MODELLING FOREST PRODUCTS DEMAND, SUPPLY AND TRADE

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Market modelling approach for EFSOS II

- ***Background paper (3) for the Team of Specialists on Forest Sector Outlook and Outlook Correspondents-***

- 2nd meeting 23-24 November 2009 -

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Through this background paper, members of the ToS and Outlook Correspondents are informed of the approach to the econometric analysis used for developing the market projections for EFSOS II. Due to cooperation with the Swedish Future Forest Project, initial results of these projections are already available. Outlook correspondents and ToS members are invited to review the results of the projections for their country (see separate excel spreadsheet). These results will be discussed in working group sessions during the ToS meeting, 23-24 November 2009. ToS members and outlook correspondents who will not be able to attend the meeting are invited to provide comments in writing directoly to Ragnar Jonsson at Ragnar Jonsson at Ragnar.Jonsson@ess.slu.se.

Introduction

Forest products such as paper, panels and sawnwood, appearing in a large number of end use products, affect our daily lives. Furtermore, in several countries the forest sector contributes in a significant way to the general economic and social development. The increasing volume of trade, and in particular the import of forest products into Europe, plays an important role also for global forest sector developments.

The current study provides a description of an econometric analysis of the forest sector in Europe and how the resulting models (henceforth market models), together with assumptions regarding economic growth and price and cost developments, are used to produce country specific projections of consumption, production and trade of wood products.

Outline of the paper

The paper begins with a description of the scope and approach for the econometric analysis, followed by a description of how the projections are produced. The paper ends by putting forward a proposal for an integration of the European Forest Institute Global Trade Model (henceforth EFI-GTM) in EFSOS II.

Approach for the econometric analysis

This study applies the methodology of Kangas and Baudin (2003); used in EFSOS I (UN, 2005) for providing projections of supply, demand and trade as regards processed wood products. The benefit of this approach is that it covers all aspects of consumption, production, imports and exports (Kangas and Baudin, 2003). Subject to the market characteristics of the country in question, two different econometric approaches are used:

(i) A multiple equations approach for demand (two equations) and supply (one equation) are applied for countries which are important in demand and/or supply terms for the product in question (see Kangas and Baudin (2003) for details). The functional form is log-linear, allowing for direct interpretation of estimated coefficients as elasticities.

(ii) A time series cross-sectional model for consumption for countries and products where either a) only short time series are available and/or the country in question is insignificant in demand and/or supply terms. Again, the functional form is log-linear.

Scope

Country coverage and grouping

Major markets and producers are analysed individually, using the multiple equation approach (Group I in Table 1). The second group consists of countries that are traditional market economies, with minor production of forest products and/or relatively low consumption (Group II). The purpose of the grouping into IIa and IIb (Table 1) is to obtain relatively homogeneous groups of countries. The countries that have recently become market economies (countries with economies in transition) constitute group III with two subgroups (IIIa and IIIb), essentially formed from practical considerations such as size and importance.

From Table 1 it is obvious that in Group III, the larger (in terms of production and/or consumption of forest products) countries form their own group (IIIa), but they are also included in IIIb. The reason for this overlapping is the lack of stability of results for group IIIb if the countries in Group IIIa would not have been included. Attempts have been carried out with several alternative groupings among countries, but the classification above is the one providing the most stable results.

Table 1: Country grouping

Group I: Multiple equation approach: Demand, supply and trade models estimated	
Austria	Norway
Finland	Spain
France	Sweden
Germany	United Kingdom
Italy	
Group II: Time Series Cross Section approach: Demand models estimated	
Group II a:	*Group II b:*
Belgium-Luxembourg	Greece
Denmark	Ireland
Netherlands	Portugal
Switzerland	Turkey
Group III: Time Series Cross Section approach: Demand models estimated	
Group III a:	*Group III b:*
Czech Republic	Albania
Estonia	Belarus
Latvia	Bosnia and Herzegovina
Hungary	Bulgaria
Poland	Croatia
Romania	Czech Republic
Russian Federation	Estonia
Ukraine	Hungary
	Latvia
	Lithuania
	Poland
	Romania
	Russian Federation
	Serbia and Montenegro
	Slovakia
	Slovenia
	Macedonia, The Fmr Yug Rp
	Ukraine

Product coverage

The products analyzed in this study are:

i. Sawnwood – coniferous and non-coniferous.
ii. Wood-based panels – plywood, particle board, and fibreboard.
iii. Paper and paperboard – newsprint, printing and writing paper, and other paper + paperboard.

For wood pulp, other fibre pulp, and recovered paper, consumption is not analyzed but derived for projection purposes from the projected production of final products using conversion factors, indicating the input of raw material needed. However, for countries which are important importers and/or exporters of a specific raw material, imports (or, in some instances, domestic demand) and/or exports are analyzed for projection purposes in the same vein as for final products. Further, demand and supply of veneer sheets are not analyzed. It is assumed that demand and supply elasticities of veneer are the same as those for plywood for the country in question.

Materials and methods

Data

The FAOSTAT database is the main source of data as to production, imports, exports as well as value of imports and exports of commodities. Based on this information, import and export unit values (in

US$) are calculated and subsequently deflated to provide estimates of real (constant) import and export prices. Trade flows were assessed in the UNECE and UN COMTRADE database.

Historical macroeconomic data, GDP (in constant US$) and deflators, was collected from the FAO database. For GDP projection purposes, IMF projections were used until 2010, thereafter the IPCC Special Report on Emissions Scenarios (SRES) A1 and B2 scenarios were used (source: CIESIN, 2002). For the A1 as well as B2 scenario, constant real prices (and costs) were assumed the price and production costs developments of the A1 and B2 reference futures as compiled/calculated within EFORWOOD was used. These baseline scenarios were chosen since they are considered to provide sufficient contrast as regards economic growth rates - a high growth and low growth scenario respectively. Added benefits are that using the same scenarios as the ones used in the EFORWOOD programme make comparisons and the achievement of project synergies possible.

The multiple-equations approach

For the multiple equations approach (see Table 1 above), the following set of equations is defined:

$$Q^D_D = f(P_d, P_m, D^D) \quad (1)$$

$$Q^M = f(P_d, P_m, D^M) \quad (2)$$

$$Q^D_s = f(P_d, P_x, Costs, S^D) \quad (3)$$

$$Q^X = f(P_d, P_x, Costs, S^X) \quad (4)$$

where Q^D_D = demand for domestically produced goods, Q^M = import demand, Q^D_s = supply to domestic markets ($Q^D_s = Q^D_D$), Q^X = supply to export markets, P_d = the real price in domestic markets, P_m = real import price, P_x = real export price, D^D = demand shifters for the domestic market, D^M = demand shifters for import demand, Costs= cost factors, S^D = supply shifters for the domestic market and S^X = supply shifters for the export market. Real gross domestic product (GDP), in constant US$, is used as demand shifter in equations (1) and (2) for paper and paperboard as well as for solid wood products, thus differing from Kangas and Baudin (2003). In the latter study an end-use index was used as demand shifter for solid wood products. Following the approach of Kangas and Baudin (2003), the activity of export markets, described by a population-weighted index, S^X, of real GDP in France, Germany, Italy and the United Kingdom, is used as supply shifter in equation (4).

In equation (1) the domestic price is expected to have a negative sign, whereas the sign of the import price can be either positive or negative depending on whether imports substitute for or complement domestic products. Analogously, in equation (2) the import price should be negative, and the domestic price can have either a positive (substitution) or negative (complement) sign. Equations (3) and (4) indicate that export and domestic markets are alternative destinations for the production. Negative cross-price elasticity signifies substitution. Hence, the expected sign for export price is negative in equation (3) and positive in equation (4), and vice versa for the domestic price.

Since domestic prices were not readily available, real export prices are used as proxies for domestic real prices in equations (1) and (2) when the country is a net exporter of the product in question. Otherwise, real import prices only are used in equations (1) and (2). Similarly, real import prices are used as proxies for domestic real prices in equations (3) and (4) whenever the country is a net importer. Otherwise, real export prices only are used in equations (3) and (4). The cost factors used in the supply equations (3) and (4) are raw material costs: log prices, chip prices, recovered paper prices and pulp prices, all in constant US$. All prices are based on deflated import and export unit values.

The four equations represent an over-identified system for projection purposes. Along with import demand and export supply (assuming both trade flows occur), only one equation must be estimated for the domestic market to fully-define production and consumption. For most countries and products, the domestic market quantity is estimated as a demand equation (Equation 1). Data for demand prices and demand shifters is generally better than corresponding data necessary to estimate coefficients in supply equations. Furthermore, since studies (e.g., Kangas and Baudin 2003) show that the differences

between a systems approach (two-stage or three-stage least squares) and ordinary least squares (OLS) regression are only marginal; OLS is used throughout the study as the estimation method. OLS is a technique for estimating the unknown parameters in a linear regression model. This method minimizes the sum of squared residuals, i.e., the sum of squared distances between the observed values and the values provided by the regression model.

The time series cross sectional approach

For the time series cross-sectional approach (see Table 1 above), total (apparent) consumption is explained using price and GDP.
The following equation is used:

$$Q^T = f(P, GDP) \quad (5)$$

where Q^T is apparent consumption, P is real export unit prices or real import unit prices, the larger of the trade flows determine which of the two price series are used. GDP is the real gross domestic product. Again, prices and GDP are in constant US$.

The estimation procedure is a time series cross-section (TSXS) approach. The methodology, described in Buongiorno (1977, 1978) and in Baudin and Lundberg (1987), is further developed in Baudin and Brooks (1995).

Projections of Demand, Supply and Trade

Processed wood products

For a given country and product an estimated (domestic or import) demand model is given as

$$lnY_t = a + b*lnGDP_t + d*lnP_t$$

For a given country and product an estimated export supply model is given as

$$lnX_t = g + h*ln\ S^X{}_t + k*lnP_t + l*lnc_t$$

where Y_t *is* domestic consumption (or import) in time period t
ln denotes natural logarithms
GDP_t is real GDP in time period *t*
P_t is real product price
t is a time index; t=1 for 1961, t=2 for 1962 etc and
X_t is exports in time period t
$S^X{}_t$ is an index of the GDP of the main export destinations
c_t is real cost of wood raw material and
a, b, and *d g, h, k and l* are estimated elasticities.

The projection method is as follows:

1. With data to year 2007, a base-year value for *Y* at the centre of the last observed five year period, 2005 is given as a five-year average:

   $$Y_{05} = (Y_{03} + Y_{04} + Y_{05} + Y_{06} + Y_{07})/5$$

   The rationale for using this average as a starting value is the objective to provide long term projections. This means that initial values for projections should, as much as possible, not reflect short term fluctuations (such as business cycles). A five-year average is expected to cancel major effects of business cycle variations, which means that it is expected to be 'on the trend line'. Considering the recent economic downturn, which did not begin to manifest itself until mid-2008, projections for 2010 could be higher than what will actually be observed. However, provided that the economic downturn is not reflecting a major change in the trend, projections should provide reasonably accurate reflections of longer term developments. The annual growth rate of consumption from 2005 to 2010 is defined as

$$Y_{05\text{-}10} = b*GDP_{05\text{-}10} + d*P_{05\text{-}10}$$

2. The projection for 2010 then is

   $$Y_{10} = Y_{05} * (1+b*GDP_{05\text{-}10} + d*P_{05\text{-}10})^5$$

   where $GDP_{05\text{-}10}$ and $P_{05\text{-}10}$ denote annual rates of growth for GDP and price respectively. For countries with short available time series, a three year average (for the years 2005, 2006 and 2007) is used when calculating the base year for projections. Hence, the centre year is 2006 and the initial projection value in this instance is obtained as

   $$Y_{10} = Y_{06} * (1+b*GDP_{05\text{-}10} + d*P_{05\text{-}10})^4$$

3. Projections for year 2015 are obtained as above with the 2010 projection as the starting point. The procedure from year 2020 should be obvious.

4. Projections for export supply are performed using the same methodology as above. In some instances when the export model produces unrealistic results, due to, e.g., highly variable export data, production was modelled instead using the same model as for exports.

5. Projections are provided for years 2010, 2015, 2020, 2025 and 2030. Values for intermediate years are given by linear interpolation.

6. By adding import demand and domestic demand (for a given product and country), apparent consumption is obtained and by adding domestic demand and export supply, total production is given.

7. The approach presented here also applies to the time series cross section demand models. In instances when only demand models are estimated, it is assumed that production is a constant share of consumption (self-sufficiency ratio) and that imports is a constant share of consumption. The ratio used is the five year average centred around 2005 or, for countries with short available time series, a three year average centred around 2006. Export is calculated from these quantities.

Raw materials and intermediate products

For wood pulp, other fibre pulp and recovered paper, consumption is not analyzed but derived for projection purposes from the projected production of final products using conversion factors, indicating the input of raw material needed.

Recovered paper

When preparing projections for the production and consumption of recovered paper, historical trends in wastepaper recovery rate (in this instance defined as recovered paper production divided by total paper and board consumption) and recovered paper utilization rate (defined as consumption of recovered paper divided by total fibre-furnish) were analyzed. There are technical limits to both of these variables, e.g., some types of paper are difficult to recover (e.g., tissue paper), whereas some types of paper are difficult to manufacture from recycled paper.

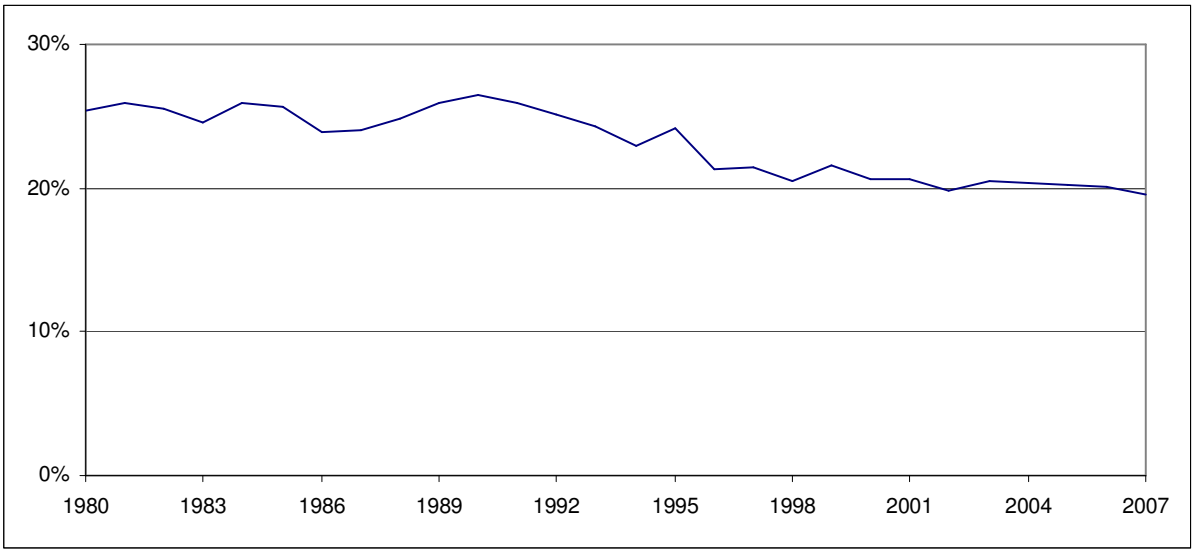
The projection of recovery and utilization rates are based on extrapolation of past trends, subject to the limitations related above. When there is no discernible trend or in instances where the recovery rates were already high (70-80 percent), the average rate for the three last years were used. Production projections are then calculated as the product of the recovery rate and the projected total paper and board consumption for the country in question. Consumption projections are subsequently given as the product of the utilization rate, projected total paper and board production and the fibre-furnish input ratio (total fibre-furnish consumption divided by total paper and board production). The fibre-furnish input ratio is assumed to remain constant over the outlook period. As already noted, for countries which are important importers and/or exporters, imports (or domestic demand) and/or exports are analyzed for projection purposes and projections are subsequently performed with the same method as for the forests products, related above. In other instances, it is assumed that imports are a constant

share of consumption. The ratio used is a three year average centred around 2005. Export is subsequently calculated from production, imports and consumption quantities.

Wood pulp

Projections of the consumption of wood pulp are calculated by subtracting the projected consumption of recovered paper and other fibre pulp from the projected total fibre-furnish (the product of fibre-furnish input ratio and projected total paper and board production). In doing so, the other fibre pulp utilization rate (other fibre pulp consumption divided by total fibre-furnish) is assumed to remain constant. Wood pulp consumption are subdivided into mechanical wood pulp and chemical wood pulp (in this instance comprising chemical and semi-chemical wood pulp) consumption by means of the historical shares of the different types of wood pulp. These shares are thus assumed to remain unchanged. Looking at Figure 1 below, displaying the situation in Western Europe, this assumption seems reasonable; though the share of mechanical wood pulp is lower than it was in 1980, it has been quite stable the last ten years

Figure 1: Mechanical pulp - share of total wood pulp



The same as for recovered paper, for important importers and/or exporters of the two different types of wood pulp defined above, imports (or domestic demand) and/or exports are analyzed for projection purposes and projections are performed with the method already described. In other cases, production is assumed to be a constant share of consumption (self-sufficiency ratio) and imports a constant share of consumption. Export is calculated from these quantities. The ratio used is a three year average centred around 2005. Export is calculated from these quantities.

Other Fibre Pulp

Consumption projections for other fibre pulp are given as the product of the utilization rate, projected total paper and board production and the fibre-furnish input ratio. The input ratio is assumed to remain constant. When projecting production and imports, it is assumed that the self-sufficiency ratio and the import/consumption quota are to remain unchanged.

Integration of EFI-GTM in EFSOS II

The most basic integration of the European Forest Institute Global Trade Model (EFI-GTM) in EFSOS II is to seek linkage between the EFI-GTM and market models, i.e., taking GDP & price elasticities from market models and apply them in EFI-GTM, subsequently checking for consistency regarding results for demand between GTM & market models results. Provided sufficient consistency, EFI-GTM will supply price trends to be used in market models.

This version of the market projections, the results of which are being made available to members of the Team of Specialists and outlook correspondents, has already used price trends which were

endogenously generated by EFI-GTM runs in the EFORWOOD project for A1 and B2 (which itself used the elasticities from earlier versions of the market model, in an excellent example of cooperation between models). As there are already significant linkages between EFI-GTM and Ragnar's market projections it would be worthwhile exploring these further.

In addition to the above, EFI-GTM could be used to provide an outlook for trade of forest products between Europe and other regions. For an the most comprehensive integration of EFI-GTM, market models, the wood resource balance (WRB) and EFISCEN; EFI-GTM output should be checked as regards production of forest products against market models supply projections. If necessary to achieve sufficient consistency, EFI-GTM runs should be repeated in an iterative process. Technical linkages between the models mentioned above will be worked out in draft so as to enable discussions at the upcoming core group meeting (25/11-09).

All of the above presupposes that adequate funding for running the EFI-GTM is forthcoming. The Core Group and the Team of Specialists will further consider possibilities in this regard which will determine if, and how, EFI-GTM could possibly be employed in EFSOS II.

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