Modelling forest products demand in European countries

Paul Rougieux[1,2] and Olivier Damette[2,3]

[1]PhD student - University of Lorraine
[2]INRA/AgroParisTech Laboratory of Forest Economics
[3]BETA, Bureau d'Economie Théorique et Appliquée

SSAFR 2015 – 16th Symposium for Systems Analysis in Forest Resources

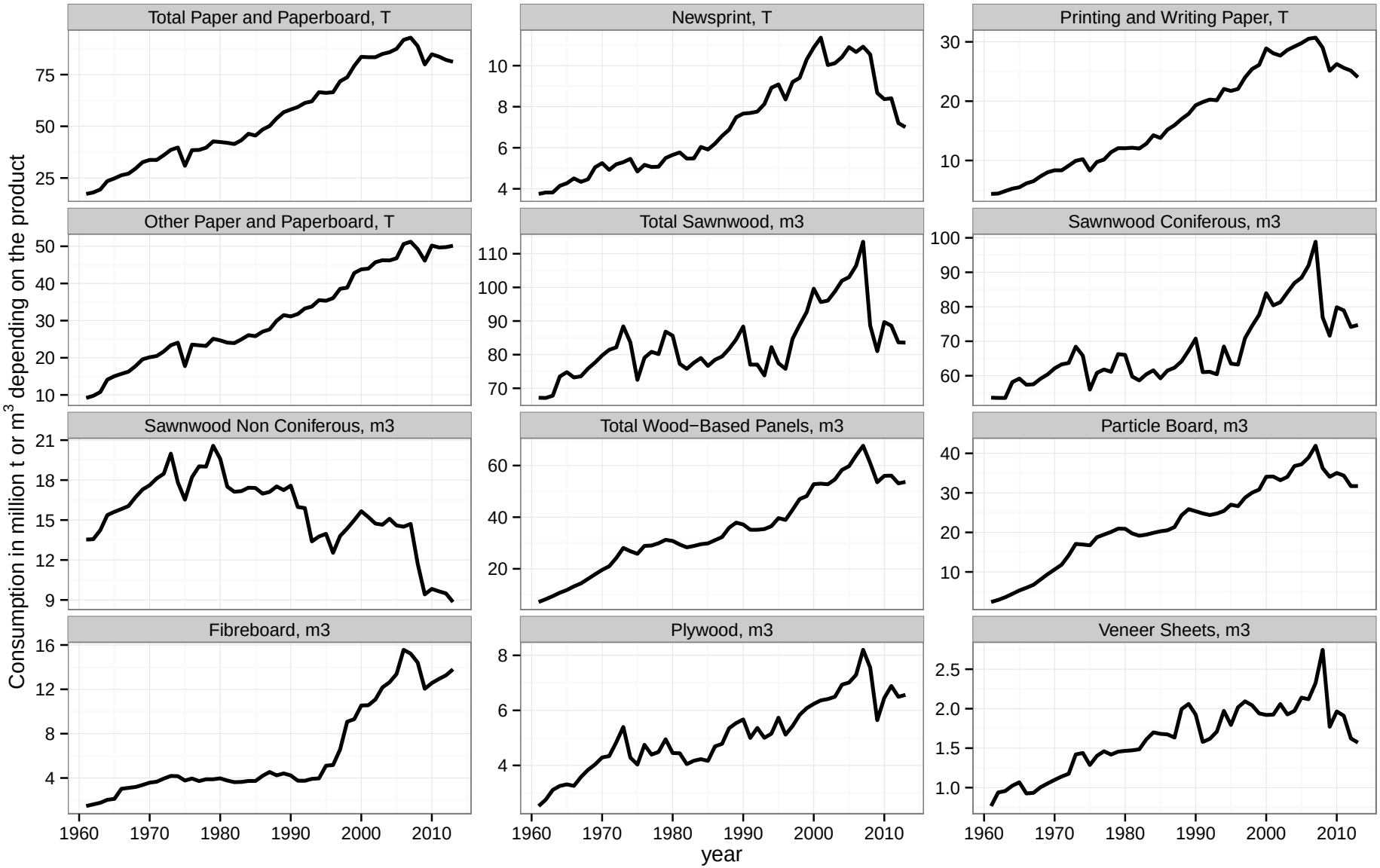
Outline

EU-28 yearly consumption of industrial forest products

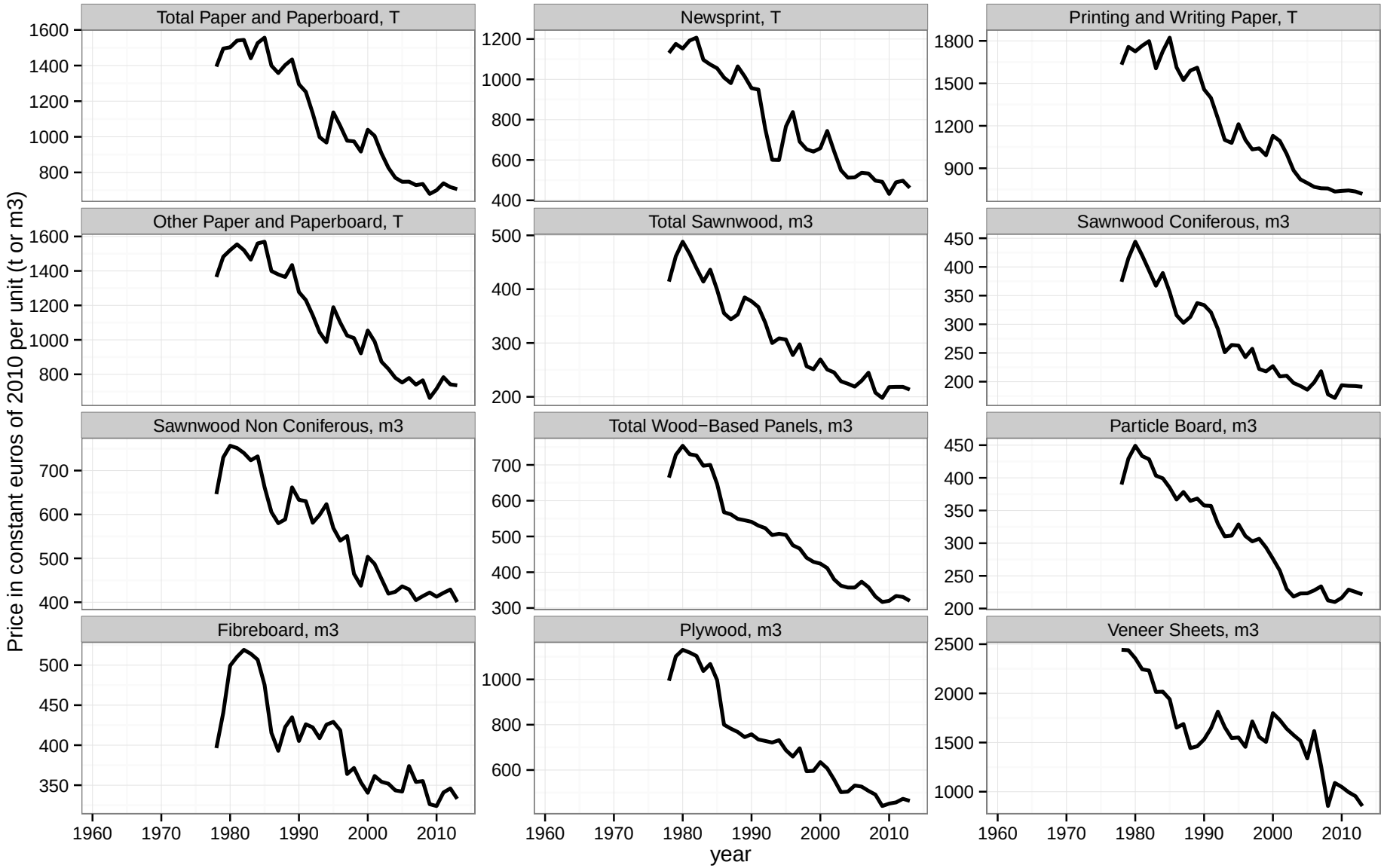
Consumption in million tonnes for paper and paperboard products and in million cubic meters for sawnwood and wood-based panels.

Item	Consumption			Percent change	
	1990	2000	2010	1990-2000	2000-2010
Total Paper and Paperboard	58	84	85	44%	1%
Newsprint	8	11	8	42%	-23%
Printing and Writing Paper	19	29	26	50%	-9%
Other Paper and Paperboard	31	44	50	41%	15%
Total Sawnwood	88	100	90	13%	-10%
Sawnwood Coniferous	71	84	80	19%	-5%
Sawnwood Non Coniferous	18	16	10	-11%	-37%
Total Wood-Based Panels	37	53	56	42%	6%
Particle Board	25	34	35	34%	3%
Fibreboard	4	11	13	149%	19%
Plywood	6	6	6	10%	4%
Veneer Sheets	2	2	2	0%	2%

Time series of forest products consumption in the EU-28



Time series of forest products prices in the EU-28



Structural Changes

Growth patterns vary extensively through the 3 dimensions of the data set: products, countries and time

Decreasing demand for newsprint and writing paper products in main European countries but continued growth in demand for packaging paper.

- [Hetemäki and Nilsson, 2005] described a structural change in newsprint demand after 1988 based on time series for the USA.

Period	GDP elasticity of newsprint demand
1931-1987	between +0.63 and +0.69
1988-2004	between -0.44 and -0.24

- Decreasing demand for Sawnwood due to economic downturn and crisis in the construction sector
- Continued growth in demand for wood panels

Panel analysis of forest products demand

Author year	Products	Panel size	Estimation methods [1]
[Chas-Amil and Buongiorno, 2000]	Demand for paper products	N=15, T=24	OLS pooling, LSDV
[Simangunsong and Buongiorno, 2001]	Demand for fuelwood, wood panels, paper products, sawnwood	N=64, T=25	Pooled OLS, LSDV, between-country, random effects, OLS by country
[Turner and Buongiorno, 2004]	Import demand for roundwood, sawnwood, paper products, wood panels	N=64,T=28	Pooled OLS, First differencing, Fixed effects, Random effects
[Hurmekoski et al., 2015]	Demand for sawnwood	N=17, T=32	OLS, OLS with dummy, TSLS

[1] LSDV Least Squares with Dummy Variables, OLS Ordinary Least Squares, TSLS Two-stage Least Squares

Theory of derived demand

Based on a cobb Douglas production function[2]:$ay^b z^c = g$ with a cost minimisation problem $min(yp_y + zp_z)$, $\beta_1 = 1/(b+c)$ and $\beta_2 = -c/(b+c)$. The derived demand for intermediate forest products can be represented by:

$$y = \beta_0 g^{\beta_1} \left(\frac{p_y}{p_z} \right)^{\beta_2} \tag{1}$$

Models used in the literature on forest products demand are of the form:

$$lnD_{it} = \beta_0 + \beta_1 lnY_{it} + \beta_2 lnP_{it} + \varepsilon_{it} \tag{2}$$

Adjustment lags can also be introduced to create a dynamic model.

[2]Where y is the consumption of forest products, z the consumption of other products and g the industry production.

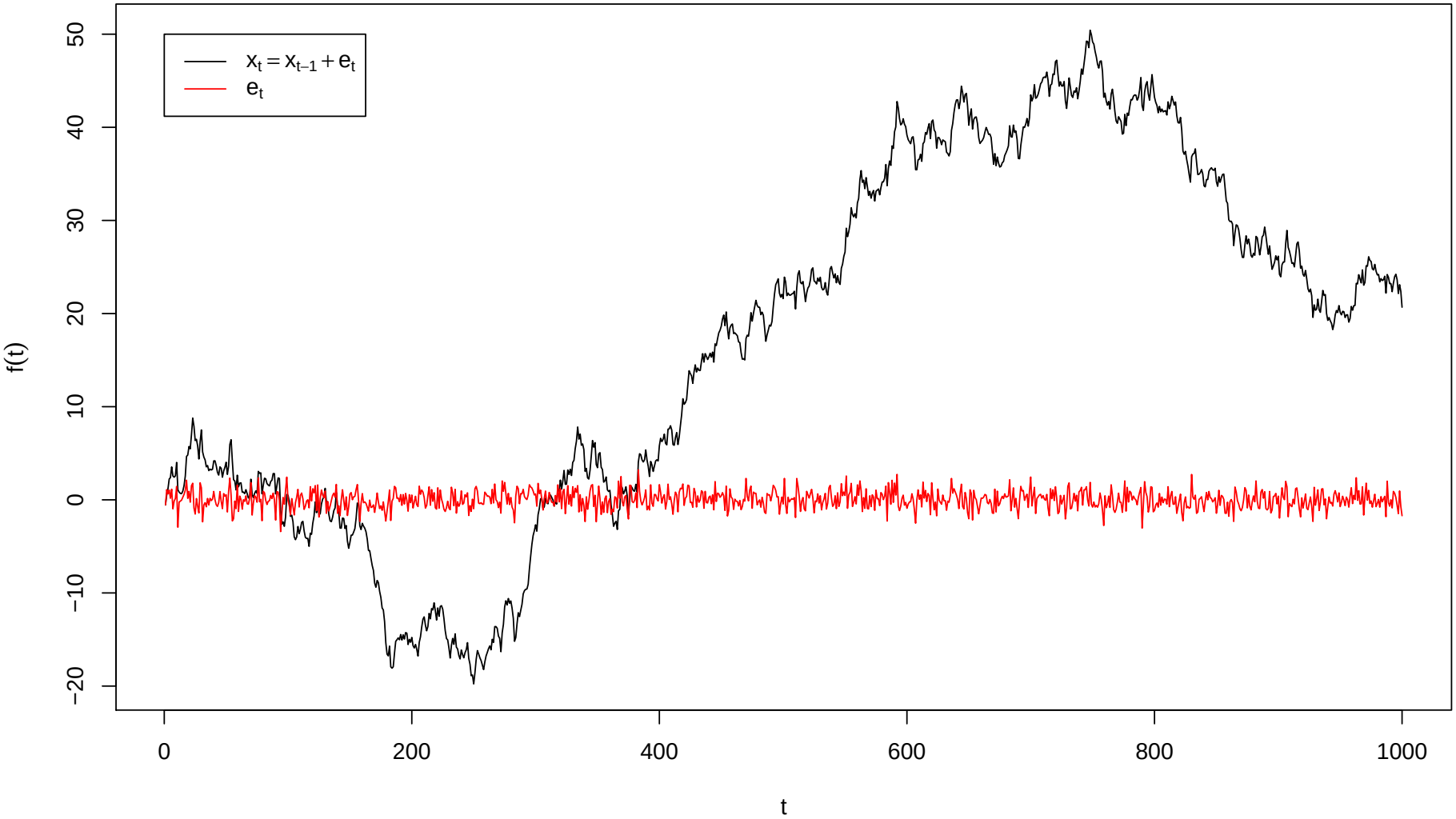
Size of the panel datasets

53 years of data is available. The number of countries included depend on variables used in the balanced panel.

item	cons	cons+price	cons+price+gdp
Total Paper and Paperboard	22	22	12
Newsprint	21	21	12
Printing and Writing Paper	19	17	10
Other Paper and Paperboard	22	22	12
Total Sawnwood	21	21	12
Sawnwood Coniferous	22	21	12
Sawnwood Non Coniferous	18	18	12
Total Wood-Based Panels	22	21	12
Particle Board	18	16	11
Fibreboard	18	18	11
Plywood	22	21	12
Veneer Sheets	13	12	7

Non Stationarity

Illustration of an auto-regressive process $x_t = \rho x_{t-1} + e_{it}$ where $\rho = 1$



First generation panel unit root tests

Consumption variable

Product consumption	N	T	breitung	fisher	hadri	ht	llc
TotalPaperandPaperboard	12	44	I(0)	I(1)	I(1)	I(0)	I(1)
Newsprint	14	44	I(1)	I(1)	I(1)	I(0)	I(1)
PrintingandWritingPaper	14	44	I(1)	I(1)	I(1)	I(0)	I(0)
OtherPaperandPaperboard	13	44	I(1)	I(1)	I(1)	I(0)	I(0)
TotalSawnwood	14	44	I(1)	I(1)	I(1)	I(0)	I(0)
SawnwoodConiferous	12	44	I(1)	I(1)	I(1)	I(0)	I(0)
SawnwoodNonConiferous	14	44	I(1)	I(1)	I(1)	I(0)	I(0)
TotalWoodBasedPanels	14	44	I(0)	I(1)	I(1)	I(0)	I(1)
ParticleBoard	14	44	I(1)	I(1)	I(1)	I(0)	I(1)
Fibreboard	14	44	I(0)	I(1)	I(1)	I(0)	I(0)
Plywood	14	44	I(1)	I(1)	I(1)	I(0)	I(1)
VeneerSheets	9	44	I(0)	I(1)	I(1)	I(0)	I(0)

Panel unit root test for the lcons variable (I(1) means that a unit root cannot be rejected at the 1% confidence level)

First generation panel unit root tests

Price variable

Product price	breitung	fisher	hadri	ht	llc
TotalPaperandPaperboard	I(0)	I(0)	I(1)	I(0)	I(0)
Newsprint	I(0)	I(1)	I(1)	I(0)	I(0)
PrintingandWritingPaper	I(0)	I(0)	I(1)	I(0)	I(0)
OtherPaperandPaperboard	I(0)	I(1)	I(1)	I(0)	I(0)
TotalSawnwood	I(0)	I(1)	I(1)	I(0)	I(0)
SawnwoodConiferous	I(0)	I(1)	I(1)	I(0)	I(0)
SawnwoodNonConiferous	I(0)	I(1)	I(1)	I(0)	I(0)
TotalWoodBasedPanels	I(0)	I(1)	I(1)	I(0)	I(0)
ParticleBoard	I(0)	I(0)	I(1)	I(0)	I(0)
Fibreboard	I(0)	I(1)	I(1)	I(0)	I(1)
Plywood	I(0)	I(0)	I(1)	I(0)	I(0)
VeneerSheets	I(0)	I(1)	I(1)	I(0)	I(0)

Panel unit root test for the lprice variable (I(1) means that a unit root cannot be rejected at the 1% confidence level)

First generation panel unit root tests

GDP variable

Variable	N	T	breitung	fisher	hadri	ht	llc
GDP	12	44	I(1)	I(0)	I(1)	I(1)	I(0)

Panel unit root test for the gdp variable (I(1) means that a unit root cannot be rejected at the 1% confidence level).
Test computed: Breitung and Das 2005, Fisher-type (Choi 2001), Harris-Tzavalis (1999) and Levin-Lin-Chu (2002) tests have a null hypothesis that all the panels contain a unit root. Hadri (2000) Lagrange multiplier (LM) test has as the null hypothesis that all the panels are (trend) stationary.

Pesaran's Cross Section Dependence Test

- First generation panel unit root tests were based on the strong hypothesis of cross section independence.
- But results of the Pesaran (2004) tests for cross section dependence show that for all products and for both dynamic or static model specifications, the null hypothesis of cross section independence is rejected at the 1% level.
- Therefore we have to use a second generation of panel unit root tests

Second generation panel unit root tests

Bai and Ng (2004, 2010) separate common factors from idiosyncratic ones

Consumption[3]	Common component		Idiosyncratic	
Item	pooled demeaned [4]	stationarity	pooled idiosyncratic [5]	stationarity
TotalPaperandPaperboard	5.3701	I(0)	-0.8000	I(1)
Newsprint	0.1551	I(1)	1.4452	I(1)
PrintingandWritingPaper	6.0358	I(0)	-2.0274	I(1)
OtherPaperandPaperboard	2.6972	I(1)	-0.9213	I(1)
TotalSawnwood	10.5853	I(0)	1.3529	I(1)
SawnwoodConiferous	-1.1125	I(1)	-1.4906	I(1)
SawnwoodNonConiferous	5.4200	I(0)	2.2502	I(0)
TotalWoodBasedPanels	3.9126	I(0)	-0.0688	I(1)
ParticleBoard	-1.7102	I(1)	-2.6868	I(1)
Fibreboard	5.4935	I(0)	1.4760	I(1)
Plywood	3.6728	I(0)	-1.3189	I(1)
VeneerSheets	6.9852	I(0)	0.7136	I(1)

[3] For both the GDP and price variables stationarity of the common component can not be rejected at the 1% level whereas stationarity of the idiosyncractic is rejected.

[4] The Pooled Demeaned test has a critical value of 2.87 at the 5 percent level, H0 is rejected above that value.

[5] The pooled idiosyncratic test has a critical value of 1.64 at the 5 percent level.

Cointegration test

Westerlund (2007) error-correction-based panel cointegration tests

item	gt_pval	ga_pval	pt_pval	pa_pval
TotalPaperandPaperboard	0.1531	0.8656	0.0003	0.0053
Newsprint	1.0000	0.9998	0.0337	0.1595
PrintingandWritingPaper	0.3613	0.2379	0.0417	0.0007
OtherPaperandPaperboard	0.1766	0.9345	0.2626	0.5282
TotalSawnwood	0.0146	0.5713	0.0143	0.0021
SawnwoodConiferous	0.8711	0.9729	0.0086	0.0073
SawnwoodNonConiferous	0.3255	0.9562	0.0132	0.3161
TotalWoodBasedPanels	0.8022	0.9207	0.0000	0.0000
ParticleBoard	0.9175	0.9164	0.5442	0.3314
Fibreboard	0.8327	0.9731	0.3414	0.7197
Plywood	0.1737	0.9397	0.0420	0.0832
VeneerSheets	0.0147	0.1418	0.0000	0.0000

Demand elasticities for forest products I

Estimated by dynamic OLS for cointegrated Panel Data

Item	GDP	Price	adj. R-sq	lit_gdp	lit_p
TotalPaperandPaperboard	0.306	-0.934	-0.703		
	(3.38)	(-5.11)			
Newsprint	0.655	-0.269	-3.96	1.02	-0.54
	(11.4)	(-2.64)			
PrintingandWritingPaper	0.568	-0.733	-12	1.3	-0.38
	(18.1)	(-12.2)			
OtherPaperandPaperboard	0.719	-0.25	-4.9	1.13	-0.3
	(7.58)	(-2.61)			
TotalSawnwood	0.539	-0.16	-3.03	0.91	-0.8
	(7.99)	(-1.67)			
SawnwoodConiferous	0.633	-0.874	-3.57	0.78	-0.35
	(11.3)	(-6.87)			
SawnwoodNonConiferous	0.617	-0.195	-9.29	0.79	-0.35
	(12.2)	(-2.05)			

Demand elasticities for forest products II

Estimated by dynamic OLS for cointegrated Panel Data

Item	GDP	Price	adj. R-sq	lit_gdp	lit_p
TotalWoodBasedPanels	0.742	-0.657	-3.45	1.37	-0.37
	(5.44)	(-6.07)			
ParticleBoard	0.556	-1.04	-9.98	1.02	-0.14
	(16.6)	(-12.7)			
Fibreboard	0.58	-0.46	-7.45	1.38	-0.26
	(10.8)	(-4.11)			
Plywood	0.552	-0.324	-5.61	1.02	-0.18
	(11.1)	(-3.2)			
VeneerSheets	1.13	0.0919	-1.98		
	(6.53)	(1.17)			

lit_gdp and lit_p are the median of long term gdp and price elasticities collected from several publications in
[Simangunsong and Buongiorno, 2001], table 10.

Conclusion

- GDP elasticities of demand are still positive, maybe smaller than previous mutli-country estimates in the literature.

Future work:

- Analyse structural breaks in time series of individual countries
- Test the explanatory power of additional exogenous variables
  - Building permits data
  - Internet and computer use

References I

Chas-Amil and Buongiorno, J. (2000).
The demand for paper and paperboard: Econometric model for the European Union.
Applied Economics, 32:987–999.

Hetemäki, L. and Nilsson, S. (2005).
Ict and communication paper markets. information technology and the forest sector.
IUFRO World Series, 18:76–104.

Hurmekoski, E., Hetemäki, L., and Linden, M. (2015).
Factors affecting sawnwood consumption in europe.
Forest Policy and Economics, 50:236–248.

References II

Simangunsong, B. C. H. and Buongiorno, J. (2001).
International Demand Equations for Forest Products : A Comparison of Methods International D emand Equations f or Forest Produc ts : A C omparison of Methods.
Scandinavian Journal of Forest Research, (November 2010):37–41.

Turner, J. a. and Buongiorno, J. (2004).
Estimating Price and Income Elasticities of Demand for Imports of Forest Products from Panel Data.
Scandinavian Journal of Forest Research, 19(4):358–373.