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NATURAL CAPITAL

October 2021

Explaining the disconnect between lumber and timber prices

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Pundits are wondering "Lumber prices are soaring. Why are timber owners miserable?" (WSJ, 24 February 2021). They declare "Lumber prices soar, but logs are still dirt cheap" (Bloomberg, 20 April 2021). Indeed, lumber prices reached record highs at levels perhaps four times what were previously thought to be "trend" prices. Many are left wondering: (1) why are lumber prices so high? And (2) why haven't timber prices, especially in the U.S. South, followed lumber prices up? In this research note we provide some comments on the former and take a deeper dive to answer the latter.

First, why did lumber prices spike? Lumber prices actually started dropping in 2005 as housing starts fell from the record 2.2 million that year. They plummeted further after the Global Financial Crisis ("GFC") in 2008 then rose only slowly from the 2009 bottoms. 2018 found a brief spike that was quickly extinguished by production bumps until COVID-19 hit. Though the forest sector was considered an "essential" industry, in Spring and Summer of 2020 sawmill operators struggled to maintain production with a COVID-19 infected or concerned workforce. In April 2020, an estimated 35% of North American lumber capacity was down (CIBC, May 2020). Strategic thinking in the industry was that demand for lumber would plummet because of the prolonged closures and restricted economic activity. This strategic thinking combined with difficulties maintaining production led sawmills to let lumber inventories shrink.

While the supply-side adjustments were made as planned, developments on the demand side were precisely the opposite of what the industry anticipated. Many homeowners had bank accounts padded by stimulus checks and savings from expenditures not made on vacations and other discretionary spending. The homebound found joy in "repair and remodeling": building home offices, constructing additions, and improving outdoor spaces with decking. Suddenly Home Depot, Lowe's and the local lumber yards faced unprecedented demand. Throughout the supply chain the wave of demand depleted the lumber inventory. Exploding lumber prices resulted as dealers paid panic-induced prices to fill orders.

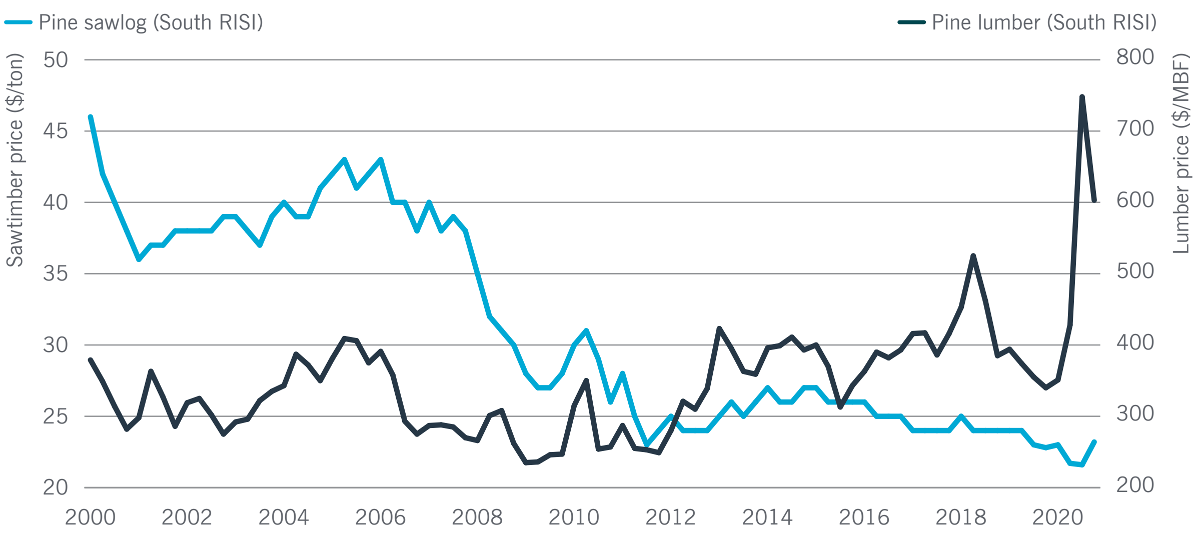
This combination of strong demand and constrained supply caused lumber prices to skyrocket from near trend levels in both the South and the Pacific Northwest to records never previously recorded. In the Pacific Northwest, forest owners benefited from rising timber prices but in the South, timber prices remained subdued. In 3Q 2020, just as lumber prices hit their historic high, average South-wide timber prices sank to an historic low.[1] To understand what is driving the relationship between timber and lumber prices we explore several factors: the historical correlation between the lumber and timber prices, the derived demand for timber, and the ratio of timber harvest and inventory as an indicator supply-demand balance in timber markets.

HISTORICAL CORRELATIONS OF LUMBER AND TIMBER PRICES

Unique market conditions in South and Pacific Northwest the years following the GFC led to a lack of correlation between lumber and timber markets in one region and a positive correlation in the other. As shown in Figures 1 and 2, lumber prices in both the South and Pacific Northwest started to fall after the peak housing demand in 2005; timber prices started falling in both regions at that time as well. In the South, however, the GFC reinforced the downward pressure, and sawtimber prices have stayed low ever since, reaching an historic low 3Q 2020. Indeed, on trend, real sawlog prices have fallen at 1.0% per year since 2000. Interestingly, from 2000 to pre-GFC recovery, the correlation between the year-over-year percent change in SYP lumber prices and pine sawtimber prices was 0.55, significantly different from zero at the 1% level—in that period, sawtimber prices more or less followed the development of lumber prices. But, from 2012 on, the correlation broke down—only 0.14 and not statistically different from zero.

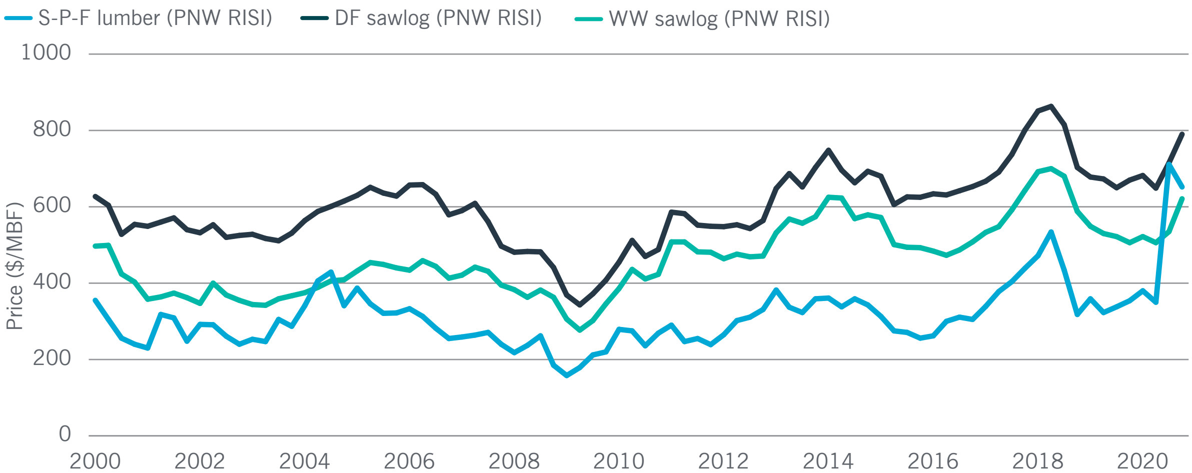
In the Pacific Northwest, the other major U.S. manufacturing region, log prices for the two principal species—Douglas fir and "white woods" (primarily Western Hemlock)—have more or less followed the development of lumber prices. The correlations between lumber prices and log prices are 0.65 for the pre-GFC recovery period, for the post-recovery period and, a bit tautologically, for the entire period since 2000. Clearly, circumstances in the PNW differ materially from those in the South. What explains the differences?

Figure 1. U.S. South timber and lumber prices, 1Q 2000 to 4Q 2020



Source: RISI.

Figure 2. Pacific Northwest timber and lumber prices, 1Q 2000 to 4Q 2020



Source: RISI.

More importantly, what are the implications for timberland investors?

DEMAND FOR TIMBER IS DERIVED FROM THE DEMAND FOR LUMBER

The residential construction sector—including both new housing and repair and remodeling—is by far the most important end-use market driver of wood products consumption in the U.S. But no individual consumer has a demand for timber. Instead, consumers demand houses that require lumber to build. And the lumber their houses need creates a derived demand for logs and that creates a demand for timber.[2] The key intermediation between consumer demand for houses and log demand for forest owners is the sawmill. Said another way, the sawmill derives demand for timber from consumer demand for lumber. So, understanding the dynamics of timber demand from sawmills and timber supply from forest owners is the window for understanding developments in timber prices.

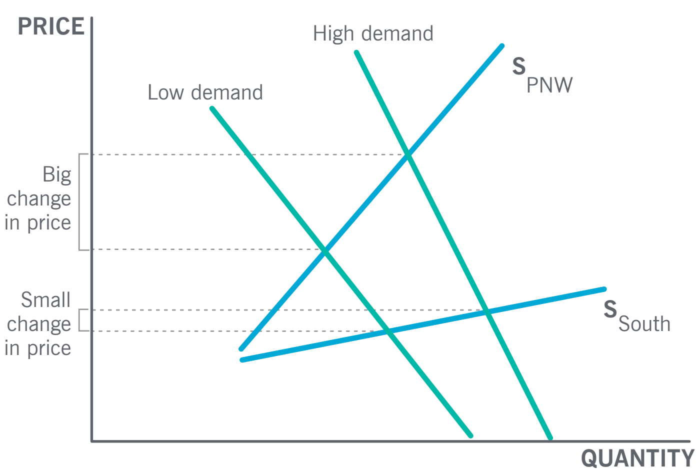
Many factors determine lumber demand—housing starts, repair and remodeling (R&R) expenditures, overall industrial activity and other factors. Collectively, these factors set the overall level of demand. The lumber demand curve represents the quantity of lumber demanded at every price. This has been evident recently as high lumber prices climbed to levels that snuffed out R&R demand for lumber—vaccinated consumers turned their flush bank accounts to travel and vacations instead of decks and home offices. In short, the location of the lumber demand curve is set by the larger macro factors, but the slope is set by of the response of consumers to changes in prices.

Lumber production requires two things "manufacturing services" and logs. The lumber supply curve is the sum of the two. Manufacturing services refers to all the non-timber costs of producing lumber. These costs include (importantly) sawmill labor, energy and materials and supplies. The costs also include some allocation of the fixed costs of installed capacity, capacity utilization, and the supply of such important ancillary service as trucking, to bring logs in and take lumber out.

It is technically possible to operate a sawmill 24 hours a day 6 days week. That is, three 8 hour shifts a day for six days a week, accounting for time for required cleanup and minor maintenance. Some BC sawmills have run on that schedule, or something close to it (e.g., two 10-hour shifts six days a week) for years but most Southern sawmills do not. Why not? The main constraint appears to be labor. Working conditions in southern sawmills are tough, especially in the summer with temperatures reaching 100+ degrees Fahrenheit in the mill, comparable levels of humidity, no air conditioning and heavy physical activity. Why work in a sawmill when you could supervise a robotin a nearby BMW factory for higher wages, better benefits, and an air-conditioned shop floor? Suffice it to say that there is cost pressure on Southern sawmill operators to bid labor away from these more attractive alternatives.

The demand for timber is derived from the demand for lumber via the intermediary of the supply of manufacturing services. The capacity of the sawmill to pay for logs is just the price of lumber less the cost of manufacturing that lumber.[3] Boiling the analysis down to timber supply and demand, Figure 3 depicts two cases, one with low demand for lumber and therefore for timber (like the immediate post-GFC period) and one with high demand for lumber and therefore for timber (like the current housing boom). We show two timber-supply situations, one for the PNW and one for the South. These supply curves are drawn with malice of forethought—supply in the South is flat and that in the PNW is steeper. So, increases in demand are more readily transmitted into increased in timber prices in the PNW than they are in the South

Figure 3. Timber market supply and demand



(note that this works in the opposite direction as well—reductions in lumber demand translate into reductions in timber prices more rapidly in the PNW than in the South).

The empirical evidence supports the way the timber supply curves have been drawn in Figure 3. Using the equation below, we estimate the timber supply equations for the two regions and three species (in total three equations) over the period 2000-2020, with results described in Table 1.

TABLE 1. SUMMARY OF REGRESSION RESULTS

	Estimated coefficient ($\hat{b}$)	
Southern Pine	1.12* (0.07)	At current harvest-to-inventory levels, Southern timber supply is **elastic**.
Douglas-fir	0.62* (0.14)	At current harvest-to-inventory levels, Pacific Northwest timber supply is **inelastic**.
White Woods	0.22 (0.17)	

*Significant at 1%-level. Note: Standard errors in parentheses. Sources: Harvest and inventory data for the PNW and South from FEA; southern pine, Douglas-fir and white woods log prices as well as southern pine and spruce-pine-fire lumber prices from RISI.

Equation 1. Log price as a function of harvest-to-inventory ratio

ln(Log price) = a + b*ln(Harvest/Inventory)

The estimated coefficients together with the current harvest-to-inventory ratio tell us about the shape of the supply curve and price elasticity – or the percentage change in the quantity supplied created by a 1% change in price. In the PNW, a change in harvest level is less than the change in price—the supply curve is steeper as drawn. In contrast, in the South, the harvest level actually changes more than the change in price.

ESTIMATING SUPPLY-DEMAND BALANCE USING THE HARVEST-TO-INVENTORY RATIO

Why are the two regions so different? As we did above, timber price is commonly modelled as a function of the ratio of harvest to inventory. This formulation makes intuitive sense. Consider the case of buyer a used car. One dealer has one car on her lot; a second has 1,000. If only one person shows up at each lot one Saturday morning, the second dealer is far more likely to give you a good price than the first—she has lots of cars to move and can make up losses on this one sale with prospective gains on the other 999 cars. So it is with timber. If a region has a lot of timber inventory in comparison to the demand for it, many sellers will be competing for that demand, driving the price down. The opposite is also true—if demand is tight in comparison with the available timber inventory, timber prices are likely to rise.

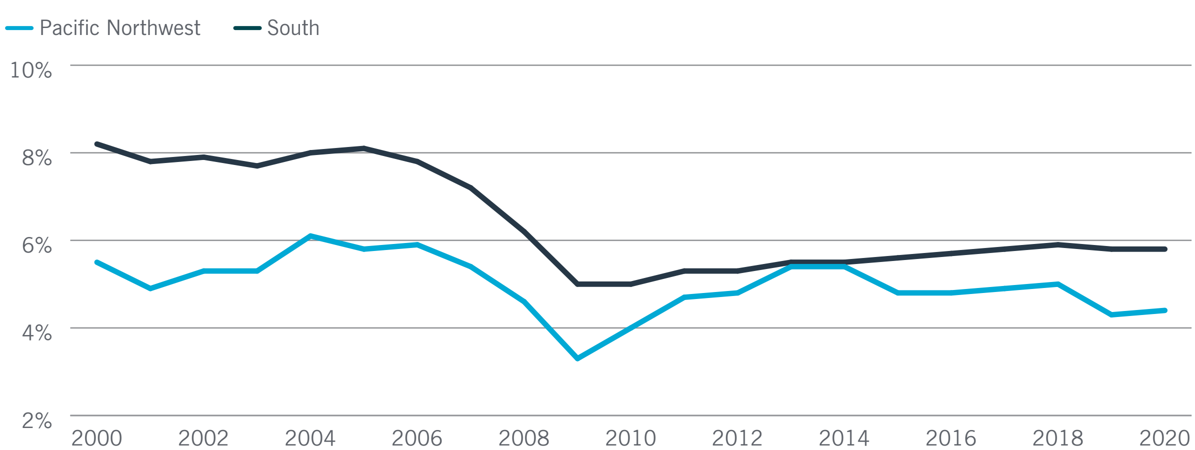
The standard for what comprises “right” and “excess” supply depends on many factors, but an important benchmark is the “normal” ratio of harvest to inventory in a sustained-yield forest. Fortunately for us, the 19th century German forester (and head of the Bavarian Forest Service) Joseph Nikolaus von Mantel figured this out. In a sustained yield forest, the steady state ratio of harvest to inventory (H/I) equals 2/T where T is the rotation age (Binkley, 1994). In the South, a typical rotation age is 25 years, so we would expect H/I should be 8% per year; in the PNW a typical rotation age is 40 years so here we would expect H/I to be about 5% per year. In Figure 4, we plot the historical harvest to inventory ratio for the U.S. South and the Pacific Northwest.

As shown in Figure 4, prior to about 2005, the ratio of H/I was around the expected values in both regions. However, in 2005 housing starts peaked at 2.2 million units and wood products demand started falling. With the precipitous decline in harvests following the GFC, the ratio of H/I declined in both regions. But in the PNW H/I rebounded sharply on the back of the increased harvest levels needed to service strong Asian log export markets. For the PNW, H/I rose through 2013 and returned to its expected level and has stayed there since.

The story in the South is quite different. Post GFC, sawmill capacity in the South fell by almost half and smaller, less efficient mills closed for good—the old iron simply rusted on the abandoned mill sites never again to be restarted. Lumber demand gradually strengthened, but there was not sufficient mill capacity to translate higher lumber demand into higher demand for timber. And, to make matter worse (from the perspective of timber owners), the mills that remained post GFC were necessarily more efficient. They used less timber per unit of lumber, dampening the demand for timber (the ratio or lumber output to log input is called the “lumber recovery factor”, or “LRF”). As the southern industry recapitalized, it did so with fewer, much larger and more efficient mills, locking in the higher regional LRF. Not only did this structural change reduce the demand for timber per unit of lumber demand, but it also resulted in fewer buyers for any specific timber tract. Auction theory studies of timber markets show that realized prices decline as the number of bidders decline, even in the absence of collusion among the buyers (Sendak, 1991; Johnson, 1979; McAfee and McMillan, 1987).

Other problems plagued recovery of timber prices in the South. Government subsides supported a planting boom in the 1980s, and that timber became mature in just after the GFC. Improved genetics and intensification of forest management produced yield gains in the range of 1% to 3% per year—those productivity improvements seem small, but they add a lot of volume over a 20- to 30-year

Figure 4. Harvest to inventory ratio, 2000-2020



Sources: FEA; GWR Research.

SUMMARY OF RESULTS

period. And, to worsen matters, many landowners deferred harvests, "storing timber on the stump," awaiting higher prices. However, this practice merely added to the inventory overhang.

Why Southern timber prices are so depressed

In summary, timber prices in the South cannot increase until the harvest-to-inventory ratio returns to its steady-state level of around 8% per year. Either harvest levels have to increase, timber inventories decline or both. Inventory will continue to increase as long as harvests are less than growth—today's under-harvest creates tomorrow's inventory overhang. Given the delayed development of additional sawmill capacity in the South, harvests are likely to remain below growth for a considerable period.

Harvests can't increase until manufacturing capacity expands, either via adding shifts to extant mills or building new mills. Both are happening, but slowly. Adding shifts is constrained by labor supply and the competition with other employers. New mills face long waits for manufacturing equipment as well as such prosaic mill inputs as trusses and steel.

To boot, capacity expansion is a mixed blessing for timberland owners. Increased capacity at individual mill sites means fewer buyers for timber. Concentration in the industry reduces competition for individual timber sales. The new capacity has higher LRFs, implying less additional timber demand for each unit of increased lumber demand. This latter factor has been profound, with the least efficient mills pre-GFC requiring perhaps six tons of logs per thousand board feet of lumber where the best new capacity might require less than four tons.

If increased harvest levels will not rebalance H/I to historical levels, what will? The other option is for timber inventories to decline. How could this happen? The obvious answer is years of strong demand, but this will take a relatively long time—as seen in Figure 4, the region as a whole has been under-harvested for at least 15 years, so one might imagine a similar period of strong harvests will be required to right the balance.

Of course, other factors can deplete the southern timber inventory. Drought may reduce growth rates and make trees more susceptible to attacks by insects and diseases. Droughts also makes fires more likely and more damaging. Windstorms, especially the increasingly intense coastal hurricanes, can destroy large swaths of timberland. Of course, such calamites generally increase supply in the short run as landowners try to salvage the damaged timber. And, inventory reductions via climate hazard events surely do not add to the returns for timberland owners.

One bright spot is the opportunity to sell carbon credits through "improved forest management" protocols. Extending rotations (by not cutting trees) stores additional carbon in the forest and therefore reduces short-term timber supply. Some companies have legal obligations to reduce carbon emissions or have stated "net zero" pledges. These companies are willing to pay for forest-based credits, which can be verified and issued by several voluntary market standards (e.g., American Carbon Registry, Verified Carbon Standard, NCX). Forest-based credits effectively lock-up timber inventory, with the length of the lock-up depending on the registry, reducing the amount of timber inventory available to supply mills. Ironically, the longer-term effect may be to increase overall timber supply.

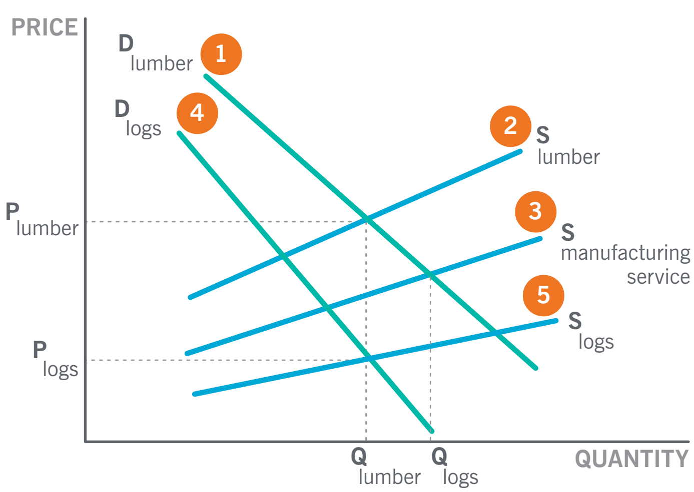
Here is why. In the U.S., the length of the optimal economic rotation is less than the length of the rotation that maximizes biological growth or the "mean average increment", that is, the average amount of timber that is grown in the forest. Average long-term growth sets a limit to long-term sustainable supply. Sale of carbon credits will induce landowners to lengthen rotations (see seminal work by Hartman 1976 and van Kooten et al. 1995). But eventually a profit-maximizing landowner finds that, unless the value of carbon credits is high, the cost of deferring harvests another year is too costly. She will want to cut the trees, even if she has to buy back carbon credits to do so. When she cuts the trees, the supply will be larger than before because the trees have grown those extra years. How the interaction of the value of trees for forest products and their value for storing carbon on the stump works out is a topic for another Research Note.

APPENDIX: DETAILS OF DERIVED DEMAND ANALYSIS

The complicated Figure 5 below depicts most everything we need to know.

Let's step through this analysis bit by bit, starting with 1, lumber demand. The main text of this Research Note describes the many factors that determine lumber demand. Figure 5 assumes the location of the demand curve has been fixed by all of those macroeconomic factors, and that the sole remaining determinant of consumption levels is lumber price.

Figure 5: Derived demand for timber



Now move to 2, lumber supply. Lumber production (2) requires two inputs: "manufacturing services" (3) and logs (5). Lumber supply is the vertical sum of the two.

We discussed the determinants of "manufacturing services" in the main text. A key point is that the supply of manufacturing services is likely to slope upward. For individual mills to increase output they generally have to add shifts. This usually requires paying more for labor, either as overtime or late-shift bonuses. Maintenance costs may increase as well. And, the additional logs may cost more as they are transported increasingly long distances. The upward slope of the manufacturing services supply curve arises from these mill-specific effects, and the fact that, at higher output levels less efficiency mills may join production.

Because the figure is constructed in terms of lumber prices and volumes, the lumber recovery factor ("LRF") is left in the background. Improvements in LRF have two effects. One is that sawmills can afford to pay more for logs at any given lumber price. This would seem to mean that improvements in LRF would raise log prices. The second is that, for any given amount of lumber demand, sawmills need less log volume, suggesting that log prices should fall. It turns out that the answer depends on the interplay of timber supply and product demand elasticities (Cardellichio and Binkley, 1988).

The demand for logs (4) is derived from the demand for lumber via the intermediary of the supply of manufacturing services. The capacity of the sawmill to pay for logs is just the price of lumber less the cost of manufacturing that lumber (note that all prices and quantities are in lumber terms). The demand for logs hits zero where the cost of manufacturing service equals the price of lumber.

Note that the derived timber demand curve both displaces downward from the lumber demand curve, but also rotates a bit. The rotation occurs because of the upward slope of the manufacturing services supply curve. Timber demand is therefore less elastic than lumber demand. As a consequence, timber prices generally are more volatile than are lumber prices.

Equilibria in log and lumber markets, in this simplistic and static picture, are determined simultaneously, as depicted in the figure.

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Endnotes

1 Just recently the demand dynamic has reversed. Fully vaccinated Americans are spending money on travel and meals out instead of decks and home offices. As of this writing, lumber prices, though still above trend levels, are free falling from their Everest highs. But, as we will see, this does not imply that log prices are necessarily going to follow lumber prices down.

2 In this paper we use the terms "timber" (i.e., standing trees) and "logs" (i.e., timber that has been felled, bucked, yarded and hauled to a mill) interchangeably although they are not the same commodity. Just as the demand for logs is derived from the demand for lumber, the demand for timber is derived from the demand for logs. In the first instance, the intermediary is the sawmill. In the second it is the logger. The distinction is not important to the present story but might well be for others.

3 See the appendix for details of how lumber demand translates into timber demand, but for the main thread of our discussion, Figure 3 simply titrates the complications down to timber demand curves (derived, as we described above, from lumber demand and the supply of manufacturing services) and timber supply curves.

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