

Reducing CO₂ emissions by changing private consumption by differentiation of VAT and other taxes on consumption

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1. SYNOPSIS

The paper shows how a differentiation in VAT can change consumption which cause energy savings, and how the differentiation effects economy.

2. ABSTRACT

The Danish Kyoto target for 2008 – 12 is to reduce 21% of emissions of all greenhouse gases in relation to the emissions in 1990 (corrected for net of exports of electricity). The latest forecast shows there will be a deficit in 2008-12 on 3,4 mill. tons equivalent to 4,4% of the total emission of greenhouse gasses (lit.1).

In this connection it could be relevant to have a look at the structure of tax on commodities and services, and how changes in this structure could affect the emissions of CO₂.

The paper analyses how a value added tax (VAT) structure differentiated in relation to CO₂-emissions can change consumption, and how it would influence economy.

In principle the VAT should be differentiated in relation to the CO₂-emission of all goods and services. This paper only examine one simple case, where the VAT is differentiated in such a way that the VAT rate on services is set to zero and the VAT rate on goods and investments is increased to an extent where the public debt is unchanged.

The results show that the VAT differentiation in relation to a reference scenario in the long term will cause a permanent saving of energy and in the short term the VAT differentiation will cause a small economic upturn. The long term economic effects are more complex. One of the conclusions made is that we need to develop methods to evaluate the socio-economic costs and benefits in relation to environmental measures.

3. INTRODUCTION

The introduction of liberalisation of the electricity and energy market has as a consequence a radical change in the energy - and climate policy, and more general in the intention of realising a sustainable development, which influence the conditions of climate-policy.

Public regulation of the energy market should be replaced by an economically optimal trade. Including climate aims in the policy objective of creating competitive markets, it is necessary also to start with trade with CO₂-quotas - which doesn't seem to be realised in the near future. To promote reduction of CO₂-emissions according to national targets it could be interesting to analyse new economic means.

Governments in some countries try to change the general price-relations between use of natural resources as fossil fuel and of labour. The intention is both to protect the environment and to fight unemployment. The changed relations of prices are achieved through the introduction or increase of taxes on natural resources and reducing taxes on labour or income. The intended result is a substitution of natural resources with labour.

This way of thinking could be supported by a changed The VAT-structure. Goods and services could be value added taxed in relation to the amount of CO₂-emissions they cause. In that way the external cost would to some

extent be included in prices. In general services contain more employment than goods. A change in consumption demanding more services could increase employment.

To increase employment governments some times introduce a deficit in the budget stimulating the economic activity. So did the Danish Government in 1994 and so does the German Government at the moment. By this kind of “kick start” of the economy the strain of environment increase and so do emissions of CO₂. Also in relation to the governments use of economic measures to stimulate economy it is interesting to examine the consequences for economy and employment of a differentiation of VAT in relation to the impacts on environment and specific CO₂-emissions.

From an environmental point of view a tax on fuel seems to be an optimal way of taxation. However, realised in one single country the competitive position of that country would be weakened. Through a differentiation of taxation of goods and services, imported goods would be value added taxed in exactly the same way as goods produced in the country itself. There will be no direct change in competitiveness, although there can be indirect effects on the economy that can influence competitiveness. On the other hand a differentiation of VAT includes no stimulation for the producers to save energy or shift to more environmentally benign fuels.

A differentiation of VAT is no “universal solution”, but is an economic instrument which can be used as supplement to others.

Many tools are used to realise concrete targets for CO₂ reductions, including tools to influence the supply of energy. A CO₂-related differentiation of VAT should be seen in relation to other instruments to reduce CO₂. One could explain the specific role of a differentiated VAT by saying that the goods and services should be taxed in a way that the resulting prices reflect the need of society for more or less reduction given a certain national target for reduction of CO₂ emissions. If the need for reduction increases the differentiation could be more significant, and less if the need for reduction decreases. The marginal socio-economic costs of changing the differentiation of the VAT should be compared with the costs of obtaining the same reduction through other initiatives.

Normally we estimate and compare the socio-economic costs of rather simple initiatives to reduce CO₂, for example we estimate the consequences of building new wind power capacity as an alternative to building new fuel capacity. It can be difficult to measure the effect on the economy by more complex initiatives such as a differentiation of the VAT. However, in the future economic tools influencing the market are likely to become more important, and we need to develop adequate methods to analyse the economic and environmental effect of the measures.

4. THE PROBLEM IN BRIEF

The paper investigates how a differentiation of VAT can contribute to reduce CO₂-emission in a way that is expedient from a socio-economic perspective. In principle the VAT should have been differentiated in relation to the CO₂-emission of every good and service. For practical reasons this paper will be concentrated on a single example: a low, zero percent VAT on services and a higher percent VAT on goods and investments. The higher VAT is set to the level where the total revenue – in relation to a reference scenario - is unchanged. (Because of the way the model is functioning it is assumed that the public debt is unchanged after 20 years).

The estimations are made on the macroeconomic model, ADAM, used by the Danish Government to calculate the consequences of new economic measures.

The results of the estimations will include an overview which shows how the differentiation of VAT will influence

- Gross value added (reflecting more stringent than the GDP the value of the economic activities over a year)
- Public sector savings
- Employment
- Import
- Private consumption of goods
- Private consumption of services
- Total private consumption
- Consumption of public services
- Investments
- Export

The consequences of the differentiation of the VAT are compared to a reference scenario that means to a “business as usual,” which include the existing and decided climate measures.

The consequences of energy consumption are estimated using the “Input-output” tables (lit.2). These are too a part of the methodical basis for the Danish econometric ADAM-model. The technical coefficients in the I/O table

are given for one year. In the estimations in this paper the expected development in the coefficients is included in the “business as usual” scenario.

5. METHOD

The simulations begin in 1999 and the results are specified for every year in a period of 20 years. Because of the “conservative” construction of the model – for example the model includes only a limited numbers of policy options - the effects of the VAT differentiation fades out after 20 years and at that time the economy is in many ways similar to the “business as usual” scenario. The relations between degree of employment, increases in wages, inflation, and development of force of competition, included in the model, is at the moment under discussion among experts of economic theory.

The simulations of the consequences of the VAT differentiation is an “everything else is equal” simulation. In the real world the economic consequences would interfere with the economic policies of the government, and with the changes in the general economic trends in Denmark and outside. For example will increasing prizes on imported goods have less influence of Danish economy in the case of differentiation of VAT than in the reference scenario with a higher imports rate of goods. The evaluation of the long term effects should be taken with care, because we don’t know the future circumstances.

In principle the Gross value added is taxed through a VAT rate at 25%. Some economic activities are already exempt from VAT. The total Gross value added was in 1999 about 139 billion Euro. The total revenue from VAT was 15,5 billion Euro. This revenue can be related to consumption of goods, consumption of services, consumption of public services, investments and use of raw materials.

Before the differentiation of the VAT, the revenue of VAT, and the revenue one year after the differentiation, are shown in Table 1.

Table 1. Revenue of VAT before and one year after differentiation of VAT

	Reference		VAT-differentiation	
	Billion Euro	%	Billion Euro	%
Consumption of goods	7,3	46,6	9,2	58,6
Consumption of services	2,4	15,2	0,0	0,0
Investments	2,4	15,1	2,9	18,3
Public services	0,2	1,1	0,2	1,1
Use of raw materials	3,4	22,0	3,5	22,0
Total	15,6	100,0	15,7	100,0

In the analysis the VAT rate is reduced to 0 % on private consumption of housing, public transportation and other services as for examples repairs, hotels and restaurants, dentists and cleaning. For consumption of goods and for investments the VAT rate is increased to 31,7 %.

(Unfortunately it would be too complicated with respect to the ADAM model to change not only the VAT on consumption of goods and investments but also on public services and use of raw materials which therefore both are held constant. It is the expectation, that this will not change the major results).

The total revenue is a little higher after the VAT-differentiation than it was before because the differentiation increase the economic activities resulting in higher revenue. In the long run – after 20 years – the revenue is unchanged compared to the reference scenario.

The differentiation changes about 2,4 billion Euro from services to goods and investments. These 2,4 billion Euro correspond to:

- 15 % of the total VAT revenue
- 2,4% of the total public expenditure

- 1,4% of BNP

In Table 2 the amount of energy used to produce the final use of goods, services, and investments and the relation between energy and production in 1995 is shown.

Table 2. Amount of energy and the relation between energy and production in 1995

	PJ	TJ/Euro
Goods	403,8	0,20
Services	63,3	0,03
Investments	115,6	0,05

To evaluate the effects on the economy through the VAT differentiation, the amount of employment and the share of import that is included in the consumption of goods, services, and investments are shown in Table 3.

Table 3. The amount of employment and the share of imports in 1995

	Employment persons pr. mill. Euro	Share of imports included %
Goods	0,18	24,6
Services	0,22	8,7
Investments	0,22	29,4

Source: Input –Output tables and analyses 1998

6 . SHORT TERM EFFECTS

In the short term the demand for services increases more than the demand for goods decreases. The total private consumption increases because of the lower VAT on private consumption in average and because of the upturn mentioned below.

A higher demand for services containing a low share of imports results in a very small increase in imports. The declining demand for goods containing a high share of imports results in a declining imports.

Increased demand for services containing a high level of employment results in increasing employment. A declining demand for goods containing a low level of employment results in a small decline in employment. The increasing employment from services is higher than the declining employment from the goods.

Because of the multiplier the increasing employment results in an increase in general demand which in combination with the increasing demand for services results in an increase of investments, which contain a high level of employment and import.

In the short run GDP and employment increase and especially because of the increasing investments the imports increase too. The increase in the amount of income tax from the expanding economy and the saved expenditures on unemployment will benefit the public sector.

The small economic upturn resulting from differentiation of the VAT takes place over a period of approximately 5 years.

It could be interesting for that period to look at the economic effects including both a general economic upturn and a change in demand from goods containing a high level of energy to services containing a small amount of energy - in relation to the development of the total energy consumption.

After the third year, 2002, which is the culmination of the economic upturn, the picture – in relation to the reference-scenario - is the following (to evaluate the magnitude the quantities is set in relation to 1999):

- The demand for services has increased by 0,75 billion Euro., corresponding to 2,0% of the demand of services in 1999

- The demand for goods has decreased by 0,13 billion Euro, corresponding to 0,3 % of the demand of goods in 1999
- The total private consumption has increased by 0,62 billion Euro, corresponding to 0,8% of the private consumption in 1999.
- The Gross value added has increased by 0,8 billion Euro, corresponding to 0,6 % of the total Gross value added in 1999
- The investments have increased by 0,54 billions Euro, corresponding to 1,7% of investments in 1999.
- Employment has increased by 16.000 persons, corresponding to 0,6% of employment in 1999.
- The revenue to the public sector was 0,82 billion Euro, corresponding to 0,9 % of the expenditure of the public sector in 1999.

Using the forecasts of the relations between economic activity and energy use – the energy efficiencies – made by the Danish Energy Agency, Table 4 shows how the energy consumption has changed as a function of the changes in consumption, investments and export.

Table 4. Energy consumption as a function of the changes in consumption, investments and export after year 3, 2002

	Energy efficiency	Change in energy consumption	
	TJ/mio. Euro	Change in billion. Euro*	PJ
Goods	0,17	-0,13	-1,3
Private services	0,03	0,75	1,3
Investments	0,04	0,54	1,2
Public services	0,03	-0,0	-0,0
Exports	0,08	0,0	0,0
Change in energy consumption			1,2
Energy consumption 1999			645,7
Change in % of energy consumption 1999			0,2
Change in GVA, in relation to 1999, %			0,6

* In relation to reference scenario.

By the culmination of the economic upturn there will be a small increase in energy consumption although less than the increase in GVA. Although the consumption is increasing the energy consumption connected to the consumption of goods and services is unchanged. The growth in investments results in increased energy consumption.

7. LONG TERM EFFECTS

In relation to the reference scenario Table 5 shows the long term effects after 20 years, in 2018. The figures are in constant 1995- prices. (To evaluate the magnitude the quantities are set in relation to 1999).

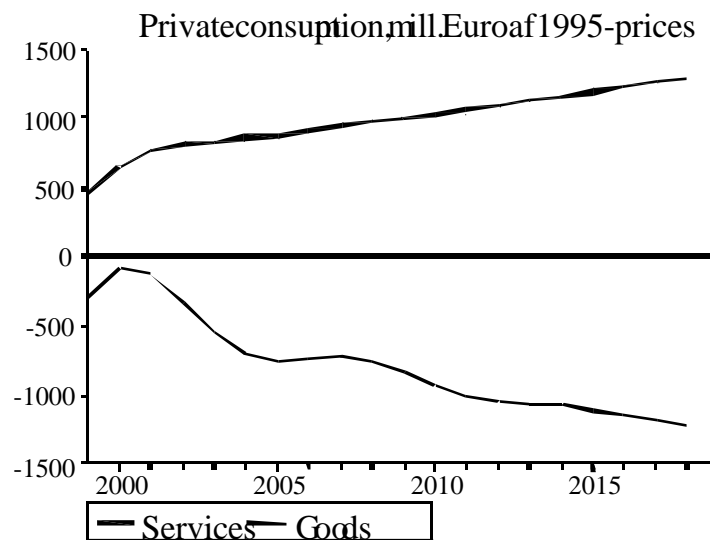
In the reference scenario it is expected that energy efficiency gradually will increase. This is included in the figures.

Table 5. Effects on key figures of economy and energy consumption in 2018 in relation to 1999

	2018	% of 1999	Change in Energy Consumption PJ
GVA	-0,11 billion Euro	-0,1	
Public sector surplus	-0,04 billion Euro	-0,1	
Employment	0 persons	0,0	
Imports	-0,31 billion Euro	-0,6	
Consumption of goods	-1,22 billion Euro	-3,1	-9,2
Consumption of service	1,29 billion Euro	3,7	1,9
Total private consumption	0,07 billion Euro	0,1	-7,3
Public consumption	-0,01 billion Euro	0,0	0,0
Investments	-0,28 billion Euro	-0,9	-0,5
Exports	-0,51 billion Euro	-0,9	-1,9
Total change in energy consumption		-1,5	-9,7

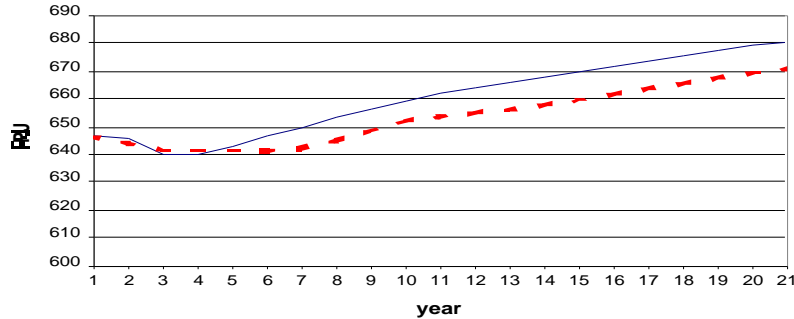
The reduction of energy consumption of 9,7 PJ corresponds to 1,5% of the total energy consumption in 1999 and correspond to 1,4% of the officially forecasted energy consumption in 2018.

The main contribution to the reduction in energy consumption comes from the reduced demand for goods. The consumption of services increases more than the consumption of goods decreases. The reduction in energy consumption mostly reflects the difference between energy use in goods and services.

Figure 1. The shift from goods to services

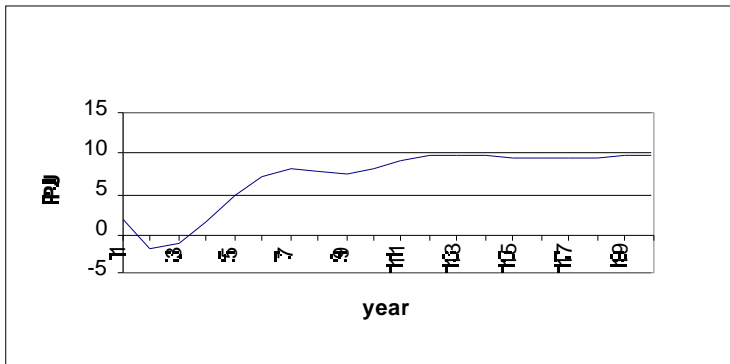
After the culmination of the upturn of the economy the effect of energy savings is permanent too. Figure 2 shows from year 0 (1998) to year 20 (2018) the annual change in energy consumption in relation to the forecast of energy consumption made by the Danish Energy Agency. (This forecast ends in 2012. For the period 2012 – 2018 the energy consumption is increased with the average annual relative growth from 1999 – 2012).

Figure 2. Energy Consumption in reference-scenario and reduced by differentiation of VAT



Explanation: The full curve correspond to the reference energy consumption and the stippled curve correspond to the resulting energy consumption from the differentiation of VAT. Be aware that the Y-axis is not starting at zero.

Figure 3. Energy savings caused of VAT-differentiation



In a period of two years when the economic upturn is culminating there is no savings. Then the savings in about 10 years are increasing, and after this they are relative stable. In 2018 the 9,7 PJ is saved.

The energy savings caused by the VAT differentiation is shown in Figure 3. Under the culmination of the small economic upturn the savings are negative. After that they are in about 10 years increasing in to a stable level about 10 PJ.

How a reduction in energy consumption will influence the emission of CO₂ depends on the fuel which is used to produce the energy. If the reduction of the in 2018 obtained 9,7 PJ replaces production of wind power the reduction of CO₂ will be 0.

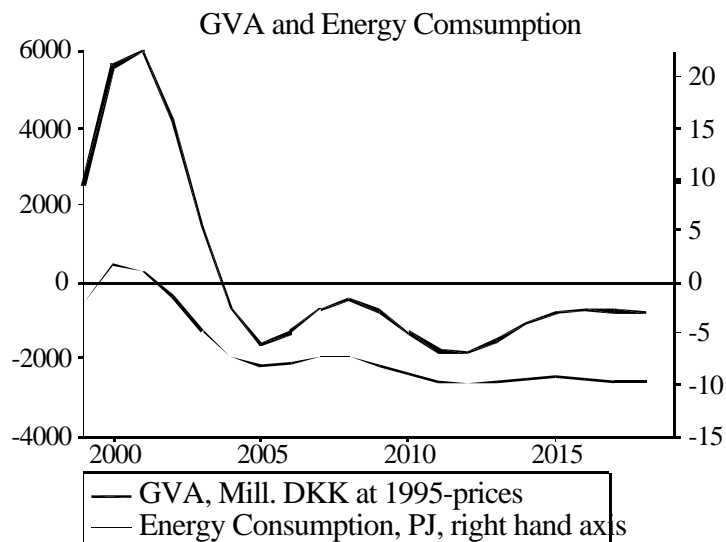
If the saved energy was electricity produced on coal with an energy efficiency of 41% the saving of 9,7 PJ displace 9,7 PJ : 0,41= 23,7 PJ coal. With a CO₂ emission on 95 tons pr. TJ the CO₂-reduction would be equal to 2,2 million tons.

The reduction of CO₂ emissions will as minimum be 0 tons and as maximum 2,2 million tons.

In the Danish electricity system electricity produced as renewable and CHP based on natural gas have a higher priority than electricity produced on coal. However, a more exactly description of the amount of CO₂ reduced will imply a special examination of the future energy system.

The relation between GVA and energy consumption is showed in Figure 4, where the left axis shows changes in GVA in million DKK and the right axis shows changes in energy consumption in PJ.

Figure 4. Development in GVA and Energy Consumption caused by the VAT-differentiation in relation to the reference-scenario



In the short run the differentiation of the VAT results in a small upturn. In the long run the effect on the economy is more complex. The ADAM model, is constructed in a way so higher employment results in higher wages, higher inflation and then subsequently in a reduction in competitive position. As a consequence exports decrease and so do employment and production. In the long term employment decrease to the level of the reference scenario.

In the ADAM model the exchange rate is constant which makes it impossible to counteract reductions in competitive position through a more flexible rate of exchange. Because Denmark is not a member of the Euro, Denmark potential has the possibilities to introduce a more flexible currency policy. Further more – for at least two reasons - is it not likely that Denmark will join the Euro. 1) Democracy is not acting very well in the EU. 2) The economic policy which have created and developed the Danish (or Nordic, Scandinavian) welfare model is inspired by Keynes and the intention of creating full employment, where the economic policy on which the Euro is based include the idea of the so called natural unemployment, where the consideration to inflation has a much higher priority than consideration to employment.

The VAT differentiation changes the structure of consumption. These changes say nothing about losses or gains in relation to welfare of the individual consumer. The consumer react on the changed price signals in relation to the price elasticity and to some extent the income elasticity.

The VAT differentiation can be seen as a first step to include considerations of environmental, social and ethical aspects in relation to general production and consumption in such a way that prices reflect what priorities society gives to environmental, social and ethical aspects.

8. CONCLUSIONS

- The analyses in this paper show that a differentiation of VAT results in a permanent change in consumption and a permanent reduction of energy consumption.
- In the short run the differentiation creates a small upturn in the economy with stagnation in energy consumption. This indicated that a political promoted upturn of the economy presumably could be realised more environment adequate than by a traditional stimulation of the economy by increasing public debt.
- In the long term the results of the model calculations show that the differentiation – with unchanged governmental policy – cause a small reduction in the growth of GVA (0,1% in relation to the reference scenario) and in the capital equipment, but unchanged employment and a little higher total consumption.
- If we shall achieve a sustainable development we need more fundamental changes in consumption. The change in consumption resulting from a differentiation of the VAT could be a step in that direction.
- With a reduction of energy consumption - in relation to the forecasted energy consumption - of 1,3% in 2010 the effects of the VAT differentiation contributes to reduce the deficit in meeting the Kyoto-targets on 4,4% for all greenhouse gases (there is no specification for the target to reduce CO₂-emission especially from the energy sector).
- The VAT differentiation analysed in this paper influences less than 1/6 of the VAT-revenue. A more fundamental change of the VAT and other indirect taxes could presumably create a bigger amount of energy savings and the integration of environmental and economic considerations could be made more suitable.
- In relation to further analyses of the impact of general economic tools - as for example the differentiation of VAT – we need to develop methods to evaluate the socio-economic cost and benefit. Not only in relation to a “business as usual” situation but also in relation to different strategies to achieve a sustainable development and as part of this to fulfil the target for reduction of CO₂ emissions.

9. REFERENCES

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