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The impacts of the German biofuel quota on sectoral domestic production and imports of the German economy

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ABSTRACT

This study analyses the impacts of the German biofuel quota on sectoral domestic production and imports of the German economy. The effects are calculated as net effects, i.e. accounting for the direct and indirect effects of both the additional demand for biofuels and the reduced demand for fossil fuels. The analysis uses an input–output model and information on quantities, production processes, import quotas etc. To calculate the impacts for the agricultural sector, which is obviously of high relevance for biofuel production, two cases are differentiated: first, and in line with classical input–output assumptions, we propose that agricultural production is not constrained by the availability of agricultural land. Thus, biofuel production is basically added to other agricultural outputs. In the second case, agricultural land is considered a limiting factor for production. As a consequence, biofuel production substitutes other agricultural outputs. The results indicate a clear increase of domestic production and a decline of net imports in the first case. In the second case gains in domestic production are smaller and net imports are, in contrast to the first case, increasing.

Contents

1. Introduction

Biofuels are seen as a way to decrease the dependency on fossil fuels in transport and to reduce the emission of greenhouse gases. In many countries, policies exist to promote the substitution of

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Table 1
Biofuel quota in % of calorific value [5,6].

Year	Diesel	Petrol	Total
2007	4.4	1.2	
2008	4.4	2.0	
2009	4.4	2.8	5.25
2010–2014	4.4	2.8	6.25

fossil fuels with biofuels. The consequences of this substitution on production and employment have been the subject of recent academic studies [1–3]. Multi-sectoral modelling approaches (CGE models, input–output models) are used in most of these studies (compare [4]) and applied to future scenarios that vary with respect to biofuel use.

In Germany, biofuels have been promoted since 2004, and were exempted from mineral oil tax to start with. In 2006, this policy was, in line with EU policy, replaced by mandatory blending of fossil fuel with biofuel [5,6]. As illustrated in Table 1, the biofuel quota (defined as a percentage of calorific value) was increased continuously until 2010, when it reached the maximum of 6.25%. There are minimum quotas for diesel, petrol and total fuel consumption. The petroleum industry has to pay high fees if the quotas are not reached. From 2015 onwards, the quota is no longer based on the calorific value, but on the reduction of greenhouse gas emissions due to the substitution [6].

Fig. 1 illustrates the development of the production and consumption of biofuels in Germany.

This study's objective is to identify the impacts of the biofuel quota on sectoral domestic production and net imports of the German economy. Applying the input–output modelling technique, direct and indirect effects are calculated for the year 2010.[2] We ignore the step-wise introduction of biofuels and compare a setting with and without a biofuel quota.

The paper is structured as follows: Section 2 provides an overview of the relevant literature and the main hypotheses. Section 3 describes the database and methodology. The results are discussed in Section 4. Finally, the paper concludes with a summary of the main findings and policy implications in Section 5.

2. Relevant literature and main hypotheses

The economic impact of substituting fossil fuels with biofuels has been intensely discussed in the last few years. According to Allan [4] multisectoral economic models are necessary to take into account “the specific biofuels feedstock and production technology employed; the sector´s embeddedness in the rest of the economy, through its demand for local resources; and the extent to which new activity is created”.

CGE models have been applied to examine the economic impacts of biofuels for a wide range of regions, including Austria [8], Spain [9], the USA [10], Brazil [11], Argentina [12], Mozambique [13] and Tanzania [14]. The majority of these studies find a positive impact on GDP.

Input–output analyses have the same positive result for various regions of the USA [15–18], Canada [19], Brazil [20,21], Australia [1], Thailand [22], the European Union [3], Croatia [23] and Germany [2]. Obviously, a positive impact on GDP is inherent if the impact of biofuels on the economy is modelled as additional final demand for a new sector without taking into account any substitution effects (fossil fuels) or constraints (e.g. land constraint of the agricultural sector). But in many of the cited studies, these aspects are included and the net impact is still positive, although there might be sectors with reduced output.

In Germany, the economic impact of biofuels is often discussed in the context of renewable energy. Employment effects are the focus of most of these studies. Gross effects concern additional employment generated through the investment in and deployment of renewable energy. These have been estimated on a yearly basis since 2007 [24,25]. In 2013, the gross employment effects of biofuels were estimated at 25,600 jobs. This is about 7% of the total impact of renewable energies. While biofuel deployment and the related jobs have only experienced a slight increase since 2007 ($<10\%$), other renewable technologies have grown much more dynamically.

However, there are also negative economic impacts of renewable energies. First, if the biofuels substitute fossil fuels, additional investments in biofuel production might crowd out investment in fossil fuel production. Second, if biofuels are more expensive than fossil fuels, this leads to a reduced budget for other expenditures. According to Frondel et al. [26], these negative effects might dominate in the long run for the case of electricity from renewable energy. Taking into account both positive and negative impacts and the respective indirect effects yields the net effects. Increased investment activity is found to be a major driver for the positive net effect on economic growth caused by the expansion of renewable energy [27]. In Lehr et al. [28], the net impact is found to be positive and its magnitude is dependent on the export of German renewable energy technology. However, this study does not include biofuels. In the study of Duscha et al. [29], biofuels are included in the portfolio of renewable energy technologies. Their impact was not calculated separately, but the total net impact of renewable energy sources was found to be positive. The net impact of biofuels was discussed in more detail as part of the biotechnology industry [2,30] and was found to be positive. Also in Wydra's study [2], input–output analysis is applied to 3 scenarios with the time horizon 2020. The scenarios differ with respect to bioethanol diffusion (up to 7.25%) and the cost difference of biofuels compared to fossil fuels. The results show a positive impact on net production of up to 1 billion euros and an increase in employment due to bioethanol diffusion of up to 9000 jobs. The main effects occur in the agricultural sector.

The effect of biofuels (and other renewable energy sources) on local value added is derived as specific values per litre plant oil, biodiesel and bioethanol as being put forward by Hirschl et al. [31]. These specific values are then applied to exemplary municipalities which vary in size and renewable energy portfolio. Aggregated at the national level, Hirschl et al. [31] estimated that biofuels contributed 561 million euros to local value added and generated 8600 jobs in 2009. These values can neither be clearly classified as net effects (losses due to the reduced demand for fossil fuels are not considered) nor as gross effects (due to the assumption that energy plants substitute other plants and that there is no additional value added generated by the agricultural sector). Finally, the study of Heinbach et al. [32] builds on these results, but generalizes them for a modelled average municipality.

Despite the varying methods, assumptions and worldwide regions, the generally robust result in the relevant literature leads to:

Hypothesis 1. *Substituting fossil fuels with biofuels leads to a positive net effect on aggregated domestic production over all sectors.*

The sectoral distribution of output losses reflects the input structure of fossil fuel production [1]. This means the main losses occur in the petroleum production sector and the mineral oil

[2] This year is chosen for two reasons. One, it is the first year in which the full quota applies, and two, it is the year of the most recent national input–output table at time of this analysis.