Denmark's Fulfillment of the EU Water Framework Directive - Sector and Macroeconomic Implication

Lars-Bo Jacobsen og Brian H. Jacobsen

Title suggestions:

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Abstract (350 words)

The Water Framework Directive was implemented in legislation in EU countries in 2003. The aim of the WFD is to achieve “good ecological status” for all water bodies by 2015 and no later than 2027. It is stated clearly in the WFD that all measures should be selected through cost effectiveness analysis. In many member states the cost effectiveness analysis has been based on financial aspects comparing annualized investment cost plus maintenance and operational costs for a catalogue of measures. The focus has in Denmark as other European Countries been on the direct costs for the different sectors with specific focus on the Agricultural sector. Rarely do these analyses include forward and backward linkages between sectors in the whole economy. Changed consumer prices of agricultural products, water supply and wastewater treatment will alter the outcome and the choices made by the utility maximizing consumer. Changed agricultural production will alter the input usage and the activity in processing industries, which again will alter the production, income and the welfare of the whole economy. In this paper the costs related to forward and backward linkages captured by the use of a Computable General Equilibrium model. The paper shows that were the direct costs included in the RBMP are 57 million € per year, whereas the sector economic costs calculated in the paper is 96 million € yearly. The higher costs come from lower productivity in the agricultural sector due to area taken out of production, which again increases agricultural output prices. The lower production decrease the number of people employed in the agricultural sector and they are then given jobs in the non-agricultural sector resulting in a limited loss in income. This analysis suggest that both the level of costs and the ranking of measures might be different had the economy wide analysis been used instead of the partiel cost effectiveness analysis. A key issue is the level of detailed used in both the direct and the sector economic analyses. A further implication is that cost calculations carried out in the European Union underestimates the actual costs of the WFD implementation.

1. Introduction

Denmark has since the 1980’ties tried to reduce the losses of nitrogen and phosphorus to the environment. The measures implemented contain a long list of measures in relation to the Nitrate Directive (Mikkelsen et al., 2010). The costs of these measures related to Action Plan II and III have been calculated both ex-ante and ex-post (Jacobsen, 2004). The cost analyses were direct costs and did not include sectorial costs.

The Water Framework Directive was implemented in legislation in EU countries in 2003 (Commission, 2000). The aim of the WFD is to achieve “good ecological status” for all water bodies by 2015 and no later than 2027. It is stated clearly in the WFD that all measures should be selected through cost effectiveness analysis and that the polluter’s pays principle applies.

In Denmark the total area has been divided into 23 catchment areas and the current status of each water body has been analyzed. Furthermore, it has been assessed what was needed to achieve “good ecological status” as required in the WFD (Ministry of Environment, 2011). In the Danish Implementation of the WFD the focus regarding improved quality for coastal areas has been Nitrogen, with respect to lakes the focus has been on reducing phosphorus losses and for the streams improved physical quality. More specifically the target with respect to Nitrogen for the first planning period has been a reduction of the losses of 19,000 tons N which was decided in the Green Growth Agreement (Government, 2009).

The selection of instruments has been done through cost-effectiveness analysis based on the "Catalogue of measures" (Danish Minestry of the Environment, 2010) compiled from research, field testing and previous project experience. This approach follows the recommendations made in Germany and United Kingdom (Jacobsen, 2009; Interwies, 2004 and RPA, 2004)

The cost assessment is conducted by integrated environmental models describing abatement costs divided between non-point pollution (agriculture) and urban wastewater. Schou et al., (2007) and Jensen et al., (2009) document the cost analyses of measures that reduce non-point agricultural pollution. The costs have been re-assessed based on their actual implementation in the RBMPs (Jacobsen, 2012a).

The selected measures in Denmark are divided into five broad categories; measures related to agriculture, measures related to the ground water resource, measures related to water courses and lakes, measures related to point source pollution and finally instruments related to aquaculture (Danish Nature Agency, 2012). Measures related to agriculture are mainly targeting leeching of nitrogen and phosphorus while the measures in the other categories targets leeching of pesticides, organic matters, environmental hazardous substances, the quantity of ground water and physical condition of lakes and water courses. Some of the latter measures will also affect nitrogen and phosphorus leeching. For each instrument the "Catalogue of measures" explicitly states the effect and associated yearly cost calculated as an annuity (Ministry of Environment, 2010).

The analyses made in Denmark follow the line described in WATECO guidelines prior to the WFD implementation. The focus is on financial or economic costs, but often wider economic cost calculations are left out of the analysis (Jacobsen, 2007).

Analyses of the cost of the WFD implementation in other European countries are mainly based on the same approach as used in Denmark. ……..

Based on this review it can be concluded that very few if any have estimated the wider sector costs of implementation WFD in their countries. The paper is therefore unique in trying to establish the sector economic costs related to the implementation of the WFD with focus on Denmark.

Whereas other research combines macroeconomic model with LITERATURE REVIEW

The paper start with a description of the costs as they are described in the River Basin Management Plans. The subsequent section gives a short description of the applied CGE model used for this analysis. The next section describes how the impacts of the measures are translated into shocks and scenarios which are used to model the consequences. The paper finished with the result of the analysis and a discussion of the wider implications.

2. Measures and costs in Danish RBMP

The Danish RBMPs build on measures that reduce the emissions from urban wastewater and non-point agricultural pollution. Urban wastewater pollution is reduced through investments in wastewater treatment plants, sanitation treatment and establishment of delay pools for rain water discharges. The measures aimed at reducing non-point agricultural pollution include catch crops, riparian zones along streams, establishment of wetlands and reduced cutting of water weeds in streams. Other measures include investments in reopening of culverted watercourses, removal of stream obstructions, and stream restoration.

The RBMPs provide a cost assessment of the reduction of 9,000 out of the 19,000 tonnes required to achieve the requirement in the WFD (Government, 2009) (Jacobsen, 2012). It is furthermore a problem that no specific measures have been included in 7 river basins as it was found that the data quality in these river basins should be improved before the required nutrient reductions could be calculated. These areas constitute 1/3 of the agricultural area and they are in the RBMP from 2011 referred to as V3 areas.

The overall target of the water plans is to achieve “good ecological status” for all water bodies. The current plans constitute phase one stating measures implemented toward 2015. Table 1 summarizes the measures selected, effects on leeching of phosphorous and nitrogen and the cost stated in the water plans.

Discussion of measures and emphasis that the stated cost will be transformed into modelshocks in a later section “Section: Formulation of scenario and calculations of shocks”

Instruments and unit	no. Unit	Tonnes nitrogen	Tonnes phosphorus	Annual cost mill. DKK
Aggriculture				
Landbrug: Ændring af normsystemet, ha	2534153			
Landbrug: Jordbearbejdning, ha, fordelt proportionalt	110000			
Plowing, hectare	15000	5250	126	135
Winter green fields, ha - Fra Brians regneark	50076			
Landbrug: Dyrkningsfrie randzoner, ha	49997			
Periodical flooding, ha	1464	0	29	5
Wetlands, hectare	10009	1131	0	62
Targeted winter green fields, ha fra Brian Excell	139637	1698	0	59
Ground water	0	0	0	
Movement of water source, mill. m3	7	0	0	
Watercourses and lakes				
Changed maintanace of watercourse, km	4160	0	0	15
Ændret vandløbsvedligeholdelse - påvirket areal, ha	30000	0	0	30
Removal of obstructions, no. Obstructions	1521	0	0	19
Restoration of watercourses, km	806	0	0	1
Genåbning af rørlagte vandløb - type 1, km	207	0	0	4
----- Hektar ekstra randzone, ved genåbning 8 m. på hver side	332	0	0	
----- Hektar der udtages til vandløb, ved genåbning - antaget 2m bred	41	0	0	
Restoration of lakes, lokaliteter	18	0	0	1
Point source pollution				
Improved wastewater treatment - no. Plants	35	19	3	9
Sparsely built-up areas, no. properties	3382	15	4	25
Stormwater outfalls reservoir, no. outflow	329	11	5	58
4.6 afskæring til renseanlæg, km	62	0	0	
Freshwater fish farms				
Recirculation	61	0	3	
Total		8125	170	422

2. The applied CGE model

The applied model is based on the generic CGE model by Horridge (2003) a descendant of the original ORANI model of the Australian Economy by Dixon et.al. (1982). Orani-G is very detailed described in Horidge (2003) therefor we will limit the description of the core model to a summary but provide details of the specific implementation for the Danish version. The specific Danish implementations covers details in regard to agriculture where we seek to include a range of agricultural products, specific treatment of inputs used to treat the land, and assumptions in regard to allocation of land among agricultural sectors.

The model is, in principle, a complete model of the Danish economy and consists of five types of agents, namely: industries; capital creators; households; governments and foreigners. The current database of the model identifies 144 industries producing 148 commodities. For each industry there is an associated capital creator. The capital creators each produce units of capital that are specific to the associated industry. There is a single representative household and a single government sector. Finally, there are foreigners, whose behaviour is summarised by export demand functions for Danish products, and by supply functions for imports to Denmark.

The model determines supplies and demands of commodities through the optimising behaviour of agents in competitive markets. Optimising behaviour also determines industries' demands for labour and capital. The assumption of competitive markets implies equality between the producer price and the marginal cost in each industry. Demand is assumed to equal supply in all commodity markets. The government intervenes in markets by imposing sales taxes on commodities. This places wedges between the prices paid by purchasers and prices received by the producers. The model recognises margin commodities (e.g. retail and wholesale trade) that are required for each market transaction. The costs of the margins are included in purchasers' prices.

The model recognises two broad categories of inputs: intermediate inputs and primary factors. Firms in each industry are assumed to choose the mix of inputs, which minimises the costs of production for their level of output. They are constrained in their choice of inputs by nested production technologies (see Figure 1).

For the land-using industries AAGE specifies nested substitutions between:

Capital, labour and herbicides (CLH);

Land, fertiliser and insecticides (LFI);

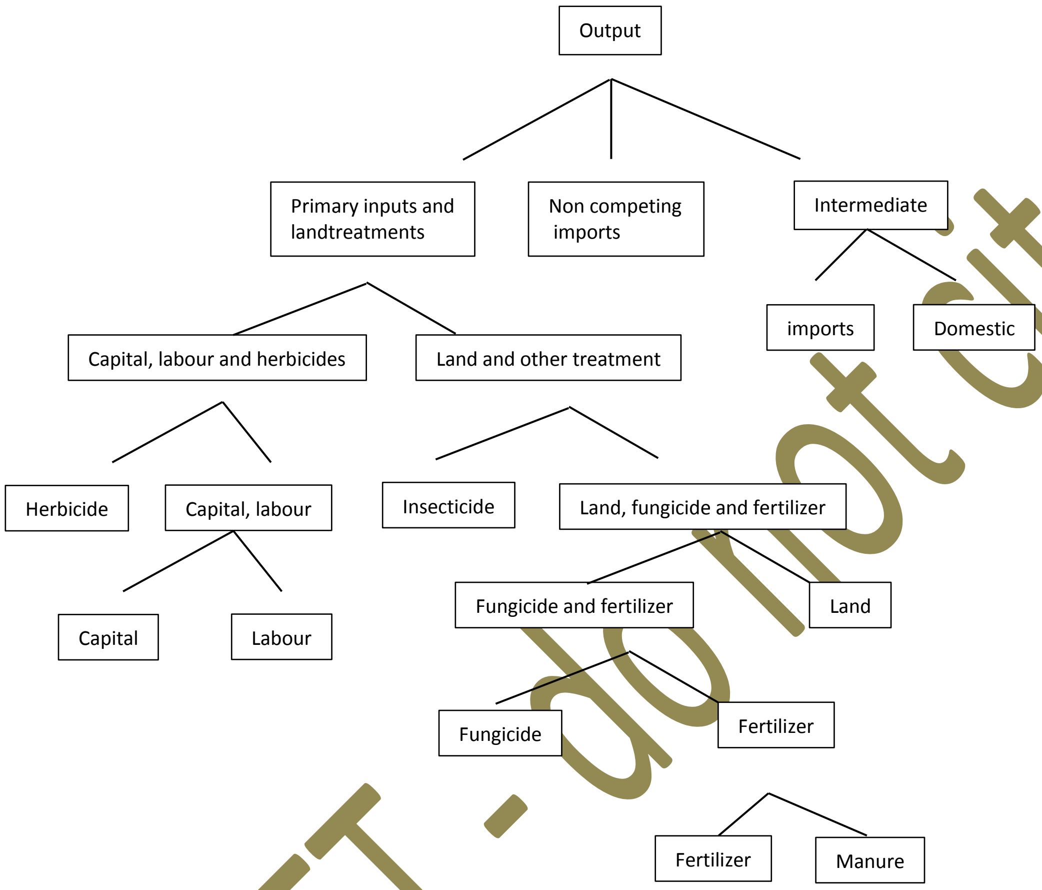
CLH and LFI (CLEHLFI); and

CLEHLFI and an aggregate of remaining intermediate inputs

For non-land using industries substitution is allowed between capital, labour and energy (CLE) and between CLE and aggregate non-energy intermediate inputs.

ADD SOME TEXT ON FUNCTIONAL FORMS

Figure 1. Nesting structure in the AAGE CGE model



Household demand

The representative household buys bundles of goods to maximise a utility function subject to a household expenditure constraint. Bundles are combinations of imported and domestic goods. ADD SOME MORE TEXT FOR THE EXPENDITURE SYSTEM

Demand for inputs to capital creation and the determination of investment

Capital creators for each industry combine inputs to form units of capital. In choosing these inputs they minimise costs, subject to technologies similar to that used for current production; the only difference being that they do not use primary factors. The use of primary factors in capital creation is recognised through inputs of the construction commodity.

Government demand for commodities

The government demands commodities. In AAGE, there are several ways of handling these demands, including: (i) endogenously, by a rule such as moving government expenditures with household consumption expenditure or with domestic absorption; (ii) endogenously, as an instrument which varies to accommodate an exogenously determined target such as a required level of government deficit; and (iii) exogenously. WHAT DO WE CHOOSE IN THIS PAPER

Foreign demand (international exports)

Two categories of exports are defined: traditional, which are the main exported commodities; and non-traditional. Traditional export commodities face individual downward-sloping foreign demand curves. The commodity composition of aggregate non-traditional exports is treated as a Leontief aggregate. Total demand is related to the average price via a single downward-sloping foreign demand curve.

Demand for foreign imports

For all industries, AAGE includes the standard Armington specification for imported and domestically produced inputs. This assumes that users of a given commodity regard the domestic and the imported varieties of this commodity as imperfect substitutes. The Armington assumption is also used in input demands for industry investment and in household demands for consumption.

Closing the model

Description of the short and long run closure

The Flows database

Description of the IO tabe and disaggregation of agriculture

The model is a system of non-linear equations. It is solved using GEMPACK, a suite of programs for implementing and solving economic models. A linear, differential version of the model equation system is specified in syntax similar to ordinary algebra. GEMPACK then solves the system of non-linear equations as an Initial Value problem, using a standard method, such as Euler or midpoint. For details of the algorithms available in GEMPACK, see Harrison and Pearson (1996).

4. Formulation of scenario and calculations of shocks

The formulation of a scenario departs from the measures selected in the water plans. Contrary to the water plans we formulate the scenarios such that results are given in the short and long run. This distinction is especially relevant for nonagricultural measures since these comprise both an investment phase and an operational phase. We assume that all investments are implemented over a five year period with equally annual investments.

Improved wastewater treatment and storm water outfall reservoir etc. demands short run investments in the sewage sector. The short run investments will build up the long run capital stock and associated increase in maintenance and operational cost. Using the information in the water plans and “Catalogue of Measures” it is possible to calculate the necessary investment in the sewage sector, assuming a 5 years implementation period leads to a 9.77 percent increase in investment in the implementation period compared to the base year investment. We assume that the total investment leads to an equivalent increase in the capital stock, resulting in a 1.49 per cent increase in the long run capital stock. The effect of increased maintenance and operational cost is captured through a 0.13 per cent decrease in the long run total factor productivity.

This means that in the short run simulation we apply a shock to investment in the sewage sector. That is, a demand side shock to the economy expected to increase economic activity. In our long run simulation we apply a positive shock to the capital stock and a negative shock to the total factor productivity, in effect a supply side shock. Normally increased capital input would also increase production, but in this case we let the model ensure that effective capital input is unchanged by adjusting the productivity of capital. We do this because the investments in the sewage sector merely increase the quality and hence lower the environmental impact. This means that both the increased capital stock and lower TFP will increase unit cost in in the sewage sector and lead to higher price of sewage services, expected to lower long run welfare in economic terms.

Construction of wetlands and measures targeting watercourses and lakes are performed and decided within the general public service sector. Model shocks are calculated in the same way as for the sewage sector and can also be divided into short run investments and long run changes in the capital stock and productivity. Contrary to the Sewage sector productivity changes are positive due to savings from reduced maintenance of watercourses.

[Write a similar section on dwellings]

TABLE calculated modelshocks

	Short run investment		Long run capital stock	Long run TFP
Sewage, pct.	9.77		1.49	-0.13
General public service,	14.9		1.47	0.65

pct.				
Dwelling, pct.	0.65		0.01	-0,00
Aggregate investment, pct.	0.20			
	Short run agricultural effects		Long run agricultural effects	
TFP, pct.	-1,4		-1.4	
Land pct.	-0.7		-3.6	
Land premium, mill DKK	182.9		182.9	

Maybe values in € would be more informative then percentage changes

The measures related to the agricultural sector will affect agricultural production in several ways. Changed agricultural practice will reduce yields and/or increase cost, furthermore buffer zones, construction of wetlands and periodical flooding will in effect reduce land available for production.

Reduced yield and/or increased cost have been transformed into economic loss per hectare for each measure. In total the water plans calculates the total loss from these measures to 135 mill. DKK or 1.4 percent of the total production value in land using sectors. We implement this in the scenario as an 1.4 percent average loss in total factor productivity in land using sectors.

Total reduction in land can be calculated by adding up the effect from buffer zones, wetlands, periodical flooding, and opening of water streams. In total nearly 92.000 hectares of land will not be used for active production, this amount to 3.6 percent of agricultural land in Denmark. The effect is implemented by removing 3,6 percent of available agricultural land.

Farmers receives compensation for the loss from introduction of buffer zones, this is implemented by increasing the subsidies to land.

We assume that land is taken out of production over a five year period. This mean that in the short run simulation available land I reduced by 0.7 per cen. For the other agricultural measure are the same in both the short and long run. All agricultural measures affect the supply-side economy by reducing land and productivity and are therefore expected to lead to welfare cost.

[Write a closing paragraph]

5. Macroeconomic and sector economic consequence

[Discussion of the short and long run macroeconomic consequences]

The calculated costs in the water plans are budgetary cost, where prices are those relevant for producers and investors. Following national guidelines these numbers can be transformed into welfare cost by multiplying the cost with 1.35 (net price factor index???), yielding total welfare cost of 77 mill. €. See the social welfare costs calculated in Jensen et al. (2013).

The macroeconomic consequences from the long run simulation are given in the table below. Using gross national expenditure (GNE) as welfare indicator, we find that the total cost of implementing the water plans is 96 mill €, that is almost double as high.

TABLE long run macroeconomic consequences of first phase WFD

			---------------------------------- Contribution from					
	Base year mill €	Total effect	Reduced land	Agricultural productivity	Land premium	Sewage	General public service	Dwelling
Consumption	100585	-74	-30	-35	6	-7	-2	-1
Investment	34971	-23	-14	-13	0	3	1	1
Government	54173	0	0	0	0	0	0	0
Stocks	1386	0	0	0	0	0	0	0
Exports	83542	-37	-4	-25	-4	-1	0	0
Imports	56921	55	28	22	-1	1	0	0
GDP	217737	-78	-22	-52	1	-4	-1	-1
GNE	191116	-96	-45	-48	6	-4	-1	-1

Sectoral consequences

Discussion of the short and long run sectoral effects. Focus on the effects in those industries effected but not included in the waterplan calculations – That is the reason we find much higher cost.

TABLE change in production, prices and export

Some results could be decomposed into contribution from different shocks

6. Conclusion/Discussion

In this paper we compared two different cost estimate of the first phase of the Danish obligation towards the EU Water Framework Directive.

Comparing the cost estimate from the general equilibrium model with those stated in the water plans indicates that the cost of Long run cost much higher when calculated by economy wide modeling. This is due to especially effects on animal production and processing of meat and dairy products.

Could very well mean that the cost estimates collected by the European Comission underestimates the cost to the European Union of full compliance of WFD in all memberstates.

Unilateral Danish policy.

Mulig litteratur

Ecological Economics: Orani model for Sydafrika med fokus på etablering af marked for vandressourcer

http://ac.els-cdn.com/S092180090700540X/1-s2.0-S092180090700540X-main.pdf?_tid=62319130-a120-11e2-8c37-00000aab0f6b&acdnat=1365517303_000c49ac3ff038c243af502408363bb6

Ecological Economics: Hollandsk generel ligevægts studie af tiltag til forbedring af vankvaliteten i vandoplande, relaterer sig til WFD

http://ac.els-cdn.com/S0921800907005393/1-s2.0-S0921800907005393-main.pdf?_tid=9f6c8bb0-a11e-11e2-a5c0-00000aab0f01&acdnat=1365516547_fa7bbfa10cd7f48c0a58d872e11f0570

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