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This paper investigates whether NAFTA has had any impact on Alabama pulpwood production using a time series model of production from 1953 to 1992 to predict what production would have been without NAFTA. The predicted path is compared with the actual path during the NAFTA years, 1993-1999.

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This paper investigates whether the North American Free Trade Agreement (NAFTA) has had any measurable impact on Alabama pulpwood production since 1993. The method used is to establish a time series model up to the beginning of NAFTA and examine whether there has been a discernable shift since. The time series model is estimated with annual production data from 1953 on pulpwood and its categories softwood and hardwood. Pulpwood has a long history of data at the state level and is a major forest product in the state. An implicit theoretical assumption is that supply has increased over the period at a steady pace. Beyond claims of import damage, an underlying policy issue is the expansion of free trade to include all of the Americas in negotiations toward the Free Trade Area of the Americas (FTAA). This paper also contributes to the empirical literature on the effects of free trade agreements.

Background on Alabama forest products and NAFTA

Two thirds of Alabama is covered with forests, 22 million acres with 1% more planted annually and more trees than ever recorded. About 95% of the forests are privately owned. Timber is the largest crop in over half of Alabama's counties. The forest products industry is the state's largest manufacturing sector with over $1 billion exported annually from Mobile (Alabama Department of Natural Resources web page). There are four types of forests, pine in the south, a mixture of pine and hardwood, bottomland hardwood, and upland hardwood in the north. Timbered areas have remained roughly the same over the past 20 years: 30% pine, 20% mixed, and 50% hardwoods. Of the softwood, 97% is Southern pine. Pine timber volume has continued to grow since the 1950s but hardwood has grown from nearly zero to over 1/3 of total volume (FAS web page).

The North American Free Trade Agreement (NAFTA) is a treaty designed to eliminate barriers to trade and investment between the Canada, Mexico, and the US. Canada and the US had begun such a move by 1988 with an agreement of their own when Mexico offered to join. The entry of Mexico increased potential gains and losses because of its dissimilarity: relatively cheap labor, scarce capital, and a different array of natural resources. Mexico also had higher tariffs and severely limited foreign investment but had begun to liberalize during the 1980s. Overall impacts on the US are not expected to be large but individual industries will enjoy expanded export opportunities while others face increased import competition. NAFTA will substantially stimulate the Mexican economy and should increase US wood exports. Mexican tariffs of 10% on logs, 15% on softwood lumber, 20% on moldings and plywood, and 5% on pulp were cut in half in 1993 and should be eliminated completely by 2004.

Wall (2000) shows that NAFTA has had different effects on the trade of various Canadian regions and has also had different effects on trade between Canada and different regions in the world. Thompson (1996) predicts different effects on different industries in Alabama manufacturing based on labor intensities. Couglin and Wall (2000) find that US manufacturing exports to Canada and Mexico have increased 15% with NAFTA, some states winning and others losing, and they predict increased exports from Alabama will more than offset export declines to Europe and Asia. Bolle (2000) estimates Alabama has enjoyed a net gain of 2,000 jobs due to NAFTA.

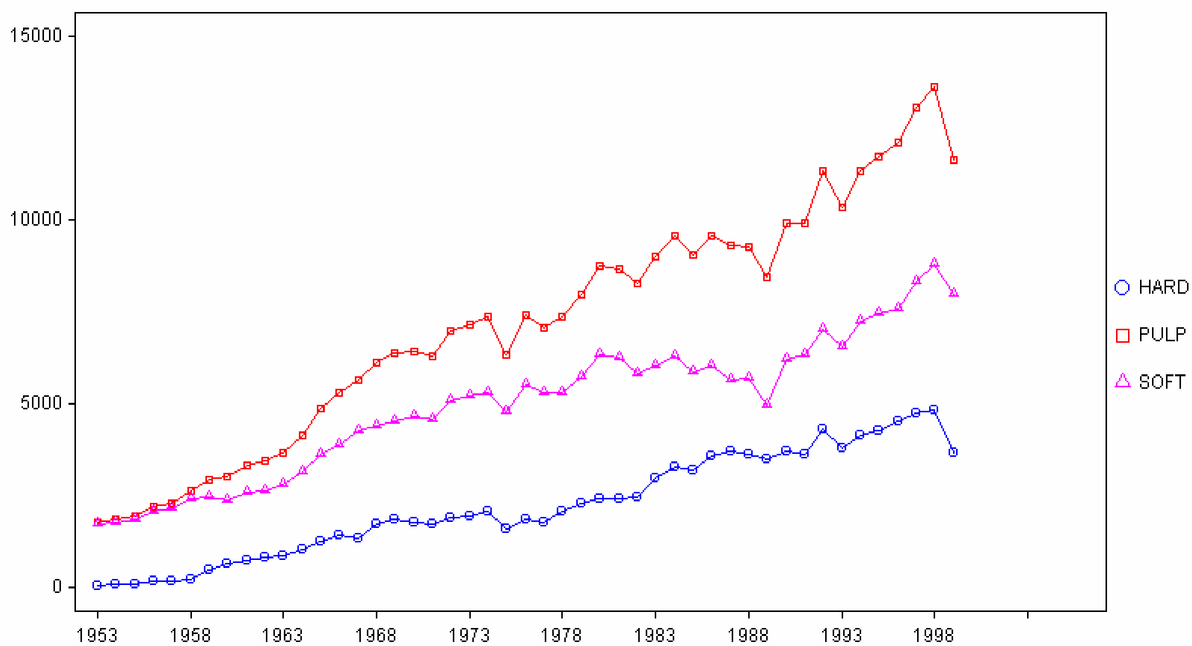
The US imports over $20 billion of wood production from Canada and exports $5 billion in return. Protection of forest products has been a stumbling block in the move toward free trade between the two countries. Canadian forests are publicly owned and stumpage rates can be artificially set. Trade in forest products with Mexico is very small in comparison, but Lyke, Theophile, and Bologna (1993) project increased trade under NAFTA. Mexico has few forests and imports forest products from Central and South America. Prestemon and Buongiorno (1996) take a close look at Mexican demand for forest products and estimate NAFTA will increase the value of Mexican imports from the US and Canada by 21% to 85%. Mexican imports of fir lumber, hardwood lumber, softwood plywood, and newsprint from the US are projected to increase the most, while imports of particleboard, hardwood veneer, scrap & wastepaper, and wood pulp are projected to be the least affected because of lower initial tariffs and inelastic demand. Boyd (1993), Boyd, Doroodian, and Abdul-Latif, (1993), and Boyd and Krutilla (1998) predict Mexican imports of fir lumber will increase 9% but there will be no change in Mexican pine imports.

Prestemon and Buongiorno (1997) show that hardwoods contribute more to state exports in the southern states. Prestemon (2001) projects increased export opportunities for hardwoods with free trade. Lyke (1998) notes that Mexico has historically imported pulp and paper products from the US. In Mexico, wood products are used in furniture and handling industries rather than construction. Under NAFTA, there has been an increase in Mexican wood consumption and increased imports from the US although there were declines during the middle 1990s linked to the peso devaluation. Extending free trade to all of Latin America and the Caribbean, Prestemon (1997) estimates that tariff reductions for US forest product exports would lead to small gains for US exporters but adversely affect producers in South America.

Production trends for pulpwood, softwood, and hardwood

Figure 1 shows the history of Alabama pulpwood production with data from the USDA. The past half-century has been a period of sustained output growth. Hardwood production has grown from virtually no output to between 30% and 40% of total volume. The fact that hardwoods play a bigger role in the exports of southern states suggests its share will continue to expand. Output growth is due to expanding supply as well as demand. Supply expands with more intensive forestry, acreage, and improved technology, all assumed to be continuously increasing in the present model. The issue at hand is whether NAFTA has had a positive impact on output by stimulating demand.

Figure 1. Alabama pulpwood production, 000s cords



Time trend estimates of production for the entire period 1953-1999 and the pre NAFTA period 1953-1993 are in Table 1. According to the adjusted R^2 values, virtually all pulpwood output is explained by the time trend. Durbin-Watson statistics, however, point to positive autocorrelation and unreliable estimates. The average annual change of pulpwood output over the entire period is 234.6 thousand cords. Yearly pulpwood output change during the pre NATFA period up to 1993 is 230.5 thousand cords, suggesting a positive influence of NAFTA.

Average softwood output increased including the NAFTA years while hardwood output did not change.

Table 1
Time Trend Estimates

d	Constant	t	R^2
pulpwood	-456496**	234.6**	.997
1.56			
preNAFTA	-440248**	230.5*	.959
1.56			
softwood	-257354**	132.7**	.924
1.54			
preNAFTA	-249353**	128.7**	.891
1.59			
hardwood	-189971**	101.8**	.963
1.69			
preNAFTA	-198690**	101.7**	.960
1.67			

R^2 = adjusted ** = 5% significance d = Durbin-Watson (d_L = 1.39)

Table 2 reports estimated average change in growth rates with a regression of Δlnx_t over time. As forestry expands into its feasible geographic areas, the output growth rate would be expected to fall and it has over the time period. For pulpwood, the growth rate declined a yearly average of 0.19% over the entire period and 0.18% during the pre NAFTA period. For softwoods, coefficient estimates are insignificant. For hardwoods, the growth rate declined more during the pre NAFTA period suggesting NAFTA may have stimulated output. The null hypothesis of no serial correlation cannot be rejected according to the Durbin Watson statistics. These estimates have very low explanatory power and would not be useful for prediction.

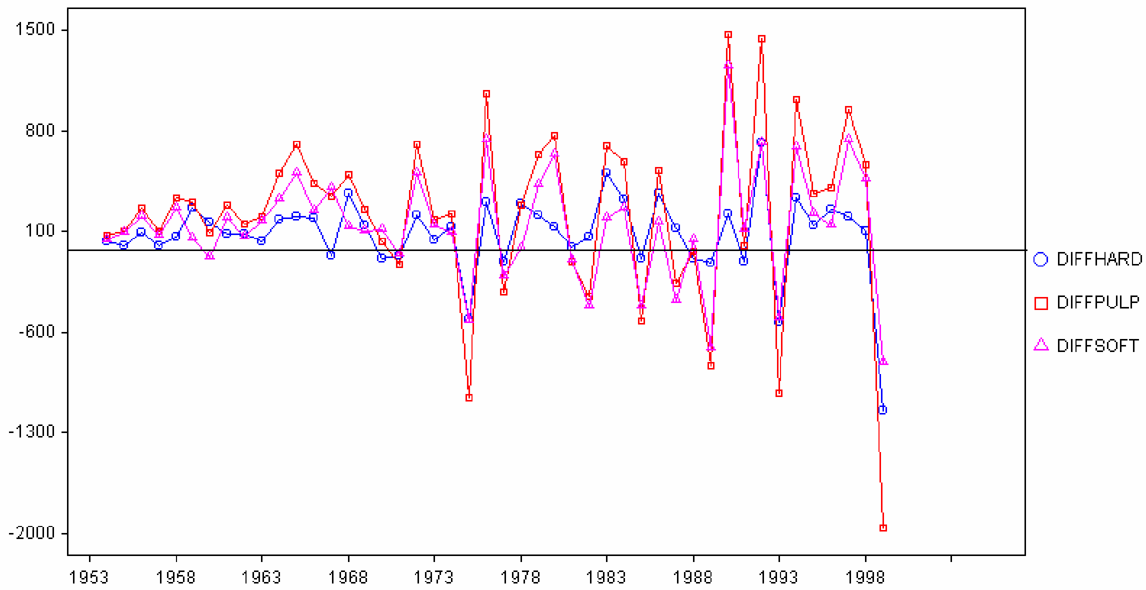
Table 2
Growth Rate Estimates

d	Constant	t	R^2
Δln (pulpwood) 1.56	3.73**	-.0019**	.091
Δln(preNAFTA) 1.56	3.60*	-.0018*	.059
Δln(softwood) 1.54	2.31	-.0012	.023
Δln(preNAFTA) 1.59	2.73	-.0014	.020
Δln(hardwood) 1.69	15.7**	-.0079**	.245
Δln(preNAFTA) 1.67	17.6**	-.0089**	.207

** = 5% significance   * = 10% significance   d = Durbin-Watson (d_U = 1.48)

Figure 1 suggests variability has increased since the early 1970s. Assuming continuously expanding supply, the conclusion is that demand has become more volatile. The 1950s and 1960s were periods of relatively steady demand growth. Increased variability can be seen when the data is differenced as in Figure 2, plotting $\Delta x_t = x_t - x_{t-1}$. Yearly differences are small and positive during most of the 1950s and 1960s. Increased variability began in the 1970s with large increases some years and decreases other years but the level of output was increasing. Differences in softwood and hardwood outputs move together with a correlation of 0.927.

Figure 2. Yearly differences



An autoregressive model of Alabama pulpwood production

Pulpwood production during a given year depends in an intuitive way on production the previous year with its foundation of established production facilities and a pool of buyers. The suggestion as in Enders (1995) is to begin with the linear autoregressive model,

$$x_t = a_0 + a_1 x_{t-1} + \varepsilon_t \quad (1)$$

where a_0 and a_1 are parameters to be estimated. The autoregressive model in (1) has one lag and is called an AR(1) model. The stochastic error term ε_t is assumed to have zero mean and constant variance. If $a_0 > 0$ and $0 < a_1 < 1$ in (1), the AR(1) model converges monotonically to the positive value $a_0/(1 - a_1)$. Such dynamic stability makes predictions more reliable. If $a_0 < 0$ and $a_1 > 1$, the series would explosively diverge. Stability is especially important when making projections well beyond the sample as in the present study. The question also arises whether output from the previous year x_{t-2} might also be included to make an AR(2) model and the series is tested for the appropriate autoregressive structure.

Moving average (MA) models are an alternative way to model economic time series. An MA model is based on a linear function of the series of random error terms,

$$x_t = \Sigma_{i=0} b_i \varepsilon_{t-i},$$
(2)

where b_i is a linear coefficient. ARIMA techniques reveal the present series are all AR(1). Autocorrelation functions display quick direct exponential decay and the partial correlations are all zero beyond the first lag, the two essential characteristics of AR(1) processes. A further test of stability is to examine whether the series are random walks. If differences are unrelated to levels, a series can be modeled as a random walk around it mean. Estimating $\Delta x_t = a_0 + a_1 x_{t-1} + \varepsilon_t$ reveals that $a_0 = a_1 = 0$ for each series, suggesting the autoregressive model in (1) with its assumption of a constant variance is appropriate.

Dickey-Fuller stability tests are reported in Table 3. The null hypothesis is that there is a unit root, similar to a coefficient between 0 and 1 in the autoregressive process (1). Critical values for the Dickey-Fuller test depend on the form of the difference model estimated. Without the time trend, the critical value for the t-statistic at the 10% level is -2.60 and with the time trend it is -3.18. In each case for every series, the null hypothesis of a unit root process cannot be rejected, supporting the AR(1) specification.

Table 3
Dickey-Fuller unit root tests (-2.60 & -3.19)

	Constant	X_{t-1}	t
Δpulpwood	0.30	-0.12	
	-1.09	-1.07	1.10
Δsoftwood	1.86	-1.25	
	-2.06	-2.24	2.07
Δhardwood	1.44	0.38	
	-2.68	-2.55	2.68

Table 4 reports estimates of the autoregressive model in (1) for the pre NAFTA period. The Durbin-Watson h statistic is the test for autocorrelation with the lagged dependent variable. Its critical value at the 5% level is 1.96 and if the absolute value of the h-statistic is above this level, the null hypothesis of no autocorrelation is rejected. The h-statistics indicate the null hypothesis cannot be rejected. The lagged dependent variable is sufficient to nullify the autocorrelation noted in the time trends. Stability requires a positive constant term but the null hypothesis that the constant terms are zero cannot be rejected. Also, the coefficient for hardwood is greater than 1 suggesting instability.

Table 4
Autoregressive models of pulpwood production

	Constant	X_{t-1}	t	h
pulpwood	307.3	.990**	.963	-1.61
softwood	278.0	.968**	.944	-1.38
hardwood	89.8	1.01**	.969	-0.83

** = 5% h = Durbin-Watson h (1.96)

Given the present focus on estimation, including the time trend is requisite. Including the time trend is also justified on the basis of economic reasoning. Coefficient estimates are partial derivatives of the dependent variable with respect to each of the independent variables and the time trend may capture the influence of smoothly expanding supply. Autoregressive model estimates with time trends are reported in Table 5, the model used to make projections,

$$x_t = a_0 + a_1 x_{t-1} + a_2 t + \varepsilon_t. \quad (3)$$

All coefficients are significant at the 5% level. The Durbin-Watson h statistics indicate the null hypotheses of no autocorrelation cannot be rejected. Explanatory power is high, coefficient estimates are reliable, and the model is stable.

Table 5
Autoregressive models with time trend

	Constant	X_{t-1}	t	R^2	h
pulpwood	-1900471**	.579**	98.0**	.969	-0.65
softwood	-58953**	.757**	30.5**	.949	-0.85
hardwood	-73938**	.646**	37.9**	.974	0.31

** = 5%, * = 10%   h = Durbin-Watson h (1.96)

The autoregressive model of pulpwood production in Table 8 assumes homoskedasticity, a constant variance across time. The time trends in Figure 1 and the differences in Figure 2 suggest there might be more variation in the last half of the sample. Predictability might improve if an estimated variance for each year were included. The estimation technique to consider time dependence variance is called the autoregressive conditional heteroskedastic or ARCH model. Error terms are derived from (3) using the estimating equations in Table 5,

$$\varepsilon_t = x_t - (a_0 + a_1 x_{t-1} + a_2 t). \quad (4)$$

The error series for pulpwood is in Figure 3 and the other two look very similar. There does not appear to be any systematic relationship for the error terms at least after the first 10 years. The ARCH model estimates a linear relationship between the square of ε_t and its lags. The ARCH models are estimated up to 8 lags,

$$\varepsilon_t^2 = b_0 + b_1 \varepsilon_{t-1}^2 + b_2 \varepsilon_{t-2}^2 + \ldots \quad (5)$$

All estimated coefficients are insignificant. The constant term b_0 is the square of the estimated variance, reported in Table 6. Estimated variances are all less than 6% of the forecasted outputs. The ARCH model would not contribute to the predictions.

Figure 3. Pulpwood error terms

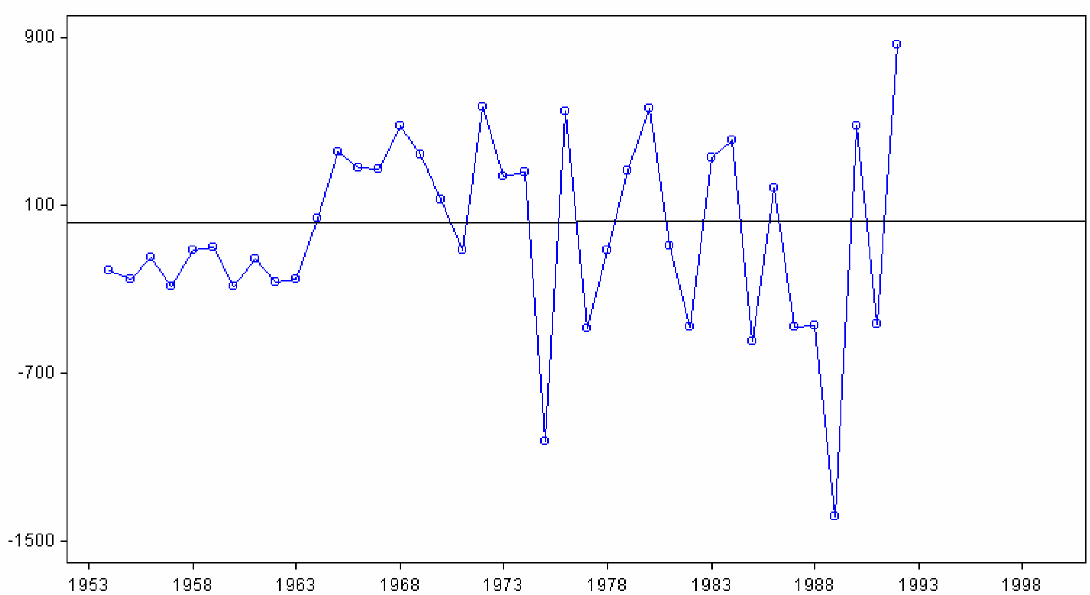


Table 6
ARCH estimates of variances

	Constant	ε_{t-1}	**t**
pulpwood	193748	.076	440
softwood	91573	.221	302
hardwood	46956	-0.72	217

Predicted pulpwood production and NAFTA

The estimated models of pulpwood production for the pre NAFTA period in Table 5 are used to forecast outputs over the seven subsequent years. The forecasting model for pulpwood is

$$x_{t+1} = -190471 + .579\, x_t + 98.0\, t. \quad (6)$$

Using output for 1992, the last pre NAFTA year, the output for 1993 can be predicted and compared with its actual value. The projection for 1994 is calculated using the forecast value for 1993, and so on. Using the single year of output x_{1992} may not be reliable because of yearly variation and averages for the last 5 years are used: 9781 for pulpwood, 6040 for softwood, and 3741 for hardwood. Tables 7 reports the three sets of rolling forecasts based on the de-trended first order autoregressive models in (5) and Table 5.

Table 7
Actual and forecasted production

Year	Pulp	Frcst	Diff	Soft	Frcst	Diff	Hard	Frcst	diff
1993	10329	10486	-157	6539	6406	133	3790	4013	-233
1994	11347	10992	355	7228	6713	515	4119	4227	-108
1995	11712	11383	329	7450	6976	474	4262	4403	-141
1996	12111	11711	400	7596	7130	466	4515	4555	-40
1997	13055	11902	1153	8335	7353	982	4720	4691	24
1998	13615	12477	1411	8796	7552	1244	4819	4817	2
1999	11651	11651	-1004	7979	7733	246	3672	4936	-1264

Pulpwood output is higher than the forecasted output for every year except 1993 and 1999, evidence that NAFTA stimulated production beyond what it might have been. These differences, however, are smaller than the estimated variance for every year except the last three. The largest yearly difference is 10% of actual output in 1998. Over the 7 years, differences average 3% above actual output, interpreted as the net impact of NAFTA. For softwood, actual outputs are greater than forecasted every year and are larger than the estimated variance every year except the first and last. The largest difference in 1998 is 14% of total output. The average stimulus over the 7 years is 8% of actual output. For hardwood, forecasted outputs are generally larger than actual outputs but the differences are smaller in absolute value than the estimated variance every year except the first and last. In 1993, there was a 12% decline in output as well as an apparent shift to a lower growth trend. In 1999, there was a sharp 24% reduction in output.

The model anticipates the decline in 1993 but not the sharp fall in 1999. Export data at the state level is not available and would have to be imputed. The average decline across the 7 years is 6% of total hardwood output.

Conclusion

The present time series model estimates the net effect of NAFTA on Alabama pulpwood production as an average annual increase of 3% with softwood production increasing an average of 8% and hardwood production declining an average of 6% annually. The predominant assumption is that supply conditions are constant or smoothly improving over the entire time period but different trees take various and relatively long periods of time to grow and harvesting conditions vary yearly. Demand determinants other than the introduction of NAFTA are also assumed to be constant but may vary. Economic expansion during the 1990s, for instance, raised pulpwood demand and the peso devaluation of 1994 cut the purchasing power of Mexican importers.

The present report suggests that NAFTA has had a net positive impact on forest products. Free trade promotes efficiency and the industry is advised to favor free international competition. The Alabama forest products industry is based on efficient utilization of abundant resources. If free trade is expanded to include South America and the Caribbean in FTAA, the US forest products industry will face new sources of competition as well as expanding markets. There are likely to be increased calls for protection against competition from South American producers but the wisest policy will be free trade. Protection may lead to temporary gains for some but is wasteful and creates dependency on unpredictable policy.

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