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Distributional Effects of the German Biofuel Quota

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1. Introduction

Biofuels are seen as means of decreasing dependency on fossil fuels in transport and reducing greenhouse gases. In many countries policies exist which promote the substitution of fossil fuels with biofuels. The consequences of this substitution process on production and employment have been subject of recent academic literature (e.g. Malik et al, 2014, Wydra, 2011, Neuwahl et al, 2008). Multi-sectoral modeling approaches (CGE models, input output models) are used in most of these studies (compare Allan, 2013) and applied to varying future scenarios with respect to biofuel use.

In Germany a blending quota was introduced in 2007 and increased stepwise to ensure that a certain percentage of fossil fuels are substituted. This case study addresses the distributional effect of this policy. Figure 1 shows a schematic diagram of the analyzed fields of impact. As opposed to most of the studies in this field we do not base our analysis on future scenarios but calculate the effects for the year 2012. So we are able to take into account information on actual prices, quantities, production processes etc. With respect to production, we analyze the output of the most important directly affected industries (petroleum industry, biofuel industry, agricultural industry). Economy-wide effects (relative change in sectoral output) are taken into account by applying input-output-analysis. The change in expenditure for fuels including energy and value added taxes depends on direct price effects and quantity effects and is addressed in the impact field marketing. With respect to consumption we ask the question on which transport related consumer group has to bear this extra expenditure: freight transport, commercial passenger transport, private passenger transport.

This paper is structured as follows: Section 2 first gives a rough overview on the used methodology and data base and is then split into subsection with more details for each of the three impact fields. In section 3 we discuss the results for consumption, marketing and production and conclude in section 4.

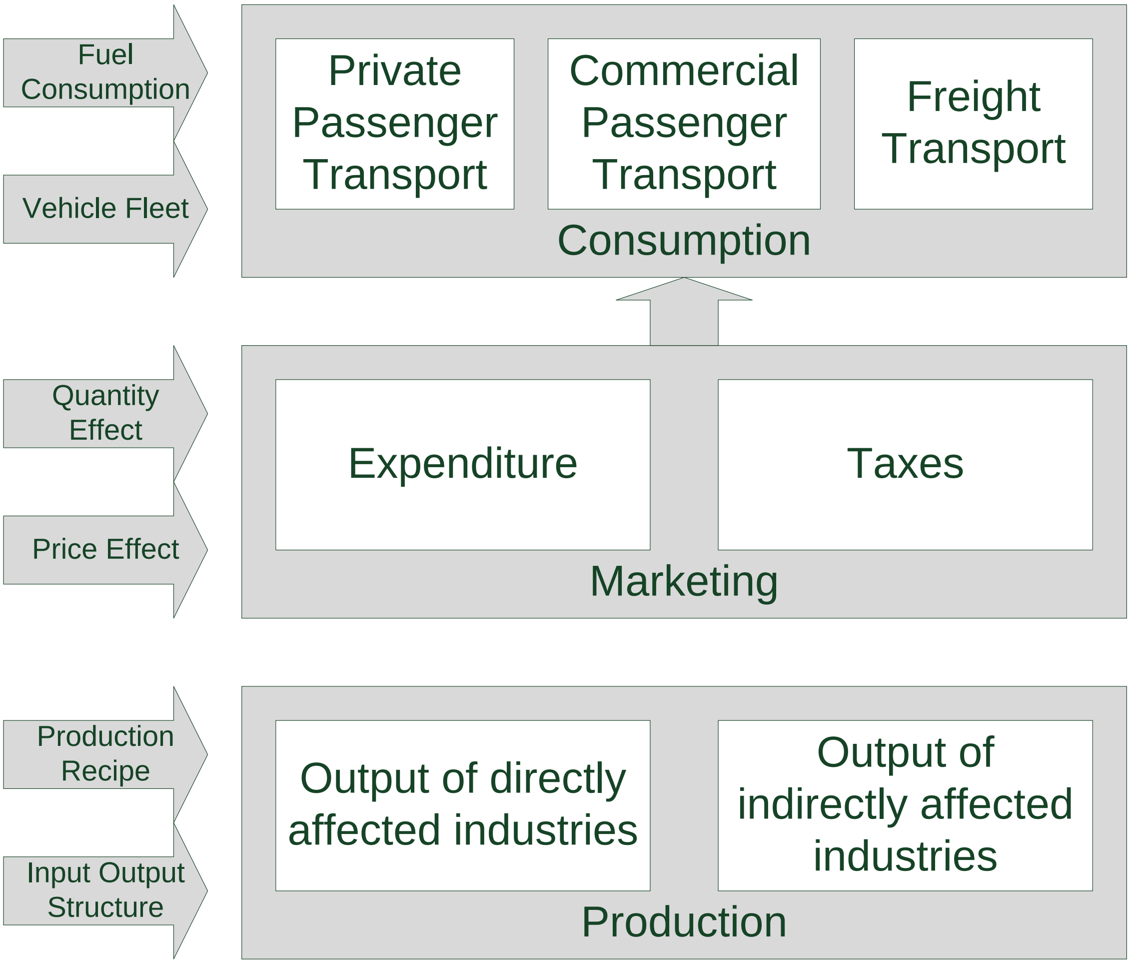

Figure 1: Analyzed Fields of impact

2. Method and data base

The distributional effects are calculated based on official data for the year 2012. To extract the impact of the blending with biofuels we compare the reference case with a blending quota of 6,04% (biodiesel) and 4,15% (bioethanol) to a no policy case without substitution of fossil fuels. The total demand for fuels measured in energy units is kept equal in both cases.

We calculate the (additional / lost) revenues of industries which are directly involved in the production of fossil fuels or biofuels such as petroleum industry, biofuel industry, agricultural industry by taking into account detailed information on prices, quantities and production processes. We further consider indirect effects on other industries by applying input-output-analysis.

With respect to marketing we differentiate between effects on price and taxes and the responding revenues. According to official statistics of the mineral oil industry the net fuel price can be split into product price and contribution margin. The impact of the blending on each of these price elements is analyzed using time series data. Due to a lack of more detailed data we only derive an estimate for a maximum price effect. So the distributional effects are calculated for two scenarios: only blending-induced quantity effects (low-case scenario) and both blending-induced quantity and price effects (high-case-scenario). Whereas the change in energy tax revenues is only due to quantity effects and hence the same for both scenarios, value added tax revenues differ.

The split of the fuel consumption into freight transport, commercial passenger transport and private passenger transport is derived by combining various official statistics on fuel consumption and vehicle fleets. The changes in expenditure derived in the impact field marketing are distributed according to this split, while the different taxation of commercial sector and private households is taken into account.

More details on methods and data used for the calculations of the impact of the biofuel quota on consumption, marketing and production are given in the following subsections.

2.1 Principal Data Base

BAFA (2013) provides data on consumption of fossil fuels and biofuels. We only consider blended biofuels as they are relevant for the quota. The calculated real quota differs from the political quota. Deviation from the political quota is possible as there are for example special arrangements for 2nd generation biofuels or the possibility to carry over-achievements of the quota to the following year. Prices for biofuels, by-products and renewable raw materials refer to information of AMI (2014) and FNR (2014). Reference to more specific information needed for the calculations of only a single impact field are mentioned in the following respective subsections.

2.2 Consumption

The effect of the German biofuel quota on the fuel expenditures including taxes is calculated for freight transport, private and commercial passenger transport. Only street transport is considered which is reasonable as in comparison the amount of biofuels in train and ship transport and in flights can be neglected. It is assumed that there is no systemic difference in blending, i.e. diesel used in freight or passenger transport contains the same percentage of biofuel.

In a first step we derive fuel / petrol consumption of freight and passenger transport. We use BAFA (2013) data on total diesel / petrol consumption in 2012 and the information on total fuel consumption of freight transport provided by Verkehr in Zahlen (2013). It is assumed that in freight transport only diesel fuels are relevant and from the difference diesel and petrol consumption of passenger transport can be calculated.

Using a bottom-up-approach fuel consumption of passenger transport split in commercial and private transport can be calculated. KBA (2014) provides statistics on commercial and private vehicle fleets split into different engine kinds (petrol and diesel). Moreover information on the average annual kilometric performance of commercial and private vehicles is available at MID (2008). On the basis of KBA's statistics about the annual kilometric performance of diesel and petrol engines it is assumed that the performance of diesel engines is twice that of petrol. Hence calculations of annual kilometric performance spilt into commercial and private passenger transport as well as different engine types can be made. With the help of the average fuel consumption per kilometre provided by TREMOD (2013) relevant fuel quantities in commercial and private passenger transport can be finally estimated. They correspond well with the numbers on total fuel demand of passenger transport calculated above.

On the basis of these quantities the impact of the biofuel quota on the expenditure of the different consumers can be calculated. The impact on expenditure can be split into fuel expenditure and taxes. We assume that mobility behaviour remains unchanged and demand for fuel changes only because of the different energy content of blended fuel compared to the pure fossil fuel but not due to a possible change in price. This can be argued as we look at a rather short time horizon and can thus assume a quite inelastic price elasticity of demand.

2.3 Marketing

The impact of the biofuel quota on fuel expenditure including taxes is mainly characterised by two effects: First quantity effects caused by the lower energy content of biofuel and thus increased fuel consumption and second direct price effects. Before describing the calculation of these effects in detail, we give some insights into the German fuel market and the composition of diesel and petrol prices. At the end of this subsection we illustrate how the integrated effect on expenditure is calculated for a low case scenario (quantity effects only) and a high case scenario (both quantity effects and direct price effects) and how the impact on public revenues is derived.

Composition of Prices and Market Structure

The structure of German petroleum market is characterised by an oligopolistic situation. The German Federal Cartel Office (2011) showed in a sector inquiry that petrol companies have strong incentives to maximise revenues by cooperative actions. In this context repeating interactions and a high level of transparency concerning the fuel prices on petrol stations are helping to develop price mechanisms. Anticipation of price setting of competitors is possible and prices can be adapted accordingly. In addition vertical integration of oil refinery, marketing at the whole sale level and marketing at the retail level within the petroleum companies effects high market entry barriers. Furthermore the demand for fuels is in the short term relatively inelastic.

Even if prices changes demand remains steady. These characteristics together explain the stabilization of the petroleum oligopoly and their power to influence prices.

To understand how the biofuel quota impacts prices it is necessary to examine prices and their composition. According to the MWV (2014a, 2014b) the price can be split into product price ("Produktenpreis"), contribution margin ("Deckungsbeitrag") and taxes. The product price (PP) is equivalent to the price of fossil fuels on the spot market Rotterdam. Costs for transport, storage and marketing as well as costs for blending of biofuels and a profit margin are implied in unknown shares in the contribution margin (CB). Taxes included in the fossil price are the energy tax (ENT) and the value added tax (VAT). The energy tax is a quantity tax that is a certain amount added to the net price. The value added tax is raised proportionally on product price, contribution margin plus energy tax. Only for private transport the value added tax has to be considered as commercial transport receives reimbursement.

Quantity Effects

Biofuels contain less energy than fossil fuels. Under the assumption of unchanged mobility behaviour, substitution of fossil fuels thus leads to additional fuel consumption Δq measured in volume units. It can be calculated as a difference between the real total demand for blended fuels measured in volume units in 2012 and the potential total demand in volume units if only fossil fuel would have been used (see Table 1).

Prices and taxes relate to volume units. This implies an increase of expenditure (C) due to this quantity effects which can be defined as

$\Delta C_q = (1 + VAT)\,(PP + \ CM \ + ENT)\,\Delta q \ \ if\ private\ use$

$\Delta C_q = (PP + \ CM \ + ENT)\,\Delta q\ if\ commercial\ use$.

	Calorific value in MJ/l	Equivalence of Fuel in %
Petrol		
Petrol	32,44	100,00%
Bioethanol	21,06	64,92%
Diesel		
Diesel	35,87	100,00%
Biodiesel	32,74	91,26%

Table 1: Energy Content and Equivalence of Fuels (BDBe, 2014b)

Direct Price Effects

In order to calculate direct price effects product price and contribution margin have to be analysed separately.

Considering the product price Bardt (2012) showed that crude oil price is the main influence parameter of diesel and petrol price. Neuwahl et al (2007) assume in line with the GTAP6 database that costs for crude oil represent 68% of the price for fossil fuels. They further estimate that the demand of crude oil declined by 1.5% - 3% through the introduction of biofuels across the EU. As we want to calculate maximum expenditure we assume in the high-case scenario a reduction of crude oil price of 1.5%. The share of German biofuel consumption is 20.93% according to data of the Euro`Observer (2013). This data can be used to calculate the impact of German biofuel consumption on the product price (FOB Rotterdam):

$$\Delta PP = (-0.68 * \ 0.015 * 0.2093) * PP = -0.21\% * PP$$

The contribution margin is subject to temporal fluctuation. Since the introduction of the quota in 2007 the contribution margin for petrol was disproportionately increasing as can be seen in Figure 2. A long-term data base for diesel fuel is missing, but since 2007 it exhibits a rising trend. In addition Figure 3 suggests that there exists a correlation of biofuel quantities counted against the quota and the level of the contribution margin.[1] Due to the non-transparency of the actual composition of the contribution margin, the lack of data for possible further explaining variables and the oligopolistic situation it remains however difficult to exactly estimate to what extent the increase can be attributed to the biofuel quota. Nevertheless, costs for biofuel blending are indicated by the MWV (2014a, 2014b) as included in the contribution margin. We thus presume that part of the increase is caused by the quota. Therefore we assume in the high-case Scenario a maximum (likely overestimated) effect ΔCM which is represented by the difference between the contribution margin in 2006 (in prices for 2012 deflated by the consumer price index) and 2012.

Hence the maximum effect on expenditure due to direct price effects can be defined as

$$\Delta C_p = (1 + VAT)\ (\Delta PP + \ \ \Delta CM)q\ ,\ \ if\ private\ use$$

$$\Delta C_p = (\Delta PP + \ \ \Delta CM)q,\ \ if\ commercial\ use.$$

[1] The contribution margin in both figures is given in prices of 2012 and was deflated using the consumer price index.

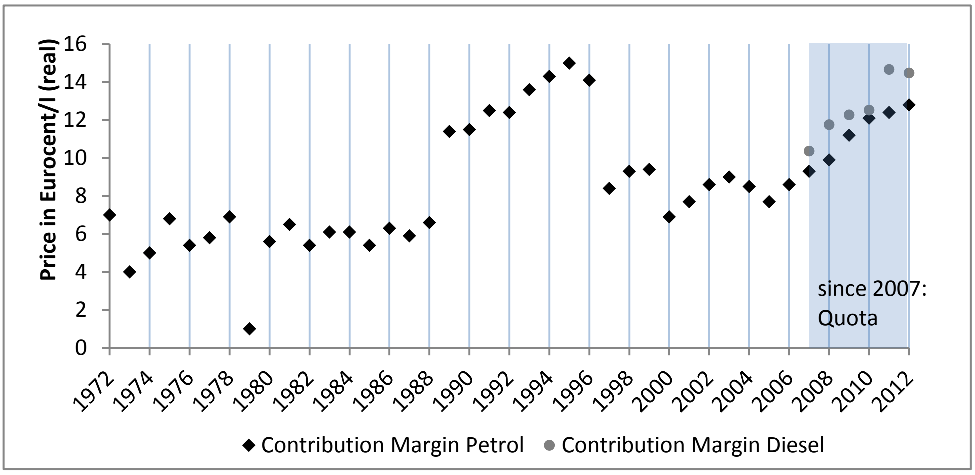

Figure 2: Development of Contribution Margins over Time (prices of 2012) (MWV, 2014a, 2014b; Destatis)

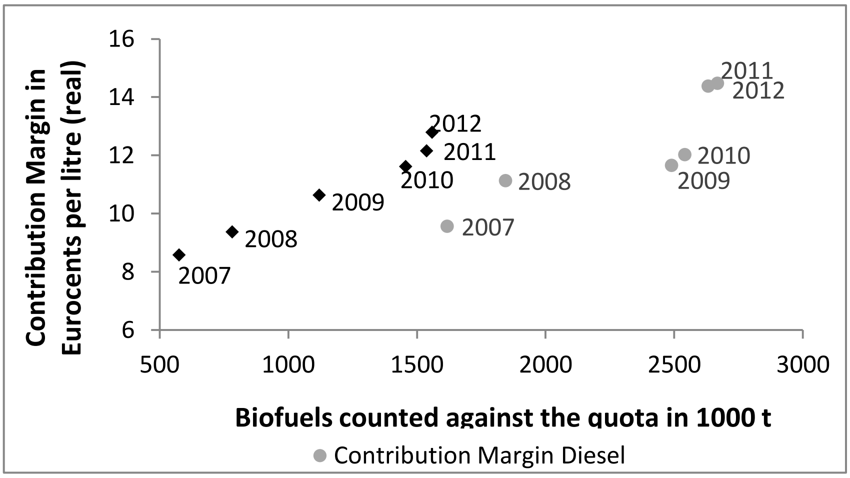

Figure 3: Contribution Margin (prices of 2012) versus Biofuels counted against the Quota

Resulting Effects on Expenditure

The results on expenditure due to quantity and price effects can be summarized as total effect on expenditure (respectively based on data for diesel and petrol):

Scenario 1, quantity effects only:

$$\Delta C^l = \Delta C_q = (1 + VAT)(PP + CM + ENT)\,\Delta q\,, \qquad if\ private\ use$$

$$\Delta C^l = \Delta C_q = (PP + CM + ENT)\,\Delta q\,, \qquad if\ commercial\ use$$

Scenario 2, maximum price effects:

$$\Delta C^{h} = \Delta C_{q} + \Delta C_{p} = (1 + VAT)[(PP + CM + ENT)\,\Delta q + (\Delta PP + \Delta CM)\,q]\,, \quad if\ private\ use$$

$$\Delta C^{h} = \Delta C_{q} + \Delta C_{p} = [(PP + CM + ENT)\,\Delta q + (\Delta PP + \Delta CM)\,q]\,, \quad if\ commercial\ use$$

Public Revenues

As mentioned before the state also benefits from additional revenues. Note that only the private transport sector has to bear the additional value added tax where as additional energy tax has to be beard by both private and commercial sector. Impacts on energy taxes are only caused by quantity effects. They can be calculated in multiplying the additional sold fuels Δq of diesel (petrol) by the respective energy tax rate. In order to estimate additional value added tax we assume again the same scenarios as we did for the impact field marketing. Dividing the additional expenditure of private sector by the value-added tax and subtracted this result by the actual additional expenditure the additional value added tax can be calculated.

2.4 Production

Direct Effects

The biofuel industry generates revenues by producing biodiesel, bioethanol and their by-products. If biodiesel is not derived from waste oil an upstream production stage to produce plant oil is necessary. In this study it is implied that in Germany the plant oil production is integrated in the biodiesel industry. Revenues of the foreign biofuel industry are considered via the imported amounts relevant for the German biofuel quota. The petroleum industry integrates production and marketing of fuels. The production level is affected by substitution of fossil fuels and therefore decreasing revenues.

Petroleum producers are affected by the substitution of fossil fuels which means a loss of revenue. It is assumed that biofuels substitute fossil fuels according to their energy content as given in BDBe (2014b). We further take into account that product prices of fossil fuel (FOB Rotterdam as cited in MWV, 2013) would be slightly higher without biofuels (as explained above in the section Marketing). Combining substituted amounts and this price effect, a potential loss of revenues can be obtained. It should be noted that here the petroleum industry is regarded on the lowest level. If further price components of the final prices at the marketing stage would be considered too, potential loss would be higher.

Statistics on German biofuel production are provided by UFOP (2013) for biodiesel and by BDBe (2013) for bioethanol. These production figures neglect a differentiation between blended and pure biofuels. Therefore it is supposed that the share of blended biofuels is the same in both consumption and production. Hence production figures are scaled with the share of consumed blended biofuels which are derived from BAFA (2013). It is assumed that there is no stock holding. The imports of biofuels are calculated as difference between production and consumption. This simplification is made to ensure the availability of data. Due to insufficient price information we assume further that realised prices for biofuels at domestic and foreign markets are the same. In multiplying the quantities of produced and imported biodiesel and bioethanol by the responding prices (AMI, 2014) the domestic and foreign revenues generated by biofuels can be obtained.

In addition to those direct sales the biofuel industry yields revenues from by-products. We only look at by-products attributed to the German production of biofuels used within the German quota. We do not take into account revenues of by-products of the foreign biofuel industry. Relevant by-products in the biofuel sector are grist on the stage of oil production and glycerine on the stage of biodiesel production. In Germany bioethanol is produced out of sugar beets or crops. By-products of beet based bioethanol are vinasse and beet pulp. In the production process of bioethanol based on crops DDGS (Dried Distillers Grains with Solubles) accrues. For further calculations biodiesel and bioethanol have to be subdivided by their raw materials. In this context VDB (2013) asked German biodiesel producers about their raw material base. Combining this survey with the respective input quantities per litre given by FNR (2013) total input of the different raw materials of biodiesel can be calculated. A split of produced bioethanol into sugar beets and crops is given by BDBe (2014a). For a more detailed analysis it is necessary to subdivide various crops used in the production. Due to a missing database we assume that for bioethanol based on crops the raw material base is the same as in the average production of the EU. Respective statistics are provided by Flach et al (2013). Combined with respective input quantities per litre required by FNR (2013) bioethanol production by crop kind can be determined (see Table 2). Given these compositions of biofuels and the respective by-products produced per litre biofuel (DBFZ, 2014; FNR, 2013) it is possible to determinate quantities of by-products in the biofuels industry. Multiplied by the respective prices (AMI, 2014) the additional revenues of the German biofuel industry can be estimated.

Indirect and Economy Wide Effects

The agricultural industry generates revenues by providing and selling renewable raw materials to producers of biofuels. Revenues of the foreign agricultural industry are considered via imported energy plants. We use the methodology indicated above to calculate the amounts of raw material which is needed for biofuels produced in Germany and used within the quota. We assume that biofuel producers abroad which produce biofuels used within the German quota purchase their raw material also from abroad, and we do not consider these revenues of the foreign agriculture sector. Statistics on foreign trade in energy plants is offered by UFOP (2013) and Destatis (2014a). This data also refers to crops and beets used in other industries. To isolate imports and exports relevant for the biofuel quota it is assumed that the share of imports and exports of one raw material irrespective of the final use is equal. Further we only consider net imports. If net imports are positive we estimate the share of domestic production on domestically available products (sum of domestic products and net imports). If net imports are negative we assume that the total amount of raw material needed originates from domestic production. In multiplying these figures with the amounts of raw materials and the responding prices (AMI, 2014) the revenues of the domestic and foreign agricultural industry can be obtained.

There are more industries which directly contribute to the production of biofuels or the substituted fossil fuels. Effects on these industries are not estimated directly but are based on literature. With regard to bioethanol and the fossil fuels we mainly used the information given in Wydra (2011) and Wydra (2009). As Neuwahl et al (2008) we use the production recipe of biodiesel described in the Well-to-Wheels Analysis (CONCAWE, 2006).

Raw Materia	Produced Bioethanol in Mio. l	Biomass required in kg per l	Produced by-products in kg per kg biomass	
Rye	23,2	2,4	0,37	(DDGS)
Wheat	198,7	2,6	0,37	(DDGS)
Barley	18,3	2,6	0,37	(DDGS)
Maize	207,6	2,4	0,37	(DDGS)
Sugar Beet	316,7	9,3	0,045	(Vinasse)
			0,05	(Beet Pulp)
Other	0,6			
Sum	765,1			

	Produced Biodiesel in Mio. l	Biomass required in kg per l	Produced by-products in kg per kg biomass	
Rapeseed	2195,6	2,2	0,58	(Rapeseed Meal)
			0,05	(Glycerin)
Soybean	258,3	4,6	0,8	(Soy Meal)
			0,025	(Glycerin)
Palm	77,5	4,5		
Other	51,7			
Sum	2583,1			

Table 2: Biofuel by Crop kind and Biomass required (BDBe, 2014a; FNR, 2013; UFOP, 2013)

Inter-industry-linkages in the economy lead to indirect effects on industries which might not even be involved directly in the production of biofuels, fossil fuels or the necessary intermediates. Input-output analysis is a well-known method to account for these indirect effects and has already been applied several times with regard to biofuels. Allan (2013) shows that in the majority of these studies a new biofuel sector is introduced by applying extra final demand of the sectors which contribute with intermediates to the production of biofuels (and in case of substitution negative final demand for the affected sectors of the fossil fuel production). This approach is described in more detail in Miller and Blair (2009, p.634-636). However, using this approach the substitution effect is only considered in first order, as the technology matrix and thus the Leontief Inverse remains unchanged. Demand for fuels resulting from indirect effects in next order only reflects the production structure of fossil fuels. This problem can be solved by introducing new columns and rows to separate fossil fuels and biofuels as done in an elegant way in Malik et al (2014). This needs however a lot of data work and estimations and in the given case of only moderate blending and thus little indirect effects on fuel demand it is reasonable to simplify using the final demand approach.

In our case we choose the final demand approach. We want to compare the sectoral output of a scenario without biofuels and to the sectoral output of a scenario with biofuels. The latter is given in the most recent input output table for the year 2010 published by the German Federal Statistical Office. It consists of 73 sectors. Biofuels are included in the sector chemical products, fossil fuels are part of the sector petroleum products. The years 2010 and 2012 are very similar with respect to the blending (same political quota) so it is reasonable to calculate the relative changes in sectoral output for the year 2010 to give insights in indirect effects, although all other figures in this paper are given for the year 2012. We calculate the additional demand in 2010 due to the biofuel production and the lost demand due to the substituted fossil fuel production. We use the data sources described above but adapting for changed prices and quantities in 2010 compared to 2012. We also take into account additional and lost investments as in the approach of Wydra (2009). Production and investment effects are aggregated to a final demand impulse (ΔY) which is multiplied with the Leontief inverse *(L)* to calculate the absolute indirect effect on domestic sectoral output (ΔX):

$$(\Delta X) = L(\Delta Y)$$

Effects on imports can be calculated using the import coefficient matrix

$$(\Delta Imp) = A_{imp}(\Delta X)$$

Relative change in sectoral output can be calculated for each sector as follows:

$$\frac{2 * (\Delta X)_i}{2 * X_i + (\Delta X)_i}$$

Adding the direct effects on petroleum industry and biofuel industry as indicated above but scaled down to prices and quantities of 2010 to ΔX (sector petroleum products and sector chemical products respectively) an integrated picture of the relative change in sectoral output due to the biofuel quota can be given.

3. Results

3.1 Consumption

In 2012 65.29 billion liters of fuels including 62% diesel fuels and 38% petrol fuels have been sold in Germany. The most relevant consumer of diesel is the freight transport followed by private passenger transport. 57% of all fuels are consumed by passenger transport, 32% by freight transport and the smallest share of 11% is consumed by the commercial passenger transport. Freight transport demanded the highest amount of diesel fuels and no petrol fuels (see Figure 4: Fuel Consumption).

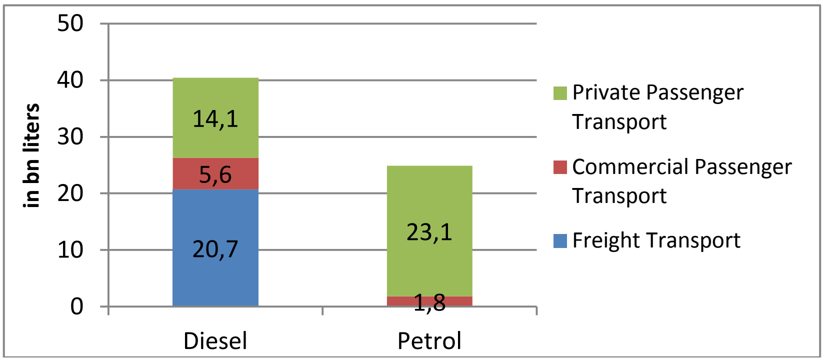

Figure 4: Fuel Consumption

All together freight transport, commercial and private passenger transport spent 94.38 billion Euros on fuels. Freight and commercial passenger transport spent 25.9 and 9.5 billion Euros on fuels respectively.

The introduction of the biofuel quota increased expenditure of freight transport and commercial transport between 0.59% respectively 1.02% in the low-case and 4.10% respectively 4.19% in the high-case scenario.

Note that private passengers also have to bear the value added tax of 58.98 billion Euros. The proportion of their additional spending due to the biofuel quota is between 1.63% (only quantity effects) and 4.31% (maximum price effects). Private households are thus confronted with an over-proportional increase.

3.2 Marketing

On base of the real blending of 6.04% for diesel fuels and 4,15% for petrol fuel the biofuel quota led to an increase in consumption (measured in volume units) of 0.60% for diesel and 2.25% for petrol fuels compared to pure fossil fuels. Since taxes and probably also prices do not take into account the additional consumption this implies an indirect increase of price caused by the biofuel quota.

The analysis of direct price effects showed that at a maximum of 4.42 eurocents or 5.7% of the net price per liter diesel is due to the introduction of the biofuel quota. The respective values for petrol are 3.14 eurocents and 4.31%. Due to this price effect, value added tax increased by 0.84 eurocents per liter diesel and by 0.60 eurocents per liter petrol fuel.

Figure 5 shows the aggregated additional expenditure for the low case scenario (only quantity effects) and the high case scenario (quantity effects and maximum price effects). In the low case scenario 1.21 billion Euros i.e. 1.28% of the spending on fuel can be explained with the biofuel quota, more than half of it being increased public revenues through energy and value added taxes. Taking also into account price effects we find that 4.00 billion Euros or 4.24% of the spending on fuels is due to the blending with biofuels.

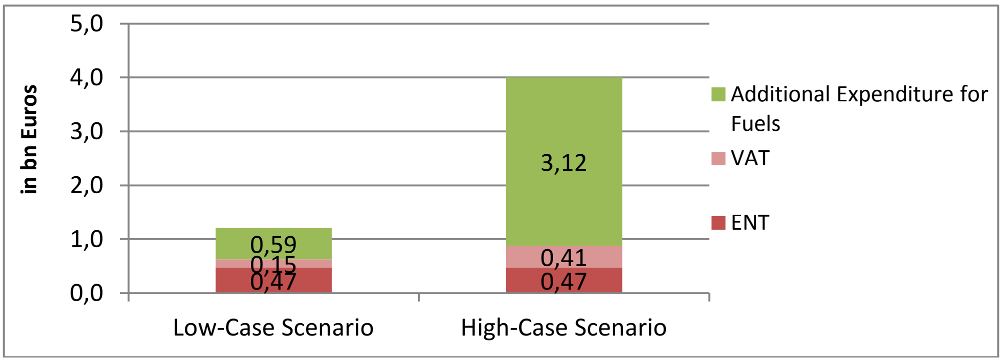

Figure 5: Additional Expenditure for Fuels

3.3 Production

Revenues of most affected industries

Within the German quota the biofuel industry obtained revenues of 3.49 billion Euros through sales of biofuels, 2.4 billion Euros of these through biodiesel. Whereas around 97% of biodiesel revenues remained in Germany, 51% of bioethanol were generated by the foreign sector. However since the share in production and use of biodiesel was much higher than of bioethanol on average 83% of biofuel revenues remained in Germany.

Furthermore the revenues of by-products in the domestic biofuel production are regarded. Due to missing sugar beet pulp prices we neglect sugar beet pulp in a first approximation. Hence by-products valued at 1.30 billion Euros, which is 31% of all revenues of the biofuel sector, have been produced. Being especially used in agriculture, rape seed meal was in 2012 the most relevant by-product, generating revenues of 0.8 billion Euros.

Substitution effects led to lower use of fossil fuels. As a consequence petrol industry had a loss of revenues of 2.16 billion Euros which are turned to the biofuel industry within their revenues of 3.49 billion Euros as producer of biofuels. The difference of 1.33 billion Euros was either borne by consumers or by the petrol industry itself.

The agriculture sector obtained revenues of 2.40 billion Euros from sale of raw materials to the German biofuel industry. 59% i.e. 1.46 billion Euros remained in Germany. Imports of raw material for bioethanol production amounted to less than 3% and were neglected. In contrast German biodiesel production relied on imports regarding their raw material needs. 85% of biodiesel was based on rape-seed, of which 43% was imported. Revenues of foreign agriculture sectors amounted therefore at least to 1.0 billion Euros. This number does not include revenues of soya and palm which are the base of 5% of domestically produced biodiesel. It has to be remarked that in this study up-stream production of imported biofuels is not considered in detail. However, they play a non-negligible role in the bioethanol industry and lead to substantial revenues of foreign agriculture industries.

Economy wide Effects

From the input output analysis we received change in domestic output and the related change in imports for 73 economic sectors. We added the information which was not used directly in the input output analysis, i.e. the direct effects on biofuel and petroleum industry as well as on imports of agricultural products and feedstock. According to our analysis the blending with biofuels lead to an increase in domestic output by about 0.08% whereas imports decreased by about 0.04%.

Figure 6 shows domestic and import contribution to the change in output. Economic sectors were grouped as classified in NACE rev 2.1 unless they contributed substantially as a single sector. Figure 7 shows for the same grouping of sectors the relative change in sectoral output. Together the two graphs give some insights into the relative importance of the affected sectors for the economic output.

Main positive contributions to change in output come from the biofuel industry and its main supplier, the agricultural industry. For the latter were considered additional production and imports. The consideration of land use change was beyond the scope of this analysis. This implies that we are likely to overestimate the effect on agriculture. Taken together the other industries and service sectors still contribute with 30% to the increase of total output, which shows that they should not be neglected. The domestic industry benefits from the increase in output much more than industry abroad.

The sectors refined petroleum products and extraction of crude petroleum receive the strongest decline in output. Imports of food products also decline substantially as we assumed that additional feedstock would have to be imported if not produced as by-products of the biofuels. This assumption goes in line with the assumption regarding additional agricultural production and implies that the decline in imports of food products is rather overestimated. The negative impact on domestic output of the petrol industry is about outweighed by the reduction of imports.

One should be careful with interpreting the economy wide results as impacts of the policy. We only intended to also include the indirect effects with respect to substitution in production process. With respect to demand we treated fossil fuels and blended fuels as perfect substitutes so that the production recipes of all other industries remain unchanged. This means that we did not include the results on additional expenditures for fuels in this analysis. In principle this would have been possible by using a price model (Neuwahl et al, 2013) or choosing the more aggregated approach of decreasing the final demand for other products (Wydra, 2011). In both cases further assumptions would have been needed. Thus, we decided not to overcomplicate the analysis.

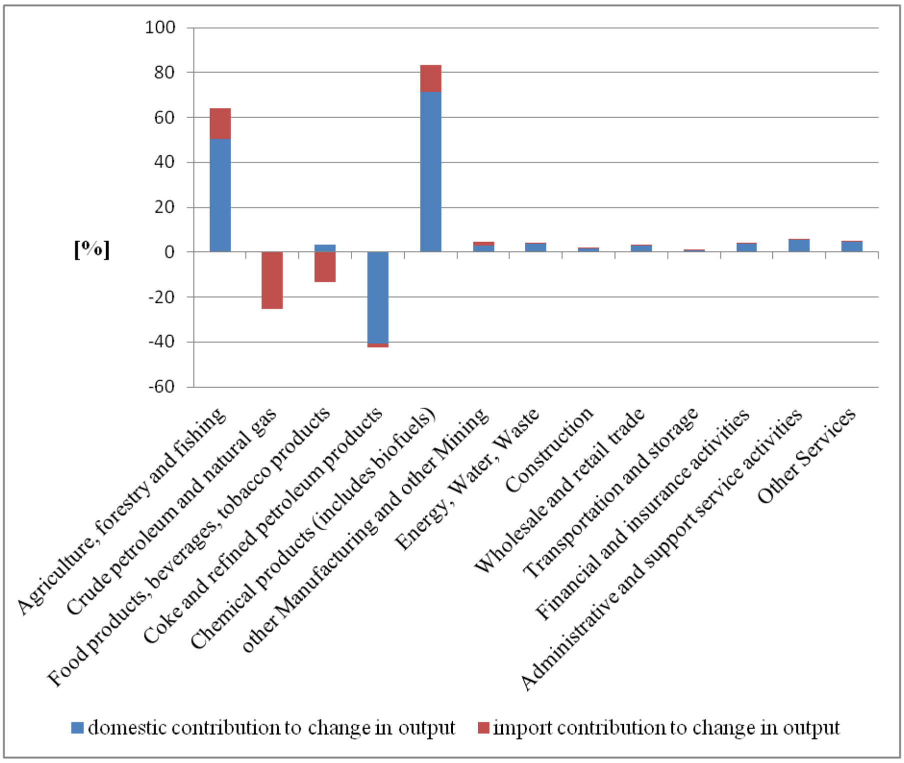

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Figure 6: Domestic and import contribution to change in output

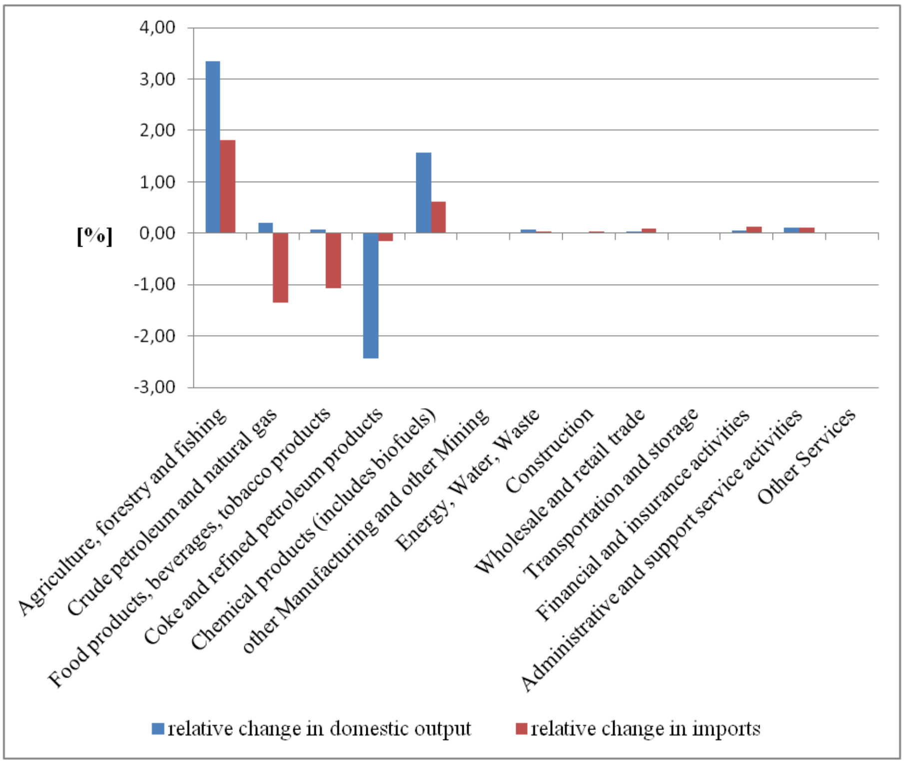

Figure 7: Relative change in domestic output and imports

4. Conclusions

In this study we analyzed the distributional effects of the blending regulated with the German biofuel quota based on data for the year 2012. Additional system analytic costs could be quantified as 1.3 billion Euros in 2012 (ISI, DIW, GWS, IZES, 2014). When looking at distributional effects single actor groups might have a burden much higher and others might benefit.

The Ex-Post analysis shows that in 2012 extra fuel spending between 1.2 and 4 billion Euros are due to the biofuels. Private Transport, i.e. households are confronted with an over proportional increase, as they have to bear extra taxes and extra spending for the fuel itself. It would be interesting to further investigate the distributional effects on different income groups.

State benefits from additional tax revenues of at least 0.6 billion Euros, so the German switch from tax relieve policy for biofuels to quota policy had a positive impact on government budgets. Comparing this number to the environmental benefits quantified with only 0.1 billion Euros in 2012 (ISI, DIW, GWS, IZES, 2014), one could even raise the provocative question if it is rather a fiscal than an environmental policy.

The German biofuel sector generates revenues of 4.22 billion Euros through sales of biofuels and by-products, the German Agriculture sector of 1.5 billion Euro, but substantial parts of revenue are still generated abroad. So one important question for the future will be how German biofuel industry will compete internationally.

The loss on the production level of the petroleum industry can be quantified with 2.2 billion. The impact on the integrated industry reaches from slightly negative to clearly negative and depends on the marketing stage. Pricing is not transparent and possibly even strategic. Depending on this, the loss on production level might partly be passed on to consumers.

This study shows that a simple analysis of distribution of extra spending, additional / lost revenues can be very complex when it has to be based on empirical data. Not because of the underlying method but rather because of the variety of sources which have to be used and the amounts of assumptions which have to be made due to insufficient data.

The data work gave us results which could be used in an input output model for the analysis of economy wide effects. This showed an increase in output of those sectors providing direct inputs to the biofuel industry and vice versa for the petroleum industry. The results could be used for further analysis (employment effects, regional distribution of change in output etc.).

Still, there are many indirect effects not included in this study, like land use change, impact on food prices, impact of increased spending for freight transport on various economic sectors etc.

This study is an Ex-Post analysis of distributional effects. Looking into the future, lower biofuel prices (learning effects) and higher fossil fuel prices compared to 2012 and the increasing transparency on the fuel market could alter the results substantially.

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