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## Assessing the contribution and linkages of the forest sector to the national economy: Case studies on Finland, Malawi, and the United States of America

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### Abstract

Economic contribution of the forest sector is commonly downplayed by only considering its direct impacts while overlooking the ripple effects on other sectors of the economy. This lack of recognition often puts the forest sector in a less favorable position in developing national development strategy and impedes unlocking the sector's full potential towards sustainable development. This study used three case studies (Finland, Malawi, and the United States of America) to illustrate how the forest sector contributed to national economies through direct, indirect, and induced effects. It identifies and quantifies how the forest sector is linked to other sectors of the economy via backward and forward linkages, and compares the structure of the sectoral linkages across the three studied countries. A structural path analysis approach based on social accounting matrices was used for the analysis.

The forest sector was found having a promising potential to contribute to national economies through direct contribution and pathways via other sectors. The forest sector's indirect and induced effects were found higher than its direct effects in terms of employment, valued added, and labour income. Wood-based processing subsectors in general had higher economic multipliers than the forestry and logging subsector. The real estate, wholesale trade, and food sectors were among the top backward-linked sectors of the forest sector and the construction sector was among the top forward-linked sectors for all three countries. There were great variations in how the forest sector interacts with other sectors among the studied countries. Stage of development, resource endowments, forest tenure, geo-economics, positions in international trade, and national forest policy all played some roles. The results can advance our understanding of the sectoral linkages of the forest sector in national economy and provide thoughts on how to weave the forest sector into national development strategies in a holistic way.

Keywords: economic contribution analysis, sectoral linkage, social accounting matrix, structural path analysis, forest sector

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### Introduction, scope, and main objectives

The presence of forests and forest sector (the forest sector) under many goals across the 2030 Agenda for Sustainable Development reflects the consensus that the forest sector can contribute to a country's progress towards economic growth, social wellbeing, and environmental sustainability in many ways (United Nations General Assembly 2015). A growing number of countries have acknowledged the importance of the forest sector and included enhancing the forest sector and improving its value added in their national forest strategy. Nevertheless, policy makers often find themselves ill-equipped with sufficient information to make informed decisions. For example, how much does the forest sector contribute to the national economy? How do various forest industries interact with other sectors in the economy?

The FAO's State of the World's Forest 2014 (SOFO 2014) estimated the direct contribution of the global forest sector to Gross Domestic Product (GDP), employment, and trade (FAO 2014). To understand the full economic impact of the forest sector, however, one must look beyond the direct industry impacts within the sector and

evaluate the far-reaching economic consequence of the sector to other industries and the ripple effects through the economy. Li et al. (2019) estimated the total economic contribution of the forest sector to national economies and provided an overview at the global level.

Based on country case studies, the present study proceeds further by conducting assessment of the forest sector's economic contribution and examining its linkages to other sectors of the economy. The three selected countries are Finland, Malawi, and the U.S.

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## Data and methodology

For each country, we first estimate the total economic contribution (including direct, indirect, and induced effects) of the forest sector and derive economic multipliers using the Social Accounting Matrix (SAM) approach. The direct effects measure the forest sector's industry output, employment, labour income, and value-added. Indirect effects arise from backward upstream linkages where the forest industries purchase supplies and services from other industries to support their production. The induced effects result from the consumer spending of employees who earn income from the forest industries and the supply industries.

We then calculate the backward and forward linkage indices of major sectors in the economy, and categorize forest subsectors based on their linkages to other sectors. Backward linkage index measures the relative importance of a sector as a purchaser to all other sectors in the economy while forward linkage index measures its relative importance as a supplier to other sectors. A key sector is the one with backward and forward linkage indices both greater than one (Hirschman 1958, Parra and Wodon 2010). A backward-oriented sector is the one when its backward linkage index is greater than one but its forward linkage index is less than one. A sector is forward-oriented if the opposite is true. A weak sector is a sector whose backward and forward linkage indices are both less than one.

Lastly, we apply the technique of structural path analysis (SPA) to unravel the economic multipliers and illustrate how and through what paths the forest sector interacts with other sectors. Sectoral linkage analysis and the SPA are implemented using the SimSIP SAM developed by Parra and Wodon (2010) for input-output analysis.

Forest-related subsectors include: 1) *Forestry and Logging*; 2) *Solid Wood Products Manufacturing*; 3) *Pulp and Paper Products Manufacturing*; and 4) *Wood Furniture Manufacturing*. The 2011 IMPLAN data (Eurostat package) are used for Finland and the 2015 IMPLAN data are used for the U.S. The 2014 Malawian SAM constructed by the International Food Policy Research Institute (IFPRI) is used for Malawi.

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## Results

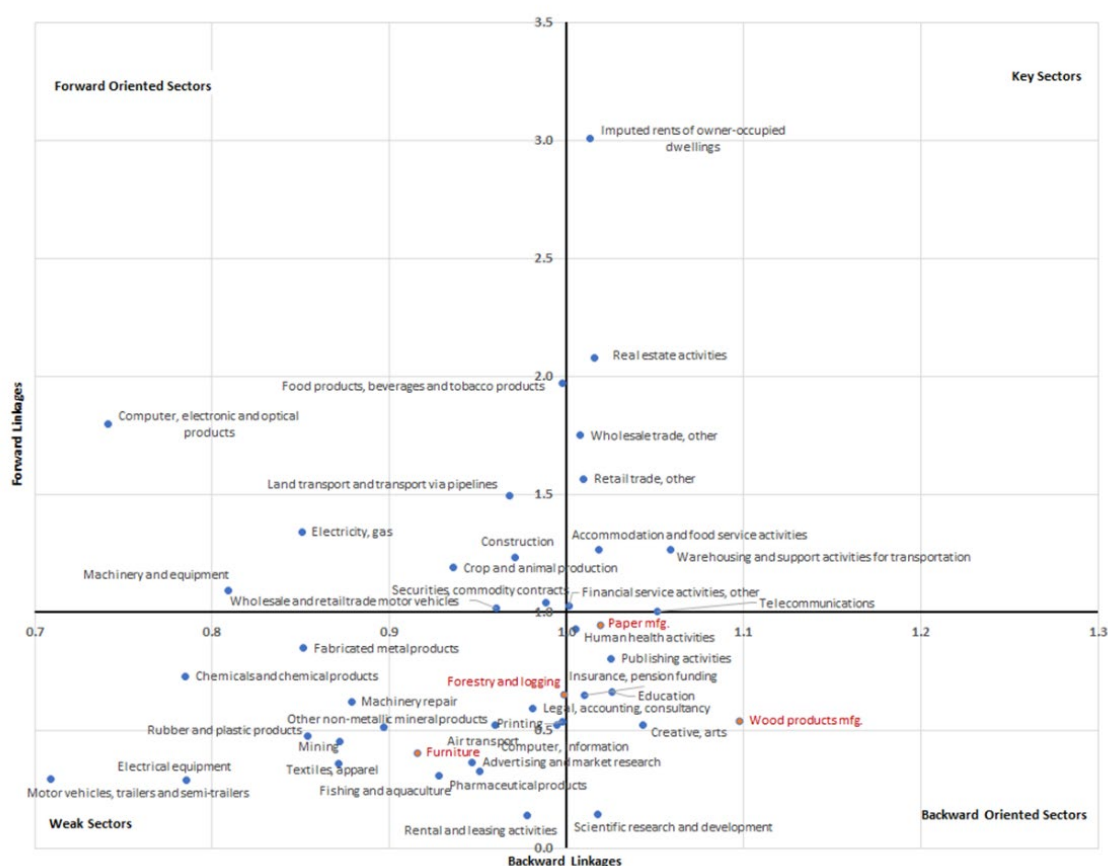
### Finland

Forests cover 22.409 million ha, or about three-quarters of the total land area of Finland (FAO 2020). The forest area has remained stable over the last 50 years (Parviainen and Västilä 2012). The abundance of forest resources allows for a strong, diverse, and highly export-driven forest sector. The forest sector has been the cornerstone of Finland's national economy for decades. The forest sector and its closely related sectors (i.e., engineering and chemical industry, automation and packaging system operations, printing industries, energy production, and research and consultation services) form a forest cluster.

The forest sector directly contributed €7.33 billion to Finland's GDP and employed over 79,800 individuals in 2011. Additionally, the Finnish forest sector supported €8.90 billion to the economy and 112,700 jobs through indirect and induced effects from other supporting industries and consumer spending of employees. The total contribution of the forest sector amounted to €16.23 billion and 192,600 jobs in the economy of Finland in 2011.

On average, for every euro generated in the forest sector of Finland, an additional €2.59 was generated in the national economy in 2011, including €1.93 in the supplying sectors through backward linkages and 65 cents due to spending on goods and services by employees in the forest sector and the supplying sectors. For every 100 jobs created in the Finnish forest sector, another 206 jobs were generated in the economy through indirect effects and 67 jobs were generated through induced effects. Employment in the *Pulp and Paper* and the *Wood Products* subsectors tended to have higher salaries and likely had a higher induced effect.

In 2011, the *Wood Products* and the *Pulp and Paper* subsectors in Finland were backward oriented sectors. An increase in the output of these two wood-based subsectors generated slightly more demand for inputs from their upstream suppliers than the average of all sectors in the economy. The backward linkage index of the *Forestry and Logging* subsector was very close to 1 (0.998), suggesting that its backward multiplier was about at the average of all sectors in the Finnish economy. The *Wood Furniture* subsector had a weaker backward linkage (0.915) compared to other forest subsectors.



**Fig. 1:** Backward and forward linkages of the selected sectors in Finland, 2011

The SPA results suggested that the influences of the forest subsectors were passed to other sectors of the economy through various paths and in different patterns. The *Wood Products* and *Pulp and Paper* subsectors in Finland had direct and strong influences on the *Forestry and Logging* subsector, as evidenced by the direct and strong backward-linked paths between them. This is because the Finnish *Wood Products* and *Pulp and Paper* subsectors largely relied on domestic wood procurement (industrial roundwood and lumber products), although imported wood has played an increasingly important role in the raw materials sourcing. The forest sector had a significant backward impact on the *Land Transport*, *Wholesale Trade*, and *Warehousing and Support Services* sectors in Finland. The export-oriented nature of the Finnish wood-based processing industries may contribute to this. The *Real Estate Activities* sector was among the top backward-linked sectors

of all four forest subsectors. An increase in the forest sector would create significant demand for the real estate market. The influences of the forest subsectors were transmitted mainly through increased income of people working in the forest sector and capital owners. Small private forest landowners played a significant role in providing wood supply of the Finnish forest sector. A significant portion of the forest sector's influences was transmitted through income on properties to households that hold forestland and other related capitals. It also suggested that the status and trends of the Finnish forest sector may have significant implications on the livelihood and welfare of these private forest landowners. The country's universal health care system shapes how the forest sector interacts with some of the service sectors. Different from the other two studied countries, an increase in the forest sector would not generate additional demand for medical care services and health insurance services.

## Malawi

Forests (2.241 million ha) account for 23.78% of Malawi's total land area (FAO 2020). People's livelihood in both rural and urban areas revolve around forest products and services. Forests are subject to deforestation and degradation due to increased demands for forest products and expansions of agricultural land resulting from the rapid growth in population and tobacco exports (FAO 2009). In Malawi, fuelwood and charcoal are the main source of energy for cooking for over 95% of the rapidly growing rural and urban population (National Statistical Office of Malawi 2017). Tobacco industry is the major non-household user of wood in the country (Ngwira and Watanabe 2019). Wood and twigs are used for building barns for air-cured tobacco and firewood is used for tobacco curing. Brick-making industry also consumes a significant amount of wood for energy.

The forest sector in Malawi directly contributed around 200 billion Malawian kwacha to its national economy in 2014. Additionally, the forest sector supported about 240 billion Malawian kwacha to its GDP through indirect and induced effects.

In 2014, the *Forestry and Logging* industry was one of the few key sectors in Malawi, with a strong forward linkage index (2.612) and an about-average backward linkage (1.022). The Malawian *Forestry and Logging* subsector was a major supplier to other economic sectors of the country. The *Wood Products* subsector in Malawi had a slightly above-average backward linkage index (1.10) while its forward linkage (0.227) was weak compared to other sectors of the economy in 2014.

A significant portion of the ripple effects of the Malawian forest sector was generated through induced effects rather than indirect effects, suggesting the importance of household spending in the national economy. This also largely limited the output multiplier effects of the forest sector and affected the transition efficiency. Several factors contributed to the weak multiplier effects. First, the wood-based processing industry is weak in Malawi. The forest sector is largely composed of forestry and logging activities, which inherently has weak backward linkages to other sectors. Second, as many other less developed countries, Malawi has limited domestic productive capacities in some inputs manufacturing sectors (e.g., *Chemicals, Machinery and Equipment*, and *Electrical Equipment*). Many essential inputs rely on imports. This resulted in leakages in the multiplier effects of the forest sector.

The *Finance and Insurance* sector in Malawi was shown among the top upstream sectors of all forest subsectors. This indicated that an increase in the demand for forest products would trigger an increase in the *Finance and Insurance* sector. On the flip side, it also indicated that the *Finance and Insurance* sector could be the bottleneck sector that limited the expansion of the forest subsectors in Malawi.

As the most important export crop of the country, tobacco is the major source of foreign exchange and government revenue. There has been a growing concern about environmental impacts of tobacco cultivation and processing on forests in Malawi (Minde et al. 2001, Otañez and Glantz 2011, Geist 2021). Our forward linkage analysis of the Malawian forest sector showed that the expansion of tobacco production and processing could be a powerful driver for the growth of the country's forest sector. The influence was mainly

transmitted directly from the tobacco industry to the forestry activities subsector without intermediate sectors. However, it could also put significant pressure on the forestry activities subsector when the demand exceeds its capacity.

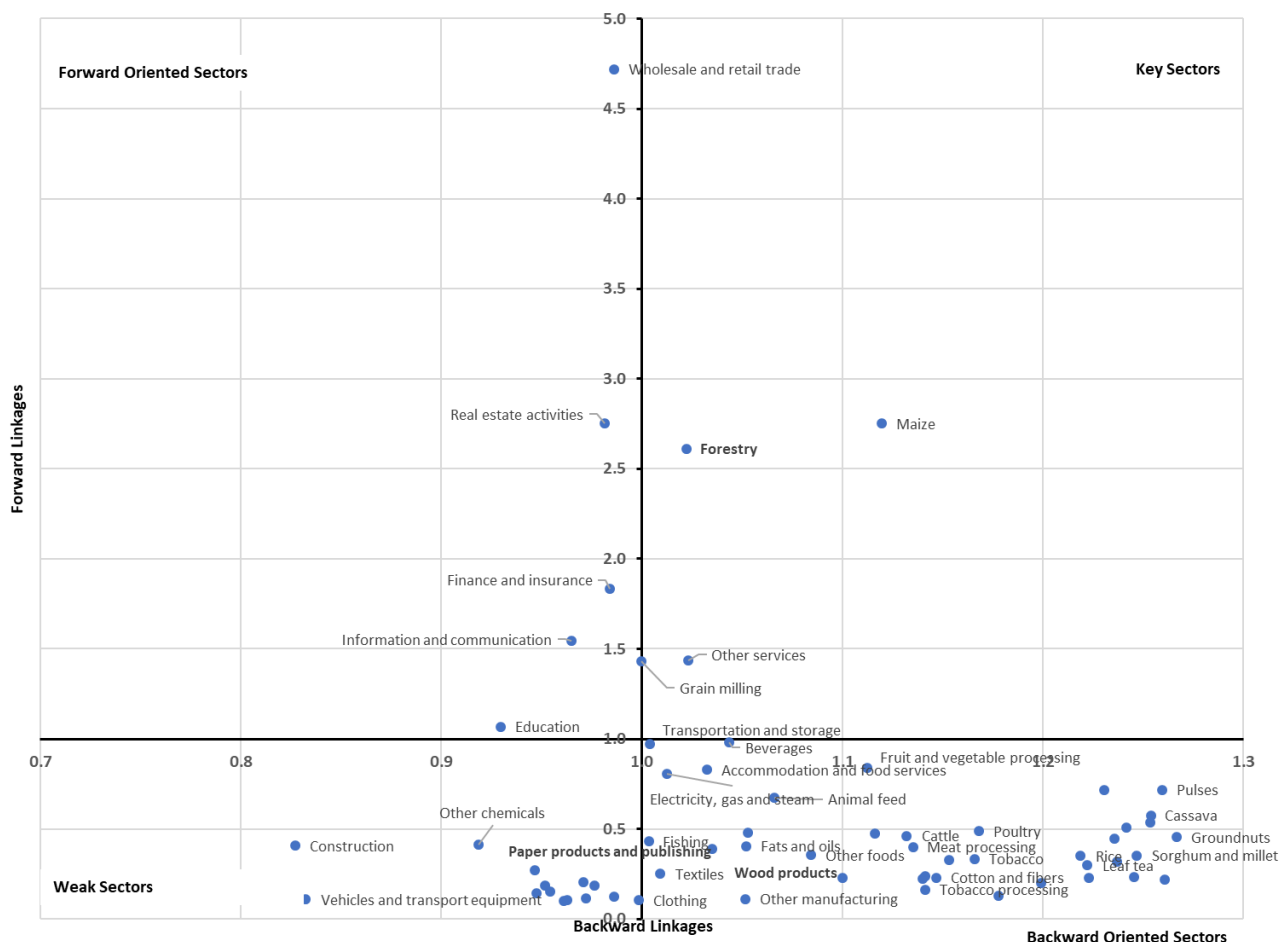


Fig. 2: Backward and forward linkage indices of major sectors in Malawi, 2014

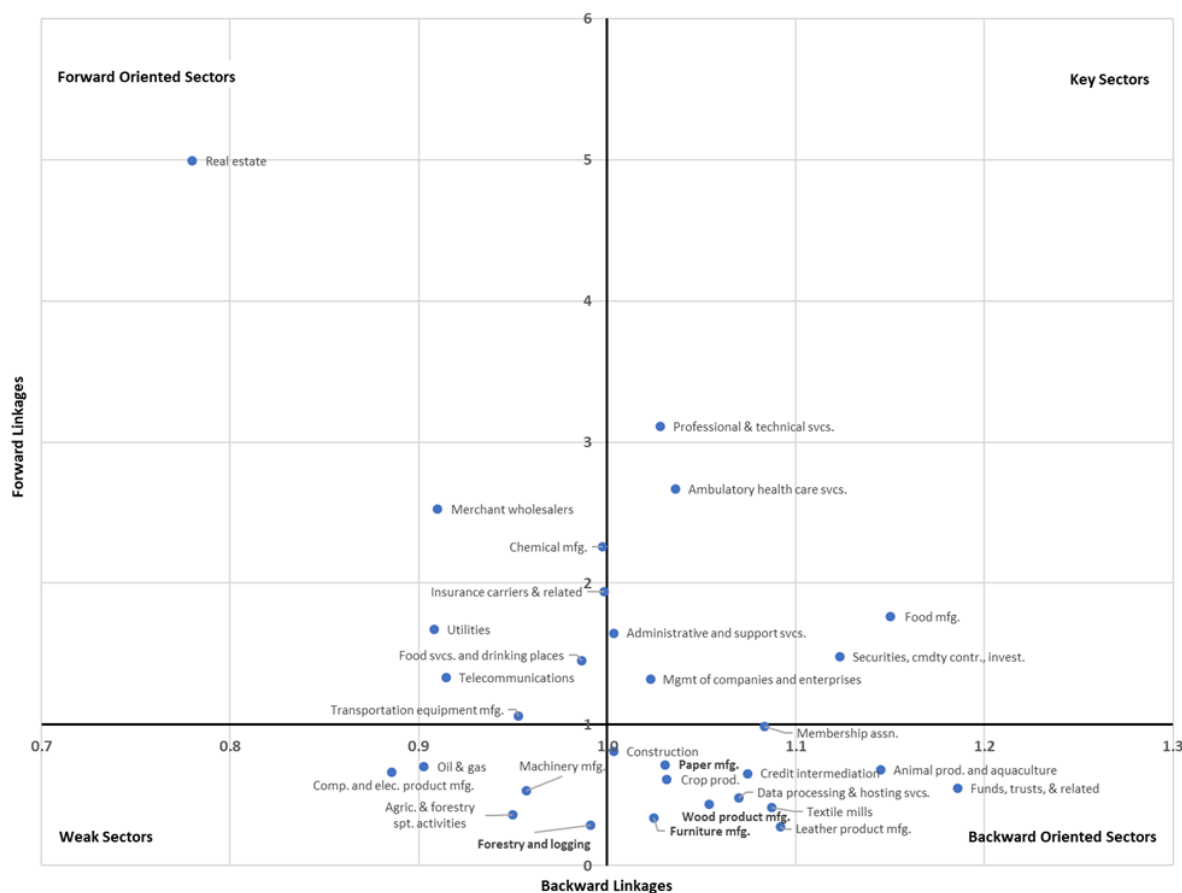
## The U.S.

Forests and woodlands combined cover 33.3%, or 309.79 million ha, of the land in the U.S. (Oswalt et al. 2019). Forest resources are the foundation of a diverse, strong, and viable forest sector that contributes to the nation’s vibrant economy. The U.S. forest sector is composed of a chain of industries starting from planting, managing, and harvesting trees, to manufacturing industries that convert timber products into a wide range of intermediate and final wood-based products.

The forest sector directly contributed USD 106.13 billion to the U.S. GDP and employed over 1.21 million individuals in 2015. Additionally, the forest sector supported USD 263.64 billion to the economy and 2.61 million jobs through indirect and induced contribution from other supporting industries and consumer spending of employees. The total contribution of the forest sector amounted to USD 369.11 billion and 3.83 million jobs in the U.S. economy in 2015.

In 2015, none of the forest subsectors was a key sector in the U.S. Most of the forest subsectors (except the *Forestry and Logging* subsector) were backward-oriented sectors, having above-average backward linkages but

below-average forward linkages to other sectors in the economy. The *Forestry and Logging* subsector in the U.S. was weak in both backward and forward linkages. Among the four forest subsectors, the *Pulp and Paper* subsector had the highest forward linkage index because the subsector in totality had a closer tie to the condition of the general economy.



**Fig. 3:** Backward and forward linkages of the selected sectors in the U.S., 2015

The influences of the forest subsectors are passed to other sectors of the economy through various paths and in different patterns. A significant portion of the influences were transmitted through household consumption rather than direct purchases from producing sectors. This indicated the importance of the forest sector's induced effects but also suggested more dispersed and longer transmission (more arcs) from the forest subsectors to destination sectors. Several sectors were among the top backward-linked sectors for most forest subsectors albeit the ranking differs. They include the *Professional and Technical Services*, *Chemical Manufacturing*, *Merchant Wholesalers*, *Real Estate Activities*, and *Health Care Services* sectors. Wood processing subsectors had more direct, stronger, and diverse influences on other supplying sectors than the *Forestry and Logging* subsector. The forest subsectors generally had greater influences on high- and moderate-income households, through either proprietor income, or employee compensation, or both, than low-income households. The low-income households benefited marginally from the expansion of the forest subsectors.

## Conclusion and discussion

The case studies show great variations in the contribution of the forest sector to national economies and how the forest sector interacts with other sectors. Stage of development, resource endowments, forestland ownership, geo-economics, positions in international trade, and national forest policy all play some roles.

There are some general patterns. As an economy evolves through various stages of its development, it shows certain patterns of structural changes across different sectors. The contribution of the service sector to value added normally increases as an economy expands. Meanwhile, the agriculture sector generally shrinks and the manufacturing sector shows a hump-shaped pattern (Diao et al., 2017; Duarte and Restuccia, 2010; Herrendorf et al., 2014). As a result, the *Forestry and Logging* subsector generally plays a less important role in the economy in terms of value added and employment generation while the wood-based manufacturing subsectors that require substantial inputs from the tertiary sectors and provide relatively high labour income would remain important in terms of the economic contribution.

The *Real Estate*, *Wholesale Trade*, and *Food* sectors are among the top backward-linked sectors of all forest subsectors for these three countries and the *Utilities* sector ranks high for indirect effects on value added for Finland and the U.S. This is consistent with the general pattern observed in the global study (Li et al. 2019). The present study shows that the influences are mostly transmitted through labour income and subsequent household consumption rather than direct purchases from producing sectors. Compared to the U.S., the *Wood Products* and *Pulp and Paper* subsectors in Finland have higher influences on some of the backward-linked sectors such as *Forestry and Logging*, *Warehousing and Support Services*, and *Land Transport* sectors. This is mainly due to the export-oriented nature of these Finnish forest subsectors.

The *Construction* sector is among the top forward-linked non-forest sectors of the *Wood Products* subsector for all three countries. This is consistent to the common observation that new construction (especially residential construction) creates demand for sawnwood and wood-based panel products and is the driver of the *Wood Products* and *Forestry and Logging* subsectors. However, the influences of the *Construction* sector on the *Wood Products* subsector vary in strength by country. The influence is the greatest in Finland and the weakest in Malawi. A significant share of wood products for construction in the U.S. is met by imports (mainly from Canada) while that in Finland is mainly met by domestic production.

National systems for health care and social security also play a role. For example, the health care services and insurance-related services are among the top backward-linked sectors for all forest subsectors in the U.S. but not for the Finnish forest sector. Finland's universal health care system accounts for the difference. With tax revenues, municipalities in Finland provide health care for their residents. Therefore, employers and households do not have apparent expenditures on medical care and health insurances.

Despite some similarities in how the *Wood Products* subsector is linked to other sectors through backward linkages in Finland and the U.S., there are noticeable differences in the composition of their backward-linked sectors and strengths of major paths. First, the *Wood Products* subsector in Finland has a stronger influence on their *Forestry and Logging* subsector than their US counterpart. Second, the influences of the *Wood Products* subsector are transmitted to the U.S. households mainly through payment of compensation for labour while the influences to the Finnish households are mainly through compensation for labor for sawmills and capital income for private landowners.

Compared to the U.S., the *Pulp and Paper* subsector in Finland has higher influences on some of the backward-linked sectors such as *Warehousing and Support Services*, *Forestry and Logging*, and *Land Transport* sectors. The Finnish *Pulp and Paper* subsector also has a larger influence on the *Repair and Installation Services of Machinery* sector than the U.S. counterpart. Additional output of the *Pulp and Paper* subsector in Finland generates less increased demand for chemicals and chemical products than in the U.S. Different composition of pulp and paper products may contribute to the difference. Mechanical pulp accounts for about 20% of the total wood pulp (weight) produced in Finland while it only accounts for around 3% of the total wood pulp produced in the U.S. Compared to chemical, semi-chemical and dissolving wood pulp, mechanical pulp requires less chemicals. Similarly, the direct backward-linked influences of the *Pulp and Paper* subsector in Finland on professional and technical services are shown smaller than that of the U.S. Compared to the U.S., the Finnish *Pulp and Paper* subsector has wider and stronger forward linkages to other sectors in the economy.

In Finland, more than 10 forward-linked sectors have a global influence with the *Pulp and Paper* subsector higher than 0.05 while there are only three (the *Printing and Support Services*, *Beverages and Tobacco*, and *Plastic and Rubber Products* sectors) in the U.S.

The Malawian forest sector has a much different structure and implication to its national economy. First, strengthening Malawian wood-based processing industries could help enhance linkages to supplying sectors and improve income of employees in the directly and indirectly effected sectors. Enhancing domestic productive capacities of other major manufacturing sectors could help alleviate dependence on imported goods and reduce leakages in economic multiplier effects. However, such policy and economic measures may create economic benefits at much greater costs. For example, many studies show that the expansion of domestic wood-based processing capacity through restrictive trade policies may cause more economic harm than good (Boscolo and Vincent 2000, Kishor et al. 2004). Second, the *Finance and Insurance* sector is shown among the top upstream sectors of all forest subsectors in Malawi. Third, the expansion of tobacco production and processing could be a powerful driver for the growth of the country's forest sector but it could also put significant pressure on the *Forestry and Logging* subsector when the demand exceeds its capacity. Fourth, the influences of Malawian forest subsectors are generally greater on capital owners than on labor. This is especially true for the *Forestry and Logging* subsector, where the magnitude of the backward linkage to capital owners (mainly households in top income brackets, rural or urban) is overwhelmingly higher than that to labor. In contrast, the *Wood Products* and *Wood Furniture* subsectors influence households with different levels of income through additional paths involving return to their labor. This has policy implications regarding the potential impacts of an injection of investment/subsidy into a particular forest subsector on various household groups for poverty reduction.

There are some limitations of our study. First, the SAM model approach is built upon the assumption of constant returns to scale, perfect elastic factor supplies, and constant technology, which may not hold true in reality. Second, we use the best available SAM data for Finland and Malawi. The difference in data sources and aggregation methods may contribute to the difference in estimated multipliers. For instance, the analysis of Malawi is based on the SAM constructed by IFPRI. Third, the case studies also show data gaps and the importance of improving data quality and availability. Missing information or underestimating the contribution of informal activities is a problem. Existing studies suggest that forests are critical for livelihood of millions of people, especially the poor and socially marginalized communities (Sunderlin et al. 2005). They provide a safety net for them as sources of food, energy, and income during hard times. Despite the importance, many forestry activities are informal (e.g., nonwood forest products and woodfuel production) and not currently captured in the national statistical system. This is reflected by the low influences of the forest subsectors on low-income households in our study because it is built on reported national accounting matrix. Including informal forest-related activities would help give a better assessment of the interactions between forest subsectors and various groups of people in the economy. Better resolution of data on more detailed breakdown of sectors, income groups, and gender groups would also help improve the assessment

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