Socio-economic impact in a region in the southern part of Jutland by the establishment of a plant for processing of bio ethanol

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1. Introduction

This report was elaborated as part of the project “Business Development, using Straw and Slurry”, The project explores the possibilities for using cereals, straw and slurry for energy production in the forms bio ethanol and bio gas.

The report analyses the regional impact by the establishment of a plant for the production of bio fuel. The report was elaborated by associate professor Henning P. Jørgensen Department of Environmental and Business Economics, (IME) University of Southern Denmark and researcher Kurt Hjort-Gregersen, Institute of Food Economics. The researchers worked in consultation with information officer Peter B. Nissen, Farmers Association of Southern Jutland, coordinator Arne B Thomsen, Leader+ Denmark. The estimations, using a regionalised input output model were made by Henning Jørgensen, IME, while researcher Kurt Hjort-Gregersen FOI collaborated in the determination and specification of agricultural conditions and cost calculations.

2. Background

The Farmers Association of Southern Jutland took an interest in the establishment of a plant for processing of Ethanol primarily due to the wish to contribute to the business development in the western part of Southern Jutland. A large plant for production of bio ethanol will bring along a significant number of local jobs with positive derived economic effects in the local community. Further the plant will also form the basis for a new possibility of marketing of cereal crops. From asocial point of view the request to produce ethanol and other biomass based propellants are motivated by the international obligation to reduce emission of greenhouse gasses, which primarily originate from energy production from conventional fossil fuels. A certain amount of fossil fuels is required in the production of crops, but it has been estimated that the net emission of

CO_2 by production of ethanol only constitutes 10% of the emission by fossil energy.[1]

The production of ethanol for energy gains ground world wide. In 2001 the production was 134 mill. hl according to the source mentioned in footnote 1). Of this 66% was produced in North and South America and only 13% in Europe. However there is increased interest in this in Europe, and thus also in Denmark. Not less, since goals were set within the ambit of the EU for a substitution of bio fuels such as ethanol for 20% of fossil motor fuels.

3. Description of the plant

The plant for production of ethanol is conventional technology. The specific plant analysed here is described by the consultants Apsa Miljø, further elaborated by the Farmers Association of Southern Jutland and described in Fuel Ethanol plant South Jutland, Income Review 2). The analysis comprises only the plant for ethanol production based on cereals, while plans for establishment of a plant for bio gas production and ethanol production based on straw and slurry will be postponed for a later phase.

The annual production expected is 150,000 m^3 ethanol, which will be sold and used for vehicle fuel. The expected sales price is DKR 3200 per cubic metre ethanol. The sales price of DKr 3200 per m^3 was assessed by Apsa Miljø as the price it would be necessary to obtain to get attractive economy in the plant, and can according to Apsa Miljø be considered a production price. In plants in the USA prices between DKR 2.1 and 2.65 per litre are usually considered production prices. 1). A somewhat smaller Swedish plant , Agroethanol, takes prices between DKR 4 and 5 per litre as sales prices according to Apsa Miljø. There is at present no assessment of the market price that will be obtainable by sales of ethanol in Denmark.

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1 Commercializing New Bioethanol Technology.
Charles E. Wyman, Dartmouth College and BC international, 2000.

There is thus no assessment here of which market price is obtainable by sales of ethanol in Denmark. Neither is this possible at present, since this presupposes knowledge of the tax deduction obtainable for bio-ethanol for transport. Since this is decisive for the economy of the project and thereby for the results of this report this point must be underlined. The Ethanol will be transported to the oil refinery in Fredericia, where a mix of ethanol and petrol will be produced and the mixed product will be distributed from there. The residual products from the ethanol production DDGS (Distillers Dried Grains with Solubles), which consist of protein rich organic material are dried and expected to be sold as fodder for livestock. The annual quantity is 121,500 tonnes. Finally well over 100,000 tonnes of CO_2, which may be used for industrial purposes, but which is not expected to carry any net revenue to the plant.

The processing plant is expected to receive 390,000 tonnes of grain, primarily wheat, on an annual basis, which amounts to what is normally produced on 55,000 Ha. It is expected that a considerable part of the present set aside land areas in Southern Jutland and adjacent areas will be used for the production of non-food grain, when this demand is effective. It has been assessed that 65% of the set aside land in the counties of Ribe and Southern Jutland may be involved for non-food production. The production from this area may supply the plant with approximately half of the necessary quantity. The rest is expected to be imported from adjacent regions in Denmark and Northern Germany or from the world market. The grain is expected to be purchased at a price of DKR 800 per MT.

For the production further 200,000 litres of enzymes are used. The energy consumption in the form of natural gas is 330,000 MWh, equivalent to 30 mill. m^3 of natural gas. The gas is expected to be purchased at an average price of DKR 1.8/m^3. The considerable quantity of energy and the costs for this is the reason for the interest in the possible production of bio-gas. Further the plant is expected to use 48,000 MWh of electricity.

The plant will employ 55 full time persons on an annual basis. But there will also be a number of jobs created in the transport sector. It is calculated that transport to the plant of grain and transport of ethanol from the plant will demand a total of 16 trucks with 30 tonnes carrying capacity. Six of these will be road tankers and other ten will be trucks for grain transport. The total investment expenditures for the ethanol processing plant amount to DKK 739 mill. According to the available budgets the annual profit will be in the magnitude of DKR 40 mill. measured in fixed prices.

Table 1 shows an example of the budget for the plant in a single year. The year 2005 is chosen as an example, since this is the first year in ordinary operation.

Table 1. Profit and loss account 2005, (Budgeted)

DKR 1000	2005
Sales of ethanol	480,000
Sales of DDGS	109,350
Total Receipts	589,350
Purchase of grain	312,000
Other raw materials	9,600
Natural gas	54,000
Electricity	24,000
Repair and maintenance	29,885
Staff	19,542
Insurance	7,471
Various runn. Expenditures	12,522
Total running costs	469,020
Interests	29,705
Depreciation	49,267
Profits	41,358

Source: Anlægsbeskrivelse Apsa Miljø:

SLF Ethanolfabrik_korr-3.xls 05.08.2003.

The table shows the total receipts to be close to DKR 600 mill. annually. The dominant expenditure entry is purchase of raw material grain, which amounts to well over DKR 300 mill. out of a total of close to DKR 500 mill. The profit and loss account is in balance at 8-9% lower sales or greater costs.

4. The income and employment impact of the plant

The socio-economic impact of the plant originates from the following four sources.

1. The direct economic impact of the plant. The activity of the plant itself.

2. The indirect impact through the purchases from other industries in the region (which again creates activity in yet other sectors). This impact can be calculated by a suitably adapted input output model.

3. The induced effect. This impact originates by the part of direct and indirect income when this is used for consumption purposes in the households. The additional consumption will induce production in the sectors in the region that produce consumption goods.

4. Transport. By the description of the direct impact of the plant an ex plant situation has been assumed in which there has been no consideration of the activity which is generated by the deliveries to and from the plant. Grain is carried to the plant on trucks. Likewise ethanol is carried to the refinery in tankers. To a certain extent this transport will be carried out by local companies.

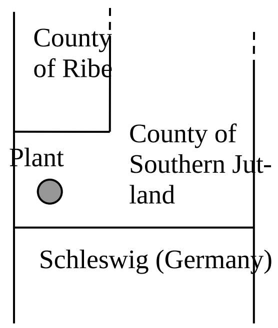
5. The direct socioeconomic impact

The direct socioeconomic impact of the processing plant comprises the income generation directly from running the plant and the employment associated directly with the production. 55 persons will be employed at the plant and the annual wages are DKR 19.3 mill., when the plant is fully in operation.

6. The calculation of the indirect economic impact

The calculations of the indirect economic impact were made with the assistance of a regionalised input output model for the region of South- and Southern Jutland. The adaptation of the model is explained in appendix 1.

Figure 1. The primary impact area



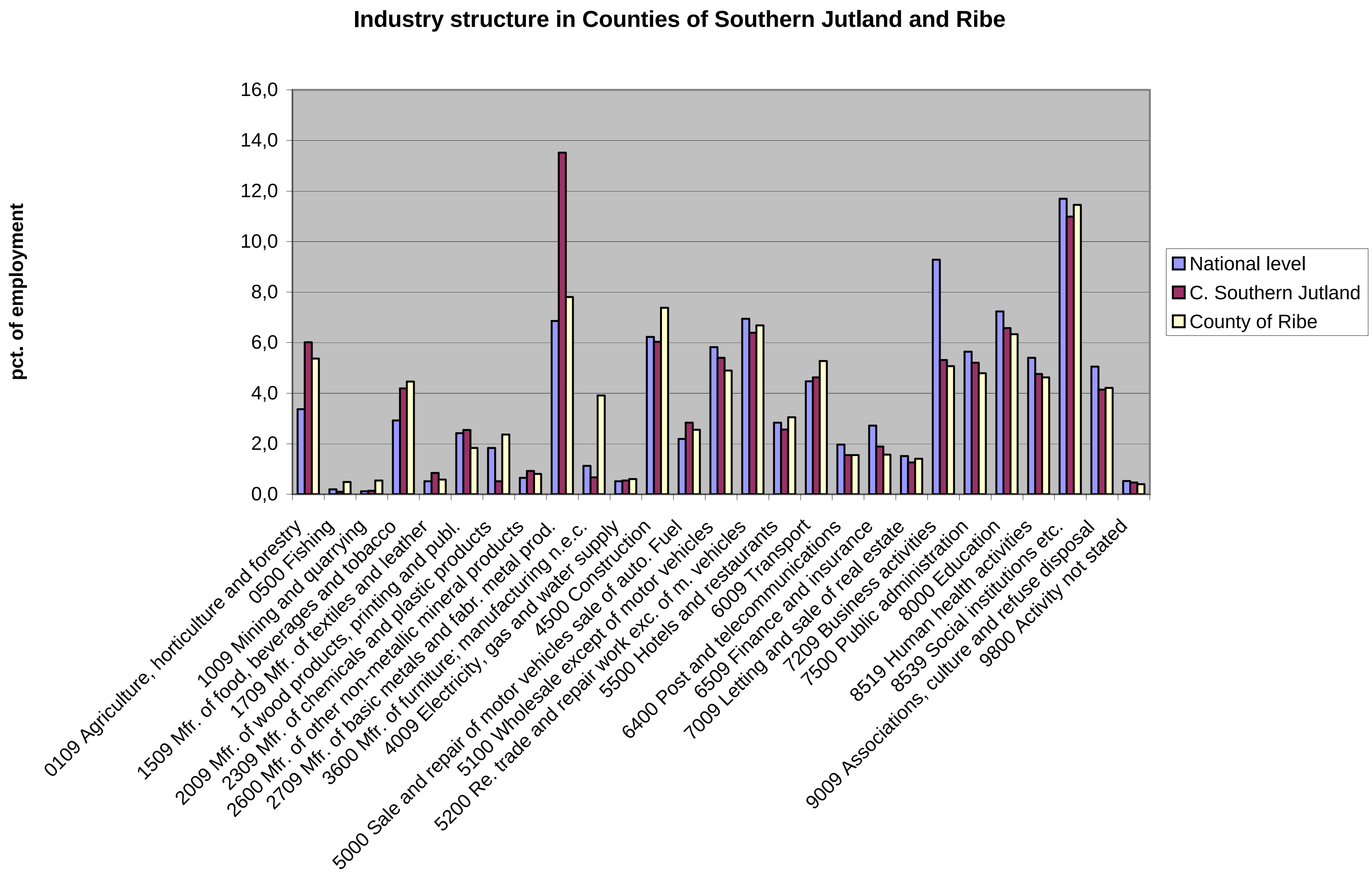
The delimitation of the relevant region was based on the intent to catch as much as possible of the local effect while maintaining a focus on the local increase in activity. The area selected is an area comprising the counties of Ribe and Southern Jutland often called South and Southern Denmark in Danish. The wording obviously not suitable for translation. With the intended situation of the plant this is the area from which the deliveries to the plant will originate as well as the home address of the staff. Therefore this will be the area where most of the indirect economic impact will be felt. Further it will be in this area the major part of the induced effect will arise in connection with the use of factor income for consumption.

There might be increases in the activity in the northern part of Germany (in Schleswig this would be in Kreis Nordfriesland and Kreis Flensburg – Schleswig) therefore the area South and Southern Jutland may be interpreted as an area of the size likely to take the major part of the local impact even though of course a part of the increase is likely to arise at the German side of the border.

In the impact area the primary and secondary industries generally are well represented, while service sectors are underrepresented. The industry structure in the two counties is compared to the national level industry structure in figure 2. Since the growth in service sectors generally is higher than the growth in primary and secondary industries, it is a feature of the region that the growth rate has been less than the growth rate at the national level over the last decade. It is therefore an important task to find alternative growth possibilities in this particular region.

Figure 2. Industry structure in the two counties and at the national level. Pct. of total employment

Source: CBS: Statistikbanken



7. Estimation A

Estimation A is carried out under the condition that the total agricultural production in the region stays unchanged. The reason may be that when the regional agricultural sector supplies grain for ethanol production, there will be an equivalent reduction in the supply for other purposes, *e.g.* for fodder. Or it may be because most of the grain is imported to the region due to favourable price conditions for imported grain or due to costs of transporting local grain to the plant. Due to the conditions of agriculture with productions limits this is an assumption often used in this type of estimations, cf. Petersan 2002. The calculations here were made along the same principles as used in the calculations for the plant in Ravenna Nebraska. See also Appendix 1 regarding the regional input-output model and the calculation procedure.

The calculation was made with the budget figures for 2005, when the plant is fully operational according to the plan.

Table 2. Economic impact of running the ethanol processing plant

	Ethanol plant	**Households**	**Total**
Employment, Full time persons			
Direct employment	55		55
Indirect	113		113
Induced		20	20
Total employment	168	20	188
Income generation (Gross values added) Mill. DKR			
Direct income, wages	19.5		19.5
Indirect	96.2		96.2
Induced		14.4	14.4
Total	115.8	14.4	130.1
Taxes, Mill. DKR			
Direct as specified in the project	27.2		27.2
Indirect (Indirect+ municip. tax)	30.8		30.8
Induced (Indirect+municip. tax)		10.1	10.1
Total	58.0	10.1	68.1
Production value, Mill. DKR			
Direct (Ethanol + DDGS)	589.4		589.4
Indirect	181.0		181.0
Induced		24.8	24.8
Total	770.4	24.8	795.2

Source: Model calculations with the regionalised input output model for South- and Southern Jutland of the Department of Environmental an Business Economics with input from Apsa Miljø: Plant description: SLF Ethanolfabrik_korr-3.xls 05.08.2003.

There was in this calculation no inclusion of the transport work associated with the delivery of the grain to the plant and the delivery of ethanol from the plant. See below for this.

8. Estimation B

In this estimation it is assumed, that agriculture in the region on top of the present production, which continues, also is able to deliver approximately half of the necessary raw material input by involving the set aside for production of non-food grain. The agricultural production value therefore in this estimation increases by the value of the extra grain delivered from the region. It was assumed in accordance with the advice from the Plant Cultivation Consultancy that approximately 65% of the set aside can be used for non food grain production, in which case 47% of the necessary grain can be sourced from the region.

Since there is production of fodder (DDGS) at the plant, this might result in a substitution and reduction of the agricultural production in the region, if the deliveries of protein fodder previously were based on local production. Since the protein fodder, which is substituted by DDGS presently is imported, the replacement of DDGS for imported fodder will not have en effect on the regional production It has therefore been assumed that the production of DDGS neither increases nor decreases the regional agricultural production.

Table 3. Economic impact of running the ethanol processing plant. Calculation B

	Ethanol plant	Households	Total
Employment, Full time persons			
Direct employment	55		55
Indirect	155		155
Induced		25	25
Total employment	210	25	235
Income generation (Gross values added) Mill. DKR			
Direct income, wages.	19.5		19.5
Indirect	119.6		119.6
Induced		17.9	17.9
Total	139.1	17.9	157.0
Taxes, Mill. DKR			
Direct as specified in the project	27.2		27.2
Indirect (Indirect+ municip. tax)	38.5		38.5
Induced (Indirect+municip. tax)		12.6	12.6
Taxes, Mill. DKR	65.6	12.6	78.2
Production value, Mill. DKR			
Direct (Ethanol + DDGS)	589.4		589.4
Indirect	229.7		229.7
Induced		30.9	30.9
Total	819.0	30.9	849.9

Source: Model calculations with the regionalised input output model for South- and Southern Jutland of the Department of Environmental an Business Economics with input from Apsa Miljø:Plant description: SLF Ethanolfabrik_korr-3.xls 05.08.2003.

In this calculation too there was no consideration of the added transport activity in the region. Calculation of taxes was performed by the same method as in calculation A.

9. Transport activity

Beside the indirect deliveries to the plant it self, there will be some creation of activity by the transport work carried out in connection with the purchase of grain and sales of ethanol. The sales of DDGS are not considered in this calculation, since this will be delivered via local suppliers of feeding stuffs, seeds and fertilizers. DDGS is substituted for imported soy, so there will be no difference in the transport work caused by this.

There will be used 390,000 tonnes of grain and sold 150,000 tonnes of ethanol. It is expected according to the project description that 50% is sourced locally, while 50% is imported from the world market. This is interpreted in the following way.

25 % from the county of	Southern Jutland within a distance of	25 km
25 % from the county of	Ribe	75 km
50 % from Esbjerg Harbour		75 km

The average distance thus will be 62.5 km. It is assumed that deliveries from other parts of the country will be less competitive compared to these sources.

The total calculated expenditure for transport of grain thereby will be DKR 16.8 mill. The ethanol is sold at the refinery in Fredericia incurring total transportation expenditure of DKR 9.3 mill.

Table 4. Economic impact of transport activities created in the region

	Ethanol project	Households	Total
Employment, Full time persons			
Direct employment	0		0
Indirect	12		12
Induced		2	2
Total employment	12	2	14
Income generation (Gross values added) Mill. DKR			
Direct income, wages.	0.0		0.0
Indirect	7.0		7.0
Induced		1.7	1.7
Total	7.0	1.7	8.7

Source: Model calculations with the regionalised input output model for South- and Southern Jutland of the Department of Environmental an Business Economics with input from Apsa Miljø:Plant description: SLF Ethanolfabrik_korr-3.xls 05.08.2003.

The transport work may be carried out by transport companies in both end-points of the route. It is therefore assumed that a share is delivered by local transport companies. It is further a possibility that part of the transport service is delivered by railroad. In the project description it is a condition that the plant is placed with a rail connection to the present railroad between the towns of Tonder and Bramming. It is therefore over all assumed that half of the transport work is carried out by the local transport sector summing up to DKR 13.2 mill. Such a delivery will result in an increase in indirect employment of 12 full time persons and 2 induced jobs via the income, which is created in consumption. Income generation can be calculated at a total of DKR 8.7 mill in the form of indirect and induced income.

10. Construction

A calculation of the extra activity which is created in connection with the construction of the plant has been done and is presented for the employment in terms of man years or person years since this activity and income is temporary. The point of departure for this calculation is that the plant can be seen as comprising three elements: A part that can be described as machinery and equipment, a part as buildings and a part as working capital acquisition. According to the project description machinery and equipment amount to DKR 677.4 mill., while buildings alone amount to DKR 7 mill. and capital acquisition amounts to DKR 55 mill. The latter amount creates activity by the service associated by the handling by financial service institutions alone.

The indirect impacts of the investments were calculated using the input entries in the input output table for a set of the relevant investment categories. As with the running of the plant there may be induced effects, due to the extra income generated by the indirect and direct activity created by the investment. The service related to the working capital during the building period was assumed to cost 5% of the working capital holding.

The calculations show that the establishment of the plant results in an employment effect of 502 person-years along with an induced effect of 65 person-years via the consumption expenditure, which the direct and indirect factor income generate.

The incomes in the region increase by DKR 259.3 mill. during the building period as a consequence of the extra business activity and further by DKR 47.3 mill caused by the induced consumption effect. The total tax revenue increases temporarily by DKR 23.7 mill calculated by the same method as in estimation A and B as explained below.

11. Taxes

The tax revenue comprises the corporate taxes stated in the project beside indirect taxes paid by the industries that experience at change in the production. (The calculation of taxes departs from the method in Petersan 2002, which does not include income taxes. Income taxes evidently are more important in a Danish context than in an American). In the following section we go over the calculation of taxes in Calculation A.

In the project description it is calculated that there will be a payment of DKR 21.3 mill in corporate taxes in 2005 and a similar amount in the following years. This is part of the direct taxes paid by the operation. Beside this there will be income tax paid to municipalities and counties. The tax rates for municipalities are shown in table 5. Over all these amount to approximately 30 percent for municipalities and counties together. If this rate is used on the direct income, DKR 19.5, mill, which is created by the project, this part can be calculated as DKR 5.9 mill., so the total tax in the direct part of the project is DKR 27.2 mill. It should be considered that only a part of these taxes go to local tax units. This also goes for the calculations by Petersan, who leave out the local income tax and only calculate indirect taxes though.

The calculation of taxes from the indirect activity is carried out by calculating the indirect taxes (commodity and non-commodity taxes paid by the industries) beside local municipality income tax computed from the indirect income originating from the project. The municipality income tax is DKR 28.9 mill., while indirect taxes are DKR 1.9 mill.

The direct and indirect wage income created results in added consumption (the induced effect), after deduction of income tax and savings. It was assumed that the extra consumption expenditure constitutes 45% of the increase in income. This addition to consumption immediately gives rise to the payment of indirect taxes, among other VAT. Additionally the increase in income gives rise to a demand from a set of supply sectors and therefore to indirect taxes. There are thus three parts of the tax payment. VAT ea. of the consumption is DKR 0.7 mill. Finally income tax to municipalities and counties are DKR 4.3 mill. In total the tax payments from the induced effect are DKR 10.1 mill. It should be noted that the indirect taxes constitute a notably larger share in connection with the induced effect, since the induced consumption is subject to VAT payment.

One of the conditions that can complicate matters in the calculation of the effect on tax revenue to the region is that in this case we are dealing with municipalities and counties that normally receive interregional transfers, because the tax base per capita is lower than the national average. If there is an increase in incomes, this will over time result in a reduction in these transfers from other regions. Anyway it has been assumed that it has an independent interest to calculate to what extent the tax payments to the municipalities and counties will change, since it is assumed that the region has a solid interest in being self sufficient rather than dependent on transfer income from other regions. Therefore the possible modifying effect of transfers was disregarded.

From a regional point of view it is obviously primarily the local tax base that is of interest. One could therefore argue that only these taxes should be considered. In the case at hand the revenue from indirect taxes were included as is usually done in input output calculations (cf. Petersan 2002). Part of these (commodity and vehicle excise duty) goes to the state and should not be considered in a regional setting. In as much as there are negotiations between state and local government levels, it may though have an effect. In this case it was chosen as a compromise to include corporate taxes and indirect taxes but not personal income tax to the state.

Table 5. Local area key figures regarding taxes

	Municipality						
	Tønder	**Højer**	**Løgumkloster**	**Tinglev**	**Skærbæk**	**Ribe**	**Esbjerg**
Tax base before transfer	127720	106273	114293	106897	129946	123133	128021
Tax base after transfers	132310	130748	127254	128656	132626	128929	132514
Population	12693	3048	6940	10292	7485	18140	82341
Work places per 100 inhab.	61	34	43	43	46	49	56
Tax rate. Pct.	19.9	21.6	20.3	20.4	19.7	20.8	21.2

Source: Netborger. 2002.

12. The price effect

Since the opening of the plant results in a considerable increase in the demand for cereals in the area there may be a price increase. The principle in such an increase in the price is illustrated in figure 3. At the outset the price is P_0 and the production of grain is Q_0. The regional supply of grain is shown by the curve S_R and demand is shown by D_0.

After the opening of the plant, the demand will increase to D_1. The quantity supplied increases to Q_1 and the price increases to P_1, if there is nothing but the local supply to meet the increase in demand.

The extent to which the price increases depends as can be seen on the slope of the supply curve. The change in the price can be calculated, if the supply elasticity and the quantity change is known.

However there may be a supply from other sources than the local agriculture. There may be a supply from other regions or from the world market. The total supply including import from other areas is shown by the supply curve S_{TOT}. Considering this as shown the price will only increase to P_2 and the quantity supplied from the region will only increase to Q_2, while the rest is covered by imports to the region. The more elastic the supply is from other sources, the less will the price increase be. If we assume that the supply from the world market is perfectly elastic, the price may only increase, if there are transport costs, which give local producers an advantage. In that case the price can change to the world market price plus transport costs from the nearest world market access point. If the plant has a relatively large demand, there will probably in the long run be built a transport system that allows the price to be only marginally different from the world market price (here the EU price).

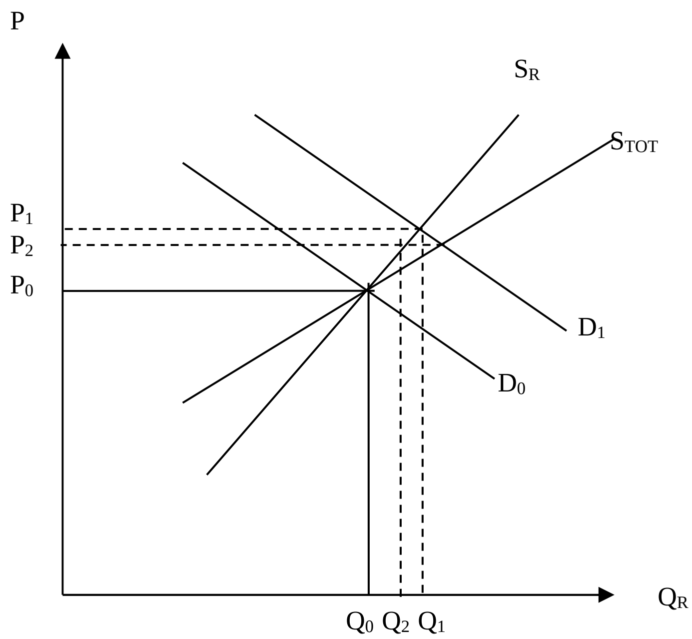
In the specific case the percentage increase in price can be calculated by dividing the percentage change in the production by the supply elasticity. If the supply elasticity is low, e.g. 0.5 the price change will be double the relative change in production.

According to Quirino Paris and Richard E Howitt, 2000, the supply elasticity for grain in a region in California was estimated at 0.696, where the alternatives were other vegetable products. With an increase in production of 390,000 tonnes relative to the present production of total 1.33 mill tonnes in South and Southern Jutland, this means that the price in the short term should change by 42 %, if there were only access to local production. This is of cause unrealistic. Due to import from other regions and from the world market the supply elasticity will be higher, as explained above.

What is decisive and what will constitute a ceiling over the price change will be the import price and the transport costs from the nearest world market access point. In the case at hand this might mean the harbour of Hamburg or the harbour of Esbjerg. If the relevant point is Hamburg, the transport costs can be calculated at DKR 118 per tonnes, while the transport from Esberg would cost DKR 50 per tonnes. A ceiling for the price increase therefore would be DKR 850 per ton wheat, if delivery to Esbjerg harbour can be made at world market, or in this case EU prices. Over time it is likely that alternative channels will drive back the price to the previous level as indicated in figure 3.

If the price increases in a region around the plant, and set a side land may be included for profitable production, this will give rise to an increase in producer surplus for farmers in the short run. Over time this advantage will be capitalised in the land. Thereby that part of extra producer's surplus, which arises in the short run, will be reduced due to an increase in land rent. The pure agricultural production therefore will no longer experience more than normal earnings. Owners of land will have experienced an increase in the value of land due to the project. Since farmers normally are both producers and owners of land there will of cause be a combination of these effects in their results.

Fig. 3. Price effect by an increase in demand for grain



13. Conclusion

The calculations show that building a plant for processing of bio-ethanol in Southern Jutland will give rise to an increase in employment by approximately 188 persons in the production itself and the indirect activities that supply the plant, and as a consequence of the increase in consumption created in the study area in the southern part of Jutland. The regional extra income, which the plant gives rise to is in the magnitude of DKR 130 mill annually.

If it is assumed that the agriculture in the region *i.a*. by involving set aside in the production can supply half the grain which is needed as input to the production, the extra employment will total 235 persons and the increase in income will be DKR 157 mill. annually.

It was in these calculations assumed that a sales price of ethanol of DKR 3200 per m^3 is an expression of a realistic production price. It has not been examined for this report if this price can be obtained in practice. This will depend on whether there will be total or partly tax exemption for ethanol for transport, which in practice will be decisive for the economy of the project.

The calculations of the change in employment and income show that employment and income potentially may increase, if the region is competitive and has a sufficient capacity in the industries that are to supply and that the necessary workforce is available in the region or can be attracted, so that the extra supply to the plant will not just produce an equivalent reduction in the supply to other purposes. However the region is well represented in the industries that are to deliver to the plant, and should therefore be able to do this.

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15. Appendix 1. Model set-up and assumptions behind the calculations

For the calculations a regionalised input output model for a region consisting of two counties in the southern part of Jutland was calibrated. The input output table for the national level was aggregated, so that numbers for regional employment and gross value added by sector could be used for the delimitation of the regional input output table.

The estimation of the regional input output coefficients were based on a method used by Madsen and Stouge (1996) by the regionalisation of AKF's regional economic model EMIL. The method implies that the technical coefficients for domestic supply to the other industry sectors and to final demand are split in a regional coefficient and a coefficient for supply from other domestic regions. The calculation of the regional coefficient is based on so called localisation coefficients, which show the regional industry share of the total production compared to the same industry share at the national level. The localisation coefficients therefore correlate with the employment shares at the regional level compared to the employment shares at the national level. By calculation of localisation coefficients it is not employment shares but production value shares that are compared. But aside from that the figures are similar.

Below in table A1 localisation coefficients for the study area in the southern part of Jutland are shown and can be seen to be comparable to the shares shown in figure 2.

Beside localisation coefficients so called cross industry coefficients,[2] which for deliveries from one sector to another compare the supplying sectors position in the regional economy with the receiving sectors position. If the supplying sector

2 Localisation coefficients are calculated by: $LQ = (PVR_i/PVR)/(PVN_i/PVN)$, while cross industry coeffficients are $CIQ = (PVR_i/PVN_i)/(PVR_j/PVN_j)$, i is the sector supplying, j is the receiving sector. PVR_i is the regional production value in sector i, while PVN_i is production value in the sector at the national level. PVN is the total production value at the national level.

is relatively small in the region while the receiving sector is large, a larger part of the deliveries must come from other regions or from foreign sources. The input output coefficients are adjusted accordingly.

For the area in the southern part of Jutland the primary and secondary manufacturing industries are typically well represented, while the tertiary service sectors as a rule are less well represented as can be seen in figure 2. This has consequences for the detailed inter industry structure linkages of the model. For the computations it means that when output from the service sectors are used, they will be supplied to a higher extent from other regions while output from the manufacturing sectors are supplied mainly from local sources, since these sectors are well represented in the region.

The calculations of the change in employment and income show that employment and income potentially may increase, if the region is competitive and has a sufficient capacity in the industries that are to supply and that the necessary workforce is available in the region or can be attracted, so that the extra supply to the plant will not just produce an equivalent reduction in the supply to other purposes. However the region is well represented in the industries that are to deliver to the plant, and should therefore be able to do this.

Table A1. Localisation coefficients for industries in the study area

Industry	**Localisation coefficient**
0109 Agriculture, horticulture and forestry	1.203
0500 Fishing	0.9642
1009 Mining and quarrying	2.0905
1509 Mfr. of food, beverages and tobacco	1.4978
1709 Mfr. of textiles and leather	1.2318
2009 Mfr. of wood products, printing and publ.	0.8253
2309 Mfr. of chemicals and plastic products	0.8253
2600 Mfr. of other non-metallic mineral products	1.4165
2709 Mfr. of basic metals and fabr. metal prod.	1.6096
3600 Mfr. of furniture; manufacturing n.e.c.	2.1053
4009 Electricity, gas and water supply	1.3531
4500 Construction	1.1118
5000 Sale and repair of motor vehicles sale of au-to. Fuel	1.1008
5100 Wholesale except of motor vehicles	0.7795
5200 Re. trade and repair work exc. of m. vehicles	0.885
5500 Hotels and restaurants	0.9095
6009 Transport	1.0224
6400 Post and telecommunications	0.7514
6509 Finance and insurance	0.6347
7009 Letting and sale of real estate	0.7728
7209 Business activities	0.5474
7500 Public administration	0.804
8000 Education	0.8427
8519 Human health activities	0.7701
8539 Social institutions etc.	0.8465

Technically the primary sectors, agriculture and forestry, fishery and extraction were exogenised, so that the production is determined outside the system for these three sectors. This refers to the fact that these sectors are severely limited by regulation, so that they cannot be expected to increase production, even if demand increases. Also in this respect in the first round the methodology applied by Petersan for the plant in Nebraska was used. In a second calculation there was allowed for an increase in agricultural production, so that a possible local expansion based on grain production on set aside was included in the calculations.

A specific calculation involves the following steps: First the increase in activity, which the plant directly causes, is calculated. This is done by looking at the cost items and considering these as expenditures for goods and services bought from the relevant business sectors. If there is in addition to this a change in agricultural production, the purchases from agriculture of commodities from other sectors are calculated. The column of representing inputs to agriculture per unit of agricultural output from the input output table is used for this purpose. The calculated activity by agriculture is then added to the activity created by the plant itself.

The indirect change in production value

Based in the computed indirect demand from other industries it is now possible to use the standard procedure applying the inverted matrix to calculate the direct and indirect demand from other industries. The result is a change in production value (sales value) in each industry.

Change in income

From the computed changes in production value in the industries it is possible to calculate the gross value added (income). From the relationship between wage and production value in a similar way. The change in wages in each industry then may be computed. The employment is calculated by dividing total wage by average wage per employed as described in the project. With this method of calculation it is not considered that the number of self-employed persons may change as a consequence of changes in residual income. The reason for this is that it is not assumed that the structure changes. There is therefore a structural marginality assumption behind these calculation.

The induced effect

The induced effect, i.e. the activity which arises because a share of the extra income generated is used for consumption can be calculated by multiplying the extra wage income by 0.45, i.e. by assuming that 45% of income (after deduction of taxes and savings)is used for consumption in the households. It is assumed that the consumption can be covered locally that is the column for consumption in the final demand part of the input output table is used directly for the calculation of the induced regional demand from the industries. From the demand on other industries the direct and indirect demand from all other sectors can be used by applying the inverted matrix using standard procedure. The calculation results in a vector of changes in production value. From this vector the changes in gross value added, wages and employment can be calculated.

Taxes

Taxes are calculated partly as corporate taxes from the project description, partly as indirect taxes, which can be computed via the input output model and finally as the income taxes which go to the regional levels. The indirect taxes (commodity and non-commodity indirect taxes on the production of the industries) are calculated from the change in production value in each industry by multiplying the input output coefficients for these taxes on the change in production value in the industries. To this are added the indirect taxes (particularly VAT) on consumption, by the immediate induced consumption expenditure. Finally the regional income tax on the income generated directly, indirectly and induced is added.

16. Appendix 2. Production and set aside areas

Expected growth in non-food wheat production by inclusion of 65 % of the present set aside areas
Import from rest of Denmark is put on the same footing as import from the world market

County	**Set-aside ha**	**65% of this**	**Yield/ha**	**Xtra prod**
				ton
Sdjr jyll	25986	16890.9	7.15	120769.9
Ribe	14457	9397.05	7.15	67188.91
Total				187958.8

Source: Pers. communication: Peter B Nielsen, Sønderjysk Landboforening.

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