EFFECTS OF A POTENTIAL NEW BIOFUEL DIRECTIVE ON EU LAND USE AND AGRICULTURAL MARKETS

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Abstract: In its Progress Report on Biofuels the European Commission proposes a more restrictive biofuel directive which sets a mandatory minimum share of biofuels in total fuel consumption in the transport sector of 10% per Member State by 2020. This is likely to have a strong impact on demand for biofuel inputs such as plant oils, cereals and sugar beet. To analyze the effects of this proposal on land use and agricultural markets, an extended version of the partial equilibrium model ESIM of the European agricultural sector is developed and applied which covers the production of and demand for biofuels. Two policy scenarios are simulated for the projection horizon until 2020: a baseline under which the share of biofuels in total transport fuels increases to 6.9% by 2020, and a scenario with a more demanding biofuel directive resulting in a 10% share. Results show that a substantial part of the policy-induced demand for biofuels is covered by imports of biofuels and biofuel inputs. Especially after the implementation of a potential Doha agreement, EU production of bioethanol strongly decreases, while almost all bioethanol demand is covered by imports.

Keywords: Biofuels, EU Biofuels Directive, agricultural markets, partial equilibrium modeling

1. Introduction

Biofuel demand is regulated at the EU level by the Biofuel Directive (2003/30/EG), which defines indicative targets for the share of biofuels in total fuel demand in the transport sector of 2% by 2005 and 5.75% by 2010. Whether and how to reach these targets is the responsibility of the Member States, which pursue a wide range of national policies such as tax rebates, mandatory blending shares and investment subsidies. Biofuel demand in the EU has grown strongly in recent years and reached the 2005 target of 2% in 2006 on average (Figure 1). Large differences exist however among Member States: in 2005 the biofuel share in Germany was 3.75%; for France, Austria, Lithuania and Malta the share was between 0.5% and 1%; and for all other Member States it stood at below 0.5% (European Commission, 2007a).

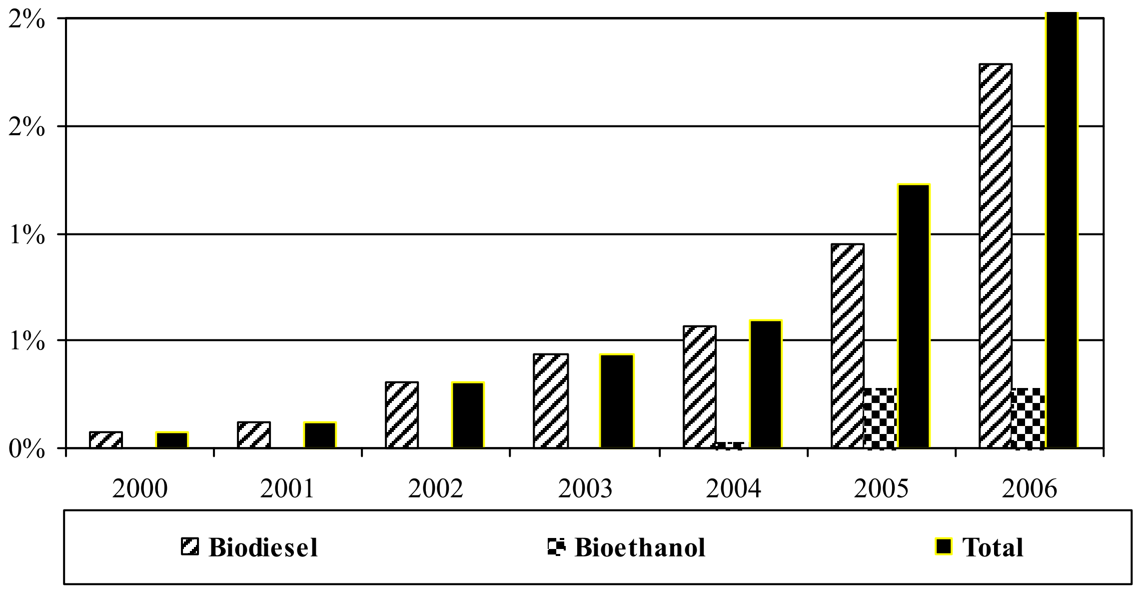

Figure 1: Development of EU Biofuel Demand as a % of Total Fuel Demand in the EU Transport Sector

Source: European Commission (2007a), European Commission (2007b).

Despite the recent growth in EU biofuel demand, the European Commission expects the 2010 target not to be met and in its "progress report on biofuels" proposes a more demanding biofuel directive which sets a mandatory minimum share of biofuels in total fuel consumption in the transport sector of 10% per Member State by 2020. Due to the high area requirement to reach such a share, it is likely that this policy will lead to significant effects on agricultural production, land use and prices in the EU and in other countries.

Recent publications provide evidence that the overall environmental impact of the political support of biofuel demand and production, which would not be viable otherwise, such as in the EU, is unclear and may even be negative. It is clear that alternative green house gas (GHG) reduction strategies are more cost-efficient. In particular, the indirect effects of biofuel demand on agricultural prices (and not only in the EU,) are at the core of concerns that the overall contribution of EU biofuel policy to GHG mitigation may be negative.

This paper aims at quantifying the impact of a 10% target by 2020 on agricultural production, land use and prices compared to a situation with a continuation of the current EU biofuel legislation. To this purpose, the ESIM partial equilibrium model of the European agricultural sector is extended to cover the production of and demand for biofuels (Chapter 2). Subsequently, two scenarios are formulated for 2020 (Chapter 3), and the results are presented and discussed (Chapter 4). Chapter 5 concludes.

2. Model Description

ESIM is a comparative static partial equilibrium net-trade multi-country model of agricultural production, consumption of agricultural products, and some first-stage processing activities. ESIM is a partial model, as only a part of the economy, the agricultural sector, is modeled, i.e. macroeconomic variables (like income or exchange rates) are exogenous. As a world model it includes all countries, though in greatly varying degrees of disaggregation. All EU Member States as well as accession candidate Turkey plus the US are modeled as individual countries; all others are combined in one aggregate (the so-called rest of the world (ROW)). ESIM is a price and policy-driven model with rich cross-commodity relations; it depicts price and trade policy instruments as well as direct payments. As ESIM is mainly designed to simulate the development of agricultural markets in the EU and accession candidates, policies are only modeled for these countries (i.e. for the USA and the ROW, production and consumption take place at world market prices).

ESIM depicts the use of oilseeds for biodiesel production and cereals and sugar crops for bioethanol production. The production of biofuel crops is modeled by one isoelastic yield function and two isoelastic area allocation functions for each biofuel crop: on none-set-aside area, area is a function of input prices, direct payments, output prices for all other crops and the special energy crop premium. The second area allocation function is for biofuel crops produced on set-aside area, which is a function of input prices, direct payments, and output prices only for those crops used for biofuel production, which may alternatively be grown on set aside area. The production of biofuels is modeled as an isoelastic function of the respective biofuel price, and the weighted net prices of the respective inputs. Net prices are defined as market prices minus the related feed output price, which is for gluten feed in case of corn and wheat, multiplied by the technical extraction factor which describes how much gluten feed results from the processing of cereals to bioethanol. Finally, the production of gluten feed is defined as the sum over cereals used in biofuel processing multiplied by the respective extraction factors.

The shares of feedstock in bioethanol and biodiesel production are determined by a CES function based on net crop prices. Finally, human demand for biofuels is a function of the respective biofuel price, the crude oil price, and the tax rates on biofuels and on mineral oil.

Other policies depicted include the special premium of 45 €/ha (non-set-aside only), which is modeled as a subsidy for the production of biofuels, assuming that it accrues to a large part to biofuel producers, as it results in lower prices of biofuel inputs. EU targets with respect to the share of biofuels in total transport fuels as set out in the EU Biofuel Directive are depicted as shifters in the human demand functions and in the oilseed crushing and biofuel production activities.

Finally, changes in the compulsory set-aside rate affect the production of crops for biofuel production. Generally, a reduction in the obligatory set-aside area increases the total agricultural area used for crop production. This increase, however, is less than 100% of set-aside reduction in order to reflect the comparatively low productivity of set-aside area.

For the model base period, price data are generally obtained from EUROSTAT. For biofuel inputs, producer and market prices are identical to those applying if these products are used for other purposes. Palm oil and ethanol prices are obtained from the FAPRI outlook database. To calibrate supply and demand functions for biofuels in the model base period, data are taken from the F.O. Licht *Interactive Data and World Ethanol and Biofuels Report*. Extraction coefficients for the processing of oilseeds to biofuels are taken from the ESIM version published in Banse, Grethe and Nolte (2005). Extraction coefficients for the processing of cereals and sugar are taken from OECD (2006).

3. Scenario Description and Results

3.1. Scenario Description

Two policy scenarios both with a projection horizon until the year 2020 are formulated: a baseline, and a scenario with a more demanding biofuel directive.

For the baseline, several assumptions are made with respect to variables which are exogenous to this analysis such as demographic developments, macroeconomic growth, consumer preferences and agri-technology. Most assumptions are based on the Scenar 2020 project (Nowicki et al., 2007), with some of them updated. Furthermore, many assumptions are made for the baseline with respect to the development of the CAP; these are depicted in Table 1.

The second scenario, "BiofDir", is based on the *Progress Report on Biofuels* of the European Commission (2007b), which proposes a new biofuel directive that sets a mandatory minimum share of biofuels in total fuel consumption in the transport sector of 10% per Member State by 2020. This scenario is implemented in ESIM by increasing human demand shifters in order to meet the 2020 target. In addition, processing shifters in biofuel production as well as oilseed crushing are also increased, reflecting the increase in processing capacities. The determination of the level of processing shifters was guided by the level of the processing margins between oils and oilseeds as well as biofuel inputs and biofuels, which were not allowed to increase by more than 10% in the BiofDir.

Table 1: Assumptions on Agricultural Policy Development in the Baseline

Topic	Assumption
Market Policies	
Intervention	• Current system of intervention prices • Exclusion of maize from intervention in 2009 • Adjustment of intervention prices to balance markets where necessary in order to comply with WTO restrictions on export subsidies: • Intervention price for butter decreases by 15% from 2012 onwards
Regulations for quota products (milk, sugar)	• Reform of the sugar MO including the first step of the restructuring process • Maintenance of quotas
Changes in consumption subsidies (skimmed milk powder (SMP), butter)	• Withdrawal of consumption subsidies • Withdrawal of SMP feed subsidy
Changes in biofuel policies	• Extension of the area eligible for crop premium to 2 m ha (including the new Member States) • Human demand shifters set to reach a biofuel share of 3.5% in total EU transport fuel consumption by 2010 and 6.9% by 2020 (European Commission, 2007a)
Trade Policies	
Tariffs	• EU offer, no consideration of sensitive products, implementation period 2009-2013
Export subsidies	• EU offer, implementation period 2009-2013
TRQs	• Constant level of current TRQs, no new TRQ
Direct Payments	
Development of direct payments	• SAPS and SFP per ha payments constant in nominal terms (deflated by EU inflation rate)
Modulation rate	• 20%
Decoupling of direct payments	• Full decoupling from 2011 onwards
Application of the Single Farm Payment in the EU-10	• Prolongation of the SAPS system until 2011 as recently decided by the Council
Obligatory set aside rates	• Removal of mandatory set-aside in 2011

3.2. Results of the Baseline

Figure 2 displays the development of world market prices in the baseline in real terms. The overall trend of world market prices under the baseline is based on projections published by FAPRI for 2015 (FAPRI, 2006). Technical progress and demand shifters in the rest of the world are programmed in order to approximate FAPRI projections. An exception is price projections for biofuels, plant oils and oilseeds, for which the implementation of human demand shifters for biofuels in the EU – in order to meet the projections of the European Commission (2007a) – leads to significantly higher prices which apply in the baseline.

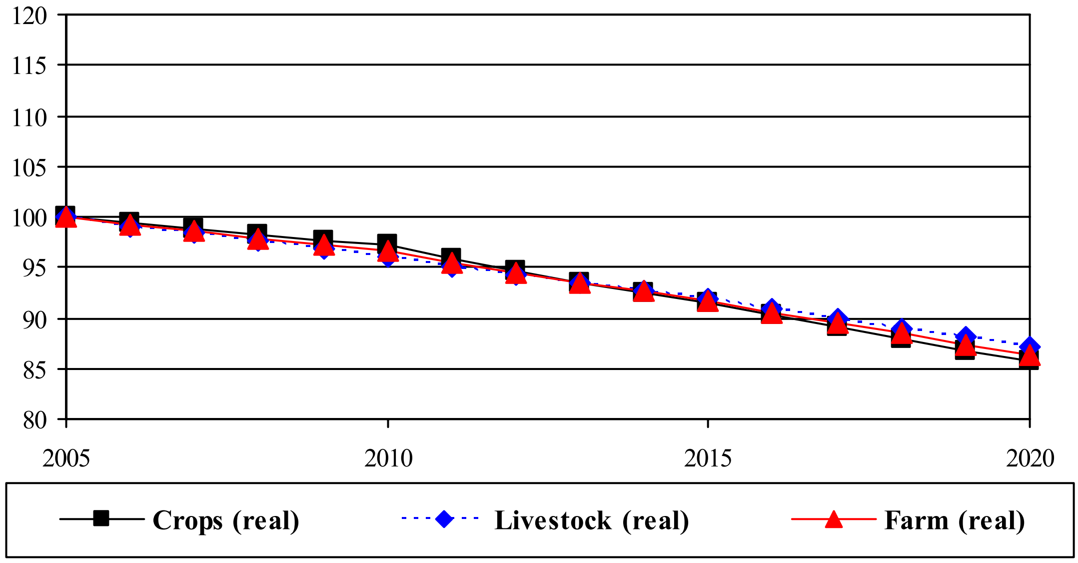

Figure 2: Real World Market Price Indices for Agricultural Products 2005-2020
Source: Own calculations.

World market prices are projected to fall by about 14% in real terms for crops and 13% for animal products until 2020. EU prices can be expressed relative to the world market price, reflecting the degree of political protection. Figure 3 displays the development of weighted (with fixed supply quantities in the base period) EU prices for agricultural products expressed in relative terms compared to the world market price.

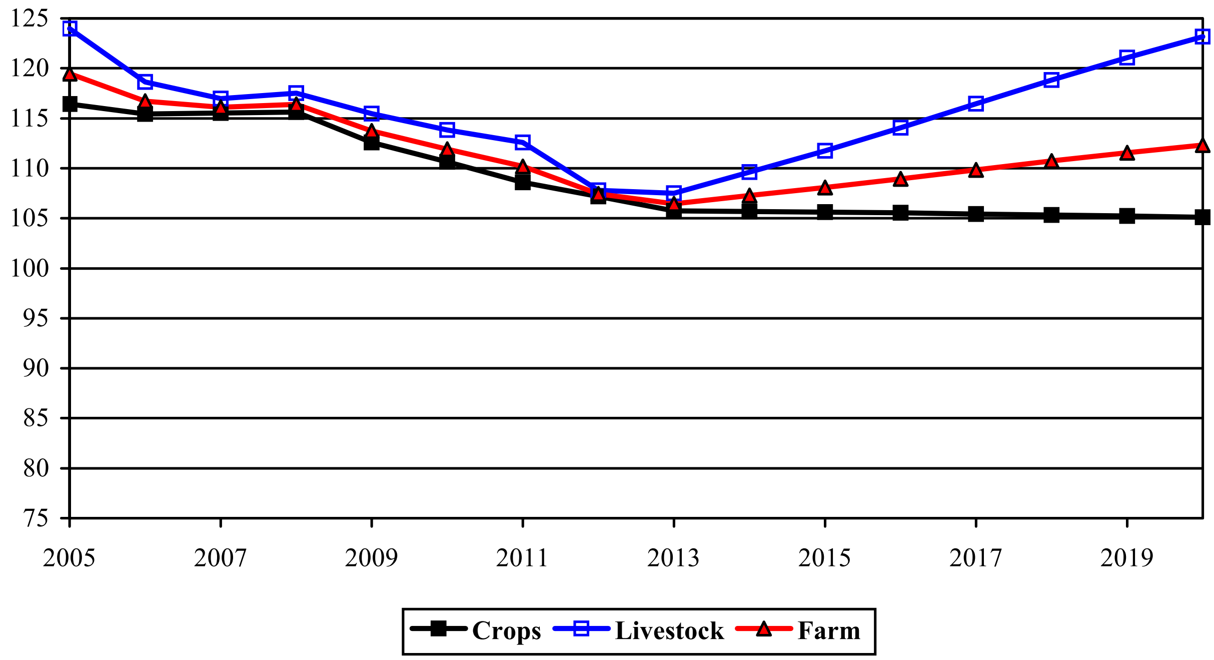

Figure 3: Development of EU Price Relative to World Market Price Indices for Agricultural Products 2005-2020 (production value-weighted)

Note: Under a situation with no distortion between EU prices and prices on world markets, all numbers in Figure 2 would be exactly 100. Numbers above 100 indicate higher prices on EU markets compared to prices on world markets, while numbers below 100 describe an EU price level below international prices. Source: Own calculations.

For agricultural products, the EU price declines on average from almost 120% compared to the world market price in 2005, to about 113% in 2013. Most of this decline is due to the implementation of the tariff reductions that are part of the EU offer in the Doha Round, which is included in the baseline. From 2013 onwards, EU crop prices remain fairly constant relative to the world market level. This reflects the fact that the EU is at the world market price level for most crop products over this period, and no other policy changes are implemented except a deflation of remaining institutional prices and specific duties. For animal products, EU prices start rising between 2013 and 2020 and almost reach their original level at about 23% above world market prices. This is caused by declining net exports of all animal products, which tends to result in higher prices: domestic prices are increasingly influenced by the relevant import price, which is the world market price plus a tariff that is higher for all animal products than the relevant export price, which is the maximum of the world market price and the institutional price (if any).
Figure 4 depicts the development of agricultural production quantity in the EU in the baseline (base price-weighted).

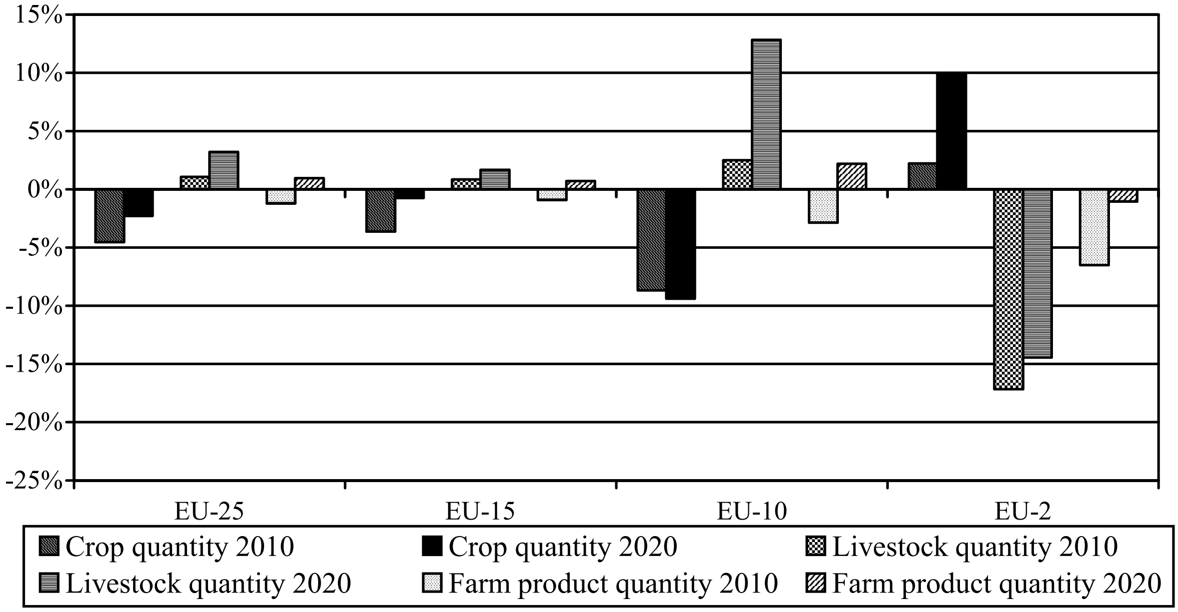

Figure 4: Development of EU Indices of Agricultural Production Quantity 2005-2020
Source: Own calculations.

Agricultural supply quantities on aggregate are relatively stable. For the EU-25, the total agricultural production quantity decreases by about 0.5% by 2010 and increases by 0.4% by 2020. For the EU-15, crop production declines by about 4% by 2010, while livestock production increases with a similar development for the EU-10. By 2020, livestock production in the EU-10 is 12% above the 2005 level. For the EU-2, livestock production decreases due to heavily declining prices for some products. On aggregate, agricultural production in the EU-2 is about 7% below 2005 in 2010 and 1% below the 2005 level in 2020.
Figure 5 displays the development of biofuel production and consumption in the EU over the projection horizon. Consumption shifters are set so as to meet a biofuel share of 3.5% in total transport fuel consumption in the EU by 2010, more than double the 2005 share. Biofuel consumption is projected to further increase to about 24 m t mineral oil equivalent (MTOE) by 2020, which is

equivalent to 6.9% of total transport fuel consumption. Shifters are explicitly set to approach the overall biofuel shares projected by the European Commission (2007a). However, shifters are uniformly set for biodiesel and bioethanol, which results in a bioethanol share of 1.7% and a biodiesel share of 5.2% in total transport fuels, whereas the European Commission projects a bioethanol share of 3.1% and a biodiesel share of 3.8%.

Production also increases significantly to 16.6 MTOE by 2020, but less than consumption, resulting in considerable EU imports of biofuels (about 7.4 MTOE, compared to negligible imports in the base period). Most of these imports (5.4 MTOE) consist of bioethanol, whereas only 2 MTOE of biodiesel imports are projected. This can be explained by the development of prices for biodiesel and bioethanol in the baseline: for biodiesel, the EU price is already at the world market price level in the base period, and the EU biodiesel price increases by 10% until 2020. Bioethanol, in contrast, is highly protected in the base period. The implementation of a potential Doha Round Agreement substantially reduces bioethanol tariffs, and the EU bioethanol price is projected to decrease by 22% in real terms until 2020, leading to less competitive bioethanol production in the EU compared to biodiesel production.

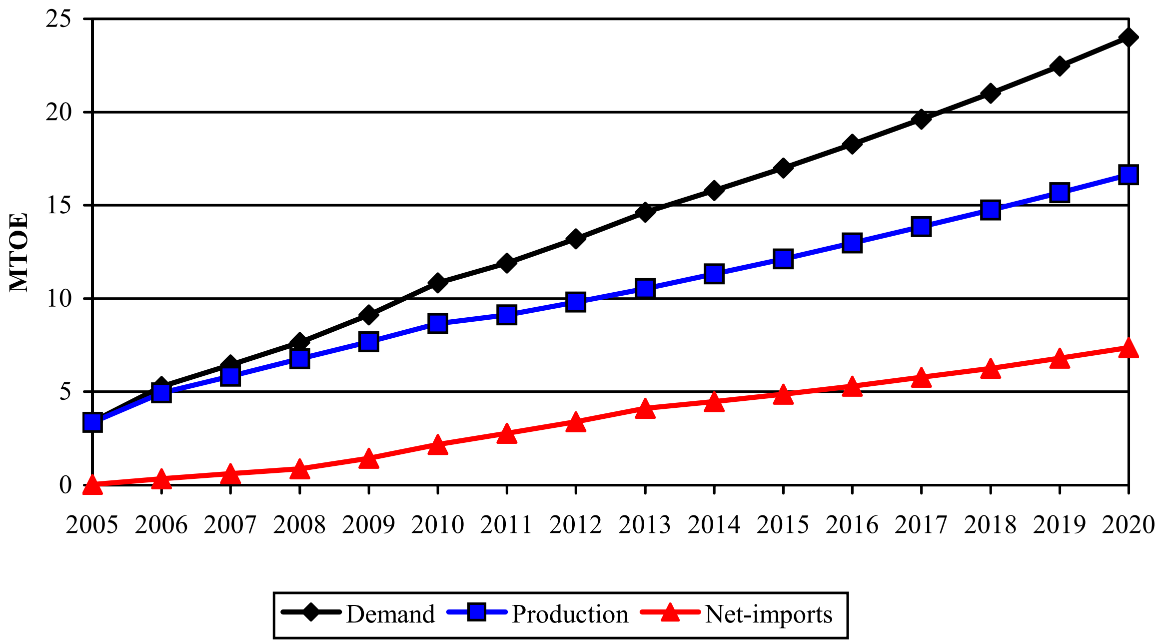

Figure 5: Biofuel Production, Demand and Imports in the Baseline (2005-2020, MTOE)
Source: Own calculations.

Net imports of products which can be used as biofuel inputs also increase substantially under the baseline, especially plant oils. EU net imports for wheat, corn, sugar, oilseed, plant oils and biofuels are projected to increase from 9 MTOE in the base period to 29 MTOE by 2020 in the baseline. EU biofuel consumption increases by 19 MTOE over the same period, thus adding substantially to the strong trend towards a situation of net imports.

Finally, technological developments could impact the results presented here. This analysis is based on first-generation technologies for biodiesel and bioethanol production. Second-generation technologies, such as biomass-to-liquids or cellulose conversion into sugars, could result in higher yields per ha and provide the option to use land which is not suited, or is only poorly suited, for the production of food crops. It is far from certain, however, that these technologies will take off during the projection horizon until 2020. For example, the International Energy Agency (IEA, 2006) assumes that second-generation biofuels will not take off before 2030.

The European Commission (2007a) specifies a scenario of second-generation technologies accounting for 30% of total biofuel production in 2020. Following the assumption of a 30% share of second-generation biofuels and assuming a higher energy yield for second-generation crops by 40%, the same amount of land use for biofuels would result in an additional production of 1.8 MTOE and thus lesser imports. Such a scenario would not alter, however, the principal fact that increasing EU biofuel demand will be satisfied by imports for a substantial share, either in the form of biofuels or biofuel inputs.

3.3. Implementation of a New EU Biofuel Directive

Figure 6 shows the development of EU biofuel consumption in % of total consumption of transport fuels in the EU-27 in the baseline as well as in the BiofDir.

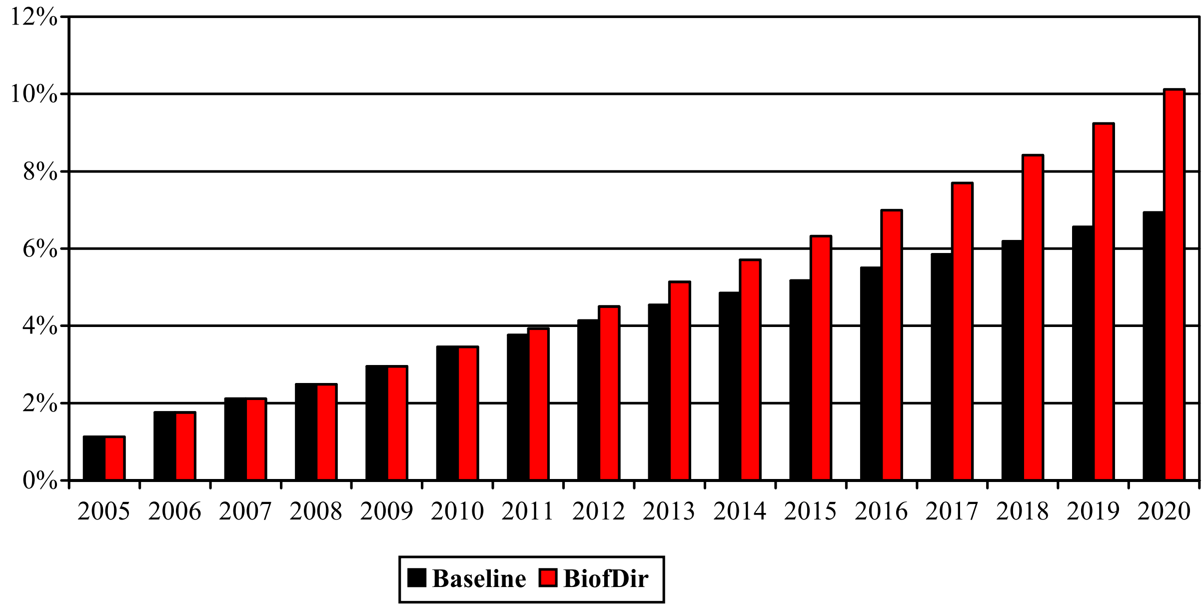

Figure 6: Share of EU Biofuel consumption in Total Transport Fuels in the EU-27
Source: Own calculations.

Until 2010, the development of EU demand for biofuels under the BiofDir is quite similar to the baseline, which is consistent with projections from the European Commission. After 2010, however, demand increases more strongly under the BiofDir, ending up at a share of about 10%, instead of 6.9%, by 2020.

The effect on area allocated to agricultural production is low. Figure 7 shows that the decline in the total area used for agricultural production which can be observed under the baseline scenario is only to a small extent compensated by the production incentives of the Biofuel Directive. The major decline in area takes place between 2009 and 2013 when the bulk of policy reforms is scheduled. However, a smooth declining trend continues until 2020 under both scenarios because of falling world market prices in real terms.

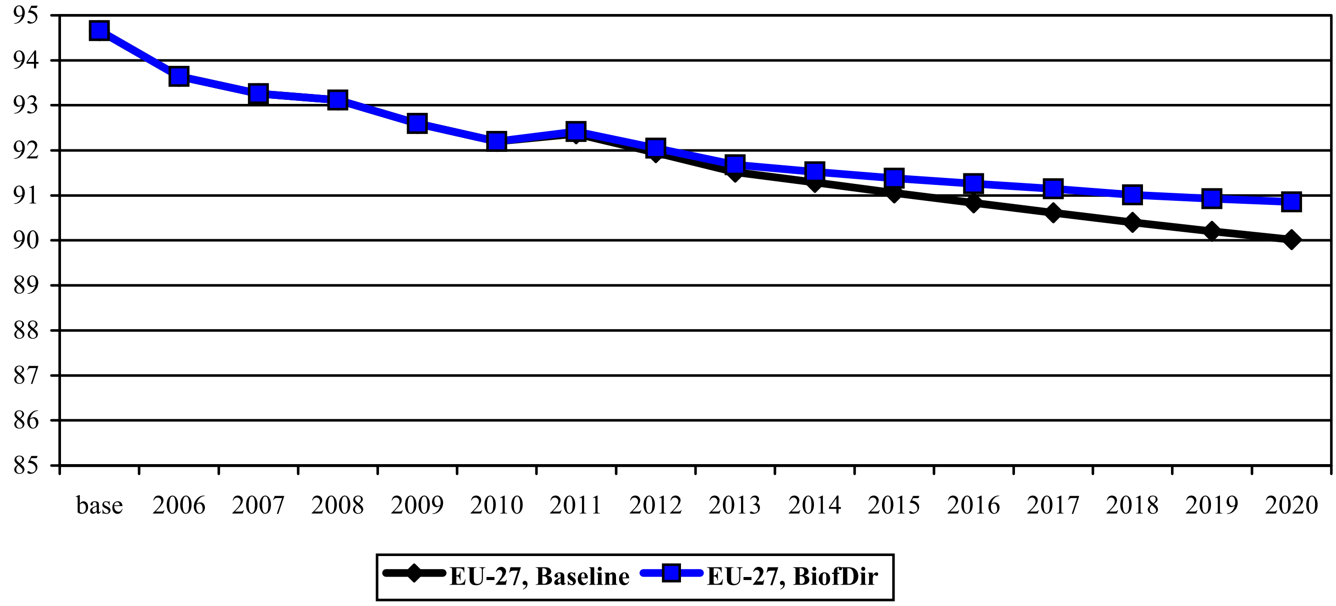

Figure 7: Development of Agricultural Land Use in the EU-27 in the Baseline and under the BiofDIr (in m ha)

Source: Own calculations.

The increased demand for biofuels in the EU has an impact on agricultural prices in the EU and also, due to the degree of trade integration of the EU, on world market prices. Price effects are displayed in Figure 8.

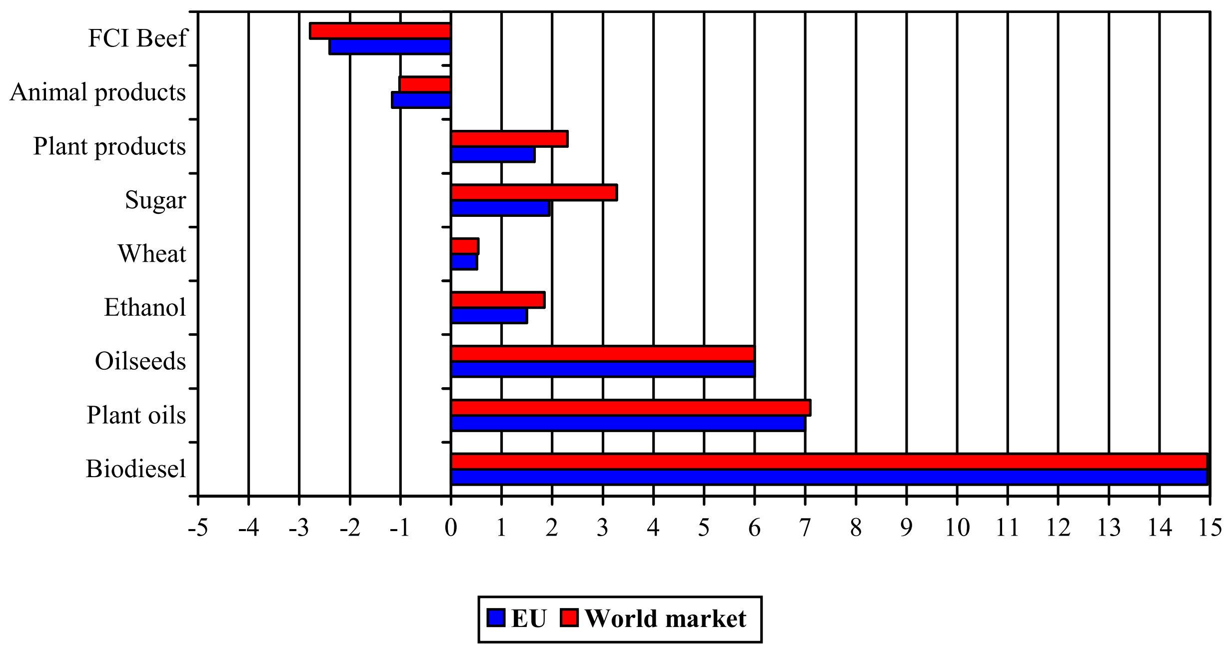

Figure 8: Scenario Results of the BiofDir: Change in Prices Relative to the Baseline (= 0) (2020)

Source: Own calculations.

As a first observation, price effects on the EU market are similar to those on the world market. This is because the EU is closely integrated into the world market, i.e. any effect resulting from stronger EU demand directly affects world market prices. The biodiesel price increases by 15% until 2020 compared to the baseline, and biodiesel input prices follow this trend. On average (world production quantity-weighted) the price for all plant oils increases by 7% while the price for oilseeds increases by 6%. Prices for ethanol and ethanol inputs increase by a much lower level of up to 3%. This can be attributed to the fact that the EU is a much smaller player on world markets for bioethanol and bioethanol inputs than it is for biodiesel and biodiesel inputs.

On aggregate, the increased EU demand for biofuels has a positive impact on the overall price level for crops in the EU (+1.7%) and on the world market (+2.2%). However, the price level for animal products declines by 1.2% in the EU and 1.0% on the world market, owing to the strong increase of supply of byproducts of the biofuel industry used in animal feed (gluten feed, oilcakes) which results in lower feed prices (for example the feed cost index for beef in the EU declines by 2.8%) and the related increasing supply of animal products.

As the EU is integrated into the international agricultural markets, the price increase in the EU that results from increasing demand for biofuels is dampened. Much of the additional demand for biofuels is covered by imports as shown in Figure 9. Demand increases by almost 50%, but production of biofuels only by 27% compared to the baseline. As a result, imports increase by more than 80%.

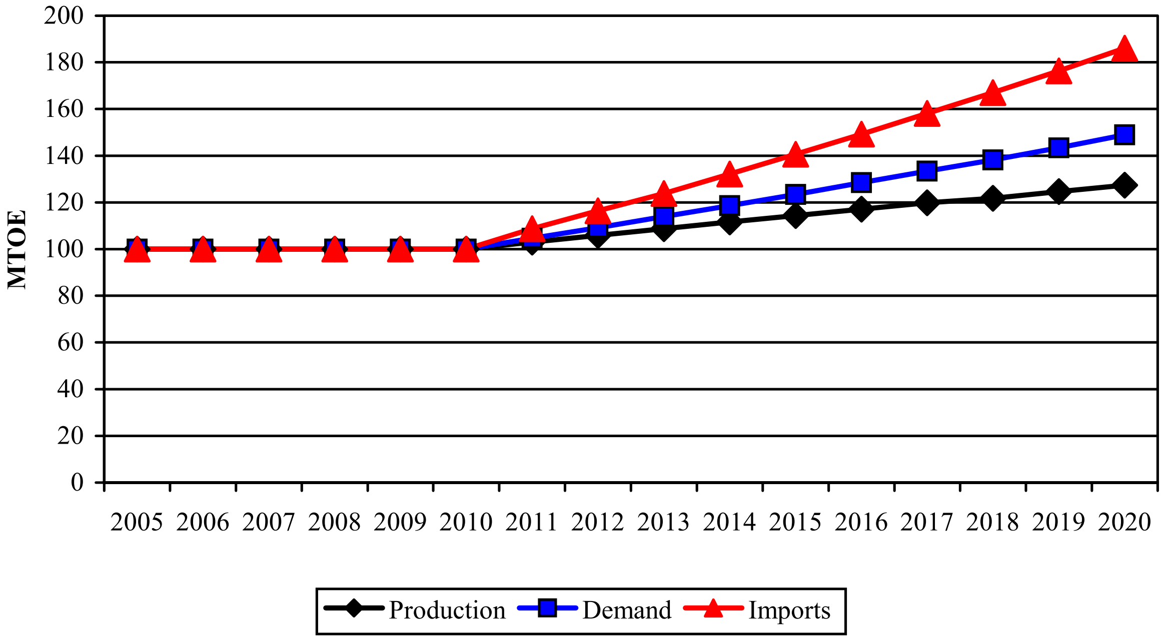

Figure 9: Development of Biofuel Production, Demand and Imports in the EU-27 under the BiofDir (Baseline = 100)

Source: Own calculations.

Imports not only occur in the form of biofuels, but also in the form of products which can be used as biofuel inputs, such as oils, oilseeds, cereals and sugar. Figure 10 shows total EU-27 net imports of biofuels and potential biofuel inputs (independently of whether they are used as biofuel inputs, for food demand or for feed demand) by 2020 under the baseline and the BiofDir.

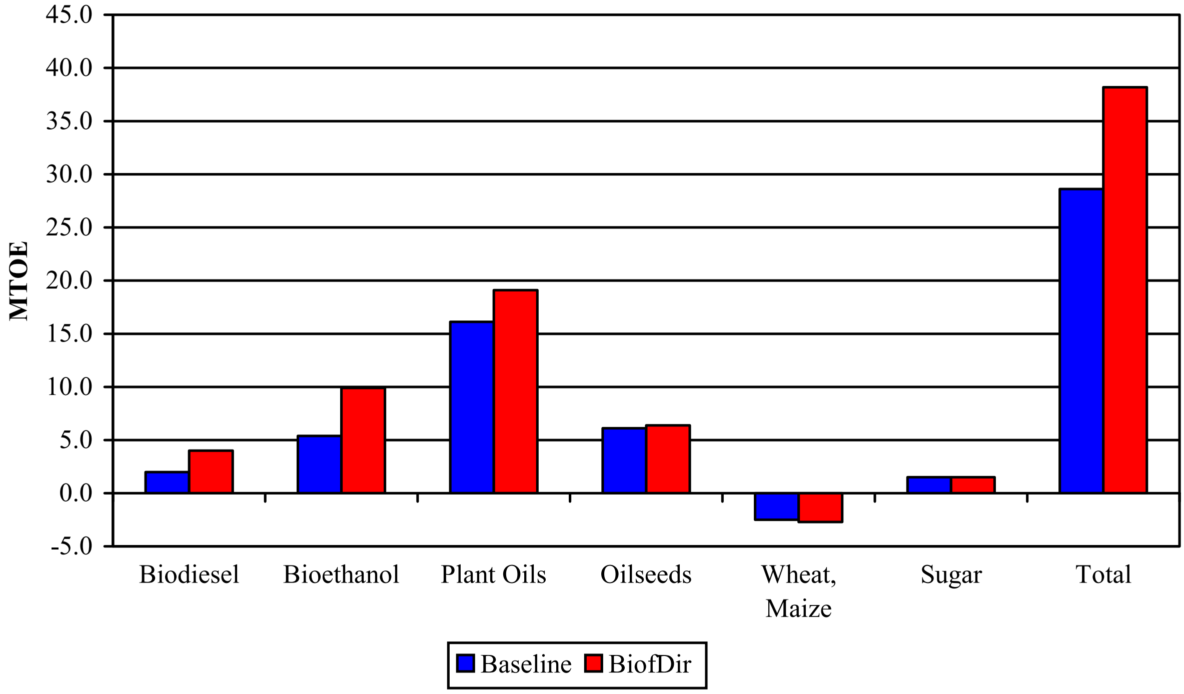

Figure 10: EU-27 Net Imports of Biofuels and Potential Inputs under the Baseline and the BiofDir in 2020 (MTOE)

Source: Own calculations.

Imports of biodiesel, bioethanol, plant oils and oilseeds increase substantially under the BiofDir compared to the baseline. Altogether, imports of these products increase from 28.6 MTOE to 38.2 MTOE. This shows that about 87% of the additional 11 MTOE demand for biofuels which would be generated by the proposed biofuel directive by 2020 would be covered by imports, whether in the form of biofuels, plant oils or oilseeds.

As for the baseline, the analysis of the BiofDir is based on first-generation technologies for biodiesel and bioethanol production. Should second-generation technologies be applied before 2020 to a significant degree, the effects on imports and prices would be less pronounced. Following the European Commission (2007a) and assuming a 30% share of second-generation biofuels and a higher energy yield by 40%, the same amount of land use for biofuels would result in an additional production of 2.8 MTOE from biofuels under the BiofDir, compared to 2.2 MTOE under the baseline. Furthermore, the price effects would be slightly lower. Still, under such a scenario, more than 80% of the additional biofuel demand under the BiofDir compared to the baseline would be sourced from imports, either in the form of biofuels or biofuel inputs.

4. Conclusions

Under the baseline, biofuel production increases to 18.1 m t by 2020, but less than consumption, resulting in considerable EU imports of biofuels (about 10.6 m t, compared to negligible imports in the base period). Most of these imports (9.0 m t) consist of bioethanol, with only 1.6 m t of biodiesel imports projected. This can be explained by the strong reduction of bioethanol tariffs, which results in a price decline of 22% in real terms until 2020, leading to less competitive bioethanol production in the EU compared to biodiesel production. Not only biofuels are imported, but also net imports of products which can be used as biofuel inputs, which increase substantially under the baseline. This is especially the case for plant oils. EU net imports for wheat, corn, sugar, oilseeds, plant oils and biofuels are projected to increase from 9 m t mineral oil equivalent (MTOE) in the base period to 29 MTOE by 2020 in the baseline. EU biofuel consumption increases by 19 MTOE over the same period, which thus adds substantially to the strong trend towards a net import situation.

An increase in the share of biofuels in total transport fuels in the EU has strong price effects. The biodiesel price increases by 15% in 2020 compared to the baseline, and prices for biodiesel inputs follow this trend. The price for plant oils also increases, by 7% on average. Prices for ethanol and ethanol inputs increase by a much lower level of up to 3%.

On aggregate, the increased EU demand for biofuels has a positive impact on the overall price level for crops in the EU (+1.7%) and on the world market (+2.2%).

The analysis shows that the additional demand for biofuels to meet the 10% share in total transportation fuels by 2020 can only be achieved by a strong increase in imports. Depending on technology assumptions, between 80% and 87% of the additional demand for energy from biofuels would be covered by imports of biofuels and biofuel inputs.

In the long run, the political perspective for biofuels in the EU is questionable. In light of the increasing evidence of the arbitrary environmental effects of first-generation biofuel production in the EU (Doornbosch and Steenblik, 2007) and the inefficiently high cost of GHG mitigation through biofuel production, political support may cease.

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