Chapter 4

NORTH AMERICAN PULP & PAPER MODEL (NAPAP)

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Abstract. This chapter describes the development and structure of the NAPAP model and compares it to other forest sector models. The NAPAP model was based on PELPS and adapted to describe paper and paperboard product demand, pulpwood and recovered paper supply, and production capacity and technology, with spatially dynamic market equilibria. We describe how the model predicts paper and paperboard product demands and trade flows over time, concurrently with regional capacity changes and corresponding shifts in process technology based on Tobin’s q theory of capital investment. We describe how the model was tested and calibrated and then provide examples of applications.

Keywords: pulp and paper model, technology forecasting, pulpwood markets, paper recycling

4.1 INTRODUCTION

The NAPAP model was designed to work within the context of the RPA Timber Assessment to project ongoing and future economic trends in the US and Canadian pulp and paper sectors. The model was designed to take into account changes in demand and supply for all primary pulp, paper, and paperboard products, changes in industry capacity by process and region, and regional markets for hardwood pulpwood, softwood pulpwood, and recovered paper. Six North American supply regions (Canada East and West, US North, Southeast, South Central, and West) were represented in the latest version of the model, along with three demand regions (Canada, USA, and the rest of the world).

The NAPAP model uses Samuelson’s theory of spatial market equilibrium and price-endogenous linear programming. Regional supply and demand functions are combined in the NAPAP model with regional manufacturing inputs and costs, transportation costs, and exchange rates to compute annual production and consumption from 1986 to 2050. Each year, short-run production is allocated optimally among competing production processes and regions, with production limited by available capacity.

Over the long run, the model predicts changes in production capacity among competing processes and regions as a function of marginal values and costs of capacity expansion, using Tobin’s “q model” of capital investment. Production capacity, costs, and input requirements are modeled by process for each of 12 categories of paper and paperboard and five categories of wood pulp, encompassing the full spectrum of production processes for all pulp and paper products produced in the USA and Canada. Evolution of manufacturing technology is projected as a result of projected changes in production capacity by process, in response to projected shifts in regional market values for products and raw materials. The NAPAP model also projects the trade between the USA, Canada, and the rest of the world, determined in part by exchange rate variations.

4.1.1 Historical context

Papermaking is an ancient activity, but it was not until the late 19th century that wood fiber began to be used commercially on a wide scale to make paper, replacing agricultural plant fibers and rags with a much more abundant source of natural cellulose fiber. Modern paper machine development changed papermaking from a slow and laborious process to an increasingly capital-intensive and highly automated technology geared toward mass production.

The widespread use of corrugated shipping containers, offset printing, print advertising, and sanitary paper products transformed paper and paperboard markets. Increased demand, and technological developments such as the efficient kraft (or sulfate chemical) pulping process and much more efficient larger capacity paper machines caused significant expansion in US pulp and paper industries in the 20th century. During this period, US wood pulp production increased from around 1 million tonnes (metric tons) in 1900 to a recent peak of over 61 million tonnes in 1995 (Figure 4-1).