omega Communities Hedge?

Alpha Homes would benefit from hedging its exposure to housing market risk because its total supply of funds becomes poorly aligned with its demand for funds when home prices are low, and hedging can realign them by transferring cash from high price scenarios to low price scenarios. But would Omega Communities benefit from hedging as well? It might appear that Omega should be less interested in risk

management because of its conservative capital structure. After all, it could adjust rather easily to a large drop in cash flow by borrowing at relatively low cost. It would not need to curtail investment and corporate value would not suffer much. The basic objective of the risk management paradigm discussed here – aligning the supply of funds with the demand for investment funding – has less urgency for Omega because its managers can easily adjust to a shortfall in the supply of funds by borrowing.

What Omega's managers have done is use low leverage instead of the derivatives markets to protect against the risk in the price of housing. An alternative strategy would be to take on more debt then hedge those risks directly in the derivatives markets. The advantage of the second approach is that, while it is no more risky in terms of the ability to make good investments than the low-debt / no-hedging strategy, but the added debt made possible by hedging would allow Omega to take advantage of the tax deductibility of interest payments.

Hedging as a Competitive Weapon

The home building business is highly competitive and fragmented. Alpha Homes and Omega Communities compete with numerous home builders of varying sizes, ranging from local to national in scope, some of which have greater sales and financial resources than they have. In addition to competing for customers, home builders compete for financing, raw materials, skilled management and labor resources and, above all, for land.

If a home builder does not hedge and its competitors do, that home builder risks losing market share to its competitors when home prices fall. The competition will have the funds necessary to make new land acquisitions and continue building and selling operations while the unhedged home builder might not.

The converse is also true. If a home builder's competitors choose not to hedge, they may not be in a position to purchase new home sites if home values fall dramatically: they will find themselves low on internally generated funds from home sales and they could also find additional external financing, in the form of additional debt or equity, expensive or unavailable. This is precisely the situation in which a home builder wants to purchase additional land – when its competitors' weakness reduces the competition for land and therefore the price for land. This makes investment in new home sites more attractive. Thus a home builder should hedge to make sure it has an adequate supply of funds for this investment.

PART THREE

Section 3.1: Choosing a Derivative Contract

Hedging vehicles can consist of any of the available residential real estate derivative contracts: forwards, futures, total return swaps and options. The decision about which type of contract to use should depend on the liquidity of the various products and the different effects the products have on the firm. Different types of contracts will be preferable for different firms. In this section I describe the residential property derivatives that are currently available for trading and discuss how differences in their institutional design can impact a home builder's choice of hedging vehicle.

Derivatives Traded on Radar Logic Indices

Forward contracts and total return swaps based on Radar Logic's Residential Property Indices (RPX) are currently traded over-the-counter by seven licensed dealers. Radar Logic publishes indices for 25 metropolitan statistical areas (MSAs) as well as 25-MSA composite indices and indices for the Manhattan condominium submarket. Three separate indices are published for each market, with one-, seven- and 28-day measurement periods, respectively. The measurement period is the number of days of housing transactions included in the calculation for each reported value of the RPX index.

At the time of writing this thesis, the derivative products traded in the RPX market are based on the 28-day measurement period for the 25-MSA composite as well as the New York, Los Angeles, Miami and Phoenix markets. RPX-based forward contracts are available for terms that expire every December 31st from 2008 to 2012. Swap contracts are available with terms of six months, nine months, and one to five years. According to Fritz Siebel, Director of Property Derivatives at Tradition Financial Services, the most liquid RPX derivative contracts are one, two and five-year swaps, though volumes are still small relative other types of derivatives (Siebel). The underlying indices and terms to maturity for currently traded RPX contracts are summarized in Table 3.1.

Settlement of RPX-based derivative contracts (including all quarterly payments for total return swaps) is based on an initial and final value (Lee and Tirupattur). The initial value is the average of the RPX values for the last five trading days of the month beginning the contract's term and the final value is the average of the RPX values for the last five trading days of the month ending the term. This averaging

TABLE 3.1
RPX-Based OTC Contracts Trading as of May 2007

Total Return Swaps

	Term to Maturity						
	6mo	9mo	1yr	2yr	3yr	4yr	5yr
Composite	✓	✓	✓	✓	✓	✓	✓
New York			✓	✓	✓		
Los Angeles			✓	✓	✓		
Miami			✓	✓	✓		
Phoenix			✓	✓	✓		

Forwards

	Maturity Date				
	12/31/08	12/31/09	12/31/10	12/31/11	12/31/12
Composite	✓	✓	✓	✓	✓
New York	✓	✓	✓		
Los Angeles	✓	✓	✓		
Miami	✓	✓	✓		
Phoenix	✓	✓	✓		

Source: Radar Logic, Quinn Eddins

is intended to minimize the effects of idiosyncratic single-day volatility. By way of example, consider a one-year contract that matures in June 2009. The average of the published RPX values on June 24th, 25th, 26th, 27th, and 30th of 2008 (the last five publication days of the month) will constitute the initial value. The average of the RPX values published on June 24th, 25th, 26th, 29th and 30th of 2009 will determine the final index value. Moreover, Radar Logic uses a 63-day (i.e. nine-week) lag between the transaction date and the publishing date to allow for delays in receiving transaction data. Thus, the published RPX value for June 30, 2009 used to calculate the final settlement value will be based on transactions as of April 28th, and if the index underlying the derivative contract has a 28-day measurement period, it is calculated using data from April 1st through the transaction date.

Forward Contracts

RPX forward contracts are quoted in terms of strike prices for specific maturities. The strike price is the expected growth in the index, from the initial to the final value. The payout at maturity is determined as follows:

$$\left(\text{Actual index growth \%} - \text{Strike index growth \%}\right) \times \text{Notional value}$$

If the difference between the actual index growth and the strike index growth is positive, the seller of a forward pays the amount calculated above to the buyer of the forward at the contract's maturity. If the difference is negative, the forward seller receives the same amount from the forward buyer. This relationship is illustrated in Figure 3.1.

FIGURE 3.1
RPX Forward Cash Flows
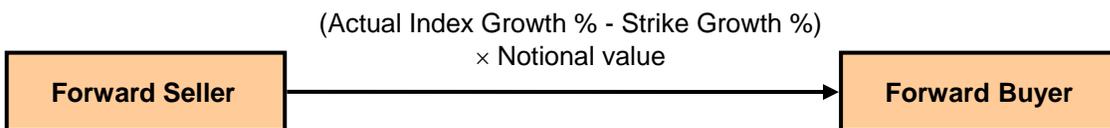
Source: Morgan Stanley

Total Return Swaps

Total Return Swaps have emerged as the preferred instrument among market participants. In swaps, there are periodic exchanges of a fixed rate for an uncertain amount that represents the total return on the underlying index. Thus, a swap involves a total return payer and a total return receiver. The total return payer is short the index and the total return receiver is long.

Total return swaps are quoted in terms of the fixed rate, which represents an annual percentage growth settled on a quarterly basis. The fixed rate is a non-compound annual rate. Thus, a two-year contract quoted as having a 5% fixed rate has a two year return of simply 10%. The total return receiver gets the actual return on the index and pays the fixed rate to the total return payer. This transaction is illustrated on Figure 3.2.

FIGURE 3.2
RPX Total Return Swap Quarterly Cash Flows
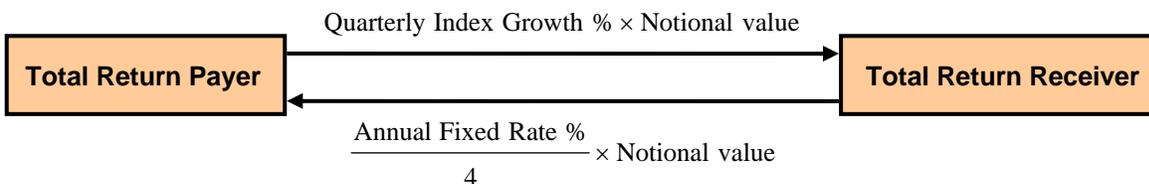
Source: Morgan Stanley

The quarterly total return payment is calculated as the actual quarterly index growth times the

notional value of the contract. The five-day averaging described above applies for calculating the relevant beginning and ending index values. The quarterly fixed payment is simply the annual fixed rate divided by four then multiplied by the notional value.

Effectively, the fixed rate is the rate that equates the present value of the known payments to the present value of the expected total return payments over the tenor of the contract. In other words, the fixed rate is the market consensus expectation of the growth in the index over a given horizon.

Derivatives Traded on S&P/Case Shiller Indices

Futures and options contracts based on the S&P/Case Shiller Home Price Indices (CSI) are currently traded on the Chicago Mercantile Exchange. CSI futures and options are cash settled to a weighted 10-MSA composite index, as well as indices for its ten underlying markets. Currently, futures contracts based on the CSI are available for maturities out to five years. Contracts extending out to 18 months in the future mature quarterly while contracts that extend from 19 months to three years mature biannually and contracts that extend between three and five years mature annually. To date, trading of CSI futures and options has concentrated on the 10 MSA composite index and the New York, Los Angeles, and Miami indices (Siebel).

TABLE 3.2
Trading Volume of SPCS Derivatives on the Chicago Mercantile Exchange, March 2008

Average Daily Volume

	March-08	Month Ago	Year Ago	2008 Jan-Mar	2007 Jan-Mar
Housing Futures	6	4	25	6	23
Housing Options	---	---	11	---	9
Calls	---	---	8	---	5
Puts	---	---	2	---	3

Month-End Open Interest

	March-08	Month Ago	Year Ago	% Change Month Ago	% Change Year Ago
Housing Futures	505	489	1,565	3.2	-67.8
Housing Options	414	414	1,924	---	78.5
Calls	84	84	610	---	86.3
Puts	330	330	1,314	---	74.9

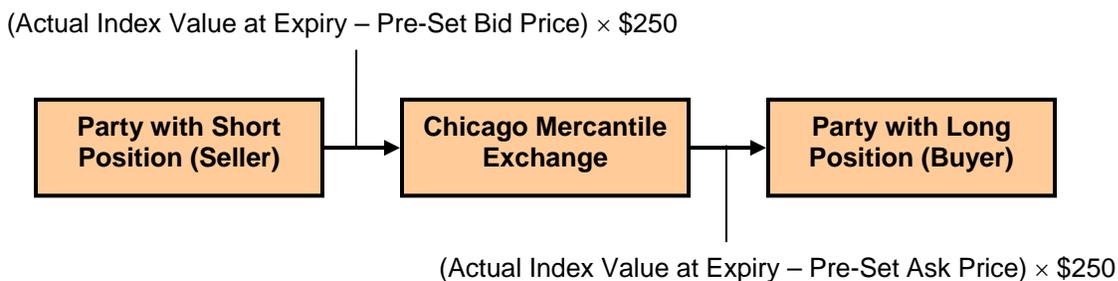Source: Chicago Mercantile Exchange, Quinn Eddins

Table 3.2 summarizes the trading volume for CSI contracts on the Chicago Mercantile Exchange. Relative to other derivatives on the Exchange, these volumes are very small. While an average of 6 CSI futures contracts traded per day in March 2008, lumber futures averaged 1,894 contracts per day and Eurodollar futures averaged 3,047,802 contracts per day. Likewise, while CSI futures had open interest of 505 contracts at the end of March 2008, lumber futures had an open interest of 14,236 contracts and Eurodollar futures had an open interest of 9,408,030 contracts. As of March 31, 2008, there were no open CSI option contracts on the Chicago Mercantile Exchange.

Standard and Poor's publishes CSI on the last Tuesday of each month and uses a two-month lag. (Lee and Tirupattur). Thus, the announcement on August 28th would be for the June index. The CSI has a 3-month measurement period, so the June index would also include sales that took place in May and April. The longer measurement period tends to make the CSI less volatile than the RPX.

Futures Contracts

Each futures contract is valued at $250 times the CSI Index. At expiry, a short position in a futures contract is settled when the seller "delivers" cash to the exchange in an amount equal to $250 times the difference between the current, or spot, value of the index and the bid price specified by the futures contract. The latter was determined by the futures market on the day the contract was purchased. As with forward contracts, the party with the short position receives payment, this time from the exchange, if the difference between the spot value and the pre-determined contract value is negative. A long position is settled when the index buyer receives cash in an amount equal to $250 times the difference between the spot value of the index and the offer, or ask, price specified by the contract. If the difference is negative, the buyer pays the exchange the same amount. The difference between the bid price and the ask price is called the bid-ask spread and is kept by the exchange. These transactions are illustrated in Figure 3.3.

FIGURE 3.3
CSI Futures Contract Cash Flows

(Actual Index Value at Expiry – Pre-Set Bid Price) × $250

| Party with Short Position (Seller) | → | Chicago Mercantile Exchange | → | Party with Long Position (Buyer) |

(Actual Index Value at Expiry – Pre-Set Ask Price) × $250

Source: Quinn Eddins

Option Contracts

CSI options are European-style, which means they can only be exercised at expiry. Upon exercise, options turn into the associated futures contracts. Thus, a put option based on the New York index will, if exercised, turn into a short position in a New York futures contract. Likewise, a call option based on the Los Angeles index will turn into a long position in a Los Angeles futures contract.

Exchanged-Based vs. Over-the-Counter Contracts

Exchange-based futures contracts are formally equivalent to over-the-counter forward contracts. They perform precisely the same function – they lock in a fixed price today for a good to be delivered at a specified point in the future – and thus their value is calculated in the same manner. Theoretically, at least, a futures contract has the same value as a forward contract on the same underlying asset.

However, despite their formal equivalence, forward and futures contracts differ in their institutional design, and these differences can influence a home builder's choice of hedging vehicle, prompting it to choose one over the other in different circumstances. For example, one key institutional difference between forward and futures contracts is the need for interim cash settlement. Futures contracts require daily cash settlement of the gains and losses, while forward contracts are often settled only at the maturity of the contract. Of course, when there is no interim cash settlement and the hedge is losing money, a liability accumulates and is carried over time. When granting a forward contract, the counterparty to the contract is aware that the firm gets an implicit line of credit in the form of a loan with the maturity of the hedging contract. Assuming for the moment that hedging contracts are default protected, the line of credit accepted in the forward contract is exactly identical to the contingent debt accumulated from implementing a futures-based hedging strategy. Consequently, trading in forwards does not give the firm any greater financial advantage than that afforded by hedging with futures. Both the forward and the futures strategy imply a debt strategy (Mello and Parsons 2000). If the limits on debt apply equally to each contract, then the firm is indifferent between hedging with one or the other.

However, this may change when we relax the assumption that hedging contracts bear no default risk. In the real world, the financing implicit in a forward contract is risky, while daily settlement makes the risk of financing a futures position minimal. While the intermediation of a market maker can make forward contracts less liquidity-sensitive, the market-maker's concerns about default risk can prompt it to request collateral, which reduces further the financial slack available to the home builder. The choice among different hedging vehicles depends on which type of vehicle entails the debt package that imposes the lowest financing cost on the firm. Some home builders may prefer to pay to get the up-front, multi-period line of credit inherent in forward contracts, while other home builders may prefer to get financing

contingent on the periodic gains and losses of futures contracts. Even if forwards and swaps avoid the periodic funding needs associated with marking futures positions to market, accumulated losses with these vehicles affect the value of the firm by triggering debt covenants specified in their contracts and by reshaping the incentives to manage the firm.

Section 3.2: Choosing an Index or Indices

To a certain extent, the choice of which index to use as the underlying asset for a hedging vehicle will be determined by the type of derivative product the home builder decides to hedge with. On one hand, if a home builder determines that exchange-traded futures and options fit its capital structure and business model better than over-the-counter products, it will base its hedging vehicle on S&P Case Shiller Indices. On the other hand, if a home builder decides to use over-the-counter forwards and swaps, then it would probably use Radar Logic's RPX to underlie its hedging vehicle because the RPX market is currently the most liquid over-the-counter residential derivatives market.

However, as liquidity in the property derivatives markets increases, as more products become available and as the existing index producers, and perhaps new index producers, begin offering products in both the exchange-based and over-the-counter markets, the decision about what index to use will become more and more important.[†] Even if the choice between the different index producers and their respective methodologies is immaterial to home builders, they will still need to decide whether to hedge using a single composite index or a portfolio of more granular indices. Therefore, home builders and other risk managers need a basis for determining what index, or indices, will make the best hedge against price changes in the housing market.

Basis Risk

There is an old saw among derivative traders: "The only perfect hedge is in a Japanese garden." This refers to the fact that cash flows from a hedging vehicle will not change over time in exactly the same way as the exposure the vehicle is meant to hedge. This is true when managing financial risk, such as when a firm hedges its own borrowing cost with a futures contract based on deposits earning LIBOR, and it is virtually always true when hedging commodity prices, such as when a firm seeks to hedge oil delivered on the East Coast with a NYMEX oil contract, which calls for delivery of oil in Cushing,

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[†] The latter is already beginning to occur. On Wednesday, February 27, 2008, Standard & Poor's announced that it had licensed Bear Stearns to trade over-the-counter contracts based on the S&P/Case-Shiller Home Price Indices.

Oklahoma. This potential gap between the performance of a hedging vehicle and the performance of the risk exposure being hedged is known as *basis risk*.

Basis risk is particularly problematic when hedging real estate assets because, due to their immobility, no two assets can ever be identical. Thus a derivative contract based on given asset or group of assets will never perform in precisely the same way as any other asset or group of assets. The only perfect hedge would be a derivative contract based on precisely the asset being hedged, but the specificity of such a contract would make it utterly illiquid; it would be extremely difficult to find anyone to take the counter position, and even then the cost associated with putting on such a hedge would probably be prohibitive. Of course, the home price indices currently available for derivatives trading do not track the prices of individual properties or even the aggregate prices of individual communities. They track aggregate home prices at the metropolitan area, and therefore may not reflect the particular market conditions that affect the asset to be hedged.

A home builder attempting to hedge using index-based housing derivatives faces basis risk from two major sources. One is the potential for misalignment between the term to expiration of the derivative contract and the typical time horizon for purchasing, entitling, developing and delivering individual homes and residential communities. This issue can be overcome by various hedging strategies and will be discussed in Section 3.3.

The second source of basis risk is the potential for the prices of homes in a builder's portfolio to behave differently than the prices of most other homes in the encompassing market measured by a home price index. Home builders do not usually own portfolios of homes distributed randomly across a city. Rather, they build homes in particular neighborhoods where home prices may or may not change in tandem with the tradable home price indices. In fact, most new homes are built far away from existing homes. Home builders usually build large numbers of homes in places where they can purchase undeveloped land at prices that permit attractive returns on their investment. Such land is usually located far from city centers and the neighborhoods where most existing houses are located. Since the majority of residential property transactions in any metropolitan market are transactions of existing homes, and since the repeat sales methodology used to calculate the S&P/Case Shiller index excludes new home sales entirely, one would expect the available home price indices to track the prices of existing homes better than new homes.

Figure 3.4 compares the cumulative quarterly growth of tradable composite home price indices to the cumulative quarterly growth of gross home building revenue per unit for three large home builders: Lennar Corp., Toll Brothers, Inc., and Hovnanian Enterprises. Home building revenue per unit approximates the average price of the homes a builder sells in a given quarter. Clearly, the available indices do not move in lock step with these builders' products. While the indices increased by 120%

FIGURE 3.4
Cumulative Quarterly Growth of Home Price Indices and Home Builder
Revenue per Unit, Q2 2000 - Q1 2008
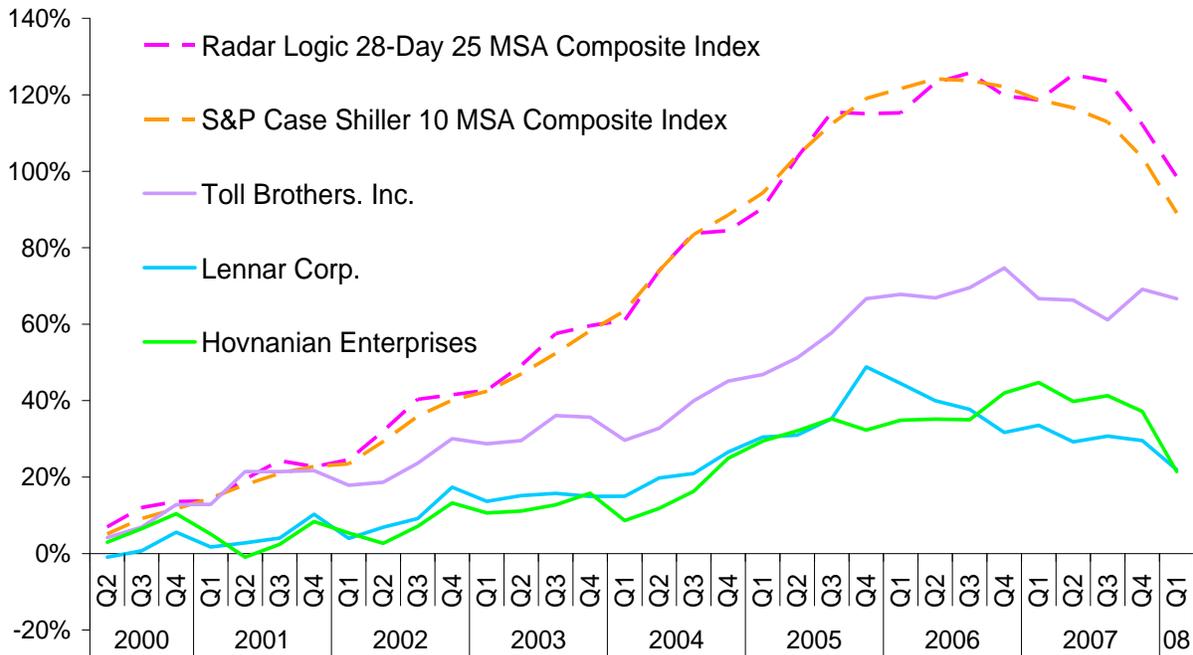
Source: Radar Logic, Standard & Poor's, Toll Brothers, Hovnanian Ent., Lennar, Quinn Eddins

between 2000 and 2006, the average home prices of Toll Brothers, Lennar and Hovnanian Enterprises only increased by roughly 75%, 45% and 35%, respectively.

Measuring Basis Risk

To choose which index or indices to use as the basis of its hedging vehicle, and to determine how much to hedge, a home builder must measure the basis risk between the prices of the homes it builds and sells and the available home price indices. To measure basis risk, the home builder must identify the metrics it will use for measurement and define the exposure it wishes to hedge. Both are discussed here.

Statistical Measures

Home builders need to understand two statistical measures of basis risk in order to design and implement an effective hedging strategy (Smoke and Russell). The first measure is the coefficient of determination, better known as *r-squared*. If the prices of a home builder's houses are highly correlated with a home price index or a portfolio of several such indices, they should exhibit a strong linear relationship. In other words, the pattern of price appreciation experienced by the firm's homes should mirror the appreciation experienced by the index or indices. If the linear relationship between an index

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and the prices of a firm's homes is strong, the builder will be able to use instruments based on the index to hedge its risk. If the linear relationship is weak between the homes' prices and the index, a home builder would not be able to hedge its risk. R-squared measures the strength of a linear relationship. It varies between 0 and 1, with the strength of the linear relationship increasing as r-squared approaches 1.

The second measure a home builder would need in order to quantify the relationship between the prices of its homes and a home price index is known as *beta*. Beta is a key statistic used to determine the relative risk associated with individual stocks compared to the entire stock market or comparable index. The beta of an investment is therefore a way to measure the risk of a particular investment compared to the broader market based on relative volatility. The beta of a specific investment reveals if a particular asset is more or less volatile and therefore judged riskier than the comparable stock market index. If an asset has a beta of 1 its volatility makes it no more or less risky than the market.

The beta of an asset is usually defined relative to a broad-based basket of securities meant to capture the overall movement of the equities markets. However, there are also instances in which the beta of a given asset is defined in relation to a narrower investment class. For instance, Peter Tufano (1998) measured the exposure of gold mining firms to changes in gold prices by calculating "gold betas" reflecting the volatility of a firm's stock price relative to the volatility of prices in the gold market. Using beta as a measurement of the basis risk associated with index-based hedging vehicles follows the same principal. In this case, the *home price beta* measures volatility in the price of a specific property (or group of properties) relative to the volatility of prices in the broader housing market, as indicated by a home price index.

Defining Exposure

When calculating the basis risk posed by a given hedging instrument, one must consider the cash flows generated by the entire firm. Mello and Parsons (1999), Copeland, Weston and Shastri and others have observed that hedging individual transactions is sub-optimal and only adds to a firm's value "by accident" because it is disconnected from the firm's true value drivers. In the case of home builders, hedging home prices in individual communities is sub-optimal because it ignores the risk-reducing effects of geographical diversification and diversification by product type. Home builders frequently choose to build new residential communities in markets where home prices have little or negative correlation with the home prices in their current markets. Likewise, home builders will build communities catering to different types of home buyers (e.g. first time home buyers versus luxury home buyers) in order mitigate the risk of decreasing demand from a given demographic group. This diversification into uncorrelated and countercyclical markets and product types effectively creates "natural" hedges. Any attempt to hedge the cash flows generated by a single residential community using financial instruments without taking

into account its correlations with the firm's other communities could unhedge these natural hedges and actually increase the volatility in the home builder's total cash flows rather than reducing it.

So how can a home builder with communities in many markets hedge the cash flow of the entire firm using derivative contracts based on available home price indices? It can either use a single composite index that reflects home prices in multiple metropolitan areas or it can use a portfolio of multiple metro-level indices.

The Efficiency of Hedging with Composite Indices

The advantage of using a composite index as the basis of a hedging vehicle is the relative ease and low cost of trading a single type of contract. The disadvantage of using a composite index is the increased basis risk caused by the inability to weight the various metro markets in the composite to reflect the geographic distribution of the home builder's own communities. Table 3.3 describes the efficiency of using tradable composite home price indices to hedge the home building revenues of Toll Brothers, Hovnanian Enterprises and Lennar. The *home price beta* (β_h) and r-squared were calculated using a linear regression in which the dependent variable was the quarterly percent change in home building revenue per home delivered and the independent variable was the quarterly percentage change in the index. Total home building revenue per home delivered approximates the average price of the homes a home builder sells across all its regions and submarkets. By using it as the basis for calculating the correlation between the price of a firm's homes and a home price index, one accounts for the natural hedges created through diversification.

The r-squared calculated in this regression is used to calculate the optimal hedge ratio for a given index. A hedge ratio is the ratio of the notional value of a firm's position in a hedging vehicle to the value of the cash flow it seeks to hedge. For instance, if a firm hedges $100 million in home building revenue by taking a short position in a forward contract with a notional value of $50 million, the firm's hedge ratio is 0.5. A firm can increase the correlation between its operating cash flow and the proceeds from its hedge by adjusting its hedge ratio. The "optimal" hedge ratio is the hedge ratio that maximizes this correlation and thereby minimizes the standard deviation of the hedged cash flow (methodology for calculating the optimal hedge ratio is discussed in the Appendix). An optimal hedge ratio cannot fully compensate for basis risk. A hedging vehicle that is poorly correlated to the cash flows to be hedged will not have a significant impact on the variance of those cash flows, whether the hedge ratio is optimal or not. Table 3.3 indicates the degree to which hedging vehicles with optimal hedge ratios can reduce the volatility of the specified firms' home building revenues.

TABLE 3.3
Statistical Measures of Basis Risk: Composite Indices (Q2 2000 – Q1 2008)

Beta relative to the specified home price index (β_h) and r-squared were calculated by regressing the quarterly percent change of home building revenue per unit onto the quarterly percent change in the composite home price index. The reduction in revenue volatility is the percentage decrease in the standard deviation of home building revenue per unit when it is modified by gains and losses from a hedge with the optimal hedge ratio. The methodology for calculating the optimal hedge ratio is discussed in the Appendix.

Toll Brothers, Inc.[1]

Index	β_h	r^2	Reduction in revenue volatility with optimal hedge
Radar Logic 25 MSA Composite	0.28	0.10	5%
S&P/Case Shiller 10 MSA Composite	0.41	0.15	8%

Hovnanian Enterprises [1]

Index	β_h	r^2	Reduction in revenue volatility with optimal hedge
Radar Logic 25 MSA Composite	0.37	0.10	5%
S&P/Case Shiller 10 MSA Composite	0.66	0.22	12%

Lennar Corp.[2]

Index	β_h	r^2	Reduction in revenue volatility with optimal hedge
Radar Logic 25 MSA Composite	0.18	0.03	1%
S&P/Case Shiller 10 MSA Composite	0.39	0.08	4%

[1] Toll Brothers and Hovnanian Enterprises end their financial quarters in January, April, July and October.
[2] Lennar ends its financial quarters in February, May, August and November.

Source: Radar Logic, Standard & Poor's, Toll Brothers, Hovnanian Enterprises, Lennar, Quinn Eddins

It appears that the composite home price indices currently available for derivatives trading are not efficient hedges for the homes these companies sell. None of the r-squareds for any of the firms surpasses 0.23 and, as a result, no hedging vehicle based on these indices could reduce the standard deviation of these companies' home building revenues by more than 13%. Furthermore, all but one of the home price betas reported in Table 3.3 are between 0 and 0.5, indicating the prices of the home builder's products and the composite indices have a very weak relationship, essential moving independently. Thus, it appears that derivatives based on these indices are not an effective means of hedging home builder revenues.

TABLE 3.4
Statistical Measures of Basis Risk: Composite Indices with 1-Quarter Lead and Lag
(Q3 2000 – Q4 2007)

Beta relative to the specified home price index (β_h) and r-squared were calculated using linear regression. The dependent variable was the quarterly percent change of home building revenue per unit and the independent variable was a rolling three-quarter average of quarterly percent change in the composite home price index. The three quarters included in the rolling average were the quarter in which the dependent variable was observed, the preceding quarter and the subsequent quarter. The reduction in revenue volatility is the percentage decrease in the standard deviation of home building revenue per unit when it is modified by gains and losses from a hedge with the optimal hedge ratio. The calculation of optimal hedge ratios is discussed in the Appendix.

Toll Brothers, Inc.[1]

Index	β_h	r^2	Reduction in revenue volatility with optimal hedge
Radar Logic 25 MSA Composite	0.32	0.04	2%
S&P/Case Shiller 10 MSA Composite	0.34	0.06	3%

Hovnanian Enterprises [1]

Underlying Index	β_h	r^2	Reduction in revenue volatility with optimal hedge
Radar Logic 25 MSA Composite	0.31	0.03	2%
S&P/Case Shiller 10 MSA Composite	0.31	0.04	2%

Lennar Corp.[2]

Underlying Index	β_h	r^2	Reduction in revenue volatility with optimal hedge
Radar Logic 25 MSA Composite	0.44	0.07	4%
S&P/Case Shiller 10 MSA Composite	0.55	0.10	5%

[1] Toll Brothers and Hovnanian Enterprises end their financial quarters in January, April, July and October.
[2] Lennar ends its financial quarters in February, May, August and November.

Source: Radar Logic, Standard & Poor's, Toll Brothers, Hovnanian Enterprises, Lennar, Quinn Eddins

Worse, taking a position in an inefficient hedging vehicle can have negative implications for taxes. According to Financial Accounting Standard (FAS) 133, a derivative transaction must pass certain correlation tests in order to be deemed a hedge and thereby qualify for more lenient tax treatment than transactions considered speculative (Naylor and Mansour). One such test is based on regressing the change in value of the derivative on the change in value of the hedged asset. Common practice suggests

TABLE 3.5
Statistical Measures of Basis Risk: Composite Indices with 1 and 2-Quarter Lags
(Q2 2000 – Q3 2007)

Beta relative to the specified home price index (β_h) and r-squared were calculated using linear regression. The dependent variable was the quarterly percent change of home building revenue per unit and the independent variable was a rolling three-quarter average of quarterly percent change in the composite home price index. The three quarters included in the rolling average were the quarter in which the dependent variable was observed and the quarters ending three and six months thereafter. The reduction in revenue volatility is the percentage decrease in the standard deviation of home building revenue per unit when it is modified by gains and losses from a hedge with the optimal hedge ratio. The calculation of optimal hedge ratios is discussed in the Appendix.

Toll Brothers, Inc.[1]

Index	β_h	r^2	Reduction in revenue volatility with optimal hedge
Radar Logic 25 MSA Composite	0.19	0.02	1%
S&P/Case Shiller 10 MSA Composite	0.39	0.08	4%

Hovnanian Enterprises[1]

Underlying Index	β_h	r^2	Reduction in revenue volatility with optimal hedge
Radar Logic 25 MSA Composite	-0.09	0.00	0%
S&P/Case Shiller 10 MSA Composite	0.06	0.00	0%

Lennar Corp.[2]

Underlying Index	β_h	r^2	Reduction in revenue volatility with optimal hedge
Radar Logic 25 MSA Composite	0.22	0.02	1%
S&P/Case Shiller 10 MSA Composite	0.49	0.07	4%

[1] Toll Brothers and Hovnanian Enterprises end their financial quarters in January, April, July and October.
[2] Lennar ends its financial quarters in February, May, August and November.

Source: Radar Logic, Standard & Poor's, Toll Brothers, Hovnanian Enterprises, Lennar, Quinn Eddins

that the adjusted r-squared of this regression should be above 80%. Clearly, hedging with a composite index does not meet this threshold for the three home builders discussed here.

It is possible that, despite the lags built into the indices, temporal misalignments persist between the index values and the actual value of homes transacted in a given period. In other words, the index may not reflect all the transactions that occurred during the period it represents. Such misalignments could increase basis risk and reduce the efficiency of hedging with index-based property derivatives. A home builder could try to account for such temporal misalignments in price movements by taking positions in a

portfolio of derivatives with different expiration dates. For instance, a firm might try to hedge its exposure for the second quarter of a given year using a portfolio of derivatives that expire at the end of the first, second and third quarters.

Tables 3.4 and 3.5 describe the basis risk associated with using portfolios of three equally-weighted derivatives expiring in successive quarters to hedge the per unit home building revenues of the three firms discussed above. The betas and r-squareds were calculated using linear regressions in which the independent variables were rolling three-quarter averages of the quarterly returns to the tradable composite indices. As in Figure 3.3, the dependent variables were the quarterly percent change in the firms' home building revenues per home sold. In Figure 3.4, the three quarters included in the rolling average were the quarter in which the dependent variable was observed, the preceding quarter and the subsequent quarter. In Figure 3.5, the rolling average consists of the quarter in which the revenue per unit was observed as well as the quarters ending three and six months thereafter.

Clearly the three quarter average returns are no better correlated with the prices of the builders' homes than the returns of a single composite index. None of the r-squareds exceed 11%, and only one of the betas exceeds .5. Thus it appears that, even when led and lagged indices are introduced to the hedging portfolio, vehicles based on available composite indices have too much basis risk to allow these home builders to effectively hedge the revenue from their home sales.

The Efficiency of Hedging with MSA-Level Indices

An alternative to hedging with derivative contracts based on composite indices is hedging with a portfolio of derivatives based on MSA-level indices. This strategy allows home builders to adjust the weights of the indices in the portfolio to better reflect the location of their communities, thereby lowering basis risk relative to a hedge based on a composite index. However, this strategy raises the practical problems of having to choose which indices to use and how much weight to give each derivative relative to the others in the portfolio. If indices are available for all the markets in which a home builder sells houses, then the home builder might be able to efficiently hedge with a portfolio based on the home price indices that correspond to the metro markets in which it operates. The weight of each index within the hedging portfolio could be proportionate to the corresponding market's contribution to the firm's total revenue. However, most public home builders are active in many markets for which no indices are currently available. Thus it would not be optimal for them to weight the indices in their hedging portfolio in this way. Rather, it would be better to weight the indices in the portfolio according to the betas derived by regressing forecasted future movements in the firm's home building revenues onto forecasted future movements in the available indices. This would also capture the volatility-reducing effects of diversification across markets and, as a result, could reduce the total notional value of the hedge.

A home builder who chooses to hedge with a basket of MSA-level derivatives would need to adopt a dynamic hedging strategy in which it regularly adjusted the weights of the indices in its hedging portfolio. This would be necessary because home builders are constantly changing the make-up of their portfolio of homes in the direct housing market by entering new markets and leaving old markets, or building new product types and discontinuing old product types with different price points. Moreover, the home builder needs to account for the fact that home price correlations across MSAs change over time and, as a result, the extent of the benefit from diversification does too. Thus, the right mix of indices in a hedging vehicle will vary from firm to firm and from time to time.

Another Option: Bespoke indices

One would expect finer geographic resolution to improve the correlation between the home builder's cash flows and the index, at least until the point where improved specificity is swamped by the measurement error, or "noise", that arises from the small number of observations. At the request of a dealer in the RPX market, Radar Logic can produce specialized indices for markets not included in the 27 indices it currently publishes. These "bespoke" indices can be produced for most metropolitan markets in the United States as well as submarkets defined by geography, down to the zip code level, and product type. Hedging vehicles based on these indices could offer such fine-grain resolution and greatly reduce basis risk as a result. Of course, the caveat to entering into derivative contracts on unique sub-indices, however, is that the trade is likely to be expensive and virtually impossible to exit before the contract's end date.

Section 3.3: Timing

The time frame of available forwards, futures, options, and swaps may not be aligned with the typical time horizon for purchasing, entitling, developing and delivering individual homes and residential communities. Once a parcel of land has been approved for development, it generally takes four to five years to fully develop, sell and deliver all the homes in typical communities. Longer and shorter time periods are possible depending on the ease or difficulty of attaining approvals, the number of home sites in a community and the sales and delivery pace of the homes in a community. Master planned communities, consisting of several smaller communities, may take up to ten years or more to complete. In the case of a downturn in the housing market, the aforementioned estimated community lives may be significantly longer.

As mentioned above, property futures with maturities out to five years are available on the Chicago Mercantile Exchange. Likewise, over-the-counter forwards and total return swaps are available with

tenors of up to five years. Thus, the longest-lived futures contracts correspond to the development time lines of many residential communities. However, until the markets for property derivatives mature and become thoroughly liquid, the longest-lived contracts may be hard to come by. And if they are available, they are likely to be expensive, as market makers charge large premiums and bid-ask spreads in compensation for the risk that they will not be able to find investors to take the counter position. These hedging costs could prove prohibitive for home builders.

Fortunately, the mismatch between the development time-lines of residential communities and the maturities of index-based housing derivatives can be overcome with various hedging strategies. One such strategy is a stack hedge, in which a firm enters into forward or futures contracts with a single maturity, with the notional value of the position calibrated so that the changes in the *present value* of the future obligations are offset by changes in the value of this "stack" of derivative contracts (McDonald).When the near-term contract matures, the firm reestablishes the stack hedge by taking a short position in contracts with a new near-term maturity. This process of stacking derivative contracts in the near term contract and then rolling over into the new near-term contract is called a stack and roll.

There are other strategies, similar to the stack and roll, that combine contracts of various maturities into a hedge position. For example, if a home builder decides to hedge the revenues from homes that are scheduled to be completed and sold in four years, but no four-year contracts are available, the firm could instead hold some short-term contracts with, say, 1 year tenors and some longer term contracts with say, 3 year tenors. As with the stack and roll, the notional value of the position would be calibrated to match the present value of the expected future home building revenues. However, this hedging strategy will likely be better than a stack of all short-term contracts because it better aligns the average maturity of the hedge with the time it takes to build and sell the homes that the builder is trying to hedge.

PART FOUR

In Part Two I argued that the objective of hedging is to increase a firm's financial flexibility by maximizing its liquidity – slack in the form of cash or unused debt capacity – when the firm needs it most: when falling output prices reduce income and make it difficult to raise external financing, but do not reduce the firm's need for funds. A successful hedging strategy, according to this paradigm, lowers the danger of costly financial distress, reduces the costs imposed by external financial constraints and makes value maximizing investments affordable. Such a strategy effectively redistributes cash balances across different states and periods, taking cash from those periods in which the marginal costs of financial constraints (including direct financing costs, opportunity costs and the costs of financial distress) is low and giving cash to those states for which the marginal cost is high. In Part Three I discussed some important decisions pertaining to the design of hedging vehicles, including the choice of derivative contract, the choice of underlying indices and the choice of strategies for correcting temporal misalignment between the expiration of available derivatives and the development time frames of residential communities. I provided evidence that hedging vehicles based on composite indices will have too much basis risk to effectively hedge against downturns in the average price of some builders' homes.

In Part Four I conclude my thesis by bringing together the why and how of hedging in a discussion about how to calculate the notional value of a hedging vehicle. The first step is to evaluate the company's exposure to the volatility of home prices. To do this, a home builder should construct pro forma financial projections and calculate its cumulative internal supply of funds, demand for funds, and external supply of funds over the period it wishes to hedge. The first two are relatively straightforward to calculate. The necessary information can be found on standard pro forma financial statements. Assessing the firm's external supply of funds is a more complicated matter. In addition to forecasting proceeds from new issues of long-term debt, scheduled repayments on existing debt and the firm's anticipated dividend streams, a home builder must estimate its unused capacity to access the capital markets. Most of a firm's available and untapped sources of external financing do not show up on a standard pro forma cash flow statement; rather, they need to be identified and quantified. This requires a good deal of judgment.

The home builder should construct projections for a wide range of scenarios in order to produce a schedule of the supply of funds and demand for funds as a function of the cumulative home price changes over the time horizon analyzed. This allows a home builder to forecast whether there will be a funding deficit, how much it will be and when it will occur. Table 4.1 illustrates such a schedule for the Alpha

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TABLE 4.1
Calculating Alpha Homes' Total Funding Gap for a Range of Scenarios
(Millions of inflation adjusted dollars)

	2008	2009	2010	2011	2012
Home Price Scenario: **12% Annual Increase**					
Cumulative Internal Supply of Funds	743	1223	1991	3172	4963
Cumulative External Supply of Funds	108	215	315	392	468
Net Supply	851	1437	2305	3564	5431
Cumulative Demand for Funds	(689)	(1099)	(1734)	(2677)	(4054)
Total Funding Surplus (Gap)	162	338	571	887	1377
Home Price Scenario: **No Change**					
Cumulative Internal Supply of Funds	628	877	1208	1623	2133
Cumulative External Supply of Funds	54	101	118	103	73
Net Supply	682	978	1326	1726	2206
Cumulative Demand for Funds	(610)	(863)	(1206)	(1645)	(2195)
Total Funding Surplus (Gap)	72	115	120	81	11
Home Price Scenario: **2% Annual Decrease**					
Cumulative Internal Supply of Funds	612	814	1082	1439	1914
Cumulative External Supply of Funds	46	86	95	77	47
Net Supply	658	900	1178	1516	1961
Cumulative Demand for Funds	(596)	(826)	(1130)	(1507)	(1966)
Total Funding Surplus (Gap)	62	73	47	9	(5)
Home Price Scenario: **8% Annual Decrease**					
Cumulative Internal Supply of Funds	529	608	700	805	925
Cumulative External Supply of Funds	24	46	41	19	0
Net Supply	553	654	740	823	925
Cumulative Demand for Funds	(557)	(721)	(922)	(1146)	(1392)
Total Funding Surplus (Gap)	(4)	(67)	(182)	(323)	(467)

Source: Quinn Eddins

Homes, the hypothetical home builder discussed in Part Two. It shows that if the prices of its homes decrease by an average of two percent a year for five years, Alpha will not have sufficient funds to implement its investment strategy in year five. If the prices of Alpha's homes fall by eight percent a year, it will suffer a funding gap by the end of the first year.

By observing the supply and demand for funds at different points of time under a range of price scenarios, the firm can calculate how large of a position it should take in its chosen hedging vehicle. The proper position will be sufficiently large to ensure that the proceeds from the hedge in low price scenarios will augment internally generated funds enough to cover the firm's demand for funds. Of course, the hedging vehicle will earn a loss in more optimistic scenarios. Thus the notional value of the hedging

vehicle should be large enough to eliminate funding deficits in the low price scenarios, but should not be so large as to create funding deficits in the high price scenarios. If there is no notional amount for which deficits in both the high or low scenarios are avoidable, the notional amount of the hedge should be that which creates the smallest possible deficit.

Table 4.1 provides a stylized example of how to calculate Alpha's exposure to changes in home prices. For this purpose, four price scenarios suffice. To describe uncertainty more realistically, however, it is necessary to consider all possible occurrences. In statistical terms, this means getting the distribution of possible outcomes by giving the proper weight to each possible outcome according to its probability of occurrence. This can be done using simulation techniques.

As in any model of reality, these simulations must be fed the right parameters. Inflation-adjusted housing prices appear to revert to a long-term mean (Eichholtz and Geltner). However, in their convergence to the long-term mean, prices are often subjected to random shocks. Deviations from the path to convergence depend on the volatility of the prices. Therefore, to generate sequences of future prices it is necessary to input into the simulation algorithm sensible values for the long-term price level, speed of adjustment and volatility. These three parameters can suffice to describe the distribution of prices at any future date, provided a sufficiently large number of iterations of the simulation are produced. Multiple iterations can be produced with the help of the random number generator of modern spreadsheet applications.

Once a firm's exposure has been forecasted and the notional value of the hedge has been calculated, that value must be adjusted by a hedge ratio in order to correct for the basis risk of the hedging vehicle. Assuming that derivatives based on composite indices will entail too much basis risk, home builders will want to use hedging vehicles based on multiple indices with a finer geographical resolution, such a the published MSA-level indices or, if possible, bespoke indices for their specific markets. The appropriate weight of an index relative to the others in the portfolio is its beta coefficient as determined by the linear regression specified by the following equation:

$$\Delta\left(\frac{\mathrm{Re}\,v}{Unit}\right) = \alpha + \beta_1\Delta(I_1) + \beta_2\Delta(I_2) + \beta_3\Delta(I_3) + \ldots + \beta_i\Delta(I_n)$$

The dependent variable, on the left hand side of the equation, is the forecasted percent change per period of the home builder's revenue per unit. The independent variables, on the right hand side of the equation, are the forecasted changes (Δ) per period in indices 1 through n (e.g. $I_1 - I_n$). α is the intercept point of the regression line and the y axis.

Once the index weights have been calculated, the hedge ratio for the entire portfolio can be calculated by multiplying the forecasted changes in the indices by their respective weights, adding the products together and then regressing the home builder's forecasted revenues onto the sum. This is expressed in the following equation:

$$\Delta\left(\frac{\mathrm{Re}\,v}{Unit}\right) = \alpha + \beta_P \sum_{i=1}^{n}\left[\beta_i \Delta(I_i)\right]$$

The hedge ratio for the hedging portfolio is the beta coefficient generated by the regression (β_P). For example, if the beta coefficient is 0.6, then for every one percent that the hedging portfolio changes, the home builder's revenues per unit change 0.6 percent. Therefore, in order to compensate for the fact that the hedging vehicle is more volatile than the prices of the output the home builder is trying to hedge, the notional value of the hedge should be reduced, in this case, by a factor of 0.6. If the hedging portfolio were less volatile than the home builder's revenue, generating a beta coefficient of, say, 1.3, then the notional value of the hedge would have to be increased by a multiple of 1.3 in order to increase the proceeds from the smaller changes in value (i.e. lower volatility).

The methodology described in this section requires a great deal of forecasting. The home builder's future revenues, expenses, and investment opportunities, the quantity of the units it will produce, and the future values of the home price indices all must be forecasted in order to calculate a the notional value of the firm's hedge. The quality of the hedge will depend in large part on the quality of the forecasts. Of course, forecasts become less reliable the further they extend into the future. Therefore, attempting to hedge exposures more than a few quarters into the future will be difficult and the outcome could be unreliable. For this reason, the hedging strategy described in this thesis is best applied to short–term exposures to home price risk. As a result, the hedges will not account for potentially large price changes in more remote time periods. This will be problematic for home builders given their long development timelines. Nevertheless, while not perfect, the hedging strategy described herein could provide a significant strategic and competitive advantage when housing prices fall.

APPENDIX

Hedge Ratios and Hedging Efficiency

The following discussion is adapted from Copeland, Weston and Shastri. In this thesis I use the term "hedge ratio" in the context of discussing basis risk, which, in this case, is the risk that arises from imperfect correlation between movements in the price of a firm's output and movements in the index underlying its hedging vehicle. In this context, a hedge ratio is the notional value of a home builder's hedging vehicle(s) divided by the value of the homes it is seeking to hedge. For instance, if a home builder hedges $100 million of revenue from home sales by taking a short position in forward contracts with a notional value of $50 million, then its hedge ratio is 0.5. A firm can increase the correlation between its home building revenues and the proceeds from its hedge, and thereby reduce basis risk, by adjusting its hedge ratio.

However, there is a limit to how much a firm can improve the correlation between its home building revenues and its hedging proceeds simply by adjusting its hedge ratio. A hedge based on an index that is poorly correlated with the price of a firm's products will ultimately be a less efficient vehicle for reducing the volatility of a firm's internal supply of funds than a hedge based on an index that is highly correlated with the prices of a firm's products. This efficiency can be quantified by measuring the degree to which an optimal hedge ratio can reduce the variance of the firm's hedged revenues.

Suppose a firm were seeking to reduce the variability of its home building revenues by hedging with a forward contract that has a price today of F_0 and an end-of-period price of F_1. The firm's hedged revenue, $\mathrm{Re}\,v$, from selling homes (assuming, for convenience, that a single home is produced) can be written as

$$\tilde{\mathrm{Re}}\,v = \left(\tilde{P_1} - P_0\right) - h\left(\tilde{F_1} - F_0\right),$$

where P_0 is the current revenue per unit, $\tilde{P_1}$ is the uncertain future revenue and h is a hedge ratio. Using basic principles of probability theory, we can express the mean and variance of the above equation as follows:

$$E(\tilde{\text{Re}}\,v) = [E(\tilde{P}_1) - P_0] - h[E(\tilde{F}_1) - F_0],$$

$$VAR(\tilde{\text{Re}}\,v) = VAR(\tilde{P}) - 2rh\sigma_P\sigma_F + h^2 VAR(\tilde{F}).$$

Note that $E(\cdot)$ denotes the expected value and $VAR(\cdot)$ is the variance; r is the correlation coefficient between the two random variables, $\tilde{P}$ and $\tilde{F}$; and σ_P and σ_F are the standard deviations of $\tilde{P}$ and $\tilde{F}$, respectively.

To calculate the hedge ratio that minimizes the variance of the firm's hedged operating revenue, we take the derivative of the variance calculated above and set it equal to zero, then solve for h.

$$\frac{dVAR(\tilde{\text{Re}}\,v)}{dh} = -2r\sigma_P\sigma_F + 2h\sigma_F^2 = 0,$$

$$h^* = \frac{r\sigma_P}{\sigma_F}$$

Thus, the optimal hedge ratio, h^*, is estimated as the slope of the regression of home building revenues and proceeds from the hedging vehicle.

By substituting the optimal hedge ratio, h^*, into the variance equation, we can see that the standard deviation of the hedged revenues, $\sigma^*(\text{Re}\,v)$, depends on the r^2 between $\tilde{P}$ and $\tilde{F}$:

$$VAR^*(\tilde{\text{Re}}\,v) = VAR(\tilde{P}) - 2rh^*\sigma_P\sigma_F + h^2 VAR(\tilde{F})$$

$$VAR^*(\tilde{\text{Re}}\,v) = \sigma_P^2 - 2r\left(\frac{r\sigma_P}{\sigma_F}\right)\sigma_P\sigma_F + \left(\frac{r^2\sigma_P^2}{\sigma_F^2}\right)\sigma_F^2$$

$$= \sigma_P^2 - 2r^2\sigma_P^2 + r^2\sigma_P^2$$

$$= \sigma_P^2 - r^2\sigma_P^2$$

$$= \sigma_P^2(1 - r^2)$$

$$\sigma^*(\text{Re}\,v) = \sigma_P\sqrt{1 - r^2}.$$

Thus, we see that the standard deviation of the firm's unhedged revenues per unit, σ_P, is reduced by $\sqrt{1 - r^2}$. The higher the correlation between the end-of-period revenues and the proceeds from the hedge, the greater will be the *efficiency of the hedge* in reducing risk. However, since the hedge reduces

the volatility in the firm's revenues by the square root of $1-r^2$, the r^2 must be very high in order for the hedge to have a significant impact. For example, an r^2 of 0.80 only reduces the standard deviation by 55%. To achieve an 80% reduction in the standard deviation, one needs an r^2 of at least 0.96.

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