Assessment of Factors Driving Spatiotemporal Variation in TPO Trends

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Background

- The Timber Products Output (TPO) survey program began in 1948.
- TPO data are procured from primary wood using mills or facilities

  - Mills report their total annual roundwood consumption
  - Proportion of consumption harvested within each county and adjacent counties
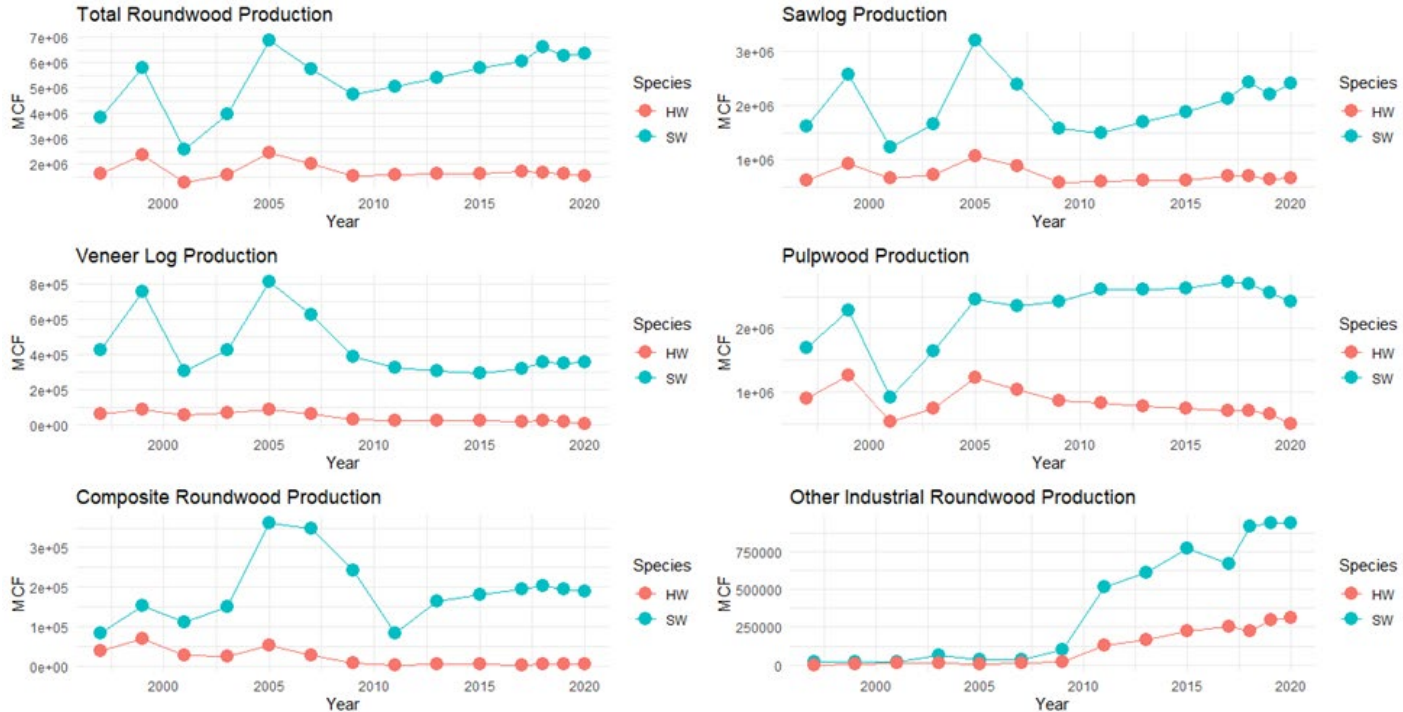

Source: Henderson Brothers

Figure 1. Trends in Timber Production Volume (southern U.S. region, 1997-2020)

Source: Rossi et al. (2022)

Limitations of the TPO Data

- Historically, TPO census varies by product class and region
  - South had a 2-year frequency,
  - The North had a 3–5-year frequency,
  - The West had a 5–7-year frequency.
- Non-response issue from mills
- Inconsistencies in survey years for certain states and missing data
- Change in Sampling Methodology

Table 1*: TPO survey years by state (1997-2013)*

State	1997	1999	2001	2002	2003	2005	2007	2009	2011	2013
AL	X	X			X	X	X	X	X	X
AR		X		X		X	X	X	X	X
FL	X	X			X	X	X	X	X	X
GA	X	X	X		X	X	X	X	X	X
KY	X	X	X		X	X	X	X	X	X
LA		X		X		X	X	X	X	X
MS		X		X		X	X	X	X	X
NC	X	X	X		X	X	X	X	X	X
OK		X		X		X		X	X	X
SC	X	X	X		X	X	X	X	X	X
TN	X	X	X		X	X	X	X	X	
VA		X	X		X	X	X	X	X	X

Source: Rossi et al. (2022)

Research Question?

- Are the pre-2017 and post-2017 measurements of roundwood production comparable and if so, at what spatial scale?

  – Rossi et al. (2022)

- **Are the variations in the TPO production attributable to shift in market factor or TPO survey methodology?**
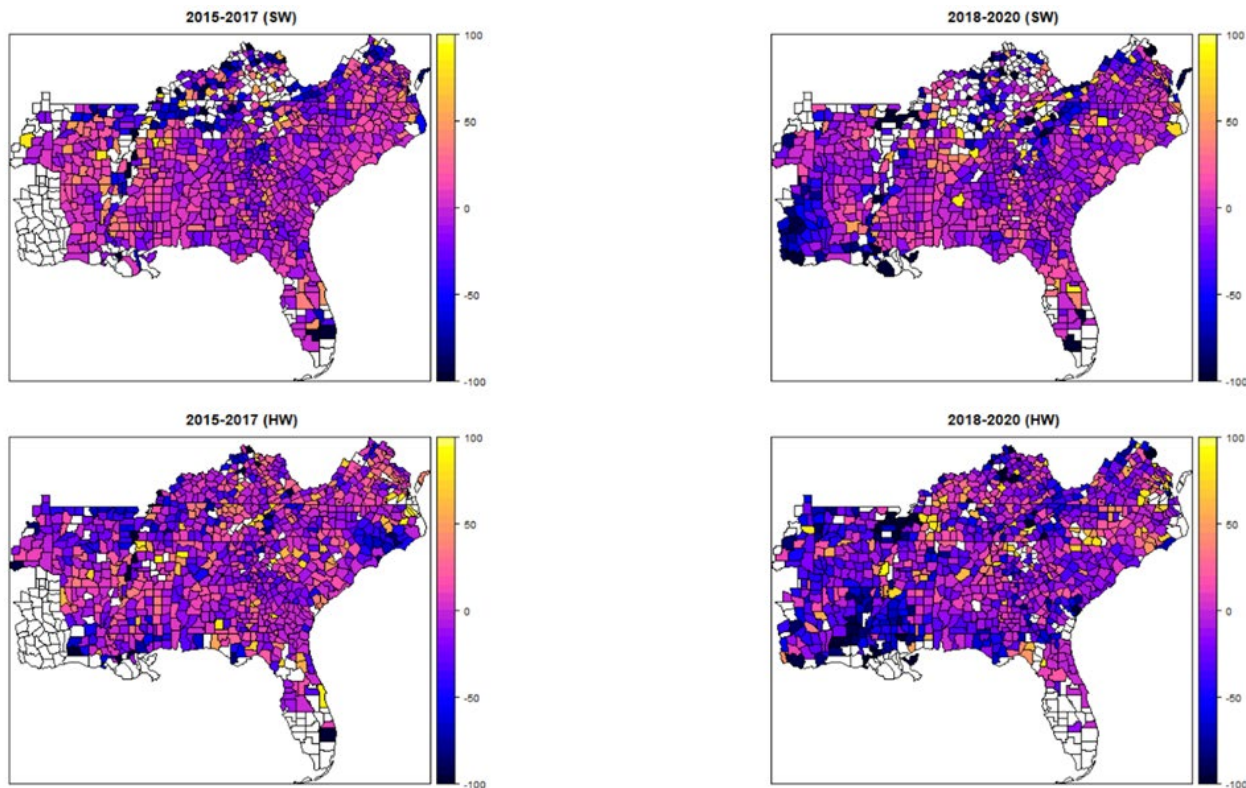
Figure 2: *Average annual percentage growth rate in roundwood production of softwood (SW) and hardwood (HW) species across counties in the southern United States*

Source: Rossi et al. (2022)

Roundwood Product:	Unpaired t-test with unequal variances for equivalence in means ($H_0: \mu_{PRE} = \mu_{POST}$)	Bartlett's K-test for equivalence in variance ($H_0: \sigma^2_{PRE} = \sigma^2_{POST}$)
Total Softwood Production	$t^*_{df=1704.5} = 3.5904^{***}$	$K^*_{df=1} = 3.4301^*$
Total Hardwood Production	$t^*_{df=1778.9} = 6.6149^{***}$	$K^*_{df=1} = 19.9350^{***}$
Softwood Sawlog	$t^*_{df=1432.5} = 4.6183^{***}$	$K^*_{df=1} = 50.0240^{***}$
Hardwood Sawlog	$t^*_{df=1378.1} = 6.4521^{***}$	$K^*_{df=1} = 89.0730^{***}$
Softwood Veneer Logs	$t^*_{df=351.24} = -0.1583$	$K^*_{df=1} = 108.880^{***}$
Hardwood Veneer Logs	$t^*_{df=227.6} = -0.2175$	$K^*_{df=1} = 22.9430^{***}$
Softwood Pulpwood	$t^*_{df=1355} = 3.4462^{***}$ (assumption of equal variances)	$K^*_{df=1} = 1.4746$
Hardwood Pulpwood	$t^*_{df=1301} = 3.2068^{***}$ (assumption of equal variances)	$K^*_{df=1} = 1.2468$
Softwood Roundwood for Composite Facilities	$t^*_{df=226} = 1.7195^*$ (assumption of equal variances)	$K^*_{df=1} = 0.0077$
Hardwood Roundwood for Composite Facilities	$t^*_{df=48} = -2.6852^{***}$ (assumption of equal variances)	$K^*_{df=1} = 0.4857$
Softwood Roundwood for "Other Industrial" Facilities	$t^*_{df=1302.7} = 2.1356^*$	$K^*_{df=1} = 5.6399^{**}$
Hardwood Roundwood for "Other Industrial" Facilities	$t^*_{df=1161} = 5.5527^{***}$ (assumption of equal variances)	$K^*_{df=1} = 0.0300$

*p<0.1; **p<0.05; ***p<0.01

Table 4: *Two-tailed tests of mean and variance equivalence in the growth rate of log production across the 2015-2017 time period ("PRE") and the 2018-2020 time period ("POST").*

Source: Rossi et al. (2022)

Hypothesis

- Do market factors (Inventory, mill capacity, price, etc.) have the same impact on the TPO growth rate in the POST and PRE periods for small and large roundwoods?

Methods

- Based on literature reviewed, we intend to apply a simultaneous equations regression model
  - Supply and demand models

$$D_{it} = f_1(P_{it,} \theta, \alpha_{it})$$
$$S_{it} = f_2(P_{it,} \Phi, \alpha_{it})$$
$$D_{it} = S_{it}$$

- D_{it} - demand for timber production in micro-market i of the year t
- S_{it} - timber supply in micro-market i of the year t
- $P_{it,}$ - weighted average stumpage prices ($/tons) in the South
- θ - vector of additional variables that determine demand (demand shifters – housing start (H), mill capacity (M))
- Φ - vector of variables that determine supply (supply shifters – inventory (V), labor).

Models

Parameter of interest

- Supply Functional Form:

$$\Delta \ln S_i = \beta_0 + \beta_1 \Delta \ln P_i . T_i + \beta_2 \ln V_i . T_i + \beta_3 \Delta \ln P_i + \beta_4 \ln V_i + \beta_5 T_i + \epsilon_i$$

- Demand functional form:

$$\Delta \ln D_i = \alpha_0 + \alpha_1 \Delta \ln P_i . T_i + \alpha_2 \ln H_i . T_i + \alpha_3 \ln M_i . T_i + \alpha_4 \Delta \ln P_i + \alpha_5 \ln H_i + \alpha_6 \ln M_i + \alpha_7 T_i + \epsilon_i$$

  - P_{it} - weighted average stumpage prices
  - T_i - a dummy variable representing the "pre" and "post" change periods in the TPO survey methodology

Comments?