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Analysis

Sailing into Unchartered Waters: Plotting a Course for EU Bio-Based Sectors

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ABSTRACT

The use of biomass to achieve a sustainable, low carbon, competitive model of growth and employment is at the heart of European Union (EU) policy making. This study constitutes a first step toward understanding (i) the medium-term prospects for biobased sectors in the context of expected EU biomass policy developments and (ii) the degree of coherency with the Bioeconomy strategy in terms of identifying potential policy conflicts.

A general finding is that EU bio-based sectors face important challenges, largely due to slower assumed rates of economic growth and land productivity, coupled with deeper greenhouse gas emissions cuts. Furthermore, EU policy conflicts are encountered in attempting to reconcile greenhouse gas reductions with macroeconomic growth, food security and biofuel mandates. To conclude, a more holistic public policy approach is necessary to avoid the perceived conflicts in biomass usage, whilst there is a clear need for targeted and sustained investments in EU bio-based activity to fully exploit its potential.

1. Introduction

As an all-encompassing sector covering renewable biological resources, associated waste, and their subsequent conversion into food, feed, industrial bio-based products and energy, the bioeconomy already constitutes a significant component of economic activity.[1] In 2014, 13% of world trade was of biological origin (El-Chichakli et al., 2016), whilst figures for the United States (US) (Carlson, 2016) and the European Union (EU) (Ronzon et al., 2015) estimate the worth of biobased activities at $US324 billion (2012 prices) and €2 trillion (2013 prices), respectively.[2] In equal measure, through strategy papers, policy makers in (inter alia) the EU, Japan, US, Malaysia and South Africa (Wesseler and von Braun, 2017), have been quick to recognise the role of this diverse collective in fostering a low carbon sustainable model of growth and prosperity. For its part, the EU's Bioeconomy Strategy and Action Plan sets out to provide, "*a more innovative, resource efficient and competitive society that reconciles food security with the sustainable use of renewable resources for industrial purposes, while ensuring environmental protection*" (EC, 2012 p.8).

A number of recent discussion articles (e.g., De Besi and McCormick, 2015; El-Chichakli et al., 2016; Wesseler and von Braun, 2017) have emerged which map out numerous key future priorities for the bioeconomy. In broad terms, there is consensus that significant and targeted investments in research and innovation supported by public-private co-operation; transparency; knowledge-sharing facilitated by advances in information and communication technologies; and a strong regulatory framework, are all pre-requisites for a successful transition to a biobased economy. Notwithstanding, the literature also highlights caveats and qualifications. Wesseler and von Braun (2017) highlight the potential dangers of overregulation on EU biobased product innovation. El-Chichakli et al. (2016) stress the importance of global oversight to complement national strategies particularly in co-ordinating the complex regulation or certification of bio-based products, which although undoubtedly bestowing marketing and brand appeal in developed countries, may constitute a trade barrier to poorer regions. De Besi and McCormick (2015) comment on the stakeholder role of society to support the bioeconomy, in terms of attitudinal shifts toward more sustainable consumption habits through continued awareness campaigns.

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[1] Starting from pre-industrial times, Wesseler and von Braun (2017) provide an insightful historical overview of the evolution of the bioeconomy.

[2] It should be recognised that more precise estimates are lacking due to the lack of explicit bio-based industry codes in the classification of national accounts in the US (NAICS) and the EU (NACE). For the EU figure, 74% is attributed to agriculture and food industries. The US figure is restricted to a narrower definition comprised of bio-based drugs, genetically modified crops and bio-industry (biofuels, enzymes, bio-materials, bio-chemicals).

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Table 1
Data sources for the new bio-based sectors.

	Database	Reference
Biomass supply sectors: residues, energy crop plantations, pellets		
Production (million US$ and PJ)	Calculated from the production and consumption of bioenergy and biochemicals	Own elaboration
Sustainable potential of residues (PJ)	EU: Biomass Policies	Elbersen et al., 2015
	Rest of the world: IMAGE (Integrated Model to Assess the Global Environment)	Daioglou et al., 2015
Cost structures (shares) and technical change	IMAGE (Integrated Model to Assess the Global Environment)	Daioglou et al., 2015
Trade (million US$)	Trade of biomass from energy crop plantations and residues is assumed to be zero. Pellet trade data is taken from UN Comtrade database	Comtrade, 2015
Transport costs (million US$/PJ)	Targets IMage Energy Regional simulation model (IMAGE-TIMER)	Stehfest et al., 2014
Bioelectricity, second generation biofuels and biochemicals		
Production (million US$ and PJ)	Biofuels: Targets IMage Energy Regional simulation model (IMAGE-TIMER)	Stehfest et al., 2014
	Bioelectricity: Energy Information Administration (EIA) database	EIA (2014)
	Biochemicals: Targets IMage Energy Regional simulation model (IMAGE-TIMER) and MARKet ALlocation model (MARKAL-UU-NL)	Stehfest et al., 2014
Cost structures (shares) and technical change	Biofuels: MARKet ALlocation model (MARKAL-UU-NL)	Stehfest et al., 2014 Van Vliet et al., 2011; Brouwer et al., 2015
	Bioelectricity: International Energy Agency (IEA) database and the MARKet ALlocation model (MARKAL-UU-NL)	
	Biochemicals: MARKet ALlocation model (MARKAL-UU-NL)	
Trade (million US$)	By assumptions: no trade of bioelectricity, trade of second generation biofuels equal to 5% of production (see text)	Own elaboration
Transport costs (million US$/PJ)	Targets IMage Energy Regional simulation model (IMAGE-TIMER)	Stehfest et al., 2014

Notes: A petajoule (PJ) is equal to one quadrillion (10^{15}) joules.

Furthermore, in seeking to achieve multiple policy goals within a single umbrella strategy, trade-offs will inevitably arise. For example, a sustainable low carbon model of growth may limit employment possibilities; or policy induced greenhouse gas reductions could have implications for food security. Moreover, with fragmented EU policies governing biomass usage (i.e., Common Agricultural Policy (CAP); biofuels mandates; 2020 climate and energy package), this potentially leads to policy conflicts with regard to competing uses of biomass (EC, 2012; Von Braun, 2015; Wesseler and von Braun, 2017). Thus, it is therefore beneficial to quantify the nature and scale of these challenges and understand the degree of coherence between the EU's current policy landscape and its strategic vision for the bioeconomy.

In recent times, so-called 'foresight' quantitative market model assessments have emerged in the literature. In some, attention is given to issues of global food security and/or climate change (e.g., Von Lampe et al., 2014), whilst other research examines European land use patterns under different 'pathways' (VOLANTE, 2010), or even sustainable strategies for assessing and addressing the challenges of food and nutrition security (FoodSecure, 2012). Tackling the issue of the bioeconomy head-on, economy-wide research by US state (Golden et al., 2015) and by EU Member State (Philippidis et al., 2014) explore the short-run wealth generating properties of specific bio-based activities employing economy-wide social accounting matrix (SAM) multipliers, whilst pilot studies for Malaysia (Van Meijl et al., 2012) and the Netherlands (Van Meijl et al., 2016) take a more medium-term view of the prospects for these sectors.

A common methodological denominator in each of these economy-wide studies is the use of fixed-price (i.e., Leontief) and flexible-price computable general equilibrium (CGE) representations. A particular strength of the latter is that it is ideally suited to evaluate the impact of multiple market drivers, both regional and global, within a fully comprehensive, consistent and closed economic system of equations. For this reason, the current study employs a multi-region flexible-price CGE approach. The aim is to assess, employing current and anticipated biomass related EU policy developments, the prospects for EU biobased sectors, their main market drivers and, if present, uncover evidence of resulting policy conflicts on biomass usage.

The study employs a medium-term (i.e. to 2030) time horizon to reflect the more immediate policy concerns highlighted in EC (2012), whilst considerable effort is expended on explicitly representing relevant EU policies combining state-of-the-art modelling and secondary data sources for implementing precise policy shocks. Furthermore, through considerable in-house data development, the scope of bio-based activity in this version of the underlying Global Trade Analysis Project (GTAP) database (Narayanan et al., 2015), although far from complete, goes way beyond the standard definitions inherent within national accounts data.

The rest of this paper is structured as follows: Section 2 discusses the construction of the bio-based global production and trade data, the model framework and simulation design. Section 3 presents the results, whilst Section 4 provides some policy discussion and concludes.

2. Material and Methods

2.1. Incorporating New Bio-Based Activities into the GTAP Database

The GTAP database is extended to represent additional sources of biomass supply (i.e., residues, energy crop plantations and pellets), first generation bio-fuels, second generation bio-fuels based on thermal and biochemical pathways, bio-electricity and biochemical activities.

To include the new sectors, data on production volumes, conversion efficiencies, cost structures, and trade and transport costs were collected for the GTAP data benchmark year of 2007.[3] The cost structures and data regarding technical change to 2030 for these new sectors were mainly based on data from two partial equilibrium (PE) models of the energy and chemicals sectors and other sources, namely the Targets IMage Energy Regional simulation model (IMAGE-TIMER) and the MARKet ALlocation model (MARKAL-UU-NL). A summary of the relevant data sources and assumptions is given in Table 1.

An overview of the new biobased sectors and their linkages within the existing GTAP database is provided in Fig. 1.[4] The arrows indicate the direction of biomass and bio-based energy and chemicals flows. A further discussion of these sectors is provided in the following sections.

[3] The study employs release 9 GTAP data benchmarked to 2007.

[4] In total 18 new commodities are introduced: residues (res), energy crop plantations (plan), pellets (pel), forest harvest residues (r_frs), agricultural residues from harvesting and processing of crops (r_prd, r_wht, r_gro, r_osd, r_ocr, r_frs, r_v_f), second generation biofuel – thermal pathway fuels (ft_fuel), second generation biofuel – biochemical pathway fuels (eth), lignocellulose sugar (lsug), polylactic acid (pla), bio-based polyethylene (pe), fossil & bio-based polyethylene (f_chem) and other chemicals (chem).