Developing Scenarios and Evaluating Policies for China and Asia Pacific Regional Forest Products Suppliers: A Proposed Model Structure

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Steve Northway and Gary Bull
Faculty of Forestry
University of British Columbia
Vancouver, Canada

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Introduction:

The purpose of the International Forest and Forest Products Trade Model (IFF Model) is to help prepare scenarios for policy analysis. It is designed to predict annual changes in the future forest products market and its economic impacts.

We built a prototype model using three principles:

- It must respond to the relevant policy initiatives.
- It has to be able to reflect the variations among the scenarios.
- It should provide meaningful measures of the short and medium-term changes in national/regional welfare and trade.

Overview of Proposed Model Structure

Following is a brief description of the IFF model elements as summarized in Figure 1 below:

- The Market model [see center of Figure] is composed of an **International Trade** module and a **Manufacturing Capacity** module. The International Trade module rationalizes the counties' supply and consumption through import and exports. In doing so, it provides estimates of imports, exports and prices at a country and product level. The Manufacturing Capacity module provides estimates of country level changes in manufacturing capacity.

- The **Market** model interacts with a number of Country models [see top of Figure] and a Rest-of-World [RoW] model [see bottom left corner of Figure].

- Each Country model is comprised of a Supply, Consumption, Manufacturing and Impact module. The Supply module incorporates land-use changes, current forest inventory and growth-and-yield information to predict the supply of primary forest products (e.g. logs). The Consumption module uses economic conditions to predict the consumption levels of final forest products. The Manufacturing module keeps track of the capacity and costs of manufacturing primary products into intermediate and final products for internal consumption or export. The Impact component predicts the socio-economic impact of changes in the country's conditions.

- The **Rest-of-World** (RoW) model is much like a country model; it covers the world not explicitly dealt with by the summation of the country models. As a consequence, it carries a much lower level of detail and does not contain an Impact module.

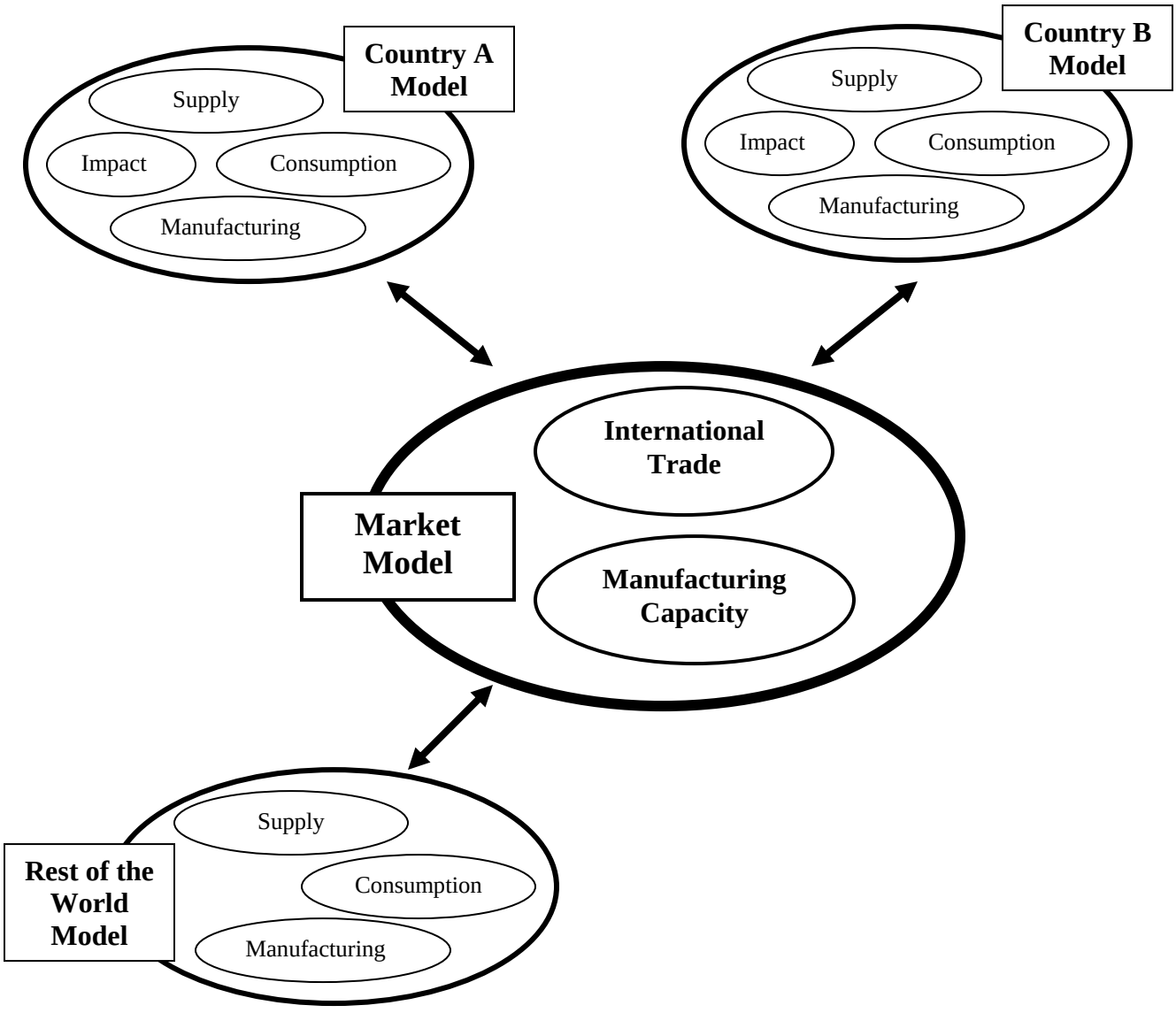

Figure 1. Overview of IFF model structure.

IFF Model Structure and General Equilibrium Modeling

A conventional general equilibrium model could represent supply and demand with price elasticity curves and use prices to "clear the market" while maximizing the sum of the consumer and producer surplus. Our proposed model structure represents supply as the result of income maximizing landowners[1] and demand as the combining of predicted consumption levels and uses, inventory buildup and product substitution to clear-the-market; all the while minimizing the cost of meeting the consumption levels.

In the prototype model, the total manufacturing capacity is represented by just one average manufacturing cost for each product in each country. Dividing the total capacity into segments representing different average costs could be used to represent supply elasticity as usually modeled in a General Equilibrium Model. Any excess supply of raw material would still be represented as unused inventory.

A similar approach can be used on the demand side. Any gap between the fixed consumption[2] and the supply is represented through substitution. In the prototype model, substitution happens at one cost with an unlimited quantity[3].

Country Models

Figure 2 summarizes the major structure of the country model and its modules. The land-use module tracks land use allocation. For example, here the conversion of commercial forest to reserves or the conversion of grazing land to plantations would be accounted for. For our initial model prototype we assume that plantation expansion is a current policy decision. The area of new plantations comes from a mix of land categories represented by a conversion matrix: 60% come from grazing land and 20% each from crop and unused land.

The output of the land use module is important to both the **forest estate module** and the **impact assessment** module. The level of detail in the land use module can vary by country and could be use to analyze various policies and scenarios that relate to within-country regional, administrative, biophysical, and forest type differences.

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[1] The landowner's objective is the driver. The model structure can adapt if she/he decides it is AAC policy or some other environmental policy is really the supply driver.

[2] Consumption represents the demand for the function of the forest product, not necessarily consumed in the form of a forest product; e.g. non-wood fibre substitution for wood pulp.

3 Substitution could also be represented in fixed quantities at a variety of costs to represent demand elasticity. This would be similar to a General Equilibrium Model approach.

The forest estate module, the core of the supply modeling, takes as its inputs the following:

1) anticipated land-use changes
2) current forest inventory
3) physical and financial yield estimates, and
4) yield regulation policies.

The forest estate module provides outputs of harvest volumes by log class. These log classes are input to the country's manufacturing module, which is described below. The prototype model of the forest estate model component assumes that the policy decision is to either maximize anticipated net present value from the forest or match the harvest volume to the country's aggregated consumption. The anticipated net value of the harvest is independent of the results of the Market model, so the model only needs to be run once[4].

4 An LP formulation could be used in the final version of the model. The results of the Market model's endogenous predictions, especially excess inventory and achieved price, could be used to affect the landowner's anticipated net value. This would require re-running the forest estate model each time the anticipated net value changed. (In the prototype model example, the anticipated net value of the harvest is determined by exogenous variables.)

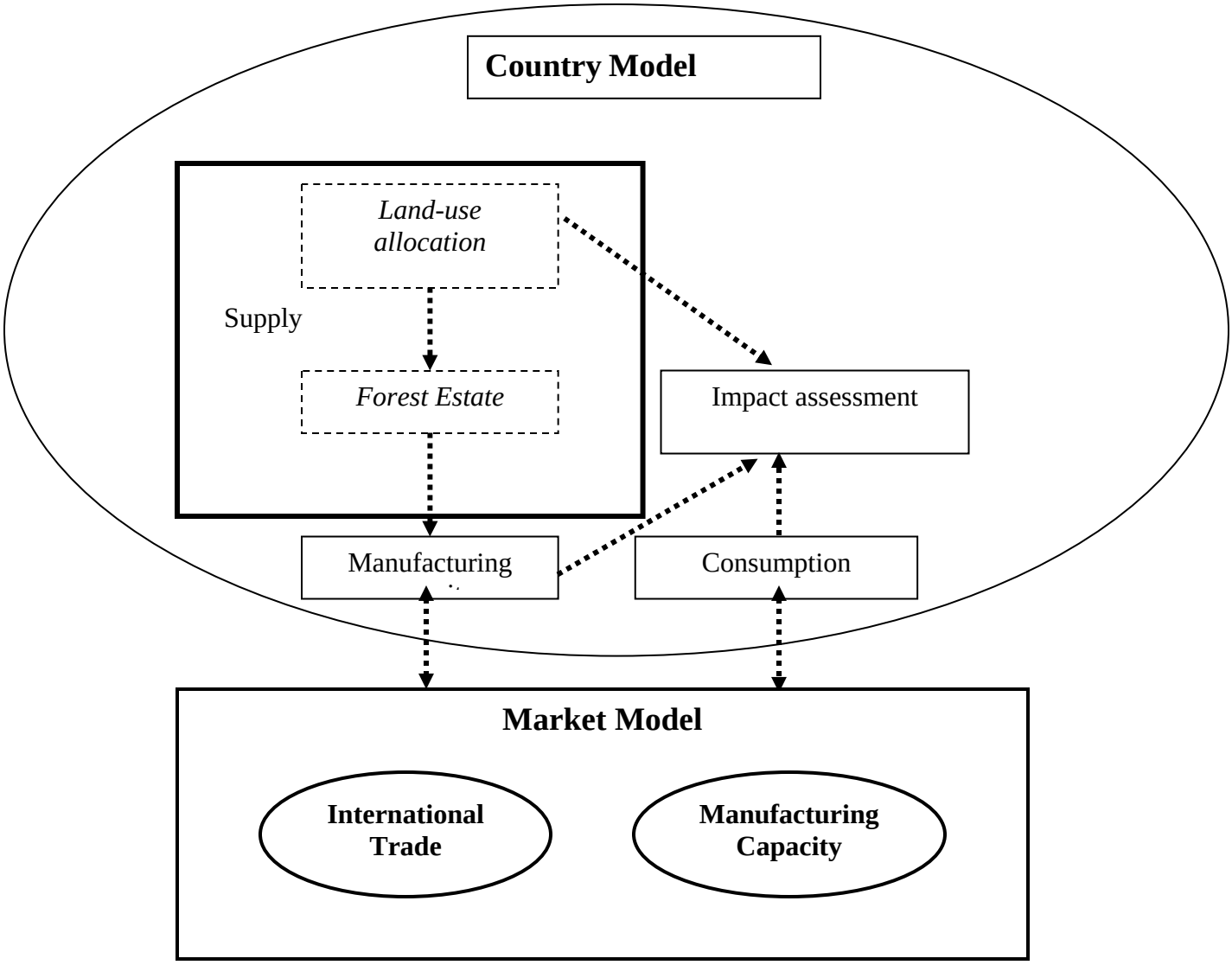

Figure 2. Details of Country and Market Model .

The manufacturing module keeps track of the capacity of the manufacturing sector to convert primary products to intermediate and final products, including conversion efficiency and cost. The data is updated annually from the Manufacturing Capacity module in the Market model. This module is represented in the prototype model structure by matrices representing efficiencies, costs and capacities for converting from the forest estate module output to the products dealt with in the Market model. Only a single price, efficiency and capacity are used for each product conversion. Several classes of conversion facilities could be modeled to represent an arbitrarily complex elastic supply curve.

The consumption module predicts changes in consumption of the products dealt with by the Market model, and tracks the prices and magnitudes of possible substitution to non-forest products. The prototype model exercise uses growth in GDP, population and wealth to create multipliers for changes in product consumption. A more sophisticated "multi-curve" model of changes to consumption could be used.

The impact module predicts the socio-economic impact of the changes that take place each year. In the prototype model exercise this component is a simple multiplier relating land-use change to economic activity. Another option could be to use input/output models to predict the employment and economic activity impacts, hopefully including an urban and rural split. The module could also be extended to use the endogenously derived changes in harvest level and manufacturing capacity.

Market Model

The international trade module reconciles the countries' supply and consumption figures through allocating primary products to different country's manufacturing facilities (considering transport and duties). Each annual solution is independent of other years and is accomplished at minimum cost. Excess supply ends up as unused inventory. Excess demand triggers substitution for non-forest products. The prototype model solves a linear programming formulation of the annual problem. The single country interacts with the Rest of the World. The Rest of the World consumes an unlimited quantity of products as long as the price is less than it can meet internally.

The international trade model could also keep track of bilateral trade. One model structure has each country import and export into a world pool. However, this structure does not have the ability to capture the effects of bilateral trade agreements[5]

5 This is an important issue affecting the model structure. For example, the Global Forest Products Model does not keep track of trade between any two particular countries; rather, it keeps track of aggregate trade

The manufacturing capacity module predicts the changes in each country's manufacturing capacity. The prototype model exercise uses a simple GDP inflator to expand manufacturing capacity. We anticipate moving to a shift-share type of economic base model[6].

Status

A prototype version of the model has been developed in MSExcel. The prototype contains all the modules of the proposed model structure in a crude form. It contains a single country, China.

The MS Excel version is not scalable. An extensible Java version is under development which gives it the added advantages of being both platform independent and not reliant on proprietary software.

The proposed model structure is extensible in size and complexity. Individual countries can adopt a level of detail that suites their available data and policy needs. The only commonality must be in common definitions to support the trade and capacity models.

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where each country exports and imports to a "world pool". Our view is that this simplifies trade and as a result we cannot report on bilateral trade, or the impact of unique bilateral agreement on duties.

6 . One task is to try and predict how regional manufacturing capacity will change through time – a field of study called multi-regional economics or geographic economics. The simplest model assumes that the share of a regions capacity is fixed and grows as a % of the whole. The shift-share models look for regional competitive advantages and predict a "shift" in the share between regions. The models can be simple or very complex.