MODELLING IMPACTS OF SOME EUROPEAN BIOFUEL MEASURES

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Abstract

Against the background of increasing concerns regarding the energy supply security as well as environmental concern the interest for renewable energy sources has increased in recent years. The biofuel sector, backed by public policies, experienced a strong increase in and outside Europe. A methodology that allows for the estimation of the impacts of the fulfilment of the proposed biofuel targets in the EU member states is proposed and implemented in the AGMEMOD model for France and Germany. The so called normative approach, based on the use of a logistic function as biofuel demand function allows to perform simulations to assess the impact of the biofuel demand expansion on agricultural markets. The implemented approach and the simulation results indicate that crops production would adjust to the modified demand situation and depending on the proposed scenario the domestic supply would not be enough for the achievement of the biofuel targets in France and Germany.

Key words: biofuel targets, biodiesel, ethanol, modelling

1. Market on biofuel

1.1. Introduction

The instability of the oil supply from big suppliers due to e.g. the US military intervention in Iraq, political instability in several minor suppliers in Africa and South America, environmental phenomena that temporarily disrupted the oil supply coming from the Gulf of Mexico affecting the supply of the US market, the continuous increase in demand by populous Asian emerging economies for energy, and the pronounced corrosion of the agricultural sector protection by the EU (with the highlight of the WTO panel decision on the sugar market organisation of the CAP), offer the background for the increased interest for alternative energy sources. Among the renewable energy sources there is the possibility of several uses of products from the agri-forestry sector or processed agricultural products. Additionally, increasing concern about the threat of climate change resulting from the build up of greenhouse gases is accelerating the momentum behind the search for ways to mitigate this phenomenon. Since carbon dioxide (CO2) is the most prevalent greenhouse gas, it is the major focus of domestic and international strategies for controlling greenhouse emissions.

Bioenergy is among the renewable energy sources often considered to play a key role in the short run to reduce carbon emissions, improve global energy efficiency, and exploit less carbon intensive energy sources. It has the potential to address the full range of energy markets, including transportation, heat and electricity. Bioenergy is generated from organic substances usually referred to as biomass. biofuels represent a subgroup of biomass which can either be in a liquid form such as ethanol or biodiesel, or in a gaseous form such as biogas. The feedstocks for bioethanol are starch and sugar, whereas biodiesel is based on vegetable oils derived from oilseed crops.

Due to the increased importance of biofuels in Europe and elsewhere and the impact of policies on the agricultural markets, the AGMEMOD - Partnership discussed ways to account for this new trend in the framework of the AGMEMOD projections for the agricultural markets of the EU member states. This paper presents one of the two proposed ways to deal with the biofuel markets growth in the AGMEMOD model.

After an overview of key factors affecting biofuel markets, the implementation of the proposed normative approach to include the biofuels in the AGMEMOD model is described and a modelling experiment around two biofuel obligation targets against a counter-factual baseline is performed and its results are presented. The paper closes with conclusions and recommendations for further work.

1.1. Biofuel production

To reduce world-wide carbon emissions, a certain degree of bioenergy is used. Bioenergy is renewable energy made available from materials derived from biological sources. Biofuels represent a subgroup of renewable energy which can either take a liquid form like bioethanol or biodiesel, or be gaseous like biogas. The feedstocks for bioethanol are starch and sugar, whereas vegetable oils serve as the basis for biodiesel. Global production of biofuels has been increasing in recent years.

Ethanol, for decades produced to be used in pharmaceutical and industrial applications, had seen a steep expansion in production following the increase in crude oil prices in the mid-1970s, before its manufacturing was reduced in the mid-1980s when crude oil prices dropped again. In 2006, biofuels market grows apace, as the debates about the relationship between the prices of fossil and renewable energy sources as well as the one between fuel, food, feed and land use for crops got prominent position in politics worldwide. Concerns regarding energy security and growing evidence of global climate change increased as oil prices surged from the summer of 2006 on, with enduring political instability in major suppliers such as Iran, Iraq, Nigeria and Venezuela. The price hype among others reanimates the Brazilian fuel alcohol program (PROALCOOL), lead to the expansion of the US alcohol production and propelled the use of vegetable oil as fuel and the European biodiesel sector.

The world ethanol production reached 50 bln liters in 2006, compared to 44.9 bln liters achieved in 2005 (Figure 1). This rise in world ethanol production is attributable to the rapid growth of ethanol production in the leading world markets – particularly the spectacular increase in the US corn production and processing to ethanol (see Figure 1). But, historically, Brazil is the largest world ethanol producer, followed by the US in addition to China, India and the EU.

The main EU ethanol producers include France, Germany, Spain, UK, Poland and Italy. EU ethanol output also grows in 2006 reaching 3.1 bln liters, up from 2.7 bln in 2005 (see Table 1). The main driver of this strong growth is output expansion in Germany, where, after initial technical problems, the major fuel ethanol plants reached their bounds of capacity. Although, in Germany, a further expansion of the industry was to be expected with at least two additional plants coming into processing in 2008, the rise in world market prices for cereal and oilseeds might seriously hamper this prospects.

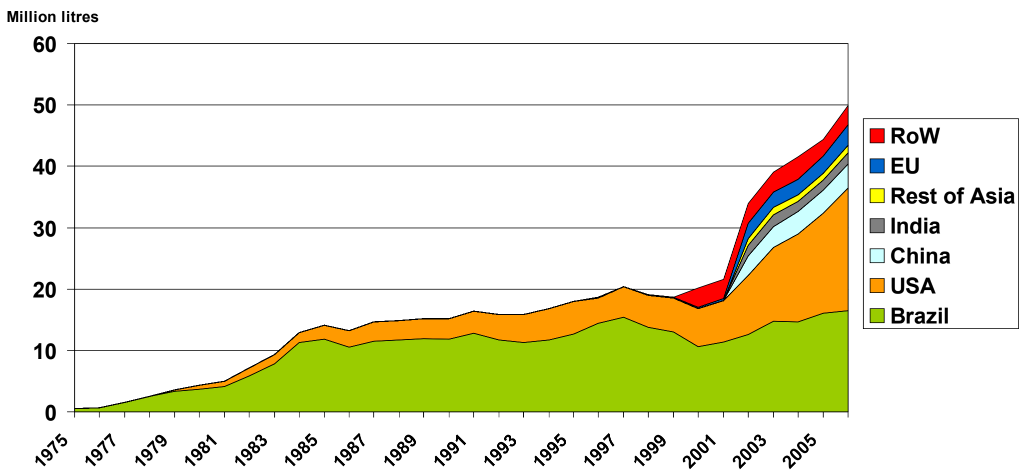

Figure 1: World ethanol production, 1975-2006

Source: F.O.Licht (2006/Mai, Nov.)

Table 1: EU ethanol and biodiesel production (2002-2006), by country

Member State	Ethanol (1000 hl)					Biodiesel (tons)				
	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006
Austria	87	81	72	70	108	33600	48600	57000	74700	75000
Denmark	201	220	218	210	205	40000	50000	70000	70000	70000
France	8440	8166	8300	9100	9500	366000	357000	348000	490000	550000
Germany	2750	2800	2300	3500	5500	645375	859125	1060375	1.690225	1.900000
Hungary	429	466	538	580	650	0	0	0	0	0
Italy	2000	1490	1500	1500	1625	210000	273000	320000	200000	200000
Poland	1650	1700	2000	2200	2300	0	0	0	70000	100000
Spain	2575	2923	3344	3762	4750	0	6000	13000	73500	150000
Sweden	970	1000	1050	1100	1150	800	5000	6000	6000	30000
U.K	4000	4100	3500	2900	2800	0	9000	9000	65000	100000
Other EU	2322	2082	2132	2251	2720	10000	15000	15000	20000	80000
EU	25424	25028	24954	27173	31308	1.335775	1.662725	1.958375	2.879425	3.375000

Source: F.O. Licht (2006).

The EU is the world major player in production and consumption of biodiesel (Figure 2). In contrast to ethanol, vegetable oils intended to food use and for biodiesel use can not be separated very well. Therefore, biodiesel production is estimated based on processing capacity and some fuzziness may occur. Business interest in biodiesel has also grown in the U.S., in Brazil, Malaysia and Indonesia. A total of 3.75 mln tons of biodiesel capacity was produced in the EU in 2005, which is sharply up by 900,000 tons year-on-year and contrasts with 1.9 mln tons in 2002. The EU market leader is Germany, with biodiesel capacity at about 1.95 mln tons in 2005, compared with 1.20 mln tons in 2004, 1.06 mln tons in 2003 and just 300,000 tons in 2002. Consumption was seen at between 1.8-2.0 mln tons in 2005, sharply up from 1.1 mln tons in 2004. Even so it must be reminded that although growing, the world market for biodiesel represents one tenth of the ethanol market.

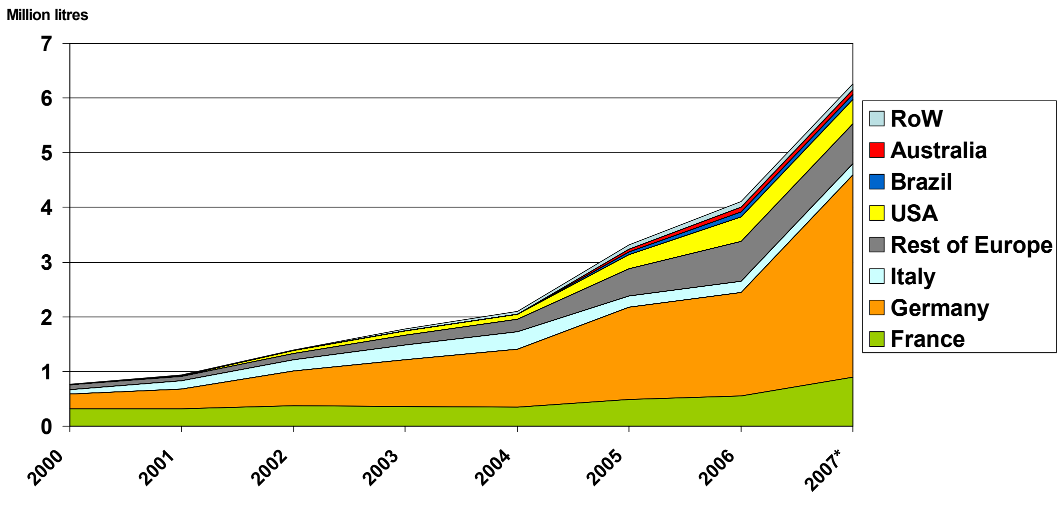

Figure 2: World biodiesel production, 2000-2007
Source: Own figure, statistics from F.O. Licht (2006); 2007*estimate.

1.2. Biofuel policies

Biofuels production costs vary significantly across the main producing countries as well as across feedstocks. For instance, the production cost of ethanol from sugarcane in Brazil is about USD 0.22 per liter of ethanol (without subsidies), which under the actual price relations is lower than the price of gasoline net of tax, whereas no other major producer is able to produce ethanol at a cost competitive with domestic gasoline prices without some form of subvention (OECD, 2006). Biodiesel, however, can be produced in the EU at a substantially lower cost than ethanol. Biodiesel production costs are still 1.5 to 2 times the oil-based diesel price (net of tax), and therefore its production is heavily dependent on government support to remain cost competitive. In all cases, when production cost is regarded policy interventions need to be taken into account. Even if no subsidies are directly provided, other measures like obligatory bend rates will have to be considered. But this not only applies to EU member states (Henke, Klepper and Schmitz, 2003) but also to other major producers like the US, with e.g. differentiated taxation for ethanol and gasoline, (Tokgoz et al., 2007) and import barriers for biofuels (IPC and REIL, 2006).

Several measures of the agricultural policies like the CAP in Europe as well as of the energy policies directly and indirectly stimulate the production of renewable energy from the agricultural sector (OECD, 2006, p.17 ff). In the EU, the Commission's Biofuels Directive (2003) sets a 2% market share (measured in energy content) as reference value in 2005 for biofuels and 5.75% share in 2010. As Table 2 shows, substantial difference in Member States' efforts is observable and doubts remain in place if the overall 2005 reference value has really been achieved.[1]

Table 2: Market share of biofuels in total energy use and targets in the EU25

Member State	Market share 2003	National indicative target for 2005	Targeted increase, 2003-2005
AT	0.06%	2.5%	+2.44%
BE	0	2%	+2%
CY	0	1%	+1%
CZ	1.12%	3.7% (2006)	+ 1.72% (assuming linear path)
DK	0	0%	+0%
EE	0	2%	+2%
FI	0.1%	0.1%	+0%
FR	0.68%	2%	+1.32%
DE	1.18%	2%	+0.82%
GR	0	0.7%	+0.7%
HU	0	0.4-0.6%	+0.4-0.6%
IE	0	0.06%	+0.06%
IT	0.5%	1%	+0,5%
LA	0.21%	2%	+1.79%
LI	0 (assumed)	2%	+2%
LU	0 (assumed)	not yet reported, assume 0	not yet reported
MT	0.02%	0.3%	+0.28%
NL	0.03%	2% (2006)	+0% (promotional measures should come into force from January 2006)
PL	0.49%	0.5%	+0.01%
PT	0	2%	+2%
SK	0.14%	2%	+1.86%
SI	0 (assumed)	0.65%	+0.65%
ES	0.76%	2%	+1.24%
SV	1.32%	3%	+1.68%
UK	0.03%	0.3%	+0.27%
EU25	**0.6%**	**1.4%**	**+0.8%**

Source: Biomass Action Plan (2005).

The market and fiscal policy instruments used for the implementation of the goals of the Biomass Action Plan in the Member States (Commission of the European Communities, 2005) are obviously linked to the agricultural sector as supplier of renewable sources of energy, but also interact with the energy sector. Here, the fuel distribution companies play a particular role as governments use this bottleneck in distribution of fuels to collect mineral oil taxes playing an important role in the national budget in many countries. The two most widely-used approaches to support the development of the biofuel market are, first, the tax exemption that represents an indirect subsidy of biofuels and second, the direct governmental obligation to blend the mineral fuel with predefined amounts of biofuel. This

[1] For more detail see the von Ledebur et al (2006) the MEACAP project homepage and OECD (2006, 2007a, 2007b)

induces the fuel distributing companies to buy biofuels and stimulate their production via increasing demand for these products. To implement the directive, many Member States rely initially on fuel tax exemptions subject to state aid control. In doing so, however, several problems arose e.g. budgetary problems. A number of Member States has recently turned to implement biofuels blend obligations, which means that fuel supply companies are forced by law to incorporate a given percentage of biofuels in the fuel they place on the market, which has already been done since the 1980's in Brazil to back-up ethanol production. Obligations came up as a promising way of overcoming national budget difficulties arising from tax exemptions like in Germany with biodiesel and stressing those targets are to be met as cost-effectively as possible. The assumption behind it is that the implementation of the obligation (the fuel blend) will be implemented by companies at market conditions. In the following section, the methodology for the implementation of the achievement of biofuel obligations in the AGMEMOD model is described and a simulation exercise is performed in order to estimate its market impact on selected country markets.

2. Biofuel market in the partial equilibrium model AGMEMOD

2.1. Basic model overview

AGMEMOD is an econometric, dynamic, multi-product partial equilibrium model wherein a bottom-up approach is used. Endogenous variables are prices and quantities national commodity markets and derived variables, e.g., agricultural sector income, or emission indicators. Exogenous variables are policy variables (e.g., intervention prices, direct payments, production quotas, set-aside rate, trade quotas), factor endowments, GDP, population, exchange rates, inflation, technical coefficients (e.g., fat content, extraction rates) as well as, currently, world market prices. In solving individual country models as stand-alone models, EU key prices and other variables relative to other countries are exogenously determined while, in the combined mode, key prices are determined endogenously. The EU net export is involved in forming the respective price at the EU level. Based on a common commodity country model template, country level models, with country specific characteristics were developed to reflect the specific situation of their agriculture and to be subsequently combined in a composite EU model. This approach captures the inherent heterogeneity of the agricultural systems existing across the EU while still maintaining analytical consistency among the country models. This is essential for the aggregation and it also facilitates the comparison of the impact of a policy across different Member States. When solving the composite model, a closure variable ensures that the supply and demand identity holds for all national markets. AGMEMOD does not consider the distinction between intra-EU and extra-EU trade at the Member State level. This intra-EU trade disappears at the EU level when summing supply and use identities over countries. The composite EU15 model allows for generating market projections and alternative scenario simulations for both the whole EU and its individual Member States, under the assumption of exogenous world prices. This organization of the composite EU model also enables analysis of agricultural policy changes for a given subset of countries and commodities modelled, while considering the rest of the EU and commodities as exogenous (AGMEMOD Partnership, 2007)[2].

In principle, the AGMEMOD model deals with 24 EU Member States whereas Luxemburg is included in Belgium, Cyprus is added to Greece. Currently, the combined mode has available the 15 OMS while in stand-alone mode, all individual country models generates projections over a ten-year time horizon up to 2020 for the main agricultural commodity markets, and could analyse the impacts of policy reforms for each country and for the EU aggregates. Main products covered are in the crop sector soft wheat, durum wheat, barley, maize, rye, triticale, other grains, in the oilseed sector rapeseed, sunflower seed, soybeans, derived vegetables oils and meals; in the livestock sector cattle, pork, poultry, sheep and goats with the respective meat products and in the dairy sector raw milk, fluid milk, butter, cheese, SMP, WMP and other dairy products. The model is programmed in GAMS, but the use of GSE and GTREE interfaces allow for easy management of input and output as well as scenario analysis. (AGMEMOD Partnership, 2007)

[2] For further details see Chantreuil, Levert and Hanrahan (2005); Erjavec, Donnellan, Kavcic (2005)

The model's database in AG-MEMOD is built up on production data and supply and use balance sheets for all commodities principally based on Eurostat sources like Agricultural Information System (AgrIS) and NewCronos, but supplemented by national sources. Reflected balance items are production, imports, exports, ending stocks as well as domestic usage partly differentiated into human food consumption, feed use, processing and industrial use. Included in the database, there are also information on exogenous variables like e.g. GDP, population, input coefficients and others. A last set of data comprises exogenous world market prices of the commodities included in the model. The price projections have, in general, been taken from the annual FAPRI report (FAPRI, 2007). In some case minor adjustments were applied. In general, for all simulations, the world agricultural commodity price projections are assumed to be unchanged. Thus, currently, developments on EU markets are not impacting the level of world prices. The base period for econometric estimation of the model version this work was done with is from 1973 to 2004. The combination of an updated version with data up to 2005-6 that includes most of the features presented here is in work (AGMEMOD Partnership, 2007).

2.2. Data on biofuels

When new sectors or parts of new sectors are introduced into the model, a general template is to be set-up to serve as a blueprint for all country models to be combined. These templates display a common structure, but have to take into account the data available for all or at least most Member States. Regarding feedstock production as input for biofuels as well as the required area, there might exist some data due to the obligation of declaration if energy-crops are sown on set-aside area or if premiums are collected for energy crops in which case delivery contracts must be presented to ensure the entitlement to the premium. In the Germany, for the past years, official data available do not contain the total amount of area respective production of feedstock cultivated to produce biofuels. First, due to the tax exemption and, later, due to the blend rates oilseed prices were so attractive for producers that the additional administrative burden of applying for premiums was hindered the declaration. This implies that we are not able to associate a specific area harvested to a correspondent amount of feedstock used in the processing of biofuels. So, there are no consistent and reliable data sources available sorted by feedstock and energy type for all AGMEMOD countries and products to be considered. Data only on parts of the market balances for biofuels could be obtained; same applies of the required inputs of feedstock. Some data could be obtained by the stakeholder of the respective biofuel processors e.g. the UFOP for vegetable oils in Germany, and the European Bio-Diesel Board and EurObserver at the European level.

If data is available for both the amounts of biofuel produced by processors as well as the amounts consumed in the market, these quantities must not be equal and, indeed, they are not. That fact provokes the question concerning self-sufficiency on the biofuel market. In fact, we must recognise that the 'partial self-sufficiency' and, thus, trade associated with feedstock for biofuels is an issue that occurs through the complete processing chain from the oilseed to the vegetable oil as well as to the biofuel itself as one can see in the flow-chart for the rape seed market in Figure 9. Scarcely available data on the whole processing chain and the potential of imports on the different levels in combination with the mostly policy driven biofuel demand have to be captured in the model approach selected.

2.3. Implementation of biofuels in the AGMEMOD model

The general idea of the template to represent biofuels is that at the moment policy and only to a small degree prices drive the demand of biofuels as in the EU, at current technology, the use of biofuel is not competitive without policy intervention compared to conventional energy. Furthermore, the demand of feedstock is partial derived by the target politically set. In order to better capture the impact of the increase in demand for feedstock and production thereof for energetic use, some modifications are implemented in AGMEMOD. One consists of an explicit additional 'decision nest' of area allocation that permits endogenously to allocate available area between the main crop sectors. In a very general way AGMEMOD determines the land allocation of the crops sub-models in a two step process. In the first step, producers will allocate their area between grains, oilseeds and root crops. Then, in a second step, the shares allocated to grains, oilseeds and root crops will be distributed to the crops belonging to that particular crop group. In particular, the allocation between cereals and oilseeds is achieved as schematically shown in Figure 3.

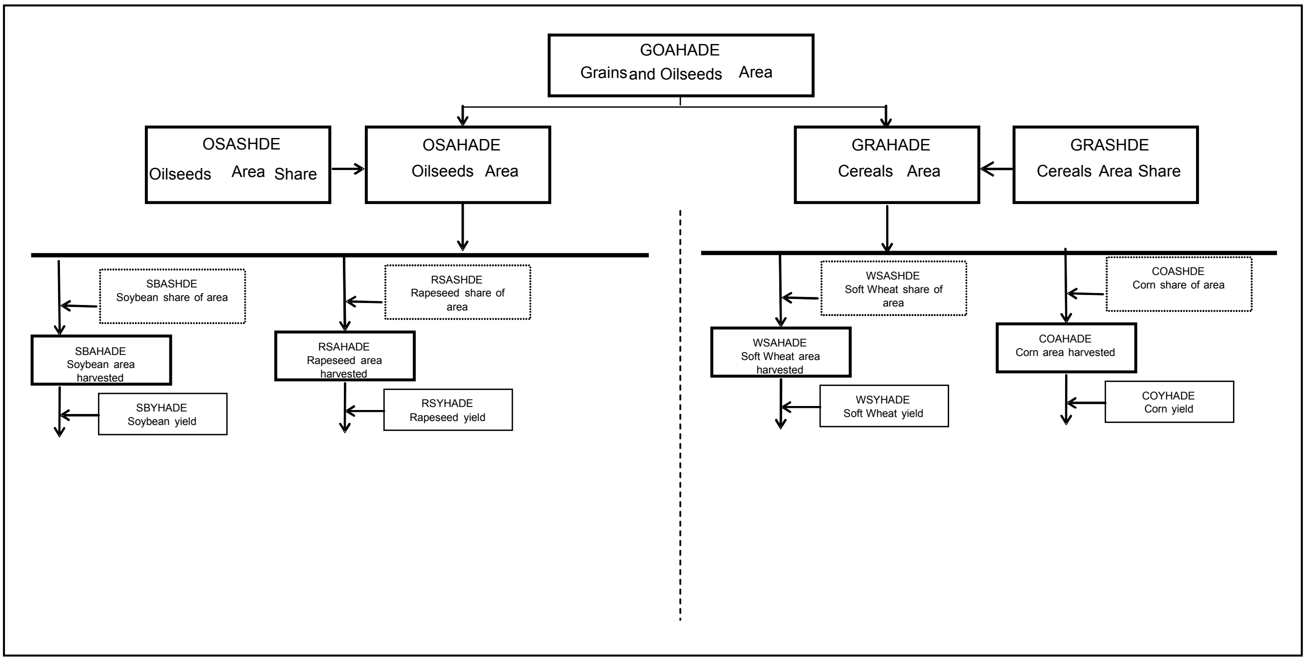

Figure 3: Grains and Oilseeds land allocation scheme
Source: Own figure.

Due to the lack of data hampering the establishment of complete market balance for the biodiesel in the processing chain, the 'biodiesel-equivalent' of vegetable oil is related to the total demand for vegetable oil as Figure 4 shows. So, the lack of information related to the trade with biofuels itself and to the trade with feedstock for biofuel production is circumvented. In the absence of adequate indicators for price incentives, the impact of the politically induced biofuel demand (see below) to the supply side is mimicked by a direct transmission of the demand impact to the supply system. Here, it is mainly attempted to maintain the balance consistency along the feedstock processing chain.

The ethanol production process is assumed less complex due to the non existence of market relevant by-products. Likewise in the case of biodiesel the demand is derived from the political targets. The correspondent amount of cereal required as feedstock is used. For Germany we presume only wheat and for France only corn to be used as raw materials for the ethanol production. The additional feedstock demanded is directly implemented in terms of biofuel equivalents.

To derive the future demand of biofuels and the related feedstock requirements the politically defined quantitative targets for biofuels are applied within a normative approach. This is quite realistic, as in the EU the market is rather steered by state intervention.

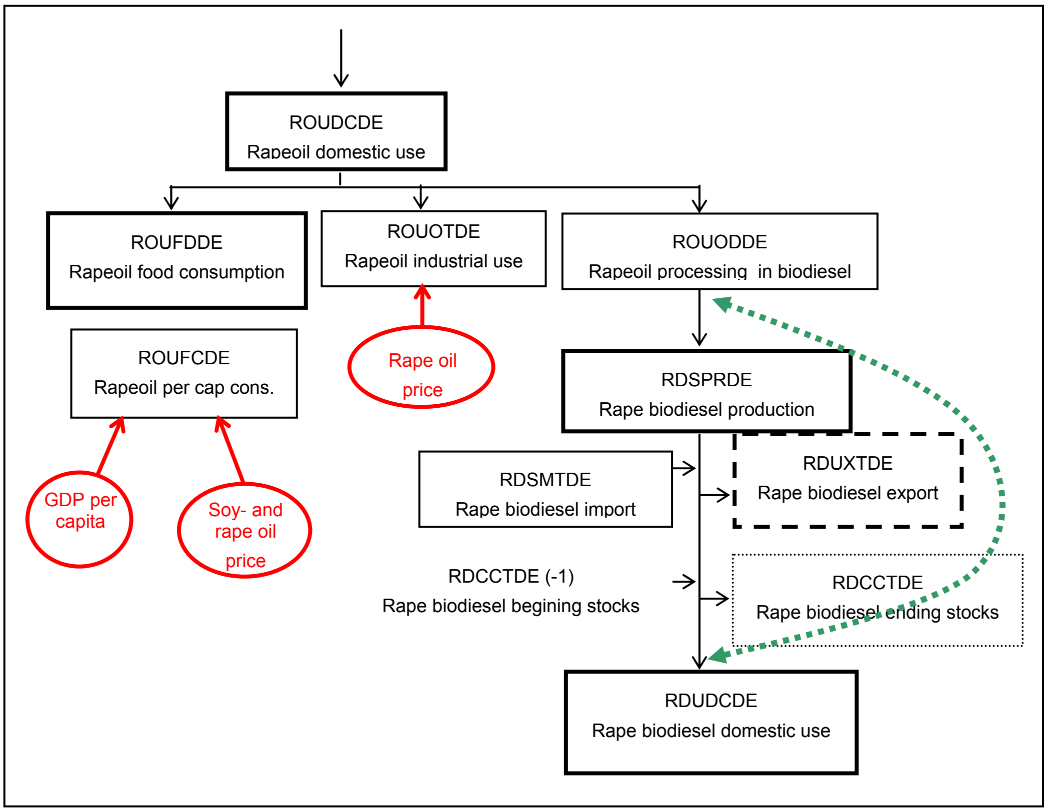

Figure 4: Schematic implementation of the Biodiesel market segment in the oilseed chain
Source: Own figure.

As the adoption of biofuels on market scale is a complex issue involving several segments in and outside the agricultural sector (oil processing industries, producers of vehicles, fuel distributors etc.), a logistic function is selected as it is suited well to mimic the expansion path of the biofuel demand. By adopting a logistic function, we assume a particular type of technological and market expansion path.

$$ROUDCDE_t = \frac{ROUDCDE_{final}}{\left(1 + b \times e^{-c \times \tau}\right)}$$

Where $ROUDCDE_{final}$ corresponds to the amount of biofuel (here rape oil as biodiesel equivalent) to be achieved according to the proposed targets or scenario at the end of the projection period; *b* and *c* correspond to parameters which give the function the appropriate shape so that it fits to the data available for rape oil use as fuel. τ corresponds to the time horizon of the projection period and is implemented by the standard trend dummy.

3 Main assumptions baseline and scenario

In the following, the approach described above is implemented for Germany and France, the frontrunners in use and production of biofuels as to be seen in Chapter 1. To derive the impacts of the biofuel targets on the French and the German agriculture, the oil and cereal equivalents are calculated by applying the normative method. So it is possible to account for the additional utilisation of the agricultural raw materials targeted to substitute fossil fuels by biofuels. As the real process is an ongoing one and the main goal of this contribution is to show how the normative approach represents the impact of biofuels on agricultural markets in AGMEMOD, we employ a basic set of policy and macroeconomic exogenous assumptions concerning different utilisation levels of biofuels.

Main differences are to be found in the levels targeted by public administration concerning the substitutions of fossil oils by biofuels. Three different scenarios are carried out. The first is a counter-factual baseline which simulates the absence of the biofuel utilization by extrapolating utilization trends on the French and German markets previously existing to the changes in the policies. Two scenarios are defined and compared to the baseline. In Scenario 1, the demand for biodiesel and bioethanol assuming that the indicative target of 5.75 % for biofuels in transport is achieved whereas Scenario 2 follows the Commission's proposal for a higher share of renewable energy including biofuels with a minimum target of a 10 % in 2020 (COM 2006 848, p. 10). Considering the CAP, and model features, but also German (8 %) (Biokraftstoffquotengesetz) and French (10 %) (Loi 2006-11) national targets set for 2015, the time horizon for scenario 2 will be 2015.

Regarding the policy variables, the implementation of the decoupling is maintained as in the Luxemburg Agreement. The Common Market Organisation on cereals although aligned with other Market Organisations remains basically unchanged, apart from corn which is excluded from the intervention system in 2007-8. For the proposed scenario this has no major impact due to the high level of world market prices. The obligatory set-aside rate is reduced to zero from 2009 on. The exogenous world market price projections are taken from FAPRI (2007).

Table 4: World market prices for cereals, oilseeds, oils and meals, and exchange rates (EURO/tonne)

Crop/derived product	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Wheat, U.S. Gulf	165.82	156.29	137.68	135.03	141.56	146.77	150.37	150.42	148.42	146.55
Barley, U.S. Portland	101.90	123.01	87.77	86.00	89.42	92.90	94.92	94.61	93.82	93.19
Maize, U.S. Gulf	126.89	115.77	112.71	109.67	113.31	115.91	116.84	115.49	112.77	110.18
Rapeseed, "00" cif Hamburg	279.17	267.64	263.78	249.27	249.95	249.98	248.33	243.32	235.98	228.39
Rape meal, 34% fob Hamburg	118.91	105.17	98.15	95.39	97.59	101.30	102.82	100.70	97.00	93.35
Rape oil, Netherland Dutch ex mill	662.55	653.36	652.73	617.19	622.85	622.26	623.78	622.37	617.25	612.02
Soy, US N°2 yellow, bulk, cif Rotterdam	228.93	220.58	219.95	213.80	219.06	223.70	225.71	222.45	215.97	209.88
Soy meal,45% cif Rotterdam	178.74	168.98	160.53	152.66	155.26	158.58	159.80	156.46	149.96	143.65
Soy oil, Netherland Dutch ex mill	513.53	521.51	538.51	536.21	558.37	574.80	585.72	588.98	586.66	584.32
Sun seed, US/Can cif Rotterdam	260.16	257.91	248.31	239.93	242.15	246.07	245.43	240.84	232.69	225.24
Sun meal, 38% pel cif Rotterdam	102.20	96.52	90.19	86.32	87.48	89.72	90.12	88.23	85.48	82.70
Sun oil, ex tank Rotterdam	552.02	549.61	549.13	539.29	562.89	584.33	596.08	600.68	597.49	592.36
Exchange rate euro/$	0.796	0.724	0.691	0.672	0.699	0.722	0.736	0.738	0.730	0.719

FAPRI (2007)

Target levels of biofuel equivalents are obtained by applying technical coefficients on the projected fuel demand for the countries regarded in the target year. To this end, projections of final energy demand in the transport sector, estimated by the EEA (2005), are used (von Ledebur at al.; 2007). From the different proportion of each biofuel in the proposed mix to achieve the required fossil fuel substitution one recognizes that there exist several feasible combinations for the achievement of the biofuel targets which make the monitoring of target achievements particularly difficult for the public administration.

Table 5: Raw material quantities assumed to be needed to fulfil the energetic biofuel substitution targets in 2015

Scenario	Biodiesel (rape oil)*		Ethanol (cereal)**	
	5.75%	10%	5.75%	10%
France	1 693 000 t	2 419 000 t	9 569 000 t	13 670 000 t
Germany	3 102 000 t	4 595 600 t	8 692 000 t	12 877 000 t

Source: own calculations.
* rape oil as biodiesel equivalent, ** corn in France and wheat in Germany as ethanol equivalent

4 Results

As France and Germanys biodiesel production represent up to 70% of the European production results will focus on these two countries, however, results were generated with the combined AGMEMOD version.

Impacts of the implementation of the biofuel use can be seen on the demand side of the product market balances of the related feedstock. Affected products markets are rape oil and rapeseed for biodiesel (Table 6 and Figure 5) and corn for ethanol in France and wheat for ethanol in Germany (Table 6 and Figure 5). The diagrams illustrating the simulations show that for the target of the 5.75% energy substitution considered in scenario 1 the German production follows the demand expansion. A domestic price increase of about 11% is projected, this is to be considered a 'short time price reaction' as the national markets for vegetable oils is closely linked to the world market. The increase represents a doubling of production whereas an increase by about three times of demand occurs compared to the 'counter-factual' baseline in Germany in 2015. The French rape oil use corresponds in this scenario to 2.5 times the rape oil use in the baseline, while the projected production of rapeseed in 2015 is twice the production in the baseline.

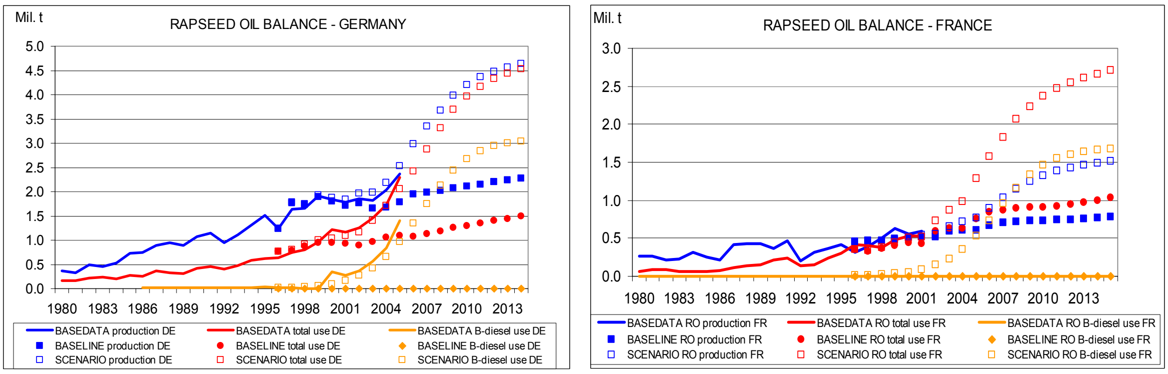

Figure 5: German and French rape oil market balance, baseline and scenario 1 projections
Source: own calculations based on the modified combined AGMEMOD model.

The outcome for scenario 2 (substitution of 10% through biofuels, Table 6) indicates for Germany that domestic rape oil production in 2015 might not to be enough as total use is projected to be larger than production, meaning that the German achievement of the biofuel target in this scenario will depend on imports. The results for France seem also to stress the outcome that under the simulated conditions the domestic biodiesel market will be supplied to some extent by imports.

Table 6: German and French rape oil supply and demand, baseline and scenario projections ('000 t)

		2007	2008	2009	2010	2011	2012	2013	2014	2015
	Germany									
Baseline	production	1984.9	2023.6	2079.1	2115.1	2153.9	2191.6	2230.6	2271.2	2311.6
	Total use	1127.4	1177.0	1248.1	1294.2	1344.0	1392.4	1442.4	1494.4	1546.3
	B-diesel use									
Scen. 1 5.75%	production	3347.6	3681.1	3979.7	4196.3	4359.0	4477.3	4566.8	4638.2	4697.4
	Total use	2874.4	3302.0	3684.8	3962.5	4171.1	4322.7	4437.5	4529.1	4604.9
	B-diesel use	1753.3	2131.9	2444.1	2675.9	2834.9	2938.3	3003.0	3042.7	3066.6
Scen 2 10%	production	4005.2	4481.0	4896.8	5200.5	5423.0	5580.1	5693.9	5780.2	5848.4
	Total use	3717.5	4327.5	4860.6	5250.0	5535.2	5736.6	5882.5	5993.2	6080.5
	B-diesel use	2597.5	3158.4	3620.9	3964.3	4200.0	4353.0	4448.9	4507.7	4543.2
	France									
Baseline	production	662.9	707.4	719.2	733.5	736.1	741.1	745.3	755.3	767.5
	Total use	841.7	866.2	897.4	903.2	912.8	920.5	942.1	968.7	1000.0
	B-diesel use									
Scen. 1 5.75%	production	1032.6	1142.1	1248.2	1326.1	1387.6	1430.5	1465.7	1493.4	1516.8
	Total use	1823.1	2060.9	2237.1	2373.3	2467.8	2545.7	2607.7	2660.6	2707.1
	B-diesel use	956.9	1163.5	1333.9	1460.4	1547.2	1603.6	1639.0	1660.6	1673.7

Scen 2 10%	production	1172.0	1323.5	1468.9	1579.1	1664.9	1724.4	1770.4	1804.8	1832.0
	Total use	2233.4	2559.9	2809.1	2999.5	3131.3	3233.4	3310.5	3372.7	3424.8
	B-diesel use	1367.2	1662.5	1905.9	2086.7	2210.7	2291.3	2341.8	2372.7	2391.4

Source: own calculations based on the modified combined AGMEMOD model.

The changes described in the rape oil markets are transmitted differently into the rapeseed markets as the projections for the rapeseed supply and demand in the Table 7 show. Increasing demand for rape oil induces demand for crushing along the processing chain and, thus affects seed production. In 2015, the amount of rapeseed produced is increased by about 50% in Germany and by 40% in France in scenario 1. This occurred basically due to the ad hoc transmission of the demand impact to the supply side within the normative approach described above as within the scenario setup no specific price incentive is scheduled. In both countries the crushing is projected to double compare to the baseline. Under that condition the German net trade status changes and rapeseed is imported. But the French net trade status does not change. Although rape oil imports increase significantly in 2015 in Germany in scenario 1, a reduced but still positive net export of rape oil is projected. For France the model predicts for the same scenario a change in the net trade status with imports growing during the projection period. The same pattern can be observed for scenario 2. This is a relatively non intuitive model response as it seems bizarre to import oil while exporting the raw material for its production in the domestic market renouncing on the value added of the product that is demanded in the domestic market.

Table 7: German and French rapeseed supply and demand, baseline and scenario projections ('000 t)

		2007	2008	2009	2010	2011	2012	2013	2014	2015
	Germany									
Baseline	production	5401.7	5416.9	5216.7	5274.7	5319.9	5364.7	5405.3	5442.6	5477.7
	Total use	4976.9	5074.0	5213.0	5303.3	5400.6	5495.3	5593.1	5694.8	5796.2
	crush	5274.2	5345.3	5442.9	5507.1	5575.8	5642.7	5711.7	5783.2	5854.5
Scen. 1 5.75%	production	6683.1	6985.0	6899.6	7174.4	7372.6	7533.3	7656.2	7752.0	7830.5
	total use	8393.7	9230.0	9978.7	10521.8	10929.8	11226.4	11450.7	11630.0	11778.2
	crush	8556.3	9406.2	10162.5	10713.5	11127.2	11428.3	11656.3	11838.3	11988.9
Scen 2 10%	production	7250.2	7695.6	7721.5	8093.5	8361.8	8572.1	8727.6	8843.8	8935.4
	total use	10042.7	11235.6	12278.4	13039.9	13597.7	13991.5	14276.9	14493.4	14664.2
	crush	10221.4	11432.0	12485.6	13257.7	13823.2	14223.1	14512.9	14732.9	14906.4
	France									
Baseline	production	3842.6	3943.9	4033.2	4115.3	4254.6	4356.4	4465.4	4578.6	4698.9
	total use	1700.2	1728.6	1763.0	1769.3	1781.4	1791.3	1815.4	1844.6	1878.4
	crush	1861.0	1882.2	1921.1	1930.7	1947.8	1961.9	1988.2	2019.6	2054.9
Scen. 1 5.75%	production	4223.5	4543.7	4869.2	5182.9	5575.8	5886.8	6180.7	6457.2	6730.1
	total use	2481.8	2745.2	3000.1	3187.3	3335.3	3438.4	3523.0	3589.6	3645.6
	crush	2724.5	2992.1	3272.7	3473.0	3640.7	3761.2	3866.3	3955.0	4033.7
Scen 2 10%	production	4414.4	4812.7	5223.4	5618.8	6084.0	6456.6	6804.7	7129.5	7445.4
	total use	2817.0	3181.2	3530.6	3795.4	4001.6	4144.7	4255.3	4337.8	4403.4
	crush	3059.4	3428.9	3805.9	4086.2	4314.5	4477.5	4611.1	4718.2	4808.7

Source: own calculations based on the modified combined AGMEMOD model.

Table 8 depicts the results for the impact of the ethanol target. Within the baseline, due to increased prices, the German wheat production increases by 17%. Total consumption rise is about 4%, while the demand for biofuel presents a plus of 40% in total demand at the end of the projection period. The wheat price is projected to increase by about 10% compared to the baseline. The additional demand accounts for about half of the initial domestic wheat use, or in other terms, nearly equals the feed demand in the baseline. Germany remains a net exporter at the end of the projection period with reduced exports and increased imports.

The results for scenario 2 indicate that the demand increase (60% to the baseline) for wheat as raw material for ethanol is accompanied by a price reaction that causes production growth of 19% compared to the baseline. The net-exports are reduced again.

While the German wheat demand for ethanol production grows about 40%, the impact of the additional corn demand for ethanol production in scenario 1 in France is even more drastic. It corresponds to 2.3 times the corn amount demanded in the baseline. France is a net exporter in the baseline situation. As world market prices are on a high level, no particular price reaction is observable. At the end of the projection period the French corn production increases by 6%, exports are reduced and imports are increased, thus, reducing the net exporter position. In the absence of clear price incentives and the assumed close linkage to the world market the proposed target in scenario 2 is basically obtained by a further adjustment in the net trade status.

Table 8: German and French cereal supply and demand, baseline and scenario 1 projections ('000 t)

		2007	2008	2009	2010	2011	2012	2013	2014	2015
	Germany - wheat									
Baseline	production	28649.2	27161.8	26945.1	29623.7	31795.2	32674.6	32940.9	33220.7	33598.6
	total use	19176.1	19474.7	19386.8	19268.8	19303.4	19405.0	19583.0	19752.9	19880.7
	ethanol use									
Scen. 1 5.75%	production	29374.4	28351.7	28583.6	30771.6	33763.9	36103.0	37586.5	38550.7	39299.0
	total use	23473.4	25050.5	25913.9	26279.9	26658.1	27073.9	27541.3	27929.3	28192.2
	ethanol use	4912.8	5973.6	6848.4	7498.0	7943.7	8233.2	8414.6	8525.7	8592.9
Scen 2 10%	production	31418.5	29520.6	29769.2	32269.4	35368.2	37237.1	38427.9	39231.4	39960.7
	total use	25884.4	27934.6	29179.3	29828.9	30408.4	30938.8	31471.1	31898.6	32186.4
	ethanol use	7278.2	8849.8	10145.8	11108.1	11768.4	12197.3	12466.1	12630.7	12730.2
	France - corn									
Baseline	production	18121.9	17354.0	18061.1	19548.0	20444.0	19664.0	19568.9	19609.2	19644.2
	total use	7066.6	6984.7	6993.1	7007.4	7020.5	7034.1	7043.2	7049.5	7055.4
	ethanol use									
Scen. 1 5.75%	production	18529.4	17702.9	18312.7	18930.2	19919.5	20352.2	20594.6	20776.9	20880.9
	total use	12605.3	13662.7	14634.6	15377.0	15892.1	16235.3	16450.5	16582.5	16664.5
	ethanol use	5408.5	6576.4	7539.4	8254.5	8745.2	9063.9	9263.6	9386.0	9459.9
Scen 2 10%	production	19103.4	17980.3	18968.1	19616.9	20460.3	20449.4	20566.6	20698.9	20774.8
	total use	14946.1	16505.7	17892.2	18943.4	19670.4	20150.6	20451.3	20357.1	20176.3
	ethanol use	7726.4	9394.8	10770.6	11792.2	12493.1	12948.4	13233.8	13408.5	13514.1

Source: own calculations based on the modified combined AGMEMOD model.

It is interesting to note that in AGMEMOD the impact of the imposition of the simultaneous fulfilment of the biofuel targets is transmitted to the area allocation system as expected. As the target scenarios were implemented simultaneously, the relative price and the scope of the market (target) gave the framework for the area allocation. The outcome for scenario 2 can be seen on the graphs in Figure 6.

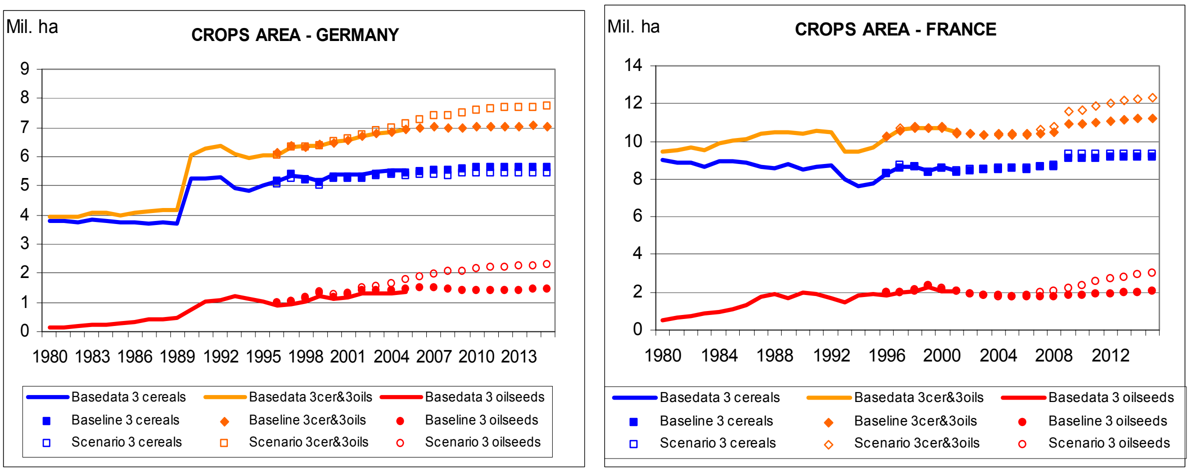

Figure 6: Area allocation impact in Germany and France – scenario 2.
Source: own calculations based on the modified combined AGMEMOD model.

The impact of the changed demand affects more clearly the oilseed sector to which area has been allocated because of the set-aside and the energy crops regulations, as shown in Figure 6. This sector faces an additional expansion during the projection period. This is because the main oilseed rape is the one that shows significant expansion of the area harvested. The aggregate of the three cereals (soft wheat, barley and corn) area is relatively less reactive in AGMEMOD as for the production of cereals, area is reallocated among cultures (barley is usually losing most area share). Some impulse for cereals area expansion apart from changes in relative pries came from the absence of the set aside obligations as can easily be seen in the French results.

Conclusions

Implemented in AGMEMOD the normative approach seems useful as it allows for the explicit depiction of the impacts of the substitution targets for fossil fuels produced based on agricultural raw products. But the approach is also restrictive as it does not allow for endogenous interactions determined by prices; supply and demand of agricultural products used as raw materials intended to be processed outside the traditional marketing structures. It allows for a plausible introduction of the new usages like e.g. as energy source into established agricultural markets. As the use of agricultural raw materials into energy conversion is currently corresponding with already significant quantities in some national markets one may expect the development of price formation – with or without interference from the government

While the rapeseed production for biodiesel production in both countries is projected to grow under the proposed scenarios the cereal production is reoriented for the ethanol production based on the cereal assumed ad hoc to the main raw material source. This is consistent, as in the EU the requirements for biodiesel for the automotive use are strictly regulated currently limiting the usable types of raw materials. The technical requirements for ethanol as fuel are not comparable to the ones for biodiesel. So while for biodiesel there is an expansion of rape seed production to satisfy the new fuel demand in the case of ethanol, there is an additional demand competing with the existing ones. For this case the trade impacts depicted in the model were clear indicating that the domestic overproduction formerly destined for export is used in an alternative way domestically – this behaviour of course will only hold if the price relation among different uses is appropriate.

The model indicates that there are limits to the self sufficiency in raw materials availability on the one hand and of processed biofuels on the other hand. Depending on the relative price situation, a particular feedstock might not be domestically available, but must be imported. Due to the actual price responsiveness regarding adjustments between the European and the world market in AGMEMOD, the market adjustments are occurring mainly via trade adjustments as world market prices are dominant and non sensitive to the changes in the EU markets. This however does not invalidate the results obtained, means only that in the presence of price adjustments different supply and demand reactions can be expected with less drastic changes in the trade situation.

Due to the lack of information about the changes in trade with raw material and with biofuel, a fair estimation of the degree of self sufficiency on the markets is difficult. The degree of self sufficiency on the markets when achieving the biofuel targets will depend on agronomic constraints (e.g. due to the necessity of crop rotation), the price competitiveness of the feedstock produced domestically against the supply from abroad, as well as the price competitiveness of each domestic biofuel against the one from abroad.

The model results show, particularly for the ethanol production from corn in France and from wheat in Germany, that changes in the European policy toolkit, like the abolition of the obligatory set-aside rate, allowing for cereal production expansion, represent a positive reaction to the world market situation. One might expect that the high demand for cereals (as food, feeding stuff and feedstock for biofuel production) will cause an intensification of the agriculture. The increased exposure of European markets to world markets volatility can not be avoided in an environment of high product prices and increasing demand will directly affect the effective competitiveness of European biofuels as the traditional protection instruments from the CAP are not in place.

The AGMEMOD Partnership is also working on a model expansion template in which price-quantity reaction in the biofuel demand will be endogenised (called the 'positive approach'). For its implementation however more detailed data are needed. Work on the improvement of cross market reactions that allow for different cereals like rye and barley as well as sugar beets for the production of ethanol and also different vegetable oils like sunflower, palm, or soy oil to be used as feedstock for the biodiesel production is needed to capture the multisided nature of the biofuel production and use.

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