Analysis of structural patterns in highly disaggregated bio-based sectors on EU member state level with IO multipliers.

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The concept of 'bioeconomy' is gathering momentum in European Union (EU) policy circles as a sustainable model of growth to reconcile continued wealth generation and employment with bio-based sustainable resource usage. In 2012, a policy strategy paper was released by the European Commission (EC) for a sustainable model of growth which could reconcile the goals of continued wealth generation and employment with sustainable resource usage. More recently, in 2015 the EC communication "Closing the loop - An EU action plan for the Circular Economy", recognises that "the bioeconomy provides alternatives to fossil-based products and energy, and can contribute to the circular economy... On the other hand, using biological resources requires attention to their lifecycle environmental impacts and sustainable sourcing. The multiple possibilities for their use can also generate competition for them and create pressure on land-use. The Commission will examine the contribution of its 2012 a Bioeconomy Strategy to the circular economy and consider updating it if necessary".

According to the EC (2012), the bioeconomy is the production of biomass and the conversion of biomass into value added products, such as food, feed, bio-based products and bioenergy. It includes the sectors of agriculture, forestry, fisheries, food and pulp and paper production, as well as parts of chemical, biotechnological and energy industries and manufacturing of bio-based textiles. The European bioeconomy generates a turnover estimated at around 2 trillion euros and employs more than 17 million of persons (Ronzon et al., 2015).

In the literature an economy-wide quantitative assessment covering the full diversity of this sector is lacking due to relatively poor data availability for disaggregated bio-based activities. This paper represents a contribution to this literature and a tentative to support the understanding of, among others, the employment generating impacts of the agriculture, food and other traditional (fishing, forestry, wood, pulp and paper) and non-traditional (biofuel, biochemical, bioenergy) bio-based sectors across the EU 28 Member States (MS). We employ a consistent set of Input-Output Tables (IOTs) benchmarked to the year 2010 for the EU28. The database for the analysis would largely depend on the IOTs that the Joint Research Centre (JRC) has estimated for year 2010 and delivered to the GTAP consortium. The database follows GTAP classification for non-agricultural commodities while the disaggregation of agri-food and bio-bases commodities has been refined to follow the

AgroSAMs (Müller et al., 2009) classification. The database has been further disaggregated by splitting the agriculture, energy and chemical sectors, to include other main bio-based sectors of the economy (e.g., first and second generation biofuels, biochemical, bioenergy, fertilisers) and the needed feedstock to feed these sectors (agriculture and forestry residuals, energy crops, pellets), at EU 28 Member States level for 2010. Additionally, the database has been further extended to include a full vector of employment requirements (or employment requirements by output, labour intensity) for agricultural and non-agricultural activities, mainly based on Eurostat sources.

A similar effort for the United States has been prepared by the United States Department of Agriculture (USDA) for the Congress of the United States of America (Golden et al., 2015). Golden et al., (2015) conducted extensive economic modelling using IMPLAN modelling software to analyse bio-based economy in the US. The model employs the so-called "economic multiplier" to estimate the total implications of economic activity as direct, indirect, and induced effects.

Based on this extended and consistent set of IOTs databases, the analysis is set out to recognize those bio-economic sectors which potentially maximise economic value added, with a view to formulating a coherent approach for reconciling wealth- and/or employment generation with sustainable resource usage.

With the help of appropriate economic statistical techniques (i.e., hierarchical clustering technique as in Philippidis et al., 2014), we profile and assess comparative structural patterns inherent within each of the EU member states' agri-food and bio-based sectors using multipliers analysis. More specifically, 'forward-linkage' (FL) and 'backward-linkage' (BL) multipliers will be analysed by MS and used as an ideal basis of comparison across sectors and countries to provide a full picture of the heterogeneity of economic structures across EU member states.

Additionally, we produce an analysis of the employment multipliers to ascertain the employment generation effects from increases in output/exports within the agri-food and bio-based sectors. Employment multipliers are defined as the number of new jobs generated per million euros of additional output value.

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