An Examination and Interpretation of Tie Market Data

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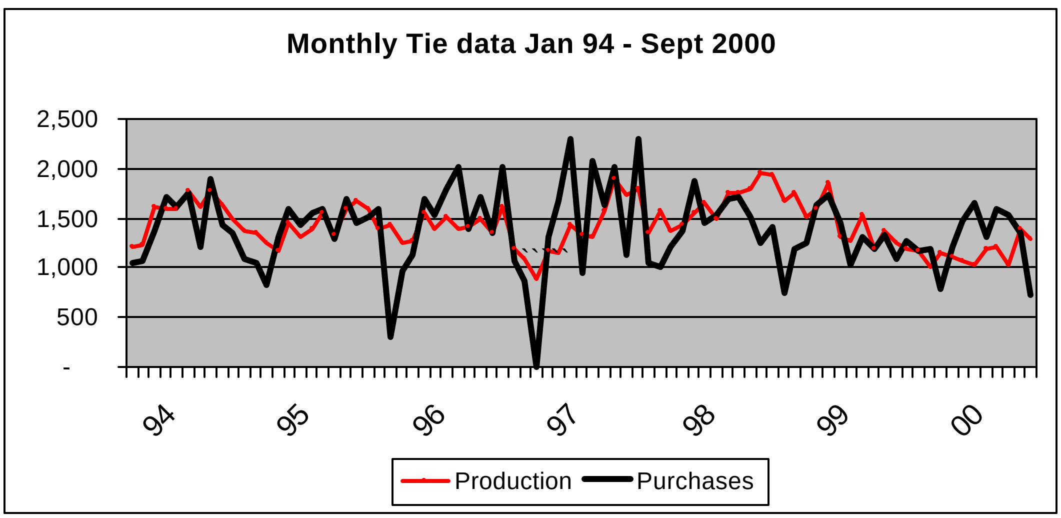
This paper contains a first look, through one economist's eyes, at the market for railroad ties. Some needed data has yet to be uncovered, and some conclusions are therefor based on incomplete information.

I. Production, inventory and estimated purchases

Monthly production and inventory of wooden cross ties are published in ***Crossties Magazine***, representing a great majority of the North American market. Production can be seen as green ties flowing into the treaters' yards; inventory consists of green and black ties. Purchases can be estimated by use of this relationship:

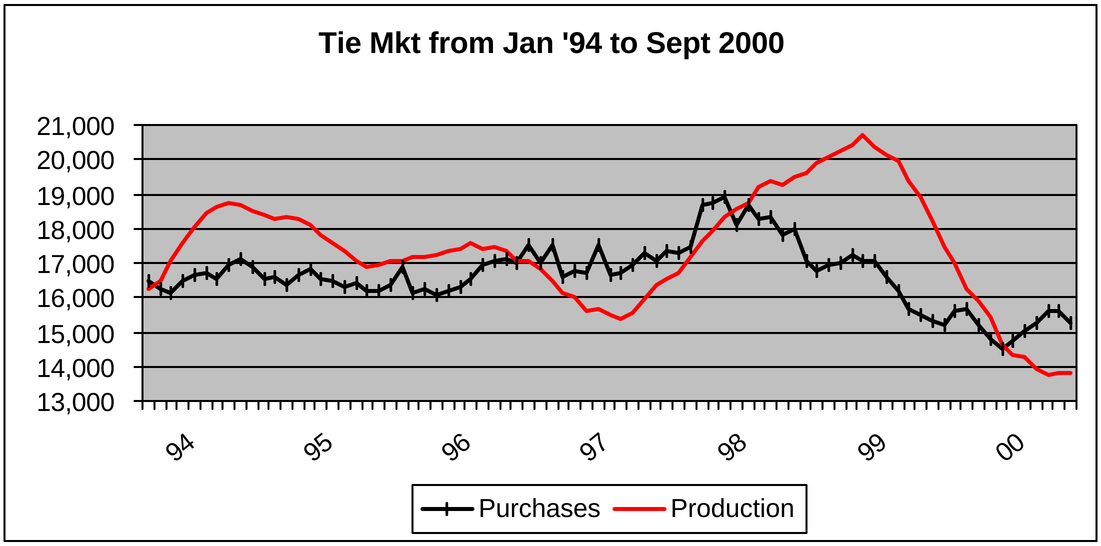
Purchases = Production - Change in inventory.

The graph below illustrates estimated purchases and production. However, since the monthly data are erratic the trend is not easily seen.

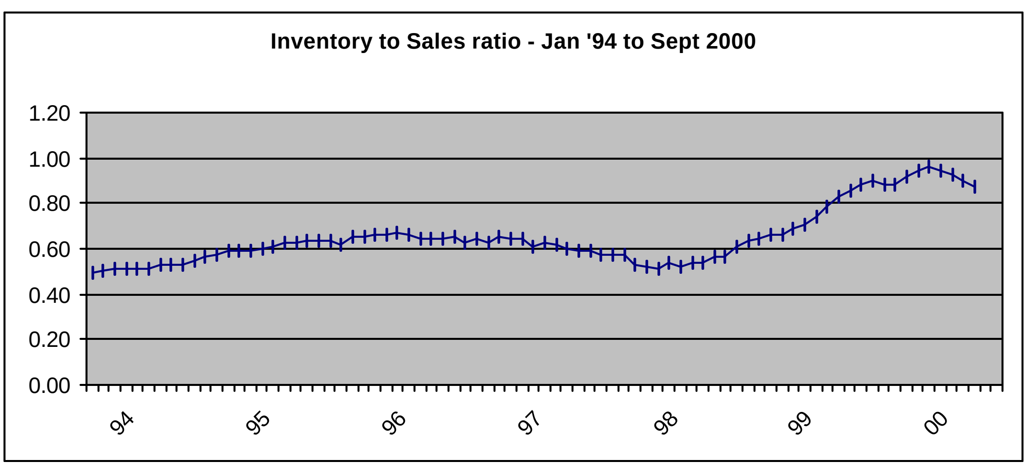


II. Trends in production, purchases and inventory

One way to shed the seasonal effects in data is to create a twelve-month moving average. In the graph below, the December '99 value for purchases represents average monthly purchases from January '99 to December '99; likewise, the January 2000 value is calculated by averaging purchases from February '99 to January, 2000.



Trends are now more easily seen: purchases were generally flat during 1994 and 1995, increased slowly in 1996 and 1997, surged in early 1998, declined in 1999, only to show small signs of recovery this year. Production roughly tracked purchases until the decline in late 1998, when production exceeded purchases by about 18 percent. Production made a big downward adjustment in 1999, but still exceeded purchases by about 4 percent; the past few months have seen production below purchases for the first time in two years. Despite their recent turnaround, purchases are at their lowest level in six years. The inventory-to-sales ratio increased from a "normal" value of about 0.6 to almost 1.0 by the end of 1999; recent inventory corrections are evident. Inventory and sales are measured here in number of ties; often such ratios use dollar amounts.

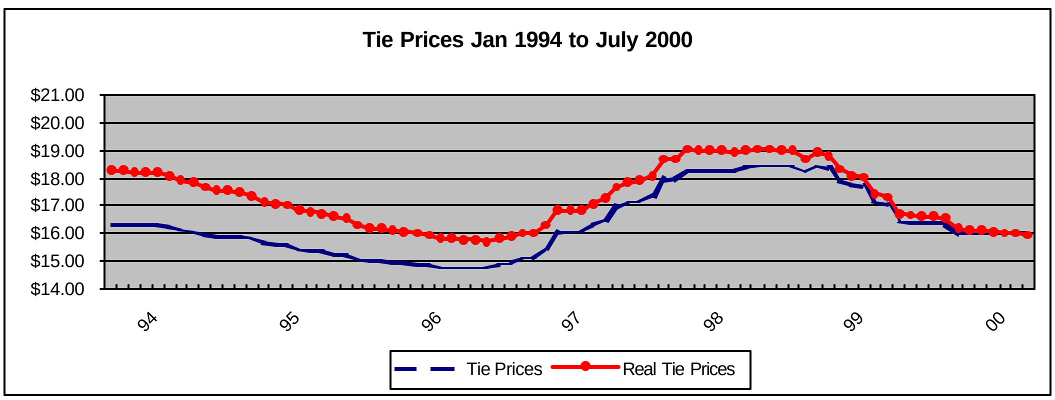


III. Trends in prices, nominal and real

Nominal prices are observed on invoices. When people speak of tie prices, they refer to nominal prices - - prices measure in dollars. The problem is the dollar (or any currency) changes in value over time. ***Crossties Magazine*** in 1921 reported a railroad offering 30 cents per red oak tie, but at that time 30 cents represented greater value than 30 cents today. To deal with the problem of a changing dollar, economists use price indices or implicit price deflators - - the GDP implicit price deflator is an example. Consider the price change below:

	Nominal Tie price	Implicit price deflator	Real price
Feb 1998	$18.30	1.000	$18.30
Feb 1999	$18.36	1.014	$18.11
Percent change	0.3%	1.4%	-1.0%

Nominal tie prices ***increased*** 0.3% over the year. However, average prices of "all things" increased by 1.4%. Since tie prices did not keep pace with inflation, real tie prices ***declined***. The calculation of real prices attempts to remove the distorting effect of inflation from the phenomenon being studied.

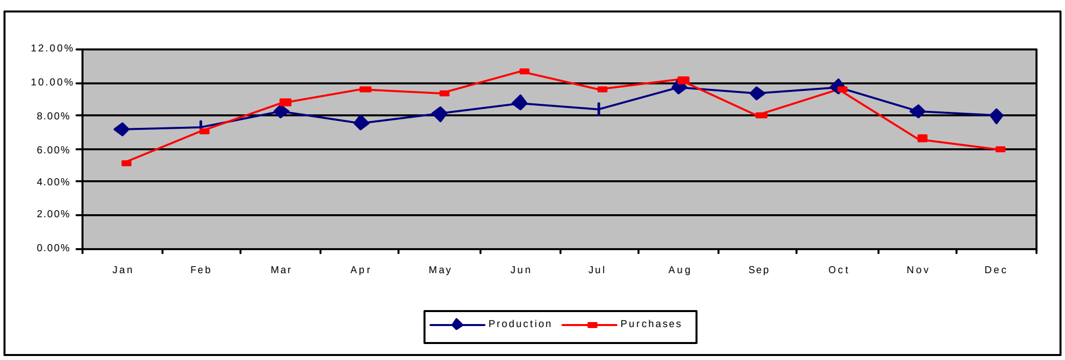


In the graph above, real price is stated in terms of 2nd quarter, 2000 dollars. Using the GDP implicit price deflator, prior nominal prices have been adjusted to remove the effects of inflation. Nominal prices of green ties are from ***Hardwood Market Report***. Real tie prices fell from 1994 to late 1996, climbed through early-1998, remained flat a year, and declined for about 18 months. Of particular interest is the relationship between purchases and production during these time periods: from 1994 to end-1996, production exceeded purchases and inventories grew; from that time until mid-1998, purchases exceeded production and inventories were drawn down. During 1999, inventories have expanded dramatically. One can see real prices of ties responding to these market forces: when purchases increase above production, inventories decline and prices increase; when purchases turn down, inventories build up, and prices decline. Why not look at nominal prices? They include the effects of market forces, but the information is disguised by the effects of inflation.

IV. <u>Supply curve estimation</u>

In order to survive, producers must respond to changing market conditions; this behavior is summarized in the supply curve. Generally, when the real cost of doing business goes up or down, so does the supply curve (same quantity is offered at higher or lower price.) Further, when the real price of the product in question increases or decreases, producers tend to supply more or less to the market.

Part of the behavior of tie producers can be seen in a seasonal cycle. Monthly patterns can be estimated by calculating each month's share of annual amount, then averaging across years. The graph below reveals that highest production normally occurs during August, September, and October. Purchasing also follows a cycle, peaking in mid-year.



Following the ideas above, various equations were estimated in an attempt to explain producer behavior. The best result to date states that the amount of green tie production depends on seasonal patterns, real employment cost, and the real price of green ties. The equation:

Monthly tie production = f (seasonal, real employment cost, real price of green ties)

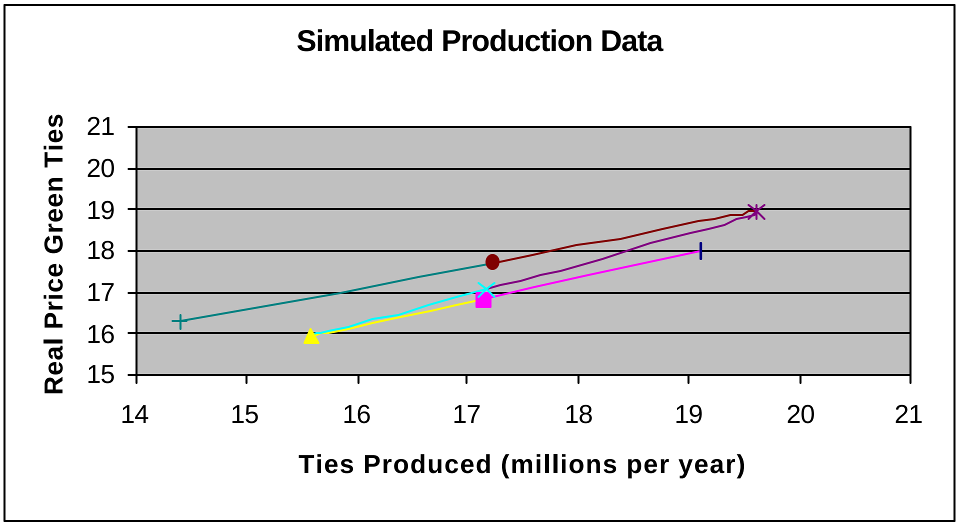
Regression Statistics	
Multiple R	0.804
R Square	0.647
Adjusted R Square	**0.632**
Standard Error	143
Observations	75

	Df	*SS*	*MS*	*F*
Regression	3	2651132	883711	**43.37**
Residual	71	1446697	20376	
Total	74	4097829		

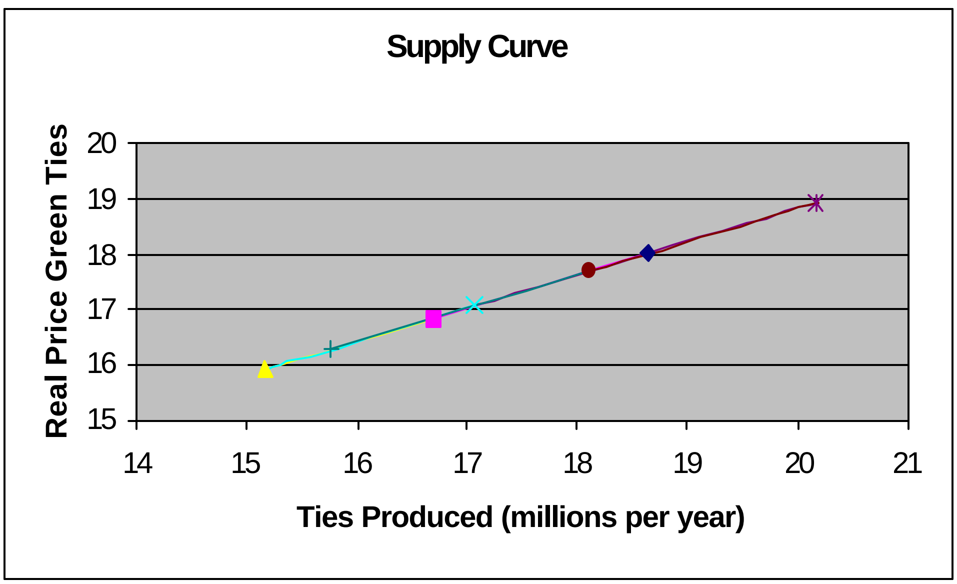
	Coeff	*St Error*	*t Stat*	*P-value*	*Elasticity*
Intercept	245	951	0.26	79.7%	
Seasonal	18503	2363	**7.83**	0.00%	1.06
Real tie price	**128**	15.4	**8.32**	0.00%	**1.53**
Real employ cost	**-18.24**	6.62	**-2.75**	0.75%	-1.76

Equation mechanics: monthly production follows a seasonal pattern, increasing when price increases, and decreasing when employment cost goes up. The portion of variance in production explained by the equation is a moderate 63 percent. The F statistic is fairly high, indicating that overall results are fairly reliable. The t statistics for seasonal factor and tie price are high, indicating a high degree of confidence their coefficients are in the ballpark. The t statistic (absolute value) for employment cost is acceptably high, but we have less confidence in the coefficient. In this case, the signal being sent is the coefficient: -18.24. The uncertainty, or noise, associated with the signal is shown in the standard error: 6.62. Finally, the t statistic is the coefficient divided by the standard error, which yields a signal-to-noise ratio of 2.75. Put another way, there is about a 16 percent chance the coefficient is -24.8 or lower, and a like chance it is -11.6 or higher. The nature of the problem here is that our equation is very much simpler than the supply relationship; some variables have been omitted from the equation.

One way to reveal the meaning of an equation is to simulate different market conditions. For example, one can feed the equation very high tie prices and observe the equation's prediction of increased monthly production. One can increase employment cost, and observe predicted production declines. Such simulation results reveal some characteristics of the supply curve. For example, the supply curve has shifted to higher cost positions from 1994 to date. The shift has apparently been driven partly by increases in real employment cost. The graph below illustrates the upward shifts; each point represents a calendar year (1994 through 1999) or part of a year (2000.)

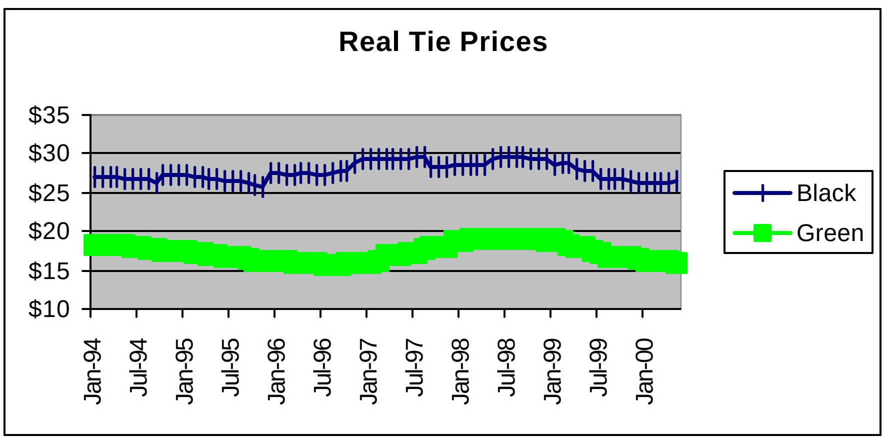


Another important aspect of behavior is producers' response to tie price changes. Price elasticity estimates reveal that when real price increases one percent, producers respond by offering about 1.5 percent more green ties. This suggests a very responsive industry -- one capable of dealing well with significant changes in demand. In the graph below, employment cost is held constant while tie prices vary; this is a representation of a supply curve for green ties.



We have no data representing the number of black ties brought to market by producers. The supply process for black ties is distinguished from that of green ties by at least three points: first, black prices are higher; second, time is required to convert green to black; and third, treating capacity potentially limits the rate at which black ties can be produced.

Black tie prices were assembled. AAR provided prices paid for black ties used in new lines and extensions; from 1990 through 1999 this data includes 29 observed prices, which unfortunately bounce around quite a bit. The second piece of data is the Bureau of Labor Statistics' Producer Price Index (PPI) for ties used by railroads and mines; these are monthly index numbers from January 1990 to date. Ten years of monthly black tie prices were estimated by dividing the 10-year average of AAR prices by the 10-year average of the PPI numbers, and multiplying this ratio by the PPI numbers. At this point a comparison of black and green tie prices can be made.



Our estimated real black prices are on average $10.42 higher than green ties during the period from January 1994 to date, with a fairly stable relationship.

In formulating the black tie supply curve, the other two issues have not been given explicit treatment. Time is required for converting green to black; some woods dry in four months in warm climates, other woods dry in ten months in northern climates. The third supply issue revolves around treating capacity. In estimating the black supply curve, we must be on the lookout for conditions in which green production exceeds black production. Otherwise, we can approximate the black tie supply curve by adding about $10 to green prices, keeping in mind the time difference.

V. Demand and market conditions

A demand curve summarizes the decisions of buyers. Buyers are changing: long hauls are consolidating, short lines are expanding where transportation opportunity presents itself, and contractors are taking on the rest. Track maintenance is the major market theme, but expansions still occur; and all of this is subject to financial wherewithal. If we want to forecast future market conditions, this is the most important equation to estimate; however, the following result is just a start. The equation states that tie purchases increase with maintenance needs, but decrease as the real cost of fuel goes up; this latter item competes with ties in purchasers' budgets. The maintenance variable is constructed as follows: annual maintenance need is predicted by the TieLife model; this represents Class 1 railroads, so TieLife's U.S. predictions are divided by Class 1 market share. The result - - a "whole market" annual maintenance estimate - - is spread to monthly values by use of seasonal purchase factors. The equation's terms are all 3 month moving averages:

3MA purchases = f (3MA maint needs, 3MA real cost of fuel)

Regression Statistics	
Multiple R	0.784
R Square	0.615
Adjusted R Square	**0.609**
Standard Error	166
Observations	118

	Df	*SS*	*MS*	*F*
Regression	2	5078217	2539109	**91.93**
Residual	115	2176318	27620	
Total	117	7254535		

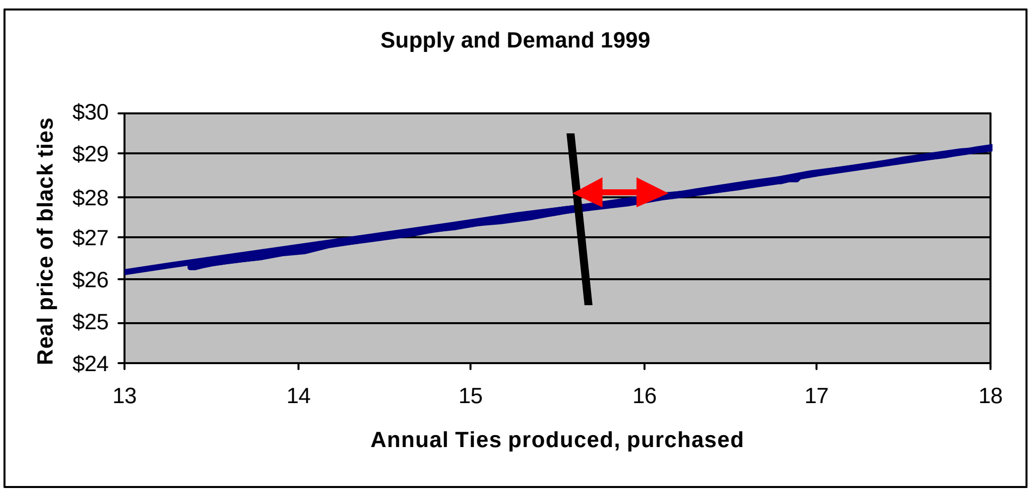
	Coeff	*St Error*	*T Stat*	*P-value*
Intercept	443.7	126	3.505	0.07%
Maint needs	0.805	0.063	**12.75**	0.00%
Real cost of fuel	-2.765	0.907	**-3.05**	0.29%

The portion of variance explained by the above equation is a moderate 60 percent - - some changes in purchasing activity remain unexplained. For example, the equation predicts 15.8M ties purchased in 1996, when the market started picking up it's pace; buyers actually took 17.5M - - 10 percent above the prediction. Much work can be done here; for example, railroad financial conditions are not represented in the equation.

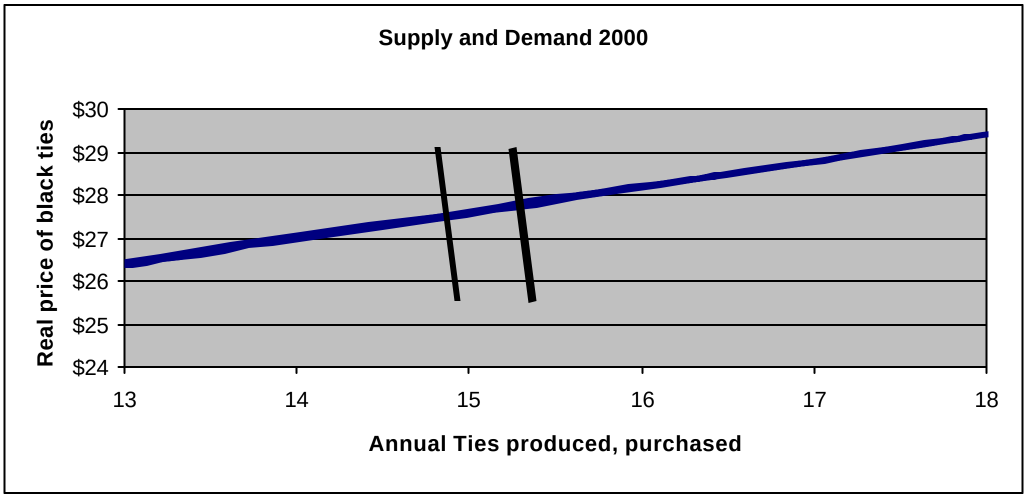
One point of note: tie prices would not fit into the equation; that is, the t statistic (signal-to-noise ratio) was very low. This can be interpreted to mean the demand curve for ties is severely inelastic; that is, buyers are not very responsive to price changes. Why not? Railroads assess maintenance needs, update maintenance plans, and when sufficient funds are available they sometimes have to act with urgency. In such situations the price of ties is not the most important problem to deal with. Through another equation (a work in progress), it has been shown that prices are driven up when purchases increase faster than production; the relationship is one which forces buyers to pay for sudden changes.

At this point we can bring the estimated supply and demand curves together, portraying recent market conditions. Quantities purchased (demanded) and produced (supplied) are stated in annual rates. Prices are stated in terms of 2nd quarter, 2000 dollars; prices are estimates of regional averages, and include a mix of grades.

<u>Market conditions 1999.</u> Production was 16.3 million and purchases were 15.6 million, so that inventories accumulated (see arrow) at an annual rate of 0.7 million ties. Price was about $28, having dropped from the previous year under the pressure of large inventory build-up.

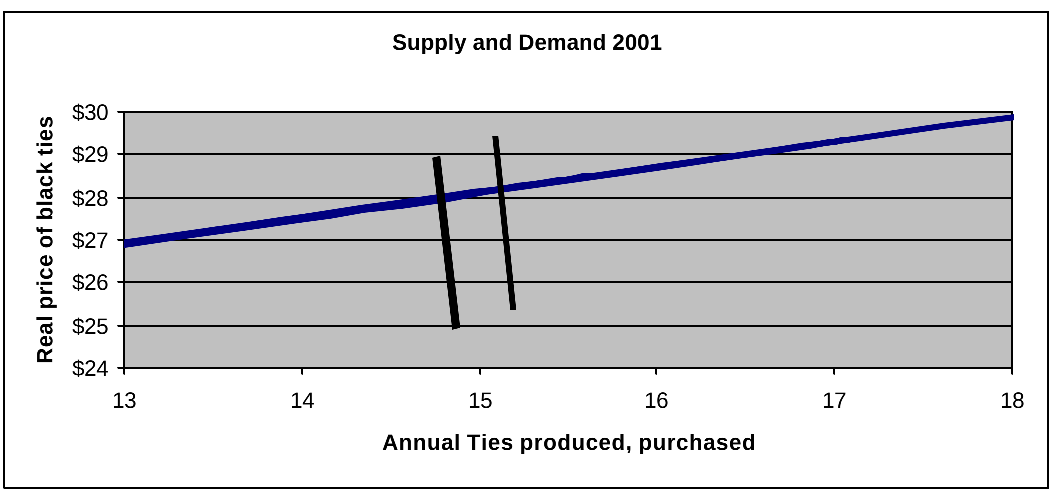


<u>Market conditions 2000.</u> Through September, production is on track for an annual 14.2 million ties. After a surprisingly weak September, year to date purchases appear to be headed toward 14.9 million by year-end. Using the demand equation developed above to anticipate annual total, purchases are predicted to be 15.3 million. This is based on an anticipated Class 1 maintenance need of 12.5 million ties (from TieLife), and for fuel prices to stay at (estimated) October levels for the remainder of the year.



Predicting with this rough equation is pretty risky because the equation needs refinement. The two demand curves shown above represent uncertainty with regard to year-end results. September's weak showing suggests the lower demand curve could be the better estimate. Prices look to be just under $27. Either demand curve shown above would imply a reduction of inventory - - a welcome event.

<u>Experimental forecast of 2001.</u> A wise person might not use a crude equation to forecast; this author has done so. TieLife predicts U.S. Class 1 maintenance needs at 12.25 million ties. Fuel prices have been wild of late, so we should consider more than one case. If we assume real fuel prices are frozen at October 2000 levels through the end of 2001, our equation predicts purchases of 14.9 million ties. However, if real fuel prices drop back to first-half 2000 levels, purchases are predicted to be 15.1 million.



If supply and demand stabilized in positions shown above, prices would rise to about $28. This prediction can be traced to rising production costs. Note the supply curves shift upward each year in the graphs above. Real employment cost has increased by about 1.5 percent in 1998 and 1999. These costs increased 2.5 percent during the past 12 months; the supply curves above for 2000 and 2001 assume this rate of increase continues.

VI. Implications of the data and areas for further investigation

Recent inventory accumulations suggest producers have difficulty anticipating changes in demand. The size of inventory imbalances (as much as 60 percent above normal) implies significant cost. More accurate predictions of market conditions would be of value to producers.

On the supply side, this involves refinement of the above equation - - inclusion of fuel or power costs, for example. Next, forecasts must be obtained for input variables. The most challenging variable on the supply side is what is termed structural change - - a consequence of new laws, new technology, or change in the number or collective size of producers.

On the demand side, track maintenance needs must be understood, but one must also develop the means to estimate financial readiness of purchasers to act upon these needs and acquire ties. Cash problems spring from numerous and sometimes unanticipated developments: fuel price increases, regulatory problems, mergers … etc. Predicting these types of events appears to be the greatest challenge on the demand side of the market. However, it is possible that these prediction difficulties can be simplified by use of an indicator, such as an index of railroad equity prices; such market valuations may be good predictors of future railroad financial performance. In any event, a good deal of improvement is needed before purchasing behavior can be predicted with confidence.

In conclusion, we have made progress toward quantifying market forces. We know the general shapes and approximate positions of the supply and demand curves. With refined equations and projections of inputs, we should be in a position to make some forecasts of market data: purchases, production, inventories, and prices (real and nominal.) If accurate forecasts can be accomplished and communicated, tie producers can better see what likely lies ahead, and improve performance of their business.