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"Will U.S. Forests Continue to Be a Carbon Sink?" by Xiaohui Tian, Brent Sohngen, Justin Baker, Sara Ohrel, and Allen A. Fawcett

APPENDIX B: DATA SOURCES FOR GLOBAL TIMBER MODEL

Forest inventory data is obtained from various sources (Table B1). The U.S. data is based on forest inventory data collected in 2014. The U.S. data are extensive and can be used to empirically estimate yield function parameters with the following functional form:

$$V_a^i = \left[\exp\left(\delta^i - \frac{\pi^i}{a}\right)\right], \qquad \text{[B1]}$$

where V_a^i is the forest yield (m^3 per ha) for each age a and type i, and δ^i and π^i are yield function parameters. Inventories for other regions are older and do not support empirical estimation; however, we can calibrate yield functions using the data described in Table B1 for each forest type. In some regions we use published ecological studies to determine yield function parameters consistent with observed yields in those regions.

TABLE B1

Forest Area and Inventory Data

Region	Data Source
United States	U.S. Department of Agriculture, Forest Service. Various years. *Forest Inventory and Analysis* (www.fia.fs.fed); collected March 2014
Europe	Kuusela 1993
Russia	Russia: *Forest Account* (2004); see Sohngen et al. (2005) for a discussion of this data
Canada	Lowe, Power, and Gray 1994; updated with Canada's National Forest Inventory in 2010; see https://nfi.nfis.org/hom.php
Australia	Australian Department of Agriculture and Water Resources 2003, 2008; Australian Bureau of Agricultural and Resource Economics, Jaakko Pöyry Consulting (1999)
New Zealand	New Zealand Ministry of Agriculture and Forestry (MAF), see http://maxa.maf.govt.nz/statistics/ (accessed August, 2016).
China	China State Forestry Administration (2013)
All other Countries	FAO 2015

The price elasticity of demand for sawtimber and pulpwood is assumed to be –1.0. This is more elastic than many estimates in the literature for the United States (e.g., Haynes, Connaughton, and Adams 1981; Newman 1987), but it is in line with estimates from global data. For instance, Simangunsong and Buongiorno (2001) estimate demand elasticity as –0.62 for sawnwood to –1.33 for plywood. Uusivuori and Kuuluvainen (2001) estimate roundwood import elasticity of –0.69 for nontropical hardwoods to –0.92 for softwood, and –0.95 for wood chips. Turner and Buongiorno (2004) estimate demand elasticity for roundwood imports of –0.74. We assume that income elasticity is 0.9. This is less than most studies report. Simangunsong and Buongiorno (2001) estimate income elasticity of 1.0 and Turner and Buongiorno (2004) find that income elasticity for industrial roundwood is 2.21.

Two other sets of elasticities are important in the global model. First, $V'(a, z_{a,t+1})$, is the derivative of forest yield with respect to management inputs, z. We assume that $V' \geq 0$ and $V'' \leq 0$. The elasticity of yield response to management inputs varies in our model from 0 for forest types that have no historical management inputs to 0.14 for intensively managed southern pines, Pacific Northwest Douglas-fir, and fast-growing plantation types in other regions of the world, such as eucalyptus or radiata pine. An elasticity estimate of 0.14 implies that a 1% increase in expenditures on regeneration will lead to a 0.14% increase in m^3 ha^{-1} at harvest time. Across the 1 billion ha of forests classified as managed in some way in this model, the average elasticity is 0.047. Across the remaining 2.4 billion ha, elasticity is 0.

Second, the rental cost functions in our model, $R'(\sum_a x_{a,t})$, are assumed to be constant elasticity functions calibrated for each region. The study by Lubowski, Plantinga, and Stavins (2006) suggests that the price elasticity of land conversions from crops to forestry (and vice-versa) is 0.30 in the United States. We have found no similar studies for other regions. Unlike with forest yield functions, where we have data on aggregate biomass volumes for separate age classes, or where ecologists have published data from study sites in a wide range of biomes, economists have not produced land supply elasticities outside the United States. We thus apply the estimate from Lubowski, Plantinga, and Stavins (2006) to other regions. We do conduct sensitivity analysis on this assumption via our Monte Carlo analysis discussed in online Appendix C.

To calculate carbon fluxes, we start by calculating the growing stock volume in each time period, S_t. Growing stock is then converted to aboveground carbon using the methods described by Smith, Heath, and Jenkins (2003) for the United States, or the Intergovernmental Panel on Climate Change Good Practice Guidelines (Penman et al. 2003) for other regions. Soil carbon stocks are calculated using methods described by Sohngen and Sedjo (2000). They assume that remaining forests have no change in soil carbon when timber harvests occur. When agricultural land is converted to forests, only the net gain relative to an initial value consistent with regional agricultural soils is counted. Soil carbon is assumed to accumulate along a logistic growth curve at a rate of 3% per year to a steady state consistent with typical forest soil carbon measurements for the type (Penman et al. 2003). When forest land is converted to agriculture, soil carbon is assumed to be released at a rate of 3% per year. In net present value terms, the typical release of soil carbon when forests are converted to agricultural land is 1.5 to 8 Tg C ha^{-1}. Storage in marketed products is also monitored, assuming that 25% of the harvested wood is emitted immediately and the rate of turnover (or release of carbon from wood product pools) is 1.0% per year for sawtimber products and 2.0% per year for pulpwood products. Slash, or the deadwood left on harvesting sites, is assumed to decompose at rates of 3% to 7% per year, following Penman et al. (2003).