

The energy impact of changing structures in foreign trade of Denmark

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Abstract

This paper examines structural changes in foreign trade patterns and the consequences for energy intensity in Danish production using input-output techniques on Danish national account and energy data. Traditionally the energy consumption or direct and indirect Danish energy input in production is used in the measure for energy intensity. In here it is argued that global energy content of Danish production should be examined as well, and particularly when analysing energy efficiency developments across branches there could be a difference between the two energy intensity measures. Different developments of the two measures are connected to a change in foreign trade structure and the effect on energy input in branches using 1966 import shares for inputs in 1992 production is analysed. Energy efficiency measured as energy intensity of Danish production is very dependent on whether the Danish energy input or the global direct and indirect energy input is used.

For economies with a high share of basic industrial production with high energy intensity, as in some of the eastern European economies, the use of different measures for energy input has important implications for the development in energy efficiency measures. Energy efficiency in production calculated from national energy content might improve fast as the share of consumer goods industries and the service sector are increased. A global energy input measure would show a more modest decline in energy intensity as higher import shares for products produced with high direct energy content does not change the global energy input measure.

Efficiency measures are most meaningful at the disaggregated level, but if national figures are considered it is important to include national energy input in production as well as energy content in imports. A change in national energy consumption should probably be evaluated based on the global energy content in final domestic demand rather than as domestic energy consumption.

Different measures of energy intensity in production

It is important to distinguish between different measures of energy intensity both when examining cross section data and time series of energy intensity. With regard to time series of energy consumption and energy intensity the change in production structure and the change in patterns of foreign trade are important determinants of the energy intensity in national production measured as the direct and indirect energy content.

It is obvious from Figure 1 that the sectors have behaved very differently with respect to the change in energy consumption from 1966 to 1992. The reason for the difference is manifold, but important determinants are:

- Different production developments caused by a change in the composition of final demand both with respect to final demand categories and goods.
- Different development in the technology and especially the energy technology used in the sectors.
- A change in the structure of foreign trade.

This analysis focus on the third option, which in turn includes two different elements. Final demand may have shifted towards higher import shares for some goods, that can be either more or less energy intensive than the average good. In the same way the import share of each input in Danish production may have shifted in a way

that leads to either more or less domestic energy input in production. The effect of this second structural change is examined in here.

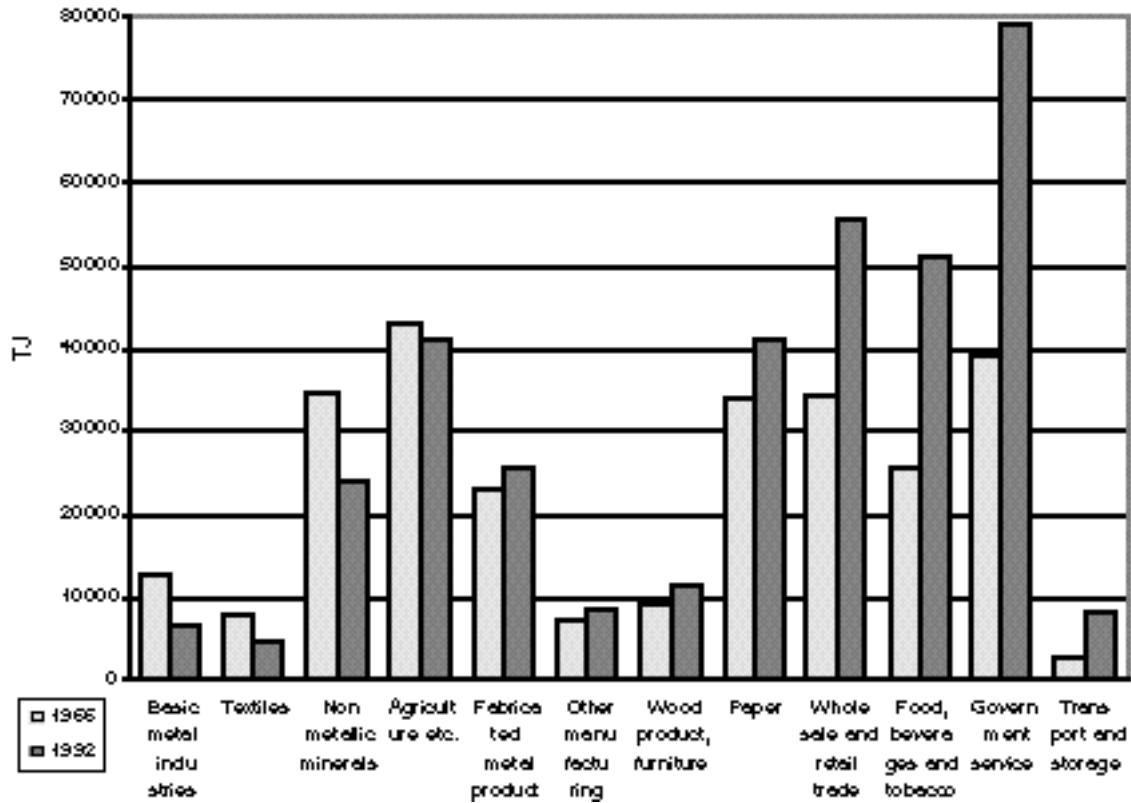


Figure 1 Energy input in Danish sectors 1966 and 1992

Input-output calculations

The analysis has been carried out based on Danish national accounts and energy balances. The available data have a time span of 27 years and this period includes both significant shifts in energy technology and energy intensity as well as foreign trade structure.

Data covers 27 industries and the energy measure used is the net energy input in GJ. Calculations of the net energy input with 1966 import shares for each of the 27 inputs in the 27 industries are carried out according to (1).

$$e_{92}x = (I - A^x)^{-1} e^x e ;$$

$$agx_{i,j} = (ag_{i,j} + am_{i,j}) am_{i,j}^{1966} ; am_{i,j}^{1966} = \frac{ag_{i,j}^{1966}}{ag_{i,j}^{1966} + am_{i,j}^{1966}} \tag{1}$$

The vector of net energy input in TJ for 1992 is $e_{92}x$, A^s is the coefficients of inputs of domestic origin and A^m is the coefficients of imported inputs. e^s is final demand for domestic goods and e is the energy coefficient (net energy in TJ per mill. DKK, 1980 prices) in each production sector. The coefficient $agx_{i,j}$ is the input of industry i production in industry j for 1992 with the import share of 1966 for each of the inputs in industry j . The imports not referable to a specific good are not included in this analysis.

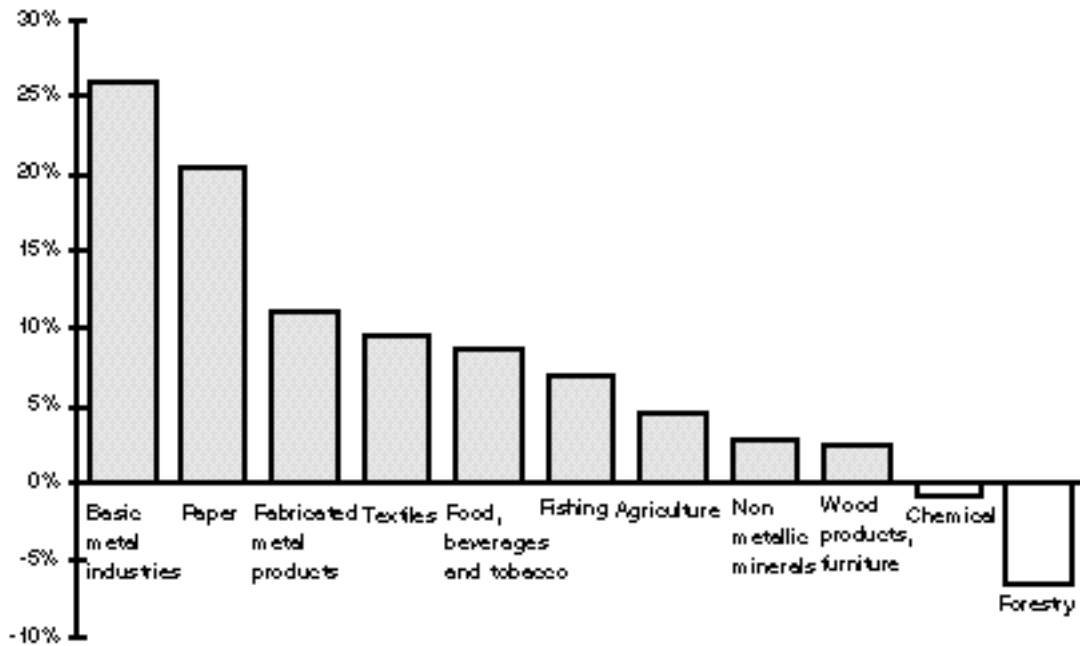


Figure 2. Energy demand in Danish industries in 1992 calculated with 1966 import shares relative to the actual energy demand in 1992

The sectors included in Figure 2 are the sectors to which the structural change in import input coefficients has the highest impact on their energy demand. It is the manufacturing and primary industries that are represented in this group. The corresponding impacts on service sectors are close to zero. Iron and metal industries would have had 25% higher Danish direct and indirect energy consumption if the import share of all inputs in Danish sectors had been like in 1966.

In general the manufacturing industries have changed their input structure in the way that inputs with high energy content to a higher degree is imported today than in 1966. Thus, the change in import shares in manufacturing input demands corresponds to an exporting of energy intensive industries.

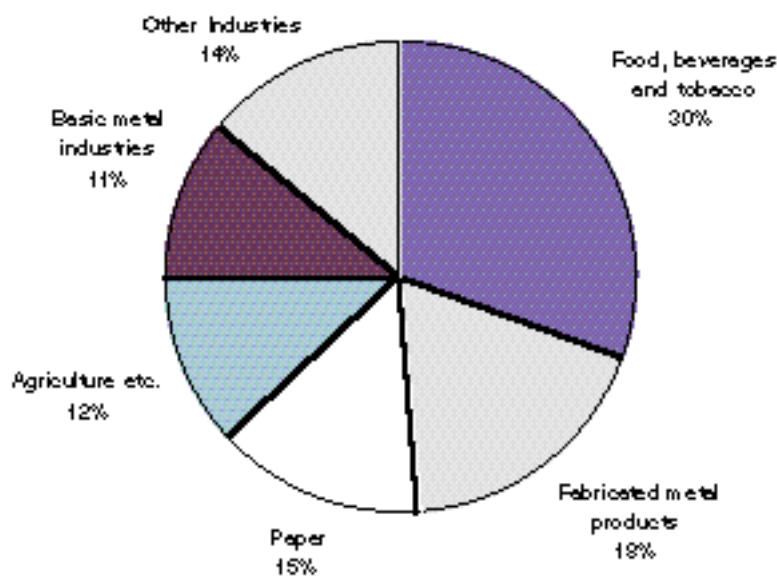


Figure 3. The relative importance of industries in the calculated increase in energy input

From Figure 3 it is seen that the major contribution to the increase in total calculated amount of energy input of 15.737 TJ originates from a few of the manufacturing industries.

Table 1 Net energy input and energy coefficients for 27 Danish industries

Industry	Increase in energy input when 1966 import shares are used	Energy consumption 1992 (TJ)	Energy coefficient 1966 (TJ)/mill. DKK	Energy coefficient 1992 (TJ)/mill. DKK
Agriculture etc.	1898	41030	1.41	0.95
Forestry	-10	151	0.10	0.20
Fishing	786	11438	3.01	4.53
Mining	-1700	4546	1.91	0.25
Food, beverages and tobacco	4838	55438	0.72	0.69
Textiles	420	4489	0.82	0.43
Wood products, furniture	211	8487	1.16	0.75
Paper	2293	11245	0.79	0.64
Chemical	-200	27759	1.01	0.71
Non metallic minerals	657	23767	5.79	3.63
Basic metal industries	1722	6640	4.95	2.34
Fabricated metal products	2791	25487	0.73	0.39
Other manufacturing industries	56	1104	0.45	0.31
Electricity, gas and water	202	3529	0.21	0.20
Construction	65	17139	0.26	0.35
Wholesale and retail trade	700	41089	0.80	0.55
Restaurants and hotels	39	8408	0.83	0.68
Transport and storage	593	79226	1.27	1.25
Communication	50	4303	0.83	0.38
Finance and insurance	36	8250	0.29	0.55
Dwellings	0	1924	0.04	0.04
Business services	248	12613	0.26	0.34
Private education and health	6	2907	0.52	0.46
Recreational and cultural service	-83	1963	0.62	0.32
Household services	82	8799	0.90	0.54
Other service	0	388	0.04	0.12
Government services	35	51275	0.48	0.41
All Industries	15737	463392	0.80	0.59
Manufacturing	12789	164416	1.10	0.70

Conclusion

In the analysis above it is shown that changes in the structure of foreign trade have an important influence on the comparison of energy intensity or efficiency developments across production sectors. Achievements of sectors with respect to energy efficiency improvements should never be judged alone based on the development of the direct or direct and indirect national energy content in inputs. A measure of global energy content in the output of a sector would be much more meaningful, even though the approximation that the energy coefficient in imported goods equals the coefficient for domestic produced goods is very rough.

To some extent the developments in Danish production structure have led to a decline in the domestic used energy intensity for manufacturing industries. For some of the manufacturing industries that have inputs of energy

intense goods, (iron and metals, paper and pulp) the energy intensity would have been much higher if the import shares of their inputs of each good had been unchanged from 1966. Manufacturing industries have increased their import of the goods with heavy energy content and hereby indirectly exported some of the energy intensive processes or sub-industries. This is only one aspect of the importance of structural changes in foreign trade. Another and maybe even more important aspect is the question of a change in the composition of final demand on domestic and foreign produced goods which also have important implications for the domestic energy consumption.