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The Economic and Environmental Effects of an EU Ban on Illegal Logging Imports. Insights from a CGE Assessment

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Summary
Illegal logging is widely recognized as a major economic problem and one of the causes of environmental degradation. Increasing awareness of its negative effects has fostered a wide range of proposals to combat it by major international conservation groups and political organizations. Following the 2008 US legislation which prohibits the import of illegally harvested wood and wood products, the European Union (EU) is now discussing a legislation proposal which would ban illegal timber from the EU market. In this study we use the ICES computable general equilibrium model to estimate the reallocation of global demand and timber imports following the pending EU legislation. With this exercise our final objective is to assess the economic impacts and measure the potential emission reduction resulting from the introduction of this type of policy. Results show that while the EU ban does not seem particularly effective in reducing illegal logging activities, its main effect will be the removal of illegal logs from the international markets. In addition, the unilateral EU ban on illegal logs increases secondary wood production in illegal logging countries as their exports become relatively more competitive. Through this mechanism, part of the banned, illegal timber will re-enter the international trade flows, but it will be "hidden" as processed wood. This effect is, however, limited. Finally, given the limited effect on overall economic activity, effects on GHG emissions are also limited. Direct carbon emissions from logging activities can decrease from 2.5 to 0.6 million tons per year.

Keywords: Forestry, Illegal Logging, International Trade, Economy and Environment, Computable General Equilibrium Models

JEL Classification: D58, Q23, Q56, R13

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The economic and environmental effects of an EU ban on illegal logging imports. Insights from a CGE assessment

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Abstract:

Illegal logging is widely recognized as a major economic problem and one of the causes of environmental degradation. Increasing awareness of its negative effects has fostered a wide range of proposals to combat it by major international conservation groups and political organizations. Following the 2008 US legislation which prohibits the import of illegally harvested wood and wood products, the European Union (EU) is now discussing a legislation proposal which would ban illegal timber from the EU market. In this study we use the ICES computable general equilibrium model to estimate the reallocation of global demand and timber imports following the pending EU legislation. With this exercise our final objective is to assess the economic impacts and measure the potential emission reduction resulting from the introduction of this type of policy.

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1. Introduction

Illegal logging is widely recognized as a major economic problem and one of the causes of environmental degradation, taking place in important biodiversity hot spot areas, depleting forest bases and placing stress on the remaining intact forest sites. In fact, forests are amongst the richest biological systems on earth, containing almost 90% of the total terrestrial biodiversity, therefore holding a major plant and animal natural genetic bank. Continued illegal logging activities seriously endanger this biological wealth creating irreversible losses, such as the extinction of potential plants for medicinal use. In addition, forests also prevent soil erosion and regulate water services, and as a result, high deforestation rates may have long-term negative effects on agricultural production and local water supplies.

Forests play a major role in the world carbon cycle, regulating climate by stocking and releasing CO_2 back into the atmosphere. In fact, currently circa 1 trillion metric tons of CO_2 are stocked in wood biomass, while this number increases to three or four times when it is also considered below ground carbon (UN FAO, 2006). On the other hand, deforestation is the second main cause of global anthropogenic greenhouse (GHG's) emissions, accounting for around 17% of total annual atmospheric carbon release (IPCC 2007).

Against this background, illegal logging must surely be associated to deforestation. The role it plays in this process, however, is still not clear. Some studies appoint illegal logging as the main cause of deforestation (Indufor 2008), others however, have identified agricultural land conversion as the major force behind deforestation rates (Geist and Lambin 2001).[1] Moreover, forest clearance driven by agriculture is associated with larger emissions than illegal logging, as in the latter case timber may be used in long-term carbon storage products such as furniture or construction, implying that a major part of carbon remains stocked in wood biomass.

Finally, illegal logging activities also create important social and economic problems. It often negatively affects communities and rural livelihoods, generates gross government revenue losses, promotes corruption and compromises sustainable forest management. Forests are indeed a critical natural resource for millions of rural poor, providing essential gathering, hunting and fuelwood products. Moreover, forests are an important cultural and social asset in many areas of the world. Illegal logging reduces government revenues from some of the poorest countries in the world due to tax evasion and royalties on legally sanctioned timber. According to a World

[1] Wood extraction can also be associated with agricultural expansion, making it harder to individually identify what drives deforestation rates.

Bank study (World Bank 2006), this amounts to around U$5 billion per year. Finally, and perhaps more importantly, illegally logged timber decreases timber prices on international markets, undermining sustainable forest management practice efforts.

Occasionally, illegal logging has also been considered as an economic source for the poor, generating employment in harvesting operations. These benefits however, do typically tend to be temporary, as the illegally logged areas are unsustainably exploited over a few years and then abandoned.

Increasing awareness of these negative effects has fostered a wide range of proposals in order to combat illegal logging by major international conservation groups and international political organizations. The first official statement on this issue took place at the G8 summit in Birmingham in 1998, when the present foreign ministers agreed on an 'Action Programme on Forests' which explicitly mentioned illegal logging. Following this demonstration of international political will to tackle the illegal logging question, the 2003 EU's Action Plan on Forest Law Enforcement, Governance and Trade (FLEGT) has been at the centre of international attempts to control the world timber products trade. Under this system producer countries negotiate Voluntary Partnership Agreements (VPA) expressing the details of a licensing scheme and setting out the capacity-building assistance to be offered by the European Union. While the FLEG-VPA system has the main advantage of creating a mechanism which makes it possible to distinguish between legal and illegal timber, the vast majority of the world timber trade remains uncovered. Conscious of this major drawback the US and the EU have considered more comprehensive policy instruments to ban illegal timber products from their internal markets. In this context, following the 2008 US legislation which prohibits the import of illegally harvested wood and wood products, the European Union (EU) is now discussing a legislation proposal on banning illegal timber from the EU market.

While the momentum for international action on illegal logging is increasing, it has been argued that policies targeting international trade are not appropriate instruments to tackle the illegal logging issue. The main criticism to this type of measure is based on the fact that most illegal logging activities tend to be poverty driven or low-level subsistence oriented. In fact, up to 80% of total felled roundwood in tropical areas is consumed as fuelwood, while only 2% of total fuelwood production is traded on international markets. While this type of criticism is indeed valid, it is also true that many commercial enterprises benefit from illegal activities, enjoying higher profits and evading taxation that could otherwise be used by national governments to implement development/economic growth programs. In addition, commercial enterprises are known to have organised rural populations to practice illegal logging in

compensation for low value payments. Actions at an international level will therefore close international markets to these types of timber, reducing incentives for enterprises to engage in this type of activity (Brack et al 2002).

In this study we use the ICES computable general equilibrium model to estimate the reallocation of global demand and imports of timber following the pending EU legislation on banning illegal timber from the EU market. This would follow the 2008 US legislation which prohibits the import of illegally harvested wood and wood products (the Combat Illegal Logging Act). With this exercise our final objective is to assess the economic impacts and measure the potential emission reduction resulting from the introduction of this type of policy.

This report is organized as follows. Section 2 presents the relevant economic literature on this topic. Section 3 presents the model, the methodology used to impose a ban on illegal logging by the European Union and describes used illegal logging data. Section 4 presents the simulation results while in section 5 a discussion is provided. Section 6 concludes the report.

2. Literature Review

A series of reports on illegal logging are already available. These have identified the main impacts resulting from continued illegal logging activities, the scope of the problem as well as its role in international timber markets and finally, presents different options in order to combat illegal logging (Contreras-Hermosilla et al. 2007, Brack et al 2001, Brack et al 2002).

While the number of these reports is relatively large, economic data and literature dealing with illegal logging is still scarce. A study commissioned by the American Forest & Paper Association to the Seneca Creek Associates LLC and Wood Resources International LLC (Seneca Creek Associates 2004) analyzed the effects of alleged illegal forest activity on U.S. exporters in non-USA markets. The main objectives of this study were: to provide a perspective and context on the issue of illegal logging from the standpoint of global production and trading patterns; assessing the impacts of illegally produced and traded wood products on the ability of U.S. producers to export into key overseas markets; and, finally, review the various institutional and government initiatives that have been proffered to address illegal logging, paying particular attention to potential implications for the U.S. wood products trade. Using two partial equilibrium economic models, the Global Forest Products Model (GFPM) and the Radiata Pine Market Model (RPMM), a study focused on New Zealand (Turner et al 2007), determined the production, trade and price effects of international trade distortions due to illegal logging, considering the effect of illegal logging on both the price and competitiveness of New Zealand

wood products. This study concluded that the elimination of illegal logging lead to significant increases in the price and production of wood products in almost all countries without illegal logging activities. Moreover, illegal logging potentially lowered investments in forest development, resulting in higher carbon liabilities for countries such as New Zealand.

More recently, a paper using the same GFPM (Li et al 2008) aimed to assess the economic impacts on forest industries by predicting how markets would react to a worldwide elimination of illegal logging over five years. While it concluded that substantial differences in the effects across countries would occur, the impact on wood product prices, production and trade were estimated to be modest. In fact, impact on world prices varied between 2 to 4% depending on the product, and industrial world roundwood production decreased by 1 to 0.5% depending on the assumed illegal logging scenario.

Finally, and closely related to the present study, a recent report has been produced with the main objective to help the European Commission in formulating its policy options aimed at banning illegal timber and timber products on the EU market (Indufor 2008). The study concludes that the final effects will depend on the implemented policy, pointing out major advantages and drawbacks resulting from different policy instruments. It is possible to state, however, that in general a decline in production volume is compensated with higher product prices. Some qualitative considerations on environmental impacts are also presented; no quantitative consequences on carbon emission reductions from deforestation are performed.

Our report uses the Computable General Equilibrium (CGE) model ICES to estimate the reallocation of global demand and imports of timber following the EU legislation on banning illegal logging. The use of a CGE model is particularly appropriate in highlighting worldwide supply and demand re-composition induced by changing prices in the timber market triggered by import restrictions. A CGE model represents national economies as a system of markets interconnected by domestic and international flows of input, goods and services and accordingly, it is particularly apt to describe substitution and transmission mechanisms induced by a given policy shock. On the other hand, it must be recognized that many complexities of illegal economy, and most importantly its interaction with the legal economy, cannot be captured. The main goal of the proposed exercise is thus, to provide a first qualitative description of potential effects in the international timber market and of the possible order of magnitude regarding feedback on income flows and CO_2 emissions.

3. Data and Methodology

3.1 Illegal logging and the industrial roundwood market

Industrial roundwood production is concentrated in three main regions/countries (see Table 1); the United States of America alone was responsible for approximately 25% of world production in 2004, while Canada ranked second. If considered as a whole, the European Union 27 is also one of the major roundwood production areas in the world, representing 20% of global production. Considered together, these three areas are responsible for 67% of total production. Accordingly, countries where illegal logging activities are a major problem, account for a much smaller fraction. Among these, Russia, Brazil China, Indonesia and Malaysia register the highest production levels. Together they produce 24% of global industrial roundwood (FAOSTAT).

Table 1. Major industrial roundwood producers in 2004 (% = country m^3 production/world m^3 production)

United States of America	25,23%
European Union 27	20,60%
Canada	12,39%
Russian Federation	7,88%
Brazil	6,44%
China	5,71%
Indonesia	1,96%
Chile	1,78%
Australia	1,59%
Malaysia	1,53%
India	1,38%
South Africa	1,29%
New Zealand	1,19%
Japan	0,94%
Austria	0,78%
Turkey	0,68%
Nigeria	0,57%
Argentina	0,56%
Thailand	0,52%
Belarus	0,44%
Norway	0,44%
Mexico	0,42%
Ukraine	0,39%
Viet Nam	0,32%
Myanmar	0,25%

Source: FAOSTAT

Some of the main industrial roundwood producers play a less substantial role in world exports. In 2004, large roundwood producers such as the United States of America, Canada, China, Brazil, and Indonesia, exported 2.49%, 1.90% 0.75%, 0.34% and 2.88% of their total

production, respectively. Russia, therefore, was the world largest exporter in 2004, representing almost 35% of total world exports (see Table 2). The European Union 27 ranks second in the list, accounting for 26% of roundwood exports. With the exception of Russia, all other major illegal logging countries play a minor role in international markets, Malaysia for example, represents 4.6% of total world exports, while Indonesia, Myanmar and Brazil account for just 1.23%, 0.78% and 0.3%. From these, Myanmar and Malaysia alone export a significant part of their national industrial roundwood production, 35.18% and 21.53%, respectively (FAOSTAT).

Table 2. Major industrial roundwood exporters in 2004 (% = country m^3 exports/world m^3 exports)

Russian Federation	34,75%
European Union 27	25,99%
United States of America	8,70%
Malaysia	4,56%
New Zealand	4,38%
Canada	3,26%
Czech Republic	2,39%
Ukraine	2,18%
Papua New Guinea	1,69%
Switzerland	1,46%
Gabon	1,44%
Uruguay	1,35%
Myanmar	1,23%
Belarus	1,21%
Australia	0,88%
Solomon Islands	0,85%
Indonesia	0,78%
Congo	0,71%
China	0,59%
Equatorial Guinea	0,57%
Croatia	0,33%
South Africa	0,31%
Central African Republic	0,30%
Brazil	0,30%

Source: FAOSTAT

The European Union is the world's largest roundwood importer (44.3%) followed by China (22.58%) and Japan (10.36%) (see Table 3). Given the aim of the present study, it is particularly relevant to identify the major European Union suppliers. As detailed data on international bilateral trade is hard to obtain, we rely on our initial model database (Narayanan and Walmsley 2008). Accordingly, we find that Africa and Russia are the main sources of European roundwood imports. European imports from Russia are mainly destined to Finland. A recent study (Indufor 2008) confirms these figures, also identifying Russia as Europe's major supplier while African countries' exports are mainly addressed towards Europe.

Table 3. Major industrial roundwood importers in 2004 (% = country m^3 imports/world m^3 imports)	
European Union 27	44,30%
China	22,58%
Japan	10,36%
Korea, Republic of	5,34%
Canada	4,87%
Norway	2,34%
India	2,12%
United States of America	1,99%
Turkey	1,44%
Russian Federation	0,82%
Morocco	0,53%
Thailand	0,43%
Bangladesh	0,28%
Netherlands	0,22%
Philippines	0,20%
Switzerland	0,20%
Uzbekistan	0,19%
Pakistan	0,17%
Ireland	0,16%
Mexico	0,16%

Source: FAOSTAT

We may, therefore, conclude that while for some countries illegal logging represents a major share of national production, it plays a minor role in international trade. Note, however, that illegal timber may also enter international markets through secondary wood products. While the scope of this analysis is restricted to a ban on illegal logging, we also consider the effects on other timber producing sectors when discussing final results.

3.2 Illegal logging shares

Given the nature of the problem, illegal logging estimates are very hard to calculate and are therefore a contentious issue. The controversy starts at its definition as a universal consensus does not exist and legality changes across countries and institutions. In fact, reports on illegal logging rates provided by NGO's and national governments tend to provide rather disparate conclusions. While government institutions' figures concentrate on officially sanctioned logging operations, NGO's usually consider sustainability and the attribution of logging permissions, among other criteria.

The broadest and most widely used study on illegal logging rates today remains the Seneca Creek study commissioned by the American Forest & Paper Association (Seneca Creek Associates 2004). More recently, a new study (Li et al 2008) building upon the Seneca Creek

2004 data provided a comprehensive number of estimates of illegal production, integrated with other report calculations.

Our study makes direct use of these figures. Note, however, that due to lack of data we are directly applying to imports a restriction based on estimates on illegal timber production. The assumption is that the share of illegal products in production translates directly on export. In general, however, illegal product shares tend to be higher in export than in production (Indufor 2008). To account for this we consider the upper level estimates provided in the aforementioned study.

To adjust the original data to the regional aggregation used in this study, we recalculate illegal logging shares, weighting it after industrial roundwood production from the various countries contained in the corresponding macro regions (see Table 4).

Table 4. Illegal logging data

Region	Illegal Logging rate
1 Oceania	3%
2 XAsia	21%
3 Japan	0%
4 China	50%
5 Indonesia	80%
6 Myanmar	80%
7 Malaysia	33%
8 India	10%
9 CAN_XNA	0%
10 USA	0%
11 LACA	12%
12 Brazil	80%
13 EU	3%
14 EST_LTV	30%
15 Finland	0%
16 XEUR	5%
17 Russia	30%
18 AFRICA	21%

3.3 Modeling framework

In order to assess the consequences of the EU ban on imports of illegal logging, this study adopts a general equilibrium perspective. The main strength of this approach is the explicit representation of international and intersectoral trade flows. Goods, services and factors of production are indeed mobile between sectors and countries, responding to scarcity signals provided by changes in relative prices. Therefore, when the final implications on the GDP from each of the economies under investigation, having been induced by some “perturbation” (in our case an import restriction), are provided, “market, social-economic adaptation” is taken into

consideration i.e., all the adjustments at work in the economic system which are able to smooth or amplify the initial impact are analyzed.

Another interesting feature of general equilibrium modelling is the possibility to highlight consequences not only for the economy as a whole (typical indicator in this sense is GDP), but also for each sector represented.

This study uses ICES, a Computable General Equilibrium (CGE) model developed at FEEM. It is a recursive-dynamic and extended version of the GTAP-E model (Burniaux and Truong, 2002), which includes CO2 emissions related to fossil fuel use.

Table 5 presents the selected regional and sectoral aggregation used for this study. The regional detail singles out those areas where illegal logging is a major economic and environmental concern. At the same time, it explicitly identifies the major actors in the world timber trade. The sectoral detail emphasizes the logging industry together with those where timber, raw or processed, is a major production factor (i.e. lumber, paper and construction). Other industries are aggregated into 10 macro-sectors for the sake of simplicity.

Table 5. ICES aggregation

Region	Sectors
Brazil	Agriculture
Indonesia	HeavyMn_Mine
Myanmar	LighMn_Text
China	MarketSrvcs
Malaysia	TransComm
Russia	Coal
Estonia Latvia (EST_LTV)	Oil
Africa	Gas
Rest of Asia (XAsia)	Oil_Pcts
Latin America and the Caribbean (LACA)	Electricity
India	Logging
Rest of Europe (XEUR)	Lumber
European Union* (EU)	Paper
Oceania	Construction
Canada and Rest of North America (CAN_XNA)	
Finland	
Japan	
USA	
* Does not include, Finland, Estonia and Latvia	

The emission module of the model has been enriched by emissions from avoided deforestation relying on data published in the last Global Forest Resources Assessment 2005 (FAO 2006). In using this data it is possible to estimate national carbon averages of stored above-ground biomass per cubic meter of wood and, therefore, calculate the reduction in forest carbon stock as a direct result from logging activities (see Table 6). In addition, to account for the fact that clearances in commercial forest plantations are usually compensated through re-plantation, we

adjust emissions to account for logging associated with primary forests alone. For this last step we use collected data from Brown (2000).

Finally, one should note that at the time of harvesting a significant fraction of carbon previously retained in woody biomass may remain stocked in wood products, which means that emissions do not take place immediately. Therefore, to correctly account for the time path of these carbon emissions it would be necessary to have a complete description of the wood product cycle. Unfortunately, this type of information is still not available on a global scale. Taking this into consideration we perform a sensitivity analysis on the amount of timber that is used in long-term storage structures (e.g. construction). In this case, if for example, 75% of harvested timber is used in long-term storage structures, this means that only the remaining 25% will eventually be destroyed in the short run. Accordingly, we may estimate the amount of carbon emissions resulting from illegal logging activities by assuming that 25% of carbon stocked in woody biomass is released when harvesting occurs.

Table 6 – Data for forest carbon release calculations

Region	Carbon in Above- Ground Biomass (tonnes/ha)	Wood m^3/ha
Oceania	36	35
XAsia	63	76
Japan	61	171
China	23	67
Indonesia	50	59
Myanmar	79	85
Malaysia	136	251
India	27	69
CAN_XNA	-	106
USA	52	116
LACA	90	101
Brazil	81	170
EU	61	166
EST_LTV	59	201
Finland	30	96
XEUR	61	174
Russia	32	100
AFRICA	73	94

The ban on illegal logging is implemented through an import tariff which reduces EU log imports until demand directed to each exporter meets exactly their legal log supply. The presence of the tariff, is however, just an artifice to replicate the desired quota restriction. It raises the problem of the revenues which, in the quota case, do not exist. In the model they are rebated lump sums to households by default, this however, would imply an excessive burden on EU log importers and perhaps an unrealistic gain to households. Thus to remove this distortion the tariff paid is not refunded to households, but to importers.

Final important disclaimers are as follows:

Although the model is recursive-dynamic, we use it in its static fashion. The aim of this exercise is indeed to highlight transmission mechanisms and possible feedback effects, rather than to study long-term dynamics. In order to do this, it is preferable to base the assessment on the verified historical data and parameterization of the calibration year (2004) and to avoid uncertain projections.

Secondly, due to the lack of data, the model does not represent as separate and different the legal and illegal timber production/market. This has many consequences.

Firstly, it is assumed that the timber export composition of legal and illegal logs from an illegal logging country is the same irrespective of the importer and is equal to the share of illegal logging over total logging production. It is also assumed that there is no difference in legal and illegal components between timber directed to the domestic or international market.

By the same token, at least where domestic production is concerned, timber is treated as an undifferentiated good composed of a given share of legal and illegal products, it is therefore, impossible to describe the re-composition between legal and illegal activity induced by the EU ban. What can be derived, however, is the impact on total domestic timber production due to the ban and through this it is possible to make some inference on illegal activity.

Nevertheless, as long as imports/exports are concerned, it is assumed that the ban is 100% effective in tackling illegal exports (perfect traceability of illegal timber).

4. Results

In this section we discuss the results of a European Union ban on illegal logging following the methodology described in the previous section. In particular, we focus our analysis on trade flows, production and prices in “wood dependent” sectors and effects on Gross Domestic Product (GDP). Finally, we assess the impact of this type of policy in Greenhouse Gas Emissions for the main illegal logging countries.

4.1 Trade flows

Table 7 extensively reports the effect of the EU ban on timber from illegal logging activities on world import/export volumes in the timber markets. Figures 1 and 2 provide a snapshot for the EU.

Table 7. Changes in timber import (columns to row)/ export (rows to columns) flows following the EU ban on timber from illegal logging activities

(1)	(2)		Oceania	XAsia	Japan	China	Indonesia	Myanmar	Malaysia	India	CAN_XNA	USA	LACA	Brazil	EU	EST_LTV	Finland	XEUR	Russia	AFRICA
2.9	5	Oceania	-0.001	-0.051	-0.021	-0.052	0.007	-0.269	-0.237	-0.155	0.007	0.005	-0.003	0.000	-2.9	-2.9	-2.9	-0.009	-0.018	-0.062
21.1	11	XAsia	0.002	-0.048	-0.018	-0.049	0.010	-0.266	-0.234	-0.152	0.010	0.008	0.000	0.003	-21.1	-21.1	-21.1	-0.006	-0.016	-0.059
	18	Japan	-0.003	-0.053	0	-0.053	0.006	-0.271	-0.239	-0.157	0.006	0.004	-0.005	-0.001	14.8	55.2	73.0	-0.010	-0.020	-0.064
50.0	14*	China	0.001	-0.049	-0.019	0	0.009	-0.267	-0.235	-0.153	0.009	0.007	-0.001	0.003	-50.0	-50.0	-50.0	-0.007	-0.016	-0.060
80.0	15*	Indonesia	0.008	-0.041	-0.011	-0.042	0	-0.258	-0.227	-0.145	0.017	0.015	0.007	0.010	-80.0	-80.0	-80.0	0.001	-0.008	-0.052
80.0	9*	Myanmar	0.967	0.806	0.841	0.790	0.903	0	0.584	0.686	0.889	0.955	0.946	0.969	-80.0	-80.0	-80.0	0.862	0.950	0.827
33.0	6*	Malaysia	0.002	-0.048	-0.018	-0.049	0.010	-0.266	0	-0.153	0.010	0.009	0.000	0.004	-33.0	-33.0	-33.0	-0.005	-0.015	-0.059
10.0	13	India	0.003	-0.047	-0.017	-0.047	0.011	-0.265	-0.233	0	0.011	0.009	0.000	0.004	-10.0	-10.0	-10.0	-0.005	-0.014	-0.058
	7	CAN_XNA	-0.005	-0.055	-0.025	-0.056	0.003	-0.274	-0.241	-0.159	0.004	0.001	-0.007	-0.004	14.8	55.2	73.0	-0.013	-0.023	-0.066
	3	USA	-0.007	-0.057	-0.026	-0.057	0.002	-0.275	-0.243	-0.161	0.002	0	-0.009	-0.005	14.8	55.2	73.0	-0.014	-0.024	-0.068
11.9	10	LACA	0.004	-0.047	-0.016	-0.047	0.012	-0.264	-0.232	-0.151	0.012	0.010	0.001	0.004	-11.9	-11.9	-11.9	-0.005	-0.014	-0.058
80.0	17*	Brazil	0.006	-0.044	-0.014	-0.045	0.015	-0.262	-0.230	-0.149	0.014	0.012	0.003	0	-80.0	-80.0	-80.0	-0.002	-0.012	-0.055
3.2	1	EU	-0.059	-0.111	-0.078	-0.111	-0.052	-0.330	-0.295	-0.212	-0.052	-0.054	-0.064	-0.061	-3.2	-3.2	-3.2	-0.069	-0.076	-0.120
29.5	12	EST_LTV	0.255	0.197	0.241	0.210	0.269	-0.008	0.024	0.105	0.252	0.241	0.251	0.262	-29.5	-29.5	-29.5	0.223	0.236	0.180
	16	Finland	-0.566	-0.556	-0.525	-0.611	-0.558	-0.833	-0.801	-0.709	-0.552	-0.509	-0.563	-0.565	14.1	54.5	0	-0.538	-0.581	-0.578
5.0	8	XEUR	0.003	-0.047	-0.016	-0.047	0.012	-0.265	-0.233	-0.151	0.012	0.010	0.001	0.005	-5.0	-5.0	-5.0	-0.005	-0.014	-0.058
30.0	2*	Russia	0.151	0.087	0.118	0.086	0.160	-0.117	-0.085	-0.024	0.155	0.139	0.140	0.153	-30.0	-30.0	-30.0	0.128	0	0.078
21.4	4*	AFRICA	0.066	0.011	0.044	0.009	0.073	-0.201	-0.172	-0.095	0.075	0.072	0.061	0.068	-21.4	-21.4	-21.4	0.053	0.050	0

(1) % of illegal over total logging activities

(2) Country/region rank in wood exports (note this rank is slightly different from that of table 4 due to the different regional aggregation)

Figure 1. Timber exports to the EU from top 7 "illegal loggers": % change wrt baseline

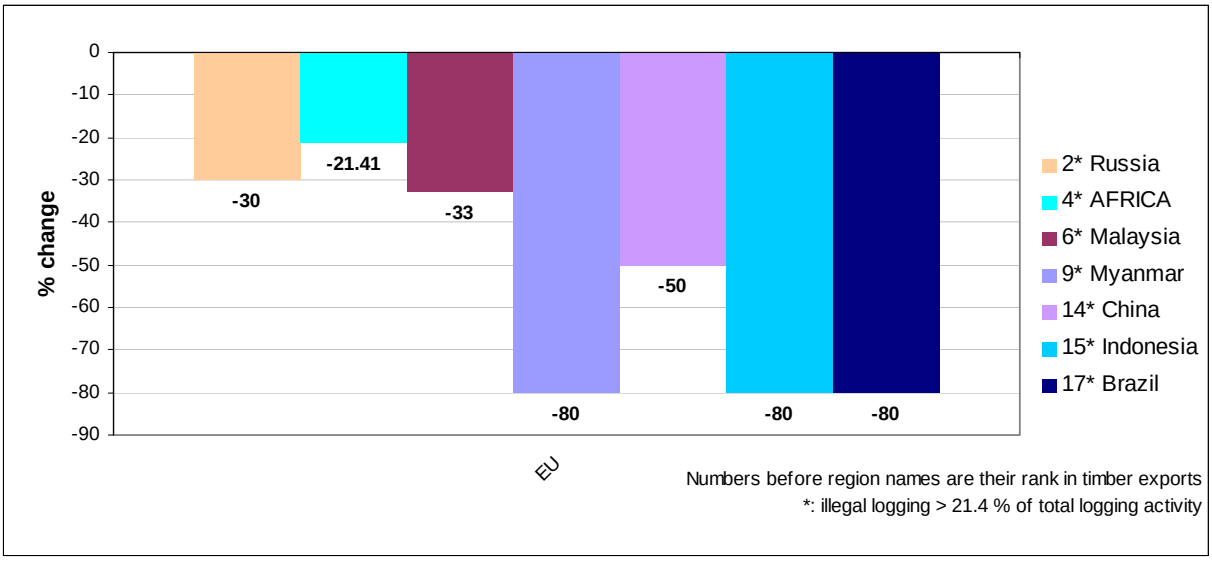


Figure 2. Timber exports to the EU from top 7 "illegal loggers": abs. change wrt baseline

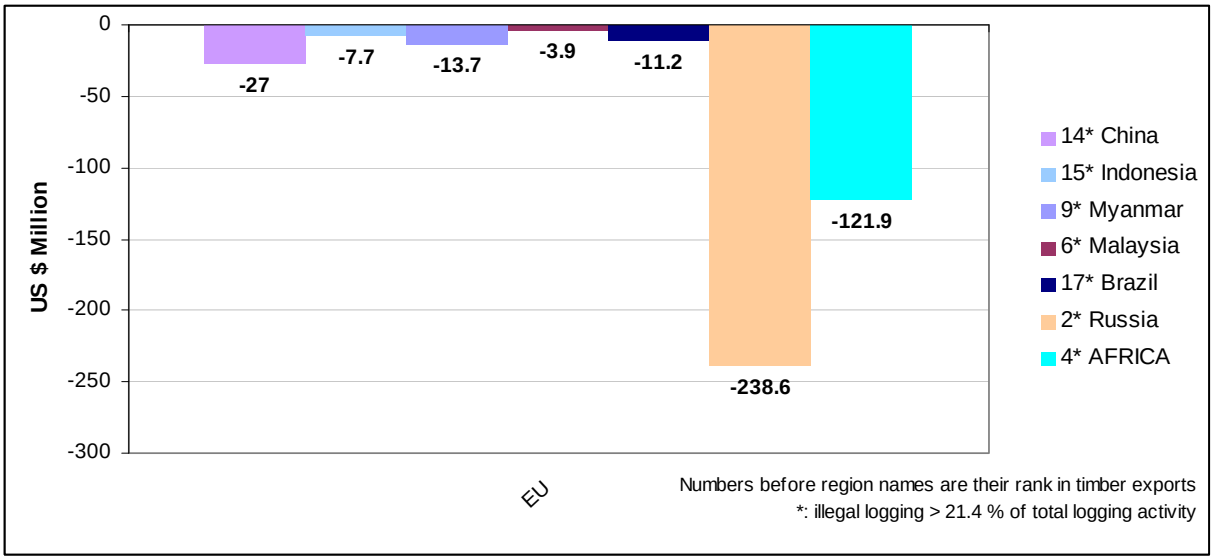
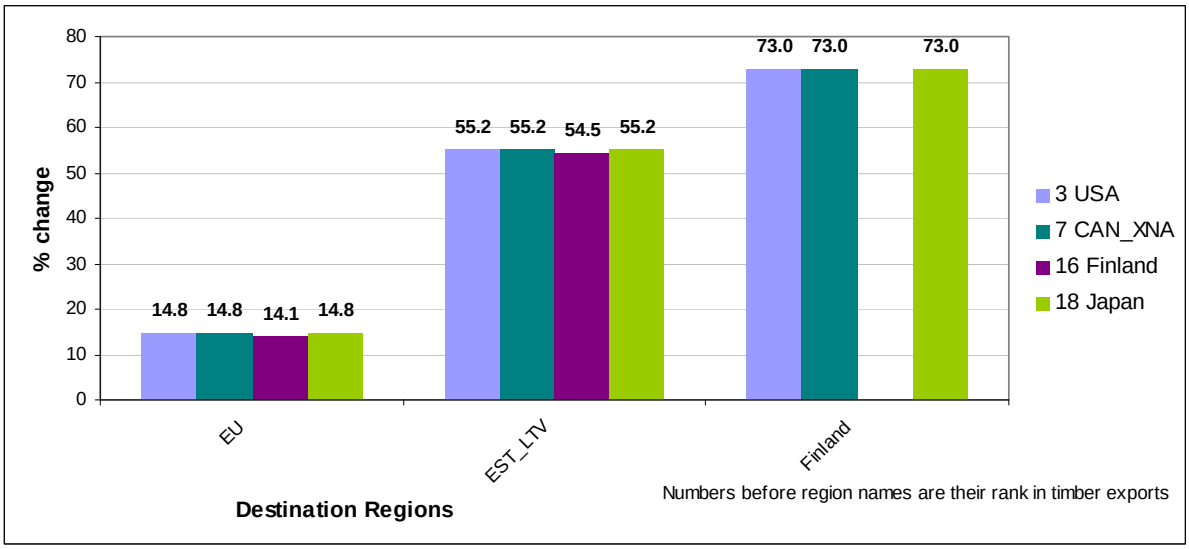
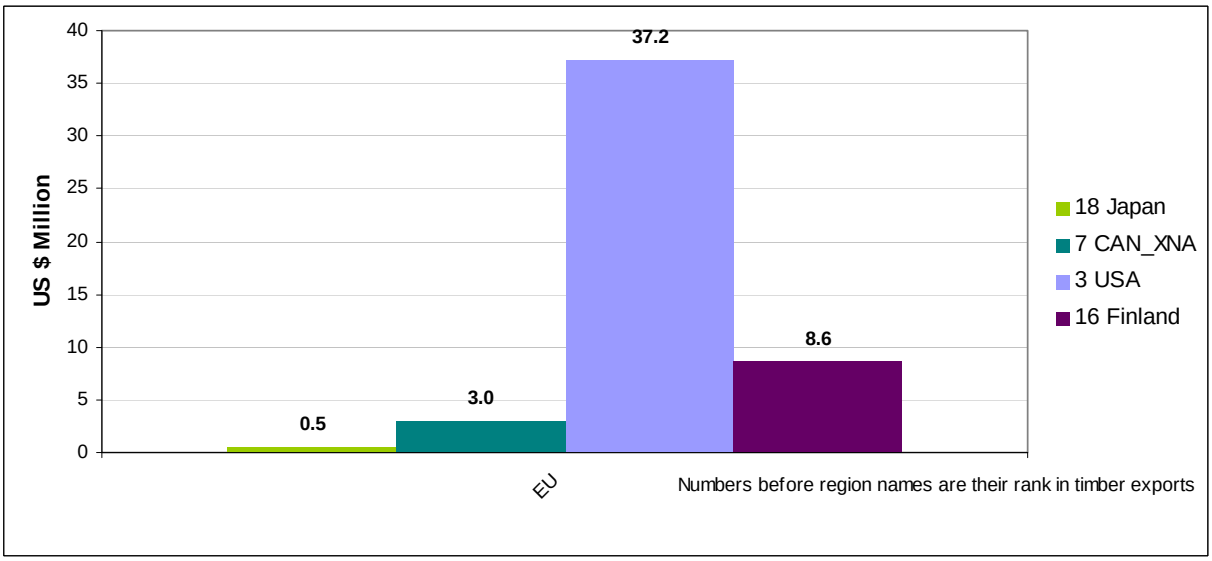


Figure 3. Timber exports to the EU from top 4 "legal loggers": % change wrt baseline



Note. EU excludes Estonia, Latvia and Finland

Figure 4. Timber exports to the EU from top 4 "legal loggers": abs. change wrt baseline

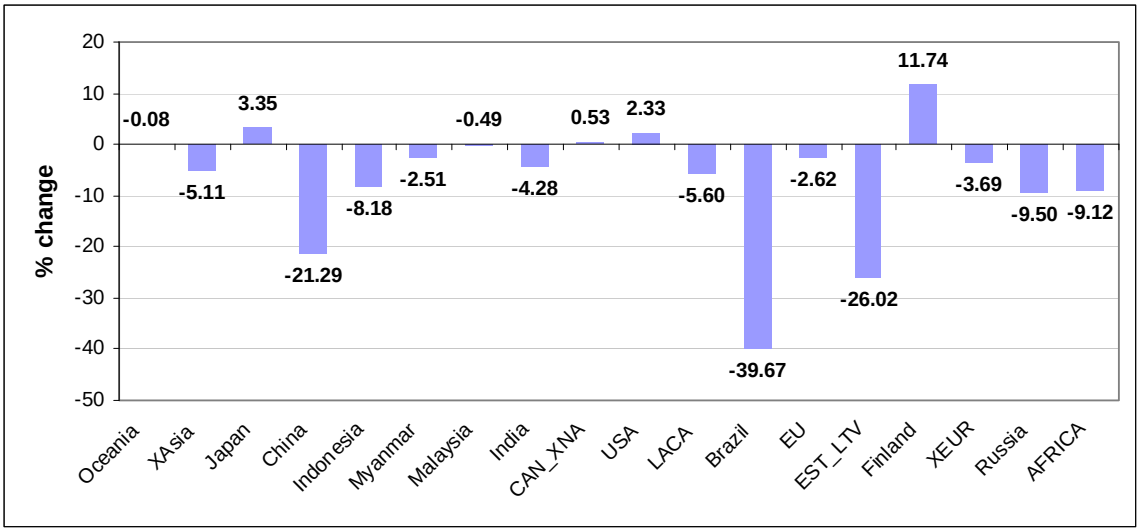


The EU ban reduces timber exports from illegal loggers to the EU by -21% from Africa to -80% from Myanmar, Indonesia and Brazil (see Figure 1). In absolute money terms, the higher export contractions to the EU are experienced by Russia (-238 US $ million) and Africa (-122 US $ million) which are the main EU timber trading partners (Figure 2). All illegal logging regions compensate the ban by increasing their timber exports to non EU countries and often timber use in the domestic market (see Table 7). At the same time, the ban increases (on average by roughly 14%) EU timber demand addressed towards the legal producers. This is met by a uniform and proportional increase in exports primarily from the USA, Canada and North America, Japan and Finland (Figure 3 and 4). The ban also fosters EU domestic logging production which increases by 1.3% (Figure 7).

The net reshuffling effect on timber import/export flows is relevant: in illegal logging prone regions total timber exports contract by -40% in Brazil to -8% in Indonesia. In "legal logger regions" they increase by 2.3% to 11% in the USA and Finland, respectively (Figure 5).

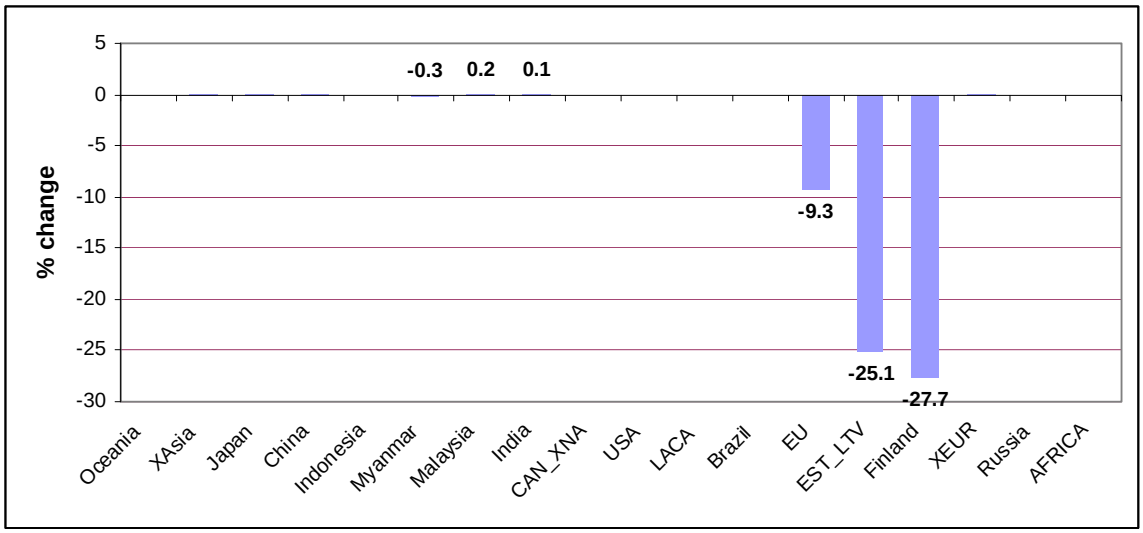
Total EU timber demand on international markets contracts roughly by -9% (in Estonia and Latvia, and Finland -25% and -27.7%, respectively – see figure 6). Imports in all the other regions are, however, scarcely affected. This confirms that a unilaterally imposed ban by the EU has mainly an EU relevance.

Figure 5. Timber exports: % change wrt baseline



Note: EU excludes Estonia, Latvia and Finland

Figure 6. Timber imports: % change wrt baseline



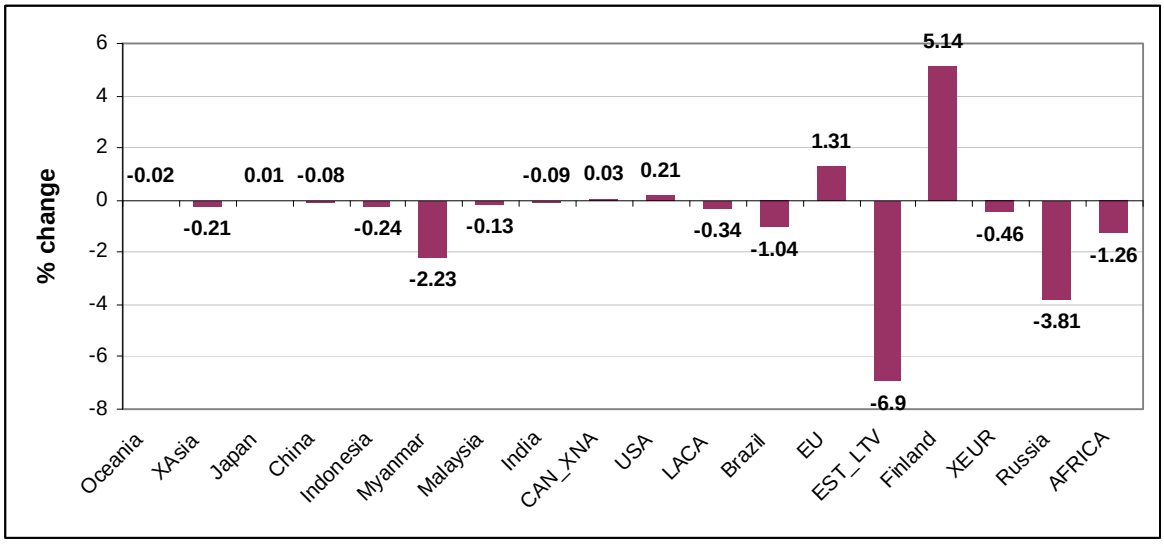
Note: EU excludes Estonia, Latvia and Finland

4.2 Impacts on wood product sectors

Exporters hit by the ban, decrease their timber production, but by much less than the drop in imports. This depends on the possibility to sell timber domestically and on the fact that exports are usually a minor share of total production. The opposite happens in regions where logging activities are mainly legal (see Figure 7).

Higher percentage contractions are thus experienced by Estonia and Latvia (-7%), Russia (-3.8%) and Africa (-1.26%). The latter two areas have more intense timber trade flows with Europe. These are followed by Myanmar (-2.2%) and Brazil (-1%). On the contrary, Finland, the EU and USA expand logging by 5%, 1.3%, 0.2%, respectively.

Figure 7. Log production: % change wrt baseline



Note: EU excludes Estonia, Latvia and Finland

Globally, contractions and expansions in logging activities almost perfectly compensate each other. This leaves world raw timber production (see Figure 8) and prices (see Figure 9) almost unaffected: they both increase, but marginally so (0.08% and 0.002%, respectively). The effect on other industrial sectors is close to zero.

Figure 8. World sectoral production (% change wrt baseline)

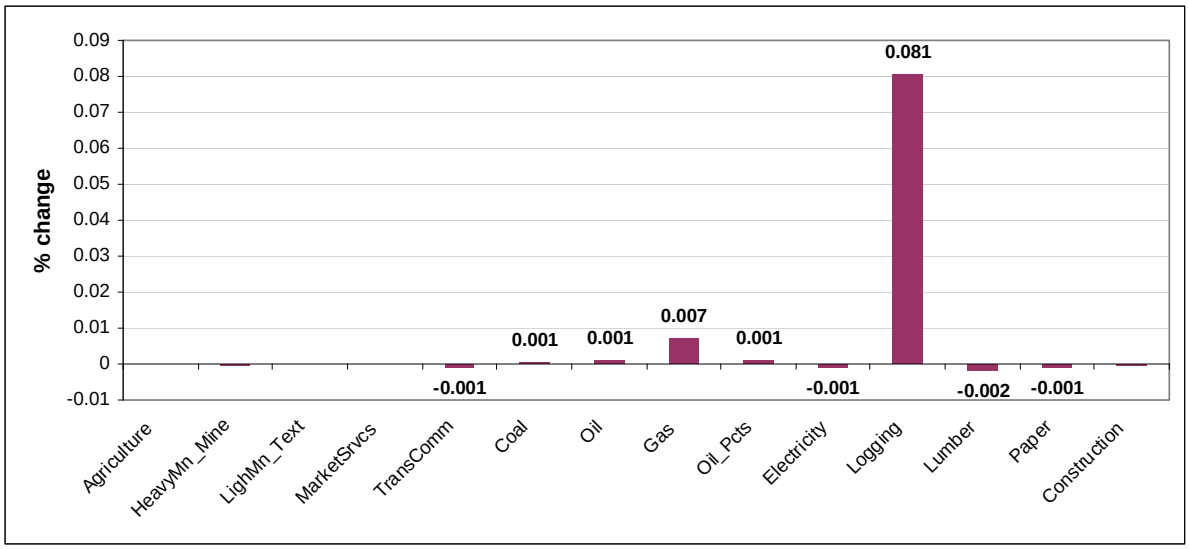
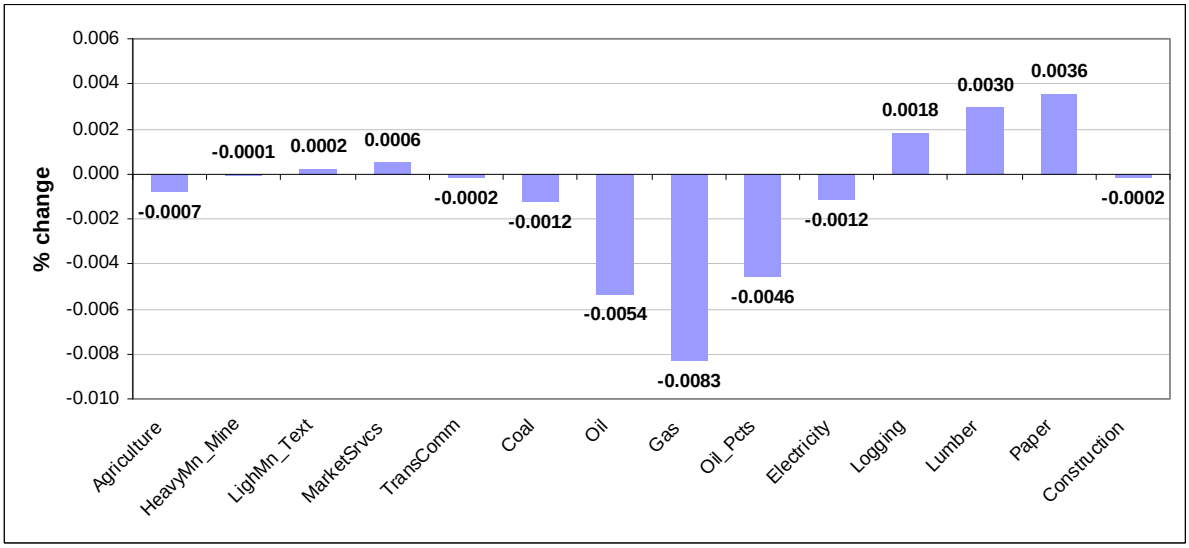
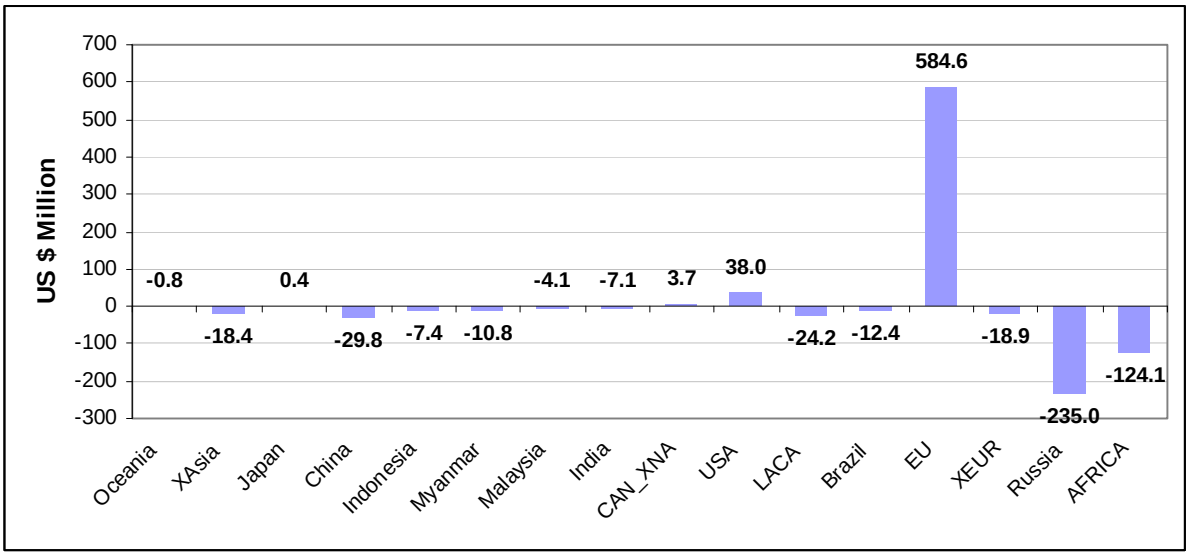


Figure 9. World prices: % change wrt baseline



In terms of value-added (see figure 10), the EU ban clearly favours logging activities from legal producers, primarily within the EU (where the gain can be quantified in 584.6 US$ Million), followed by the USA, the rest of North America and marginally, Japan. It penalizes the logging activities in regions where illegal logging is widespread, especially those where the EU is the main export destination i.e. Russia (-235 US$ Million) and Africa (-124 US$ Million).

Figure 10. Value added of the logging sector: abs. change wrt baseline



Summarizing, the results so far obtained allows us to derive

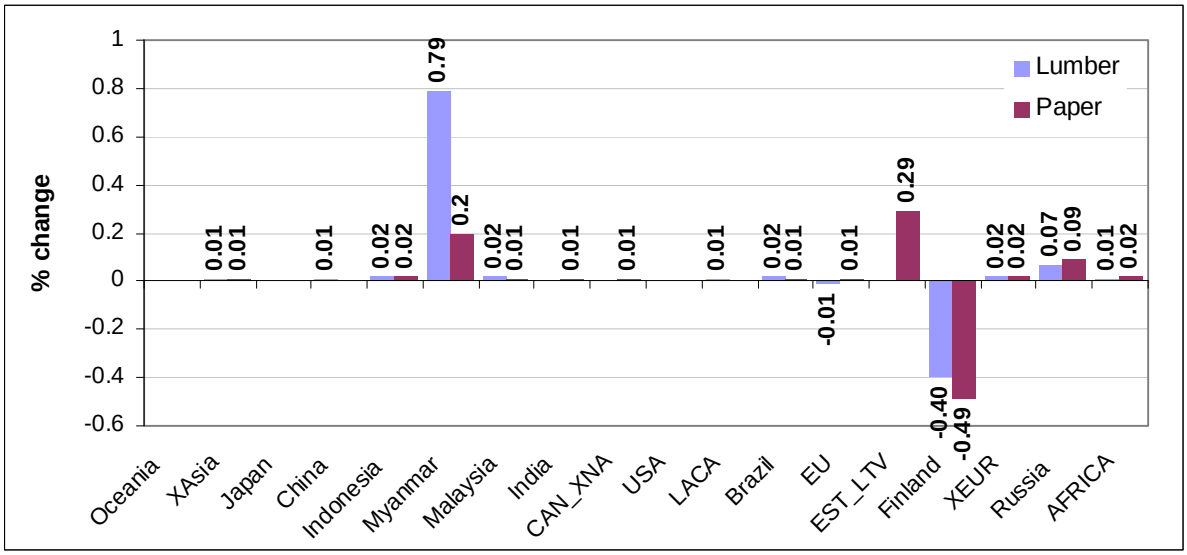
conclusion 1: *"the (unilateral) EU ban has the main effect of removing illegally logged timber from the international market (as witnessed by the contraction in exports from illegal loggers), but it is not really effective in reducing illegal logging activities (much smaller contraction in logging activities)"*

conclusion 2: *"the (unilateral) EU ban has a (moderately) positive effect on logging industries in legal logging regions (especially the EU) as their production increases together with prices. Conversely, the ban damages logging industries in illegal logging regions"*

As shown, the size of quantity and price effects on production in the logging industry are rather modest. This being the industry more directly affected by the ban. Accordingly, smaller impacts can be expected in those sectors using raw timber as a direct intermediate input such as lumber (which is a timber processing industry), and those higher up in the production chain, such as paper and construction, both of which are only indirectly hit by the EU policy. The negligible global and regional effects on lumber and paper production are indeed highlighted in Figure 11[2]. Effects on sectoral value-added are reported in figure 12.

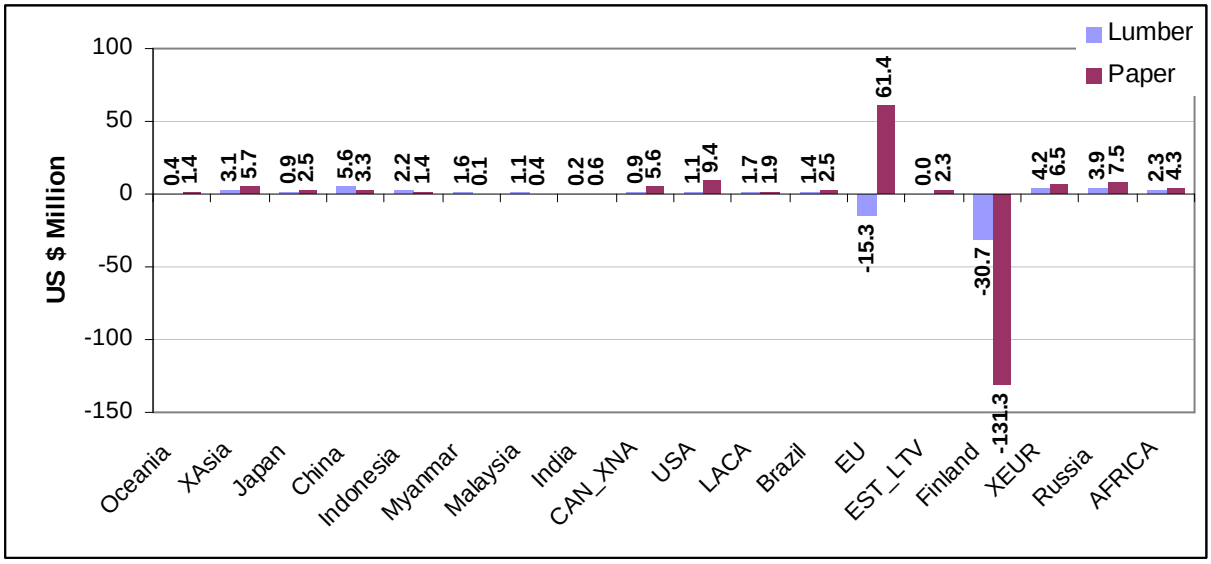
[2] Construction is omitted as impacts on sectoral production are basically zero.

Figure 11. Lumber and paper regional production: % change wrt baseline



Note: EU excludes Estonia, Latvia and Finland

Figure 12. Lumber and paper value added: abs. change wrt baseline



Note: EU excludes Estonia, Latvia and Finland

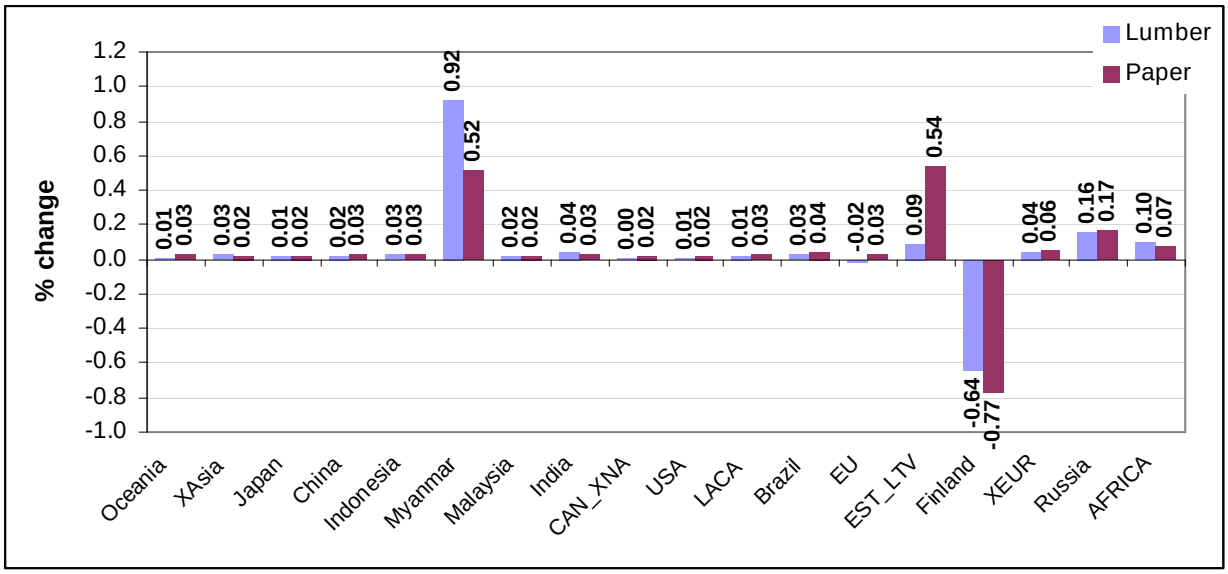
These latter results allow us to draw the following

***conclusion 3**: "the (unilateral) EU ban has an effect which is mainly circumscribed to the logging sectors and the logging market; in general it affects the activity and income of other wood dependent sectors only marginally."*

However, Figures 11 and 12 also convey other important information.

Illegal loggers, primarily Myanmar and Russia - and within the EU, Estonia and Lithuania - are *increasing* lumber and paper production. A similar pattern can be observed in their exports (see Figure 13).

Figure 13. Lumber and paper exports: % change wrt baseline



Essentially, in illegal logging countries there is an excess supply of raw timber (logs) which cannot be sold abroad. Therefore, this becomes a cheaper intermediate input for domestic lumber and paper industries which can increase production and exports.

This leads to

conclusion 4*: "the (unilateral) EU ban also has the effect of stimulating secondary wood products in illegal logging countries and, through this mechanism, part of the banned illegal timber will remain in the international trade flows, but will be "hidden" as processed wood."*

This is a kind of pervasive effect as all illegal logging countries increase their exports of secondary wood products. This increase is, however, rather small. Therefore, while illegal timber may still enter international markets through this channel it would seem that they do not compensate a reduction in log flows, and conclusion 1 is, therefore, still valid[3].

[3] This conclusion is also indirectly supported by analyzing Figure 10 which shows the effects on value-added of secondary wood products sectors are positive, even though very small.

The final effect of the EU ban on secondary wood products in legal logging countries depends on trade relationships. Surely all their paper and lumber industries will face a stronger competition from illegal loggers homologues. This will be felt more heavily in those countries sourcing their exports of paper and lumber to the EU. The case of Finland is emblematic. It experiences the major contraction in value-added (-162 US $ Million), production (-0.45% on average) and exports (-0.7% on average) as these are mainly addressed to the EU market where they have to compete with Russia, Estonia and Latvia which use illegal timber as intermediates[4]. The US also export paper and lumber to the EU, but their market is wider and the effect on domestic paper and lumber sectors is negligible.

Therefore, it can be added that

conclusion 5*: "the (unilateral) EU ban also has the effect of exposing secondary wood producers in legal logging countries to higher competition from secondary wood producers in illegal logging countries. This can be somewhat harmful for those legal logging countries sourcing a higher share of their secondary wood product exports to the EU."*

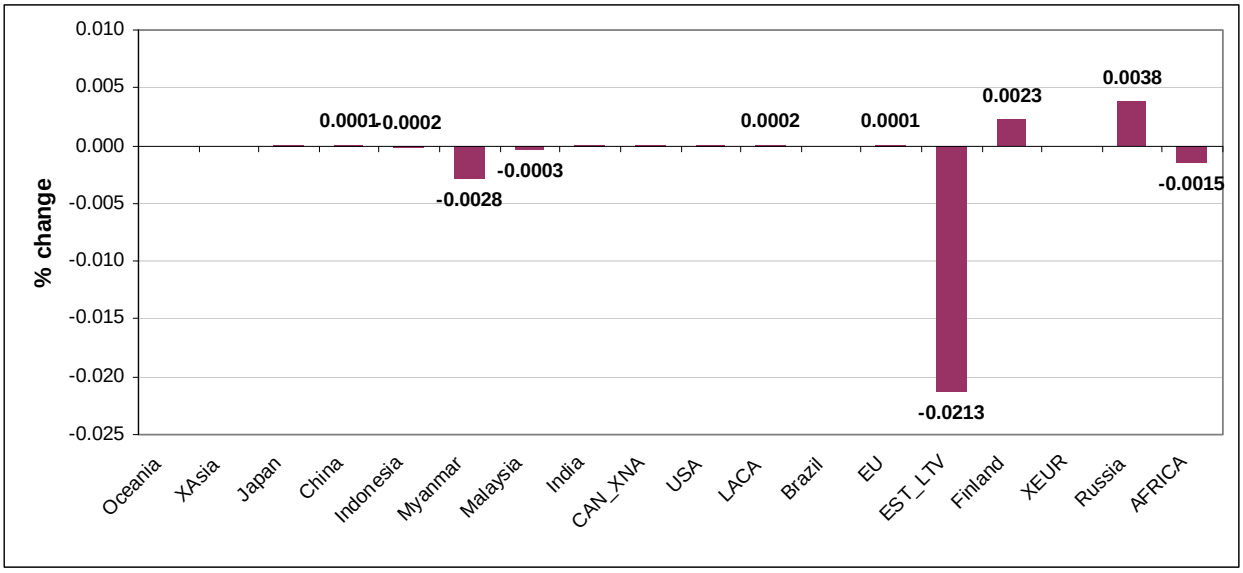
4.3 Impacts on GDP

Impacts on GDP are minimal (Figure 14), thus, it becomes difficult to explain them in detail. As a matter of fact, secondary and re-composition effects can prevail over direct effects, shadowing the role of typical market mechanisms. Three illegal logging regions: Myanmar, Estonia and Latvia, and Africa, can be seen as experiencing GDP losses. On the contrary, Russia, another illegal logger, performs better in term of GDP. Take this last example: Russia is not only gaining, but its gain is also the largest on a world level. However, as a result of the ban, its logging activity decreases by -3.1%; its logging exports by -9% and its terms of trade also worsen (-0.02%). The only positive notes for Russia are the slightly increased production and exports of lumber and paper (0.07%, 0.09% for production and 0.16%, 0.17% for exports respectively). These are not sufficient to justify the slight GDP gain. Marginal adjustments of demand and supply in all the other sectors can explain this. Could we thus conclude that the EU ban is beneficial for Russia? Mathematically yes, however, the right (and robust) message to derive from the whole exercise is that the EU ban has practically no effect on GDPs. Estonia and Latvia is the region worst off by a decrease of 0.02%. Thus, the ban is relevant and should be analyzed at the sectoral level. Given that the weight of logging activity is small if compared

[4] Note incidentally that the decrease in lumber and paper industry value-added (-163 US$ Million) is smaller than the increase in the logging industry value- added (207 US$ Million).

to regional value-added, the feedback of shocks in the logging market onto the overall economic system are also small. Losses(gains) for the illegal(legal) logging sectors are thus dwarfed by demand, and supply adjustments occurring inside the remaining economic sectors.

Figure 14. Impacts on real GDP (% change wrt baseline)



Finally, this allows us to draw the following

conclusion 6*: "The effects of the (unilateral) EU ban are particularly relevant at the sectoral level, primarily in the logging industry. Outside of this sector effects are mainly distributional with scarce scale implications for the overall economic activity."*

4.4 Impacts CO2 Emissions

Given the characteristics of the ICES model, it is possible to identify not only the direct effects on forest carbon release associated with changes in logging activities, but also the overall change in carbon fluxes occurring on the rest of the economy due to the introduction of the ban. Table 8 presents the direct forest carbon release effects occurring on the logging sector, indirect carbon emissions and the resulting total effect. Globally, total reduction varies from 2500 to 600 thousand tons of carbon depending on the assumption made regarding the amount of timber entering long term storage wood products. The reduction effect is the highest for Russia, followed by Africa and Brazil. Considering that 75% of harvested timber is used in long-term storage structures, illegal-logging–related emissions in Russia decrease by 300 thousand tons, while for Africa and Brazil emissions decrease by 115 and 95 thousand tons of carbon, respectively. Finally, it is worthwhile noting that while logging decreases in these countries, harvesting increases in other areas. These increases, however, take place in countries where

managed forests are responsible for almost all logging activities (United States of America, Canada and Finland), signifying that all eventually released carbon will be compensated by re-plantation of previously cleared areas.

We now turn our discussion to indirect carbon emissions. Given the limited size of the logging sector on the overall world economy production, global effects are relatively small. World emissions increase by 62 thousand tons of carbon, offsetting the total reduction on forest related carbon emissions by 10% when we assume that 75% of illegally logged timber is used in long term storage structures. Interestingly enough, the European Union is the world region that increases its fuel related emissions. In particular, it is the logging sector within this region registering the highest increase. A similar effect is observed in Finland, even if its total level of emissions decreases after policy introduction. We may, therefore, conclude that while banning illegal logging may have a negative overall effect as global fuel emissions increase, it is not enough to reap the benefits from illegal logging forest carbon release reductions.

Summarizing, we can derive that

conclusion 7*: "the effects of the (unilateral) EU ban on CO_2 emissions is moderate if emissions from forestry are considered (-0.9%), it is negligible if total world CO_2 emissions are the reference (-0.01%). However, in absolute terms, carbon saving can be from 2.4 to 0.57 million tons per year."*

Table 8. CO2 emission effects (1000 tonnes)

	Forest carbon emissions			**Total change in emissions**		**Change in emissions / Total emissions (%)**	
Region	all carbon released at harvest	25% carbon released at harvest	**Indirect emissions**	all carbon released at harvest	25% carbon released at harvest	all carbon released at harvest	25% carbon released at harvest
Oceania	-2,03	-0,51	1,22	-0,81	0,71	0,00%	0,00%
XAsia	-38,83	-9,71	18,74	-20,09	9,03	0,00%	0,00%
Japan	0,00	0,00	9,49	9,49	9,49	0,00%	0,00%
China	-21,19	-5,30	8,75	-12,43	3,45	0,00%	0,00%
Indonesia	-51,63	-12,91	2,64	-49,00	-10,27	-0,05%	-0,01%
Myanmar	-67,35	-16,84	0,70	-66,65	-16,14	-2,69%	-0,65%
Malaysia	-13,34	-3,34	1,47	-11,87	-1,87	-0,03%	0,00%
India	-6,22	-1,55	3,95	-2,27	2,39	0,00%	0,00%
CAN_XNA	0,00	0,00	2,55	2,55	2,55	0,00%	0,00%
USA	0,00	0,00	28,43	28,43	28,43	0,00%	0,00%
LACA	-143,95	-35,99	2,58	-141,37	-33,41	-0,05%	-0,01%
Brazil	-383,15	-95,79	2,13	-381,02	-93,66	-0,37%	-0,09%
EU	0,00	0,00	40,17	40,17	40,17	0,00%	0,00%
EST_LTV	-70,33	-17,58	-4,40	-74,73	-21,98	-1,10%	-0,32%
Finland	0,00	0,00	-11,28	-11,28	-11,28	-0,05%	-0,05%
XEUR	0,00	0,00	11,50	11,50	11,50	0,00%	0,00%
Russia	-1220,05	-305,01	-72,51	-1292,56	-377,52	-0,30%	-0,09%
AFRICA	-461,02	-115,26	16,59	-444,43	-98,66	-0,17%	-0,04%
Total	-2479,08	-619,77	62,73	-2416,36	-557,05	-0,03%	-0,01%

5. Conclusions

This research analyzed the potential economic implication of a EU unilateral ban on imports of illegal logging within a general equilibrium perspective. The main messages to have emerged from this exercise are the following:

- the unilateral EU ban has the main effect of removing illegally logged timber from the international market. This is witnessed by the sharp export contractions from main illegal loggers (in a range from -8% to -40%). At the same time, it does not seem particularly effective in reducing illegal logging activities as in general, countries with illegal logging activities decline only moderately (-7% at most in Estonia and Latvia). Illegal logs are indeed partly re-addressed to importers, other than the EU, and used more in the domestic market.
- The unilateral EU ban has a (moderately) positive effect on logging industries in legal logging regions, as their production and value-added increase. The stronger positive effects are in the EU where log industry value-added increases by 584.6 US $ Million. Conversely, the ban damages logging industries in illegal logging regions, primarily those located in major log exporters to the EU i.e. Russia and Africa. These countries find it more difficult to internationally recompose their portfolio of customers.
- The unilateral EU ban primarily affects the logging sectors and the logging market. In general, the overall economic activity is not affected; impacts on GDP performances are negligible. Nonetheless, some interesting second-order effects can be seen in secondary wood products sectors.
- The unilateral EU ban indeed offers a more abundant and cheaper input (illegal timber which cannot be sold abroad) to secondary wood-products industries (lumber and paper) in illegal logging countries. Accordingly, their production increases and their exports become relatively more competitive and thus, also increase (0.9% at the maximum in Myanmar). Through this mechanism, part of the banned, illegal timber will re-enter the international trade flows, but will be “hidden” as processed wood. This effect is, however, limited.
- As a consequence the unilateral EU ban also has the effect to expose secondary wood producers in legal logging countries to higher competition from secondary wood producers in illegal logging countries. This can be somewhat harmful for those legal logging countries (e.g. Finland) sourcing a higher share of their secondary wood product exports to the EU.

- Given the limited effect on overall economic activity, effects on GHG emissions are also limited. Direct carbon emissions from logging activity can decrease from 2.5 to 0.6 million tons per year, however this is a tiny advantage (a reduction of the -0.01%) if compared to world CO2 emissions.

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Annex I: The ICES model description

ICES (Intertemporal Computable Equilibrium System) is a CGE model for the world economy. Its general equilibrium structure - in which all markets are interlinked - is tailored to capture and highlight the production and consumption substitution processes at play in the social-economic system as a response economic shocks. In doing so, the final equilibrium determined, takes explicitly "market-driven adaptation" of economic systems into account.

ICES is a recursive-dynamic CGE that shares the production structure of GTAP-E model (Burniaux and Truong, 2002) using data for the year 2004 available from the Global Trade Analysis Project (GTAP) database version 7 (Narayanan B.G. and Walmsley T.L., 2008).

Since the aim of this particular exercise is to highlight transmission mechanisms and possible feedback effects from a import ban, rather than to study long-term dynamics, we use it in its static fashion relying on the detailed information resulting from simulations for the calibration year (2004).

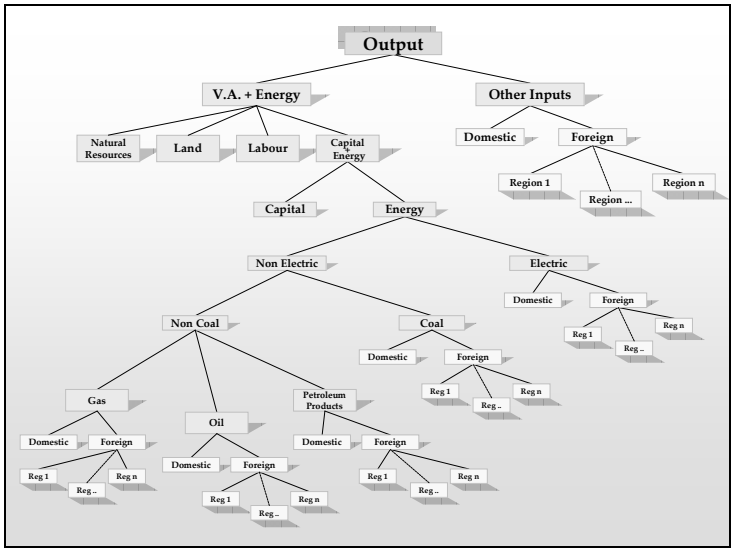
The main features of the model are:

- Top-down recursive growth model: a sequence of static equilibria are inter-temporally connected by endogenous investment decisions
- Detailed regional and sectoral disaggregation.
- Inter sectoral factor mobility and international trade. International investment flows.
- Representation of emissions of main GHG gases: CO2, CH4, N2O.

As in all CGE models, ICES makes use of the Walrasian perfect competition paradigm to simulate adjustment processes, although the inclusion of some elements of imperfect competition is also possible.

Industries are modelled through a representative firm, minimizing costs while taking prices as given. In turn, output prices are given by average production costs. The production functions are specified via a series of nested CES functions. Domestic and foreign inputs are not perfect substitutes, according to the so-called "Armington" assumption (Figure A1).

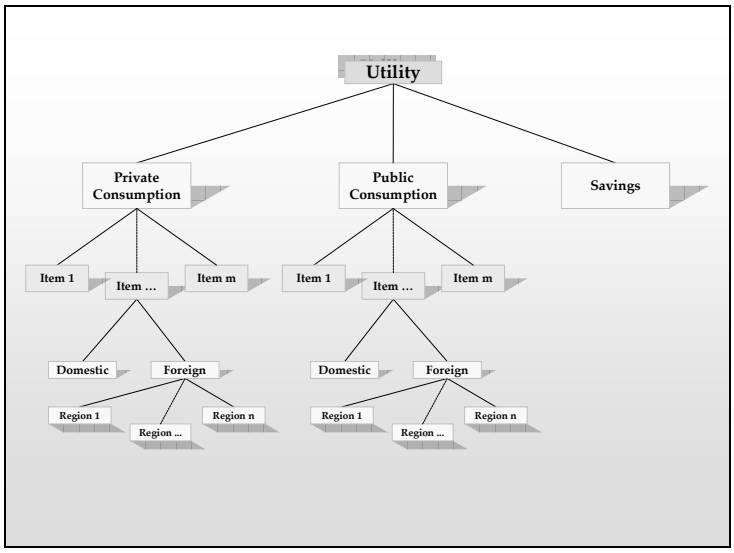
Figure A1. Nested tree structure for industrial production processes



A representative consumer in each region receives income, defined as the service value of national primary factors (natural resources, land, labour, capital). Capital and labour are perfectly mobile domestically but immobile internationally. Land and natural resources, on the other hand, are industry-specific.

This income is used to finance three classes of expenditure: aggregate household consumption, public consumption and savings. The expenditure shares are generally fixed, which amounts to saying that the top-level utility function has a Cobb-Douglas specification.

Figure A2: Nested tree structure for final demand



Public consumption is split in a series of alternative consumption items, again according to a Cobb-Douglas specification. However, almost all expenditure is actually concentrated in one specific industry: Non-market Services.

Private consumption is analogously split in a series of alternative composite Armington aggregates. However, the functional specification used at this level is the Constant Difference in Elasticities form: a non-homothetic function, which is used to account for possible differences in income elasticities for the various consumption goods.

Investment is internationally mobile: savings from all regions are pooled and then investment is allocated so as to achieve equality of expected rates of return to capital.

In this way, savings and investments are equalized at the world, but not at the regional level. Because of accounting identities, any financial imbalance mirrors a trade deficit or surplus in each region.

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