EMISSIONS TO THE AIR AND THE ALLOCATION OF GDP: MEDIUM TERM PROJECTIONS FOR SWEDEN IN CONFLICT WITH THE GOALS OF CO_2, SO_2 AND NO_x EMISSIONS FOR YEAR 2000*

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Abstract

Implications for CO_2, SO_2 and NO_x emissions of the Government's medium term economic projections are assessed considering Sweden's environmental goals. Data from the first environmental accounting matrix of Sweden is exploited within the framework of the inter industry model to give emission multipliers for various components of aggregate demand. It is evident in view of these emission multipliers, that the outlined macroeconomic development does not conform with Sweden's environmental goals. The oil price and the structural changes assumed in the economic projections still further stress the need for strong environmental policy measures to attain the emission goals.

1 Introduction

Some important environmental issues are global and Sweden has signed international agreements on controlling acid rain and the green house effect. Specific goals for the emissions of CO_2, SO_2 and NO_x are formulated in the Government's bills of 1988 and 1993. The emission of CO_2 should be stabilized at the 1990 level in 2000 and thereafter reduced. The emission of SO_2 should be reduced to 80 per cent in 2000 and that of NO_x to 30 per cent in 1998 compared to the levels of 1980. To reduce SO_2 emissions, regulations have been taken in Sweden since the beginning of the 1980's. The accepted level for the sulphur content of

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petroleum products has been reduced gradually and emission limits for SO_2 were initiated for fuel combustion plants and the processing industry in 1987. Also, a SO_2 tax was introduced in 1991. The measures to reduce emissions of NO_x include regulations for different kinds of road vehicles and a NO_x tax. A CO_2 tax was introduced in 1991 and in 1995 the parliament voted for a tax increase.

Measures taken to reduce the emissions that pollute the environment will impose restrictions on production activities. As some activities are less pollutant than others the underlying trend in allocation of real GDP is of importance to the strength of policy measures that must be taken implemented in act to attain certain environmental goals. The less emission intensive allocation of total expenditure, the less we must restrict production activities by policy measures. The Medium Term Survey 1995 of the Swedish Economy (MTS), recently published by the Ministry of Finance, estimates that the total environmental restrictions will cause costs corresponding to 2-10% of GDP over a period of 30-40 years. The MTS, however, does not report on environmental effects of the macroeconomic development presented. Furthermore, Sweden's environmental goals for emissions of pollutants to the air are not at all discussed in view of the macroeconomic development. Input-output analysis is used here to calculate emission multipliers of the pollutants CO_2, SO_2 and NO_x for the following components of final demand: exports, private consumption, investments and public consumption. The effects on total emissions of macroeconomic growth in Sweden to 1998 and 2000 are assessed by this method and compared with actual emission goals in the present paper.

A reallocation of total expenditure could change the amounts of emissions to the air. Changes in the amounts of emissions could be calculated given the emission multipliers for components of aggregate demand. Such an assessment reveals if the macroeconomic development is in conflict with environmental goals and would draw attention to the need for further policy measures, or for another economic development, to protect the environment. The pollutants CO_2, SO_2 and NO_x are emitted at different stages of the production process from raw materials to products for consumption. By tracing all the emissions through the production chain, emission multipliers for the components of final demand could be calculated. Structural changes, thus, affect the emission multipliers and examples of this are given with the data of 1991. Relative prices of fuels also influence the emission multipliers. The price elasticity of aggregated energy demand estimated for Sweden is used to illuminate this aspect of the price assumptions made in the economic projections.

Without the possibility of building nuclear power plants in the future, the allocation of real GDP will be vital to the emission intensities of the Swedish economy. The emission goals can be expressed as emission output ratios by relating the accepted emission levels to the GDP development prospected in the MTS. The emission output ratios of the Swedish economy must reduce to attain these emission goals for 1998 and 2000. The emission ratios must reduce by 10 per cent for SO_2 and CO_2 and by 30 per cent for NO_x compared to the ratios of 1991. If the emission/GDP ratios of 1991 cannot be reduced, then the prospected growth rate of GDP will increase CO_2 and SO_2 emissions by almost 13 per cent in 2000 and NO_x emissions by almost 9 per cent in 1998. The emission levels will then exceed the environmental goals for emissions of pollutants to the air by 26% for CO_2 and SO_2 and by 56% for NO_x. It is not likely that the CO_2, SO_2 and NO_x emissions can be brought to accepted levels for 1998 and 2000 without an environmental policy of considerable strength according to the analysis carried out in the present paper.

A presentation of the method and data follows in Section 2. Emission coefficients for various sectors of the economy are reported in Section 3 and Section 4. Changes in the composition of aggregate demand have effects on total emissions, and these effects are analysed in Section 5. The environmental effects of perspectives for the Swedish economy are reported in Section 6 and compared with actual emission goals. Finally, some policy implications are discussed.

2 Method and data

Input-output analysis is used here to calculate emission multipliers of the pollutants CO_2, SO_2 and NO_x for the following categories of final demand: exports $\mathbf{y}_e$, private consumption $\mathbf{y}_c$, investments $\mathbf{y}_v$ and public consumption $\mathbf{y}_g$. The open static Leontief system is combined with an emission identity stating that total amounts of the pollutants to the air are equal to the amounts of the pollutants emitted by different industrial activities, the household sector and the public sector. All commodities are produced as well as imported and can either be used as intermediate input, or finally consumed. Intermediate input of commodities and industrial emissions of pollutants are assumed to be proportionally related to output.

The economic relations are represented by the following system of equations:

$$\mathbf{x} = \mathbf{A}\mathbf{x} + \mathbf{y}_x \tag{1}$$

$$\mathbf{m} = \mathbf{M}\mathbf{x} + \mathbf{y}_m \tag{2}$$

Where:

$\mathbf{x}$ is a column vector of produced amounts of n commodities.

$\mathbf{A}$ is a $n \times n$ matrix of coefficients A_{ij} for input of produced amount of commodity i for production of commodity j.

$\mathbf{y}_x$ is a column vector of final demand for produced amounts of n commodities.

$\mathbf{m}$ is a column vector of imported amounts of n commodities.

$\mathbf{M}$ is a $n \times n$ matrix of import coefficients M_{ij} for input of imported amount of commodity i for production of commodity j.

$\mathbf{y}_m$ is a column vector of final demand for imported amounts of n commodities.

By using equation system (1), we can relate final demand to produced amounts through the Leontief inverse, $(\mathbf{I}-\mathbf{A})^{-1}$; **I** is a $n \times n$ identity matrix. This guarantees that the matrix $(\mathbf{I}-\mathbf{A})$ is non-singular, i.e. matrix **A** fulfills the Hawkins-Simon conditions, which hold for the matrix used in the present study. Call the Leontief inverse **H.** The equation system (1) can then be written:

$$\mathbf{x} = \mathbf{H}\mathbf{y}_x \tag{3}$$

The emission identity is represented by the following system of equations:

$$\mathbf{e} = \mathbf{E}\mathbf{U}\mathbf{x} + \mathbf{e}_c + \mathbf{e}_g \tag{4}$$

where:

e is a column vector of total emission, in physical units, of *m* types of pollutants to the air.

E is a $m \times n$ matrix of coefficients E_{kj} for pollutant of type *k* emitted by sector *j* for unit output.

$\mathbf{e}_c$ is a column vector of quantities emitted by the household sector for *m* types of pollutants.

$\mathbf{e}_g$ is a column vector of quantities emitted by the public sector for *m* types of pollutants.

U is a $n \times n$ matrix of market shares U_{ij} for amount of commodity *j* produced by sector *i*.

The combination of Equation systems (3) and (4) gives:

$$\mathbf{e} = \mathbf{E}\mathbf{U}\mathbf{H}\mathbf{y}_x + \mathbf{e}_c + \mathbf{e}_g \tag{5}$$

The identity: $\mathbf{y}_x \equiv \mathbf{y}_c + \mathbf{y}_v + \mathbf{y}_g + \mathbf{y}_e$ holds and the term $\mathbf{EUH}(\mathbf{y}_c + \mathbf{y}_v + \mathbf{y}_g + \mathbf{y}_e)$ represent emission of pollutants due to roundabout consumption of commodities for the various demand categories. Where private consumption and public consumption are concerned, emissions by household activities, $\mathbf{e}_c$ and emissions by public service activities, $\mathbf{e}_g$ are also considered. The emission multipliers e_j for the four demand categories are thus:

$$\mathrm{e}_j = \left(\mathbf{EUHy}_j + \mathbf{e}_j\right)\left(\mathbf{iy}_j\right)^{-1}$$

where:

j=$c,v,g,e,$ and $\mathbf{e}_j = \mathbf{0}$ for $j \neq c, g$

$\mathbf{i}$ is a $1 \times \mathrm{m}$ unit vector and $\mathbf{0}$ is a $\mathrm{m} \times 1$ null vector.

The vector $\mathbf{y}_g$ refers to demand of material inputs in public production, but for convenience of notation let the sum $\mathbf{iy}_g$ denote total public consumption. The equation system (5) can now be rewritten as:

$$\mathbf{e} = \mathrm{e}_c\left(\mathbf{y}_c\right) + \mathrm{e}_v\left(\mathbf{y}_v\right) + \mathrm{e}_g\left(\mathbf{y}_g\right) + \mathrm{e}_e\left(\mathbf{y}_e\right) \qquad (5a)$$

where:

e_c is a column vector of emission multipliers for private consumption, with *m* types of pollutants.

e_v is a column vector of emission multipliers for investments, with *m* types of pollutants.

e_g is a column vector of emission multipliers for public consumption, with *m* types of pollutants.

e_e is a column vector of emission multipliers for exports, with *m* types of pollutants.

All the data of emissions are taken from the official report on Environmental accounts for Sweden published by the National Institute of Economic Research and Statistics Sweden, NIER (1994). The report includes the first environmental accounting matrix of Sweden showing the emissions of the pollutants CO_2, SO_2 and NO_X for 16 industries, the household sector and the public sector. Emissions are measured in physical units for the year 1991. The input-output data, a commodity by commodity table for 1991, was produced by Statistics Sweden at the same level of aggregation. The economic projections to 1998 and 2000 for the Swedish economy are taken from the Medium Term Survey 1995 published by the Ministry of Finance, SOU (1995).

3 Emissions of pollutants by industrial subsectors

In 1991, about 92 % of SO_2, 71 % of CO_2 and 75 % of NO_x were emitted by the Swedish production system. However, the amount of CO_2, SO_2 and NO_x emitted at a given level of economic activity might vary. Some industries expand while others stagnate or even decline. Emissions per unit produced (the emission coefficient) differ among individual industries.

The emission coefficients may also change over time for a number of reasons. Changes in the production mix within an industry may have taken place so that the products no longer are identical and/or are not produced in the same proportions. Production techniques may have changed owing to technical progress or by input substitution in the medium term. Existing production techniques often permit some variation in the input proportions. In the longer run, as production capacity grows and older plants are partly or totally replaced, input combinations become less restricted. The substitution of inputs depends on changing relative prices. Here, influences from both emission coefficients and structural changes are discussed.

Changes in capacity usage influence both the emission coefficients and our measure of structural changes. The share of emissions from fixed combustion of fuels - space heating, etc. - per unit produced increases with unused capacity. All the sectors, however, do not necessarily share the same business cycle. The influence of increased emission coefficients, on the amount of pollutants emitted, relative to economic activity, could therefore be counteracted by a changed production share, due to a reduced capacity in the sector.

The years 1980 and 1991 were both on the downswing of the business cycle of total industry according to NIER (1995). It is possible that the emission coefficients in 1980 and 1991 have an upward bias compared to those of the projected years 1998 and 2000 for which normal capacity utilization is assumed. It has not been possible to quantify this bias or estimate the extent to which our measure of structural changes also reflects that the business cycles of the different sectors do not coincide.

The production system is divided into 16 subsectors as shown in Table 1. The subsectors ranked by emission intensities form three groups, which are also given in the table. The group of subsectors characterized by high emission coefficients have coefficients above the average of total production for all the three pollutants SO_2, CO_2 and NO_x. The subsectors with medium emission coefficients have at most two of three coefficients that are above the average of total production. Finally, subsectors with low emission coefficients have all three coefficients below the average for total production.

Table 1 Emissions per million SEK of gross output and production shares 1991.

Subsector	*CO_2 ton*	*SO_2 kg*	*NO_x kg*	*Production share in %*	*ISIC 1968**
High coefficients					
El.,gas,heating	206	334	362	2.66	41
Fishery	167	174	4003	0.06	13
Transportation	57	195	857	6.72	7
Mining	50	327	443	0.48	2
Primary metals	102	246	125	2.29	37
Refineries	57	218	204	1.13	353/4
Medium coefficients					
Pulp,paper	129	153	139	5.92	34
Agriculture	49	49	671	1.45	11
Forestry	19	14	626	1.12	12
Chemicals	63	60	63	3.66	35 excl. 353/4
Other industries	40	69	88	9.50	31,32,33,36
Low coefficients					
Services	7	4	103	28.50	6,8 excl. pt. 831,9
Construction	8	4	38	9.39	5
Dwellings,real est.	4	6	12	10.95	pt. 831
Water,sewage	0	0	123	0.45	42
Engineering	4	3	11	15.73	38,39
Total production	31	53	149	100.00	

*United Nations, Statistical Office, *International Standard for Industrial Classification of All Economic Activities*, Statistical Papers, Series M, No 4, Rev 2, New York, United Nations, 1968.

Industries where combustion of fossil fuels plays a dominant role in the process of converting, transforming or transporting various goods and raw materials constitute the first group (high emission coefficients). Sectors in this group account for 41% of the CO_2, 60% of the SO_2 and 52 % of the NO_x emitted by the production system while producing only 13% of total gross output. Production activities of the five subsectors in the second group (medium emission coefficient) combust less of fossil fuels than the first group but take a larger share of gross output 22 %. The combustion of lye and wood waste in the pulp and paper industry, however, makes the second group contribute with 47 % of the CO_2 emitted by the production system. In the third group (low emission coefficient) are services, engineering and construction, to mention a few. Subsectors in this group take about 65 % of the gross output and are registered for 5% of SO_2, 12 % of CO_2 and 25 % of NO_x, emitted by the production system.

Structural changes should have a large influence on pollutants emitted relative to total output of the Swedish production system, which has a highly differentiated structure of production with reference to CO_2, SO_2 and NO_x coefficients. For example, an increased output corresponding to 1% of the production shares for any of the industries with high emission coefficients would raise the emission of SO_2 relative to total production in a range from 3 to 6%. A corresponding increase of output for industries with low emission coefficients would hardly affect this ratio.

4 Emissions of pollutants by households and the public sector

Swedish households accounted for 26% of the economy's total emission of CO_2, 7% of total SO_2 emission and 24% of total NO_x emission for space heating and private transport in 1991. Most of the emissions were due to combustion of motor fuels (55% of households’ CO_2 emission and 92% of households’ NO_x emission). The households’ emissions of pollutants are determined, among other things, by income, energy prices and policy measures. Variations in all of these and other determinants are reflected on an aggregated level by changes in the ratio between pollutants emitted by the household sector and total private consumption. This ratio appears in Table 2 for CO_2, SO_2 and NO_x.

Table 2 Emissions per million SEK consumption in 1991.

	CO_2 in ton	*SO_2 in kg*	*NO_x in kg*
Private consumption	24	9	123
Public consumption	5	6	7

Of the total CO_2 emissions in the economy, 4% are registered for the public sector. The corresponding figure is 2 % for SO_2 and 1% for NO_x. Space heating accounts for most of these emissions. The public sector comprises a variety of activities, which can be classified as either general administration, national defence, education and health- and social services. The emissions of this sector are in turn dependent on political decisions concerning the size and concentration of public services. The emissions of CO_2, SO_2 and NO_x are set in relation to public consumption as a measure of the emission ratios in the public sector. Changes in the composition of public consumption will of course affect these ratios and any observed decrease could be due either to this changed composition or changing emission ratios in the different activities.

5 Effects on total emissions of changes in aggregate demand

So far the emissions of CO_2, SO_2, and NO_x in the Swedish economy have been discussed with reference to the direct use of fuels in three major economic sectors. The relationship between the emission/GDP ratio and the emissions of these sectors is not evident, however. A link suggested here are the emission multipliers of different components of aggregate demand.

In two of the three economic sectors (households and the public sector), fuels are combusted to yield desired indoor temperature and transport services, but in the production system fuels are used for producing goods and services. It is desirable to know how much of total emissions due to fuel combustion should be attributed to the different categories of aggregate demand as the emission/GDP ratio is affected by changes in the composition of aggregate demand.

All production of goods and services, ultimately, serves the purpose of final consumption, but through a complexity of inter-industry linkages. It is possible, using input-output analysis, to consider this interdependence and thus account for all emissions in the processing chain, from primary products and semimanufactures to finished products. In this way, the total emissions embodied in goods and services are computed for the different categories of final demand. For private consumption and public consumption, the direct emissions must be added. The other categories of final demand are investments and exports, but for these, only emissions embodied in goods and services have to be included.

By setting the calculated total emissions (direct and embodied in goods and services) of CO_2, SO_2, and NO_x in relation to private and public consumption, investments and exports, one obtains emission multipliers for each of these demand categories. The emission multiplier of total final demand becomes a weighted average of these multipliers. The effect on the emission/GDP ratio of changes in the composition of final demand can thus be studied.

Table 3 Emission multipliers for various final demand categories in 1991.

	CO_2 Ton per million SEK		*SO_2 Kg per million SEK*		*NO_x Kg per million SEK*		*Final demand share in %*
	Embodied	Total	Embodied	Total	Embodied	Total	
Private consumption	32	56	55	64	164	286	42.1
Public consumption	14	19	25	31	73	79	21.6
Investments	20	20	29	29	120	120	14.2
Exports	65	65	114	114	272	272	22.1
Total	34	45	58	63	162	215	100.0

There are considerable differences amongst the four demand categories, as can be seen from Table3. The highest multipliers of CO_2 and SO_2 are noted for exports. Regarding the emissions of CO_2, SO_2, and NO_x embodied in goods, exports hold the very top position, which is explained by Sweden's traditional reliance on energy intensive products in its exports - pulp, paper, and paper products and primary metals. The combustion of motor fuels by households for private transportation makes private consumption having a higher total NO_X multiplier than exports. Public consumption is noted for the lowest emission multipliers.

Variations in the composition of final demand could *per se* lead to significant changes in the emission multipliers for total aggregate demand - and thus affect the emission/GDP ratios.[1] For example, in 1980 the shares of final demand were 44.1%, 21.8%, 15.5% and 18.5% for private consumption, public consumption, investment and exports, respectively. The final demand shifted in the direction of an increased share of exports, but a decreased share of private consumption. A demand shift in this direction increases the emission multipliers of total demand. The emission multipliers and the emission/GDP ratios would have been somewhat lower than the actual figures in 1991 without this demand shift. The emission/GDP ratios increased more than the emission multipliers as an increased import share, to 20.6% from 18.9% in 1980, counteracted the increase in the emission multipliers of 1991.

6 Economic perspectives and environmental effects for 1998 and 2000

The analysis above emphasizes that shifts in the composition of aggregated demand influence the emission intensities of the Swedish economy. The figures in Table3 show that the environmental implications of the economic policies for the late 1990s, suggested in the MTS, conflict with the environmental goal of reduced CO_2, SO_2 and NO_X emissions in Sweden during the same period. The report outlines a main road for the economic development of Sweden characterized by an ambitious and successful economic policy aimed at improving today's low employment rate, cutting the budget deficit and stimulating savings to induce economic growth.

The shares of private consumption, public consumption and investments drop from 1991 to 1998 by 5.0%, 3.6% and 1.3% of final demand respectively. The export share increases by 9.9%. From 1991 to 2000, the share of private consumption decreases and the share of exports increases by 5.3% and 10.7% of final demand respectively. The shares of public consumption and investment decrease by 4.2% and 1.2% respectively. An application of the emission multipliers computed for 1991 shows that these substantial changes in the composition of final demand will increase the emission/GDP ratios from 19991 to 1998 and from 1991 to 2000. [2]

The macroeconomic development outlined in the MTS does not conform with the reductions of the emission/GDP ratios put up as environmental goals for Sweden. The environmental goals can be expressed as indices for the emission/GDP ratios in relation to the actual figures for 1991 as shown by Table 4. The emission goal for NO_x must be attained in 1998 and those for CO_2 and SO_2 in 2000. Without reductions in the 1991 emission multipliers of aggregated demand, the NO_x/GDP ratio will increase by 11% to 1998 and the CO_2/GDP and SO_2/GDP ratios will increase by 16% and 21%, respectively to 2000. The corresponding environmental goals are reductions by 30%, 10% and 10% as shown by Table 4 and these will thus be exceeded by 59%, 30% and 35%, respectively, given current economic perspectives.

Table 4 Emissions in relation to real GDP. Index 1991=100.

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[1] The emission multiplier of final demand is always lower than the emission/GDP ratio because satisfaction of the aggregated demand requires imported products in addition to domestic products (GDP), but only the production of the latter causes emissions in Sweden.

[2] In addition, it should be said that in 1998 the GDP increases by 8.9% and the share of imports increases by 5.3% compared to 1991. The corresponding figures for 2000 are 12.7% and 6.5%.

	1980	1998	2000
CO_2	167	-	90
SO_2	564	-	90
NO_x	131	70	-

Also shown in Table 4, is a dramatic decrease in the emission/GDP ratio from 1980 to 1991 for the pollutants CO_2, SO_2 and NO_x. GDP grew by 20 per cent from 1980 to 1991 but the emission reduced by 28 per cent for CO_2, by 79 per cent for SO_2 and by 8 per cent for NO_x. The main factors behind the reduced emission levels from 1980 to 1991 are conversion of heating systems from the combustion of fuels to heating by electrical energy in family houses and the nuclear energy program (60% of today's capacity in nuclear power was installed during the 1980s). The composition of aggregate demand, however, developed in a direction that should increase emissions from 1980 to 1991. This opportunity to reduce emissions is closed in the future as Sweden is committed not to build any new nuclear power plants.

Adaption to a price rise of energy brings about investments in energy conservation and thus helps to reduce emissions. Also, energy conserving technology will be introduced in production processes by normal replacement investments, especially in energy intensive production. This assertion is supported not only by economic theory but also by historical and statistical data examined in the numerous energy studies published during the last 20 years. In the MTS, the real price of oil to the consumer is assumed to increase at an annual rate of about 2%. To lead to the desired decrease in the emission/GDP ratios, a price increase of 1% must bring down the NO_x/GDP ratio by 2.5%, the CO_2/GDP ratio by 1.1% and the SO_2/GDP ratio by 1.3%. Assuming a constant relation between fuel consumption and emissions to the air, this development implies price elasticities well above those estimated by Östblom (1983) for aggregate energy demand in Sweden; they range from -0.2 to -0.4. The assumed increase of real petroleum prices is then not enough to attain the environmental goals set up for the reduction of emissions in 1998 and 2000. Higher taxes on emissions and regulatory policy measures would also be required, but this is not discussed in the economic projections reported by the Ministry of Finance.

The economic perspectives outlined in the MTS result in structural changes towards the production of labour intensive services and skill intensive goods whereas the production shares of labour intensive goods, protected goods and the letting of dwellings reduce significantly. Although, the picture of structural changes is mixed, it can hardly be said to favour less emission intensive goods. Labour intensive services have low emission coefficients. Skill intensive production, include some subsectors with high emission coefficients (transportation and refineries) as well as some subsectors with low emission coefficients (engineering). Labour intensive goods, protected goods and the letting of dwellings represent some subsectors with high emission coefficients (fishing), some subsectors with medium emission coefficients (other industries) and some subsectors with low emission coefficients (construction and letting of dwellings).

7 Conclusions

The main factor behind the reduced emissions during the 1980s was the expansion of nuclear power, whereas the composition of aggregate demand developed in a direction that should increase emissions from 1980 to 1991. In the future Sweden cannot substitute the combustion of fuels for electricity produced by nuclear power in the heating system. For reducing the emission intensities of the Swedish economy without this possibility, the allocation of real GDP will be vital to the strength of policy measures that must be taken. If the emission/GDP ratios of 1991 cannot be reduced, the growth rate of GDP prospected by the Ministry of Finance will increase CO_2, SO_2 and NO_x emissions. The environmental goals for emissions of pollutants to the air will then be exceeded by 26% for CO_2 and SO_2 and by 56% for NO_x. Considering the economic structure prospected for 1998 and 2000, the CO_2/GDP, SO_2/GDP and NO_x/GDP ratios will rise, and thus the environmental goals for emissions of pollutants to the air will be exceeded still further.

The macroeconomic development outlined in the latest MTS focuses on emission intensive allocation of GDP. This makes it difficult to attain the environmental goals set up for the reduction of CO_2, SO_2 and NO_x emissions in Sweden for 1998 and 2000.. Attaining these goals without strong environmental policy measures requires a considerable increase in the real energy price and an extraordinary adaptation to this price rise. A continuing fall in real oil prices would of course affect the CO_2/GDP, SO_2/GDP and NO_x ratios in an opposite direction and would then further emphasize the need for strong policy measures to attain Sweden’s environmental goals.

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Svensk sammanfattning

Utbyggnaden av kärnkraften var den orsak som främst låg bakom de reducerade utsläppen av luftföroreningar under 1980-talet. Inriktningen av efterfrågan påverkade däremot utsläppen i motsatt riktning från 1980 till 1991. I framtiden kommer Sverige inte att kunna ersätta bränslebaserad uppvärmning med kärnkraftsbaserad eluppvärmningen. Utan denna möjlighet att minska utsläppsintensiteterna i den svenska ekonomin, framstår allokeringen av real BNP som vital för styrkan i de åtgärder som kommer att behövas för att Sverige skall uppnå uppsatta miljömål.

Om relationerna mellan utsläppsnivåer och BNP för 1991 består innebär den BNP-tillväxt som anges fram till år 2000 i långtidsutredningen LU 95 att utsläppen av CO_2, SO_2 och No_x kommer att öka så att utsläppsmålen kommer att överskridas med 26% för CO_2 och SO_2 och med 56% för NO_x. Beaktar vi också den strukturutveckling som projiceras i LU 95 för 1998 och 2000, så kan CO_2/BNP, SO_2/BNP och NO_x/BNP kvoterna komma att öka och därmed överskrids utläppsmålen ytterligare.

En omallokering ekonomins samlade efterfrågan kan förändra nivåerna på utsläppen av luftföroreningar. De förändrade utsläppsnivåerna som en omallokering leder till kan beräknas med kännedom om utsläppsintensiteten hos den samlade efterfrågans komponenter. En sådan utvärdering skulle avslöja om en viss makroekonomisk utveckling står i konflikt med miljömål och uppmärksamma behovet av ytterligare miljöskydande åtgärder. Utsläppen av CO_2, SO_2 and NO_x sker i flera led i produktionsprocessen från råvara till färdig produkt. Genom att spåra alla utsläpp i produktionskedjan så kan utsläppsintensiteter för olika efterfrågekomponenter beräknas. Strukturförändringar påverkar således utsläppsintensiteterna och detta exemplifieras här med data för 1991. Utsläppsintensiteterna påverkas också av relativa bränslepriser. För att belysa priskänsligheten tillämpas elasticiteter som estimerats för den aggregerade energiefterfrågan i Sverige tillsammans med LU:s antaganden om bränsleprisernas utveckling.

Den makroekonomiska utveckling som skisseras i den senaste långtidsutredningen är inriktad mot en utsläppsintensiv allokering av BNP. Detta försvårar möjligheterna att uppnå de svenska miljömålen beträffande utsläppen av CO_2, SO_2 and NO_x till 1998 och 2000. Förutsättningarna att uppnå dessa mål utan starka miljöskyddande åtgärder innefattar kraftiga reala energiprisökningar och extraordinär anpassning till dessa prisökningar. Ett fortsatt fall i det reala oljepriset skulle naturligtvis påverka CO_2/BNP, SO_2/BNP och NO_x kvoterna i en icke önskvärd riktning och således ytterligare understryka behovet av en omfattande och sträng miljöpolitik för att uppnå Sveriges miljömål.