

Resort Real Estate: Does Supply Prevent Appreciation?

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Abstract

This paper examines the behavior of ski resort property in a major New England market over the last 25 years. A constructed property price series reveals that *nominal* prices are quite volatile and only slightly higher today than in 1980. These fluctuations and trends are investigated with a time series VAR model. The findings indicate that (1) natural snowfall is crucial to business; (2) regional annual business is central to individual resort demand and hence price appreciation; and (3) resort supply responds so elastically to any movement in prices, that it effectively curtails any long-term property appreciation. Impulse responses reveal that positive demand shocks fail to generate any long-term (real) price appreciation because of excessive new development. This behavior could be typical of many other ski resorts.

Introduction

As the economy in the United States continues to grow, an increasing number of Americans are purchasing and building second homes: by the ocean, near lakes and in the mountains. According to *Ski Magazine*, in 1960 there were only a handful of ski areas that had any permanent housing, while by 1990 the country contained more than forty major resorts with collectively over 100,000 housing units (excluding hotel rooms). The objective of this paper is to examine the investment performance and economic behavior of such second homes in one particular market, ski resorts, and in one part of the country, New England. This appears to be the first effort to study a market for “second” or resort homes. A number of authors have examined the cyclic movements of commercial property markets (Wheaton, 1987; King and McCue, 1987; Voith and Crone, 1988; Grenadier, 1994; and Hendershott, Lizieri and Matysiak, 1999). The hotel lodging industry has been studied (Wheaton and Rosoff, 1996; and Coopers and Lybrand, 1999), and of course the primary home and apartment markets have been well researched (Grebler and Burns, 1982; DiPasquale and Wheaton, 1992, 1994; and Blackley, 1999). There is no published work, however, on second home resort housing.

To study this market, a property price series is first constructed for one particular resort, Loon Mountain. This resort is believed to be quite typical of New England

ski areas. The series reveals that *nominal* prices are only slightly higher today than they were in 1980, and consequently *real* prices have eroded—by 40%. In addition to showing little long-term nominal appreciation, the series exhibit considerable variation across time. The series is stationary, however, and so can be examined with traditional econometrics. The causes of these fluctuations are explored with a time series model of the resort, a conditional VAR, and three things are learned.

First, natural snowfall in the region is probably more important than either the region's long-term economic growth or business cycle in explaining the annual volume of the region's ski business (New England skier visits). Secondly, regional ski business in comparison to Loon Mountain's own stock of units closely explains price appreciation. Finally, new supply at Loon Mountain responds so elastically to any movement in prices or regional business that it effectively curtails any long-term property appreciation.

To further reinforce these conclusions, VAR impulse responses to both transitory and permanent demand shocks are examined. The shocks are truly exogenous and are generated by either exceptional snowfall in one year, or by a permanent increase in annual snowfall. In both cases the initial increase in prices that results from the generated business is soon reversed from exuberant new development. In most situations, prices (in real terms) actually wind up slightly lower a number of years after the shock. This behavior could be quite typical of many ski resorts and hence can clearly limit long-term investment performance for such property markets. Buying a condominium in a ski resort might bring the owner some yield (either personal or rental), but it is unlikely to produce much capital gains.

Data and Modeling Approach

The New England ski market is composed primarily of nineteen major resorts and fourteen minor ski areas in the three northern states of Maine, New Hampshire and Vermont. Major resorts have a large number of trails as well as extensive lodging and condominium developments. Minor areas focus primarily on local day skiing. Most skiers in these markets live in the Northeast, and much of the skier traffic comes from automobile-based weekend trips, between the months of December and March. These weekend and holiday trips generate most of the demand for resort real estate. The region's snowfall is not as abundant as in the western U.S., so over the last thirty years all of the resorts have installed full snowmaking capacity on virtually all of their terrain. The resorts compete extensively with each other for destination skiers that come predominantly from Boston and New York.

Loon Mountain lies in the center of the northern states, in the White Mountains of New Hampshire. Being located directly off the state's largest interstate highway (I-93) it is very accessible and has grown in popularity. The first ski trails were

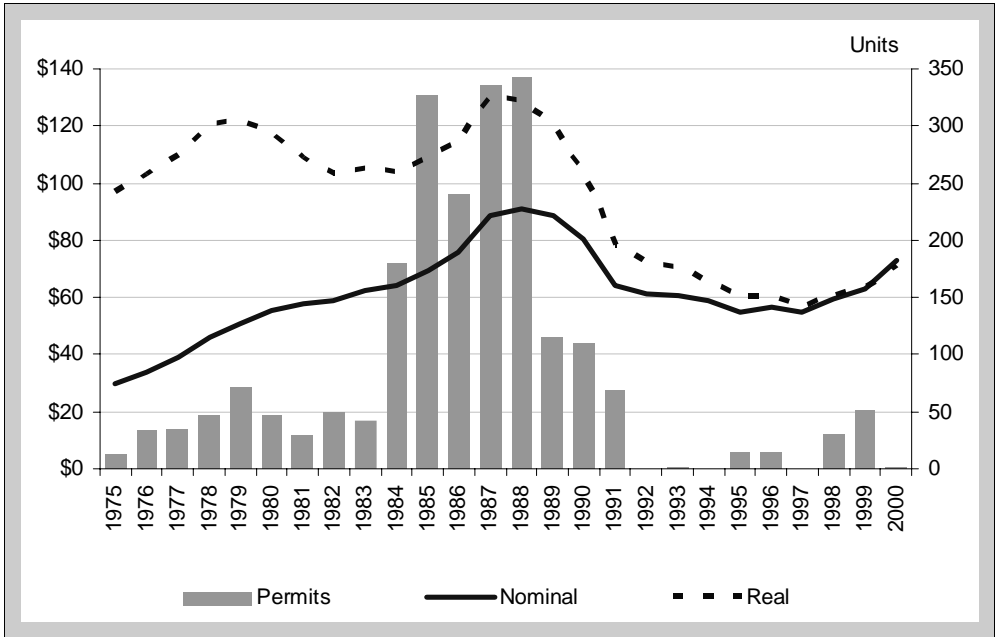
cut in the mountain in the early 1960s, and a hotel was built at that time. Condominium developments were begun in 1975, and today more than 2,100 units sprawl along the access road that leads from I-93 to Loon.

The condominium market at Loon divides itself into two parts. Those that were developed directly adjacent to the resort, the Village at Loon Mountain, contain a total of 555 units and are considered to be more desirable because of their direct access. Over the same time a host of smaller developments were undertaken that lie along the three miles of access road, and together contain roughly 1,600 units. The real estate market for all of these condominiums is quite active, and sales of units occur in all seasons, with slightly higher transactions in October through December.

Since the objective of a price index is to identify a time pattern in the price of identical assets, only transactions at the Loon Mountain Village were chosen for analysis. A listing of sales of these units was obtained from several sources: tax records, brokers, and most recently an online service. All together a sample of 616 transactions was obtained from 1975 to 2000. The developments at Loon Mountain Village fall into one of four complexes, and each individual unit is configured in one of twenty-four “types.” Each type involves specific square footage, bedrooms, baths and amenities. Thus, rather than try to measure unit attributes directly, a hedonic equation was developed that simply had three complex and twenty-three unit “fixed effects.” In the Appendix, the results of this equation are presented including the year (of sales transaction) coefficients.¹

The results of this analysis are quite startling, and are displayed in Exhibit 1. Since the earliest recorded sale, in 1975, the price index (per square foot) has risen only 70% in nominal terms and has fallen 40% in real terms—as of January 2000. Furthermore, there was a significant price “bubble” in the 1980s that saw nominal prices more than double (from 1977 values) and real prices increase 25%. Since that peak, nominal prices have fallen 30% and real prices have declined almost 50%. Thus over the twenty-four years studied, not only have condominium prices failed to keep pace fully with inflation, but there has been considerable risk associated with their ownership as well. Those purchasing in the mid to late 1980s could have actually lost considerable value in nominal terms.

It must be admitted that this index has several biases. First, the original units have gained in “location” value as the resort expanded. Since location is not part of the equation, there is an upward bias in the index—if it is used as a constant quality measure. Secondly, the original units at Loon have undoubtedly deteriorated somewhat over the intervening years, and this creates a downward bias. In the end, it cannot be said for sure that the index perfectly reflects a constant quality measure, but it does reflect an investor’s appreciation. The series also raises two central research questions: why has long-term appreciation been so little, and what accounts for the sharp decline of prices since the late 1980s. Exhibit 1 also suggests an answer to this latter question, for it shows the huge development boom that accompanied the rise in prices during the early 1980s.

Exhibit 1 | Condominium Prices (\$/sq. ft.) and Construction

Before proceeding with any kind of analysis it is important to check for the stationarity of the series, since non-stationary variables can generate misleading statistical inferences with standard econometrics. Using the real price series, the null of a random walk with drift was tested against a stationary time trend with a Dickey-Fuller F-Test. There is sufficient autocorrelation in the series so the augmented test is warranted. The null was rejected at the 10% level, but not the 5% level. This test is widely thought not to have much power, particularly for a sample with only twenty-four observations, but it is the best that can be done.²

To study the determinants of the movements in the price series, a series was collected on the number of skier visits: a good ex post measure of demand. Each individual resort keeps these figures quite private, and the few resorts that are public companies, report only visits for an aggregate of all resorts owned. Trade associations at the state and regional level, however, do report aggregate statistics, as authorized by the resorts. The longest standing statistical series is for the three-state northern New England region, which goes back to 1976. While it might have been possible to pry loose visit data for just Loon Mountain, such a series would be hopelessly endogenous in any analysis of prices. The advantage of the aggregate New England visit data is that it is a fine exogenous *instrument* for Loon Mountain demand. A rough guess would place Loon business at about 3% of New England's. Thus, real estate activity at Loon is unlikely to have any impact on region-wide ski business.³

While the use New England skier visits would be sufficient to identify the models, it is also interesting to study its determinants. To do this, data was obtained on the standard economic series for the region: employment and income per worker. In addition it is widely felt that the level of natural snowfall in the region plays a strong role in generating skier business. Some feel that this results from a directly improved skiing experience, while others argue that artificial snowmaking is perfectly sufficient, and natural snowfall just “awakens skier interest.” In either case, national weather service data was obtained for a site in the middle of the region.

Finally, a direct count of all condominium developments along the three mile access road was undertaken. From records, the permit date of each development was obtained and a series created for the total stock of units servicing the resort—based on the time of construction. This covered the full period since the first development in 1975. All these data series are defined in Exhibit 2.

Conspicuously absent from Exhibit 2 is any information about condominium rental rates, either daily or seasonal. The current resort management agency said that less than half of the units are ever rented, and that over the span of this study several different agencies have handled rentals. The records from previous agents are the property of the agent (not the resort) and could not be obtained. Thus, it was impossible to ascribe a rental “yield” to these assets. Since most units are used by the owner, the “yield” in this second home market remains an elusive flow of personal services.

To study how resort prices are related to these variables, a two-equation “conditional” Vector Auto Regressive (VAR) model was developed. Like a traditional VAR model, a conditional VAR jointly predicts the endogenous variables (in this case, prices in constant dollars and the stock of condominium units) as a function of lagged values of these variables. Conditional VARs,

Exhibit 2 | New England Ski Data

Variable	Definition
S_t	Stock of condominium permits at Loon Mountain Resort
NEV_t	New England skier visits (lift tickets sold)
NES_t	New England average snowfall (Plymouth, NH)
P_t	Price index for Loon Mountain Resort (constant \$)
C_t	Construction starts of units at Loon Mountain
NEE_t	New England employment
NEY_t	New England average income per worker
R_t	Interest rate {real, nominal}

however, also include contemporaneous variables that are exogenous and not influenced by price or stock. Since it's known a priori that New England skier visits are exogenous to the Loon resort, it was added to the VAR along with national interest rates to “condition” the price and stock equations, as in Equations (1) and (2) below. As an aside interest, a third equation was estimated for New England skier visits, Equation (3), which includes the other exogenous variables: snowfall and regional economic performance.

$$P_t = f_1(S_{t-1}, P_{t-1}, NEV_t, R_t). \quad (1)$$

$$S_t = f_2(P_{t-1}, S_{t-1}, NEV_t, R_t). \quad (2)$$

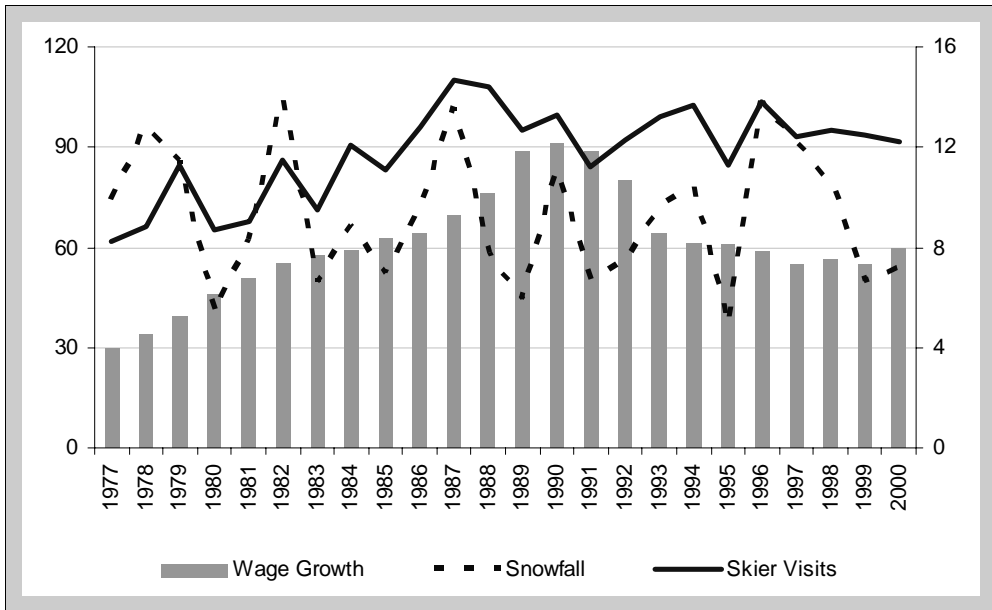
$$NEV_t = f_3(NEE_t, NEY_t, NES_t, NEV_{t-1}). \quad (3)$$

The advantage of the conditional VAR system is that it can examine two kinds of reactions. The first is the impact that a transitory shock to demand (*NEV*) has on prices and stock through a traditional impulse response analysis. Secondly, because the demand instrument is exogenous, the effect of a permanent change to demand can also be examined. To do this, *NEV* is manually set to a higher value over some period of time, with the resulting forecast of prices and stock being compared to the original price–stock forecast. The advantage of examining a permanent as opposed to transitory demand shock is that the subsequent changes in prices and stock can be used to estimate an implied supply elasticity for units at Loon Mountain—as determined over different time intervals.⁴ To make the analysis interesting the magnitude of the shock to *NEV* is set equal to that which results from having regional snowfall jump up to historic levels—as determined from Equation (3).

New England Skier Demand

Exhibit 3 tracks the total skier visits (day tickets sold⁵) to all resorts in the northern New England states. From 1977 to 1987, there was a pronounced 50% rise in the volume of regional ski business. Since then, however, there has been a gradual downward trend, with business falling cumulatively about 15%. These patterns in many respects mirror the industry nationwide, and there have been many explanations offered. Some see the growth in the 1970s and 1980s as being powered by a strong economy, but the surging economy of the 1990s has failed to turn around the industry. Others explain the trend in terms of demographic shifts: aging baby boomers are less interested in cold weather outside activity. In the case of New England, however, there is also the issue of natural snowfall, which has both trended and exhibited much fluctuation over the sample period.⁶

Exhibit 3 also compares visits to both natural snowfall, and the growth in regional income per worker from 1977 through 2000. Wage growth was low (and even

Exhibit 3 | Annual Snowfall, New England Skier Visits and Wage Growth

negative) during the 1970s and then rose until peaking in 1988. During this period, prosperity and skier visits seem to match each other. During the recession of 1990 and subsequent strong recovery, however, the two do not match well. In terms of the snowfall data, the annual movements in skier visits do seem remarkably related to the variation in snowfall. Plentiful accumulation during the winters of 1978, 1982, 1987 and 1996 all correspond to local peaks in the number of skier visits.

An initial equation predicting New England skier visits used NEE , NEY and NES as contemporaneous exogenous variables. This produced the results in Equation (4). Snowfall is clearly most important in generating skier visits, in the year that it occurs, and the region's economic variables are surprisingly weak.⁷

$$\begin{aligned}
 NEV_t = & -4.6 + .003NEE_t + 1.87NEY_t + .042NES_t, \\
 & (-1.6) \quad (1.9) \quad (0.1) \quad (3.8) \\
 & + .41NEV_{t-1}. \quad (4) \\
 & (2.2) \\
 R^2 = & .71, N = 24 (1977-2000), DW = 1.77
 \end{aligned}$$

In any VAR type analysis it is important to try different lags for the right-hand side variables and let the significance of each lag be the guiding principle for how

many lags to include. Further experimenting with Equation (4) revealed that including lagged right-hand side variables, as well as contemporaneous values, often was quite important and produced coefficients of almost identical magnitude and opposite sign. In this case it is effectively the change in the economic variable which impacts skiing—not its level.⁸ With the snowfall variable, however, adding a lagged value produced no gain, implying that it is only the current level of snowfall that impacts skier visits. The endogenous variable *NEV* also never needed a second lag.⁹ Thus, when the visits equation uses lagged as well as current values for the economic variables, the results are:

$$\begin{aligned}
 NEV_t = & 1.4 + .0042NEE_t - .0041NEE_{t-1} + 945.NEY_t \\
 & (0.4) \quad (1.8) \quad \quad \quad (-1.7) \quad \quad \quad (3.4) \\
 & - 886.NEY_{t-1} + .042NES_t + .26NEV_{t-1}. \quad (5) \\
 & \quad \quad \quad (-5.1) \quad \quad \quad (4.4) \quad \quad \quad (1.5) \\
 R^2 = & .82, N = 24 (1977-2000), DW = 1.93
 \end{aligned}$$

In Equation (5), a permanent increase in the level of regional personal income (*NEY*) will impact visits strongly in that same year, but the increase quickly vanishes as the coefficient for its lagged value takes effect. Eventually the impact is virtually zero. In this sense, permanent improvement in regional wealth has only transitory impacts on skier visits, not permanent effects. The same is true for increases in regional employment (*NEE*).

Since snowfall will be used to determine the magnitude of the demand shock, its impact is examined in more detail. With only a single coefficient, a *permanent* increase in snowfall will generate a concomitant permanent shift in skier demand. If every year, there were fifty inches of extra snowfall (roughly the sample range, or 4 standard deviations) this would boost visits by 18% in the first year ($50 \times 0.042/12.2$), while after several years, the impact on visits would be $1/0.74$ times this amount or a 25% increase in visits. In terms of transitory impacts, if the same fifty extra inches occurred only in one year, the 18% impact in that initial year would drop to 4.5% the year after and to only 1% two years later.

Loon Mountain Price-Stock VAR

The two-variable VAR model predicts the Loon Mountain condominium stock and price as a function of these variables lagged as well as the two conditioning variables, interest rates and region-wide skier visits. The equation for condominium prices is shown in Equation (6) and that for the condominium stock in Equation (7). The price equation looks quite similar to a structural demand model: skier visits has a strong positive impact while interest rates and the condominium stock are negative. Experiments with real (as opposed to nominal)

interest rates yielded a worse fit, and in no case was a second-order lag on the price or stock variables significant.¹⁰

$$P_t = 19.9 + 2.51NEV_t - 1.48R_t - .014S_{t-1} + .79P_{t-1}.$$

(1.7) (2.7) (-2.8) (-5.1) (10.3) (6)

$R^2 = .96, N = 24$ (1976–2000), DW = 1.54

The equation for the condominium stock, Equation (7), also has some of the features of a (stock adjustment) supply model. Prices have a significant positive effect and interest rates a negative effect on new construction and this moves the stock similarly in the next period. Without coefficient restrictions, however, the VAR equation also allows a direct impact of visits on development. The strong effect of this variable could have several behavioral explanations as well. First, visits could easily be a proxy or instrument for the unobserved condominium rental rate. Second, visits is a direct measure of potential buyer traffic, and in a market with frictions, buyer traffic is an important determinant of prices (Wheaton, 1990). For example, in the single family housing literature, numerous studies have found that sales traffic and sales time add much explanatory power over prices, to a construction (supply) equation (Blackley, 1999). As with the price equation, the coefficients for a second-order lag on the stock and price variables were insignificant and a first-order VAR seems sufficient.¹¹

$$S_t = -498 + 2.19P_{t-1} + 44.7NEV_t - 6.14R_t + .93S_{t-1}.$$

(-3.3) (2.4) (3.6) (-0.9) (27.5) (7)

$R^2 = .994, N = 24$ (1977–2000), DW = 1.68

If one was to attempt to interpret these equations as demand and supply structural equations, the long-term elasticity of price with respect to stock is about -2.5 in Equation (6) when evaluated at current (year 2000) values. Inverting, demand would have an elasticity of about -0.4 . In Equation (7), the long-term elasticity of stock with respect to price is larger—about 1.0 —again when evaluated at year 2000 values. This exercise, however, runs contrary to the VAR approach, which is to examine the dynamic properties of the *full system* of equations and make inferences about implied elasticities therefrom.

VAR Impulse Responses

Since VARs are linear systems, the matrix of coefficients is sufficient to determine the impact of any shock on the future values of all variables in the VAR. In other words, initial conditions do not matter. The traditional impulse response analysis

is to trace out the yearly *changes* in the forecast values (stock and price) that result from a temporary one-period shock to any variable in the system—or in this case the exogenous variable that is outside of the system. This first exercise undertaken is to examine how the forecast of prices and stock would differ if *in one year* snowfall was fifty inches greater, and hence skier visits were 18% higher. Exhibit 4 traces out the change in the predicted values of condominium prices and stock that result from this shock—over a ten-year horizon.

Since region-wide skier visits is an important conditioning variable in both VAR equations, the shock's impact is immediately felt in terms of generating both higher prices and more new development. The positive effect on prices carries forward a few periods, and thus even though skier visits returns to normal in subsequent years, the price impact continues to propel a growth in the stock. Since the additions to the stock are long lived while the shock to demand vanishes, prices soon start to fall from their non-shock path. Eventually, by year nine, there is a greater stock, visits are back where they were originally, and hence prices are *lower* in real terms, but most likely not in nominal dollars.

The second exercise is to ask what happens if there is a permanent shift in weather and there is fifty more inches of snowfall each year in the forecast horizon. Of course the impulse response functions in Exhibit 5 will start out as in the transitory shock case, but now demand (skier visits) continues to be higher each year during

Exhibit 4 | VAR Impulse Response, Temporary Increase in Snowfall in Period One: % Change in Forecast Values from Steady State

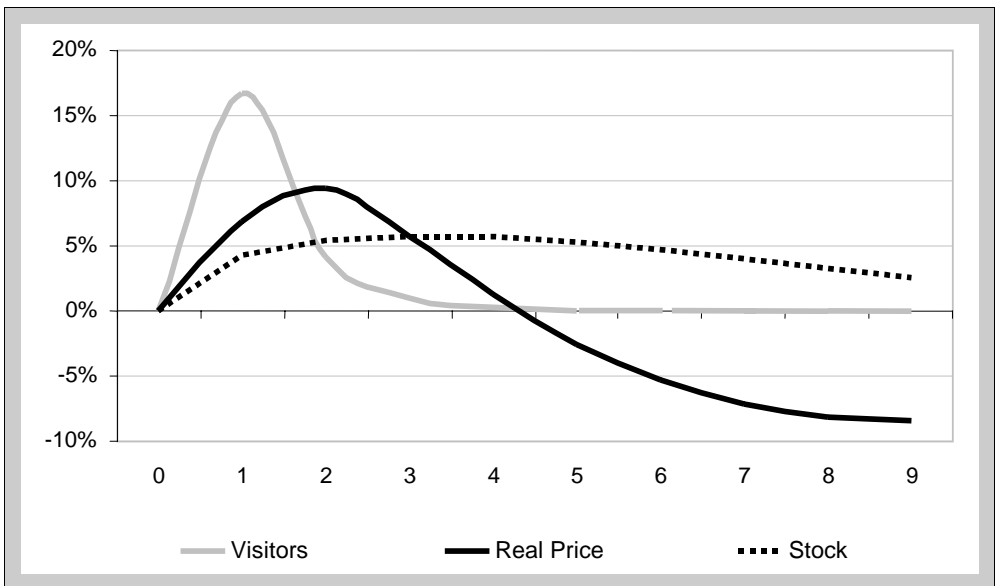
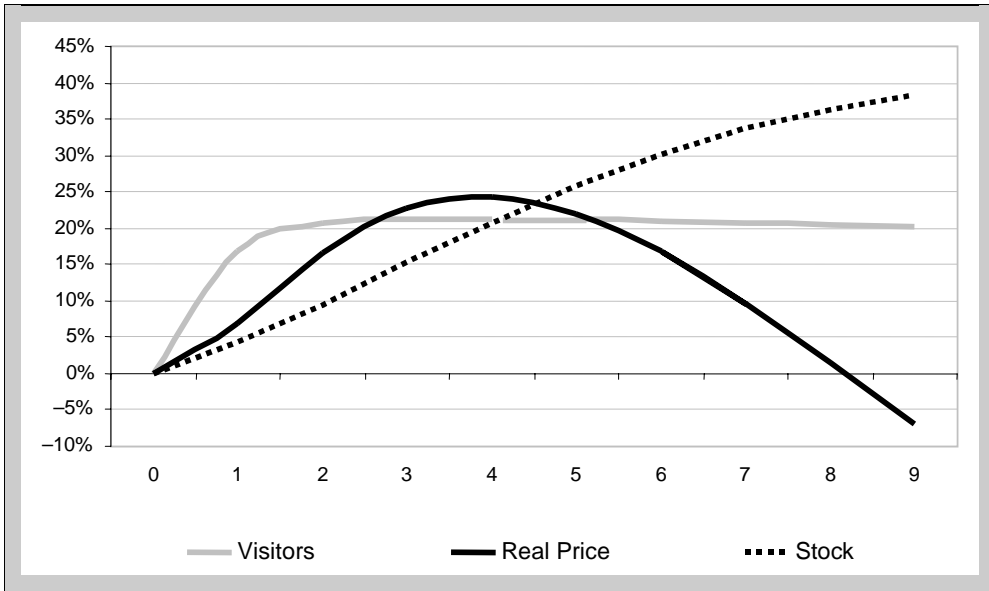


Exhibit 5 | VAR Impulse Response, Permanent Increase in Snowfall from Period One: % Change in Forecast Values from Steady State



the forecast. With demand now permanently higher, prices rise much further and longer than in the transitory snowfall case. This in turn sets off a much more pronounced growth of the stock (development boom). By the fifth year, this development boom begins to fulfill the higher demand and prices turn downward. The boom is slow to correct, however, and by year nine prices are again *lower* than they were without the permanent shock. Prices bottom out in year fourteen at about 13% lower than in the non-shock case in constant dollars. This would still likely represent some increase in current dollars.

It is possible to calculate an implied elasticity of supply from the permanent shock impulse response function—for each year after the shock. This is one advantage of the VAR methodology over structural models. For example, in the second year of the shock, the stock has increased by only 10% while prices are 17% higher—an implied elasticity of 0.57. By year six the same calculation gives an elasticity of 2.0. As prices approach zero and then turn negative, the implied elasticity is effectively infinite.

It is this long run infinitely elastic supply (with respect to *real* prices) that largely explains the absence of much long-term price appreciation in the Loon Mountain Resort. Positive shocks to skier demand, whether generated from weather, economic growth, or purely unpredictable changes in recreational preferences, quickly lead to increased real estate development. If the demand shocks are

permanent, then supply eventually outstrips demand and prices fall below their original value. If the shocks are transitory, then whatever supply increases occur are permanent, while demand returns to its lower normal pattern. This of course will also depress prices.

A reasonable question at this time is why the VAR model does not generate any type of ongoing cycle in reaction to demand shocks. Conceptually, oscillations would necessitate that after prices have fallen (in reaction to a shock and excessive supply) that somehow the stock of condominiums begins to contract and if this is sufficiently strong, prices might then begin to turn upward. The estimated coefficients in the VAR model simply do not give this response pattern.¹² Quite possibly, over the timeframe of this study, there has been little depreciation or demolition of the stock, which might generate such a response.

Conclusion

The data at Loon Mountain suggests that the historical movements in condominium prices and stock behave as if supply were perfectly elastic in real price levels and prone to overbuild every time positive demand shocks occur. Continual growth in regional income, as well as sharp snowfall fluctuations historically have provided these shocks. There can be little doubt about these short run market dynamics. They also are consistent with evidence that most New England resorts continue to expand their trails and lifts even in the face of stagnating or declining overall demand. What is still a question, however, is why this behavior occurs. What is it about the operation of the local land market and development industry that generates such behavior? An answer clearly requires further and more detailed micro economic analysis, but some thoughts are possible.

At the most simple level, it could well be the case that the opportunity value for the extensive amount of open land in northern New England, mostly forestry and agriculture, has been declining in real (if not nominal) terms. This might help to explain the over-willingness of land owners to develop parcels into resorts. It would also suggest that the conclusions here might well not apply in other parts of the country where suitable land for ski development could be much more constrained. Most importantly, it does not explain the willingness of buyers to invest in such developments.

It is clear that for informed agents, the dynamic patterns discovered here offer significant arbitrage opportunities—buying just after the shock and selling two to three years later. Perhaps this is just what developers do. They hold development options and exercise them just after the shock occurs. Given development and marketing lags, these projects typically take two to three years to finish and hence sell out at the price peak. The obvious question is who buys them, and the answer is vacationers who perhaps are not aware of the market's price dynamics. Of course such an explanation requires two categories of agents with asymmetric

information and possibly very different investment objectives. Naïve vacationers will look for “yield,” or alternatively the personal utility flow from the unit, while only developers are profit maximizing. This paper has only begun to scratch the empirical surface of the second home market, to try and establish some “stylized facts” that then can be investigated theoretically.

Appendix

Condominium Price Equation

Variable Description	Coefficient
Clearbrook I	4.7
Clearbrook II**	1.7
Coolidge	11.8
Cannon	—
Aspen	(6.8)
Burke	(7.1)
Aspen or Burke	(6.5)
Dartmouth	(14.8)
Dartmouth Deluxe	(10.1)
Columbia II**	(7.2)
Columbia II Deluxe	(9.0)
Cannon Deluxe	5.3
Columbia	(13.1)
Pedestal**	(10.0)
Super Dartmouth	(23.7)
Super Cannon**	(5.0)
1500 Deluxe**	(2.2)
1700 Deluxe	(22.1)
2300 Deluxe	(14.0)
1800 Standard	(17.2)
1600 Deluxe**	3.0
1800 Deluxe	(10.6)
2200 Standard	(7.6)
2200 Deluxe**	(3.6)
1600 Standard**	(0.5)
Special Design**	1.2
1500 Standard	—
1976	1.1

Condominium Price Equation (continued)

Variable Description	Coefficient
1977	3.2
1978	6.8
1979	11.5
1980	16.2
1981	18.6
1982	20.0
1983	23.5
1984	25.2
1985	30.6
1986	36.9
1987	49.3
1988	51.7
1989	49.5
1990	41.3
1991	25.1
1992	21.8
1993	21.8
1994	19.7
1995	15.6
1996	17.2
1997	15.6
1998	20.5
1999	23.7
2000	27.8

Notes: All coefficients significant at the 5% level except those with **.
 Usable Observations = 616
 Degrees of Freedom = 567
 Centered R^2 = .6841
 Un-centered R^2 = .9824
 Mean of Dep. Variable = 59.4724
 Std. Error Dep. Variable = 14.4176
 Std. Error of Estimate = 8.4391

Endnotes

- ¹ The hedonic equation was estimated both in linear and log form, with the latter reflecting a slightly better fit using a Box-Cox test. The R^2 of .68 is quite high for an equation predicting sales price per square foot (rather than total sales price).

- ² The null hypothesis is that the series in differences is related only to its lagged differences. The alternative adds in lagged levels and a time trend. The coefficient for lagged levels is $-.12$, the time trend is statistically significant (negative) and the residual sum for this unconstrained equation is 1193. That for the constrained equation is 803. The suggested F value is 5.9, which is significant at the 10% level using the test values suggested by Dickey–Fuller (see Hamilton, 1994:227–28).
- ³ If it was thought that the price movements at Loon Mountain closely matched a common price movement at all New England resorts, then it might be the case that New England skier visits would be “influenced” by Loon prices. To neutralize this possibility, results are reported later using instrumented values for visits. These are essentially the same as OLS results.
- ⁴ In a structural model, it is possible to trace out how the stock changes over time as a function of a price change, but the time pattern of the elasticity is completely determined by the equation’s functional form: the long run elasticity is a simple extrapolation of the short run value. In a two-variable VAR, the full matrix of coefficients determines the implied elasticity, that is, the ratio of: change-in-stock/change-in-price. This allows for a much less restrictive pattern of elasticity over time.
- ⁵ Season ticket sales have an assumed value for total daily usage that is made by each reporting resort.
- ⁶ The snowfall series has a mean of seventy-six inches, with a standard deviation of 13. Over time it is a random walk with a slight downward drift. The trend is hard to see, and the variance in the random walk is very large.
- ⁷ In each statistical equation, t -statistics are reported in parenthesis under each coefficient. The coefficient on lagged visits suggests that a transitory shock to a RHS variable carries on for a year or two. Alternatively, a permanent shock takes a few periods to reach its full impact.
- ⁸ If the equation is re-specified using differences and a level for each variable, the difference coefficient will be the difference between the 2nd level coefficients in the current equation and the level coefficient will be the remainder. Its standard error will be that of the first level variable. Hence, with the results in Equation (5), only differences would matter for the economic variables.
- ⁹ Second-order lags for visits were not significant, and the smaller value for the lagged visits coefficient in Equation (5) suggests it has less autocorrelation than Equation (4).
- ¹⁰ The VAR equations were estimated with OLS, and no effort was made to insure orthogonality of the errors. The latter is necessary if historical variance decomposition is undertaken, but is not needed to achieve unbiased coefficient estimates and impulse responses. When Equation (4) is used to instrument for the skier visits variable, its coefficient increases to 3.3, while those of the other variables remain essentially unchanged.
- ¹¹ As with the price equation, an instrumented value of skier visits was tried, where Equation (4) is used as the instrumenting equation. The visits coefficient increases slightly (to 52.1) while the values for the other coefficients are effectively the same.
- ¹² In a system of difference or differential equations, the solution must have complex rather than real valued roots to generate oscillations.

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