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The NAMEA as validation instrument for environmental macroeconomics

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This paper shows how environmental issues can be incorporated into macroeconomic accounting and analysis by the construction and use of a National Accounting Matrix including Environmental Accounts (NAMEA). The paper firstly elaborates on a number of conceptual issues on the harmonisation of environmental statistics and the national accounts. Specific attention is given to the consistent allocation of pollution to production and consumption activities and the importance of aggregated environmental indicators. Further, various applications are presented which vary from simple comparisons of macroeconomic performance indicators for economy and environment to more comprehensive modelling exercises. The paper does not only review recent experiences in the Netherlands but also those from other countries.

1. Introduction of NAMEA

The System of National Accounts (SNA) [21] consists of a coherent and integrated set of macroeconomic accounts and balance sheets based on internationally agreed accounting rules. One the one hand, the system is designed for purposes of detailed economic analysis, policy development and decision making. On the other hand, the national accounts provide key aggregate indicators which can be used to inform the public. These indicators refer to economic activity, i.e., gross domestic product (GDP), national income, consumption, as well as to economic status, i.e., the financial and non-financial resources at the disposal of different sectors or the total national economy. This total resource availability at particular moments in time is summarised as net worth in the balance sheets of the national accounts.

Macroeconomic theory is to a large extent formulated in terms of these key macroeconomic aggregates. Usually the national accounts deliver empirical evidence for the verification of macroeconomic theory. At the same time, the national accounts are applied for the calibration of parameters in so called general equilibrium models. In this process the validity of models is improved by creating consistency with historic outcomes as represented in the national accounts. Obviously the Dutch Central Planning Office is one of the heavy users of national accounts in the Netherlands.

In general, the value of goods and services in the SNA is based on actual market payments and receipts. This valuation approach represents the revealed preferences on markets and the preferences for public goods as the outcome of (democratic) decision-making processes. Therefore, the standard national accounts and their key aggregate indicators do not review all aspects of welfare. For example, in the national accounts the costs of production are restricted to the sum of all factor payments for labour and capital and exclude the production factor nature for which usually no factual payments are made. Similarly, in the national accounts the virtues of unpaid household labour and leisure are not expressed in terms of money. So the market valuation principle guarantees the comprehensibility and transparency of the national accounts but restricts at the same its scope.

The 1993 SNA recommends the construction of so-called satellite accounts to expand the scope and the analytical capacity of the national accounts to specific areas of social concern. Typically, satellite accounts allow for additional information such as the linkage of physical data and the use of alternative concepts (see [21, chapter XXI]). Since 1994, the annual national accounts publication in the Netherlands (e.g., [4]) have been extended with a National Accounting Matrix including Environmental Accounts (NAMEA) and from 1995 onward together with a Social Accounting Matrix (SAM, see also [21, chapter XX]).

The NAMEA extends the national accounts with a system of environmental accounts and indicators and could be regarded as a satellite accounts system. The SAM contains sub-classifications for the household sector (types of households) and wages and salaries (types of employees) and provides as such an integrated system of labour accounts, economic accounts and income distribution accounts. Since the NAMEA and SAM are built on one similar framework, the so-called National Accounting Matrix, both systems are directly compatible. In this way one integrated information system is created that facilitates comparability and consistency between social, economic and environmental statistics and subsequently integrated analysis of these data [14].

The first "pilot" NAMEA for the Netherlands was compiled in 1993 [7]. This pilot greatly benefited from the work done on environmental indicators at the Ministry of the Environment [1]. Subsequently, the Dutch National Accounts Advisory Committee, a sub-committee of the Central Statistical Committee that decides upon the CBS work programme, advised a regular compilation of this framework. At present, a consistent time-series of NAMEAs for

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the Netherlands is available for the years 1986–1992 and another one for the years 1993–1997.[1] These NAMEAs cover the depletion of crude oil and natural gas as well six types of environmental degradation – the greenhouse effect, ozone layer depletion, acidification, eutrophication, waste and wastewater. On the highest level of aggregation each of these problems is monitored with the help of a single summary indicator. All problems concerned have also been identified in the National Environment Policy Plans [18,19].

In 1994, the Commission of the European Communities (EC) released an official communication to the Council of Ministers and the European Parliament [5] in which the Commission proposed to establish in two years time a European System of Integrated Economic and Environmental Indices which resembles the Dutch NAMEA system. The last two years, the statistical office of the EC (Eurostat) has co-ordinated a work program which has resulted in the availability of NAMEA-type of accounts in most EC member states. The comparability of applied methods and data sources is currently being investigated. This year results will be published by Eurostat and will include the national experiences and present the possibilities of compiling comparable NAMEAs throughout the EC.

The next section provides an overview of adjustments in environmental statistics that are required for its consistency with the national accounts. In a number of examples, the third section shows how the NAMEA can generate empirical evidence for verifying theories on how the economy interacts with the environment. One major point of concern in this respect is the possible disconnection of economic growth from increasing environmental pressures. The last section reviews some recent developments in environmental accounting.

2. Consequences of national accounts principles for environmental accounting

Since the national accounts have served as an analytical framework tailored to the needs of macroeconomic modelling, environmental accounts based on national accounts principles facilitate the incorporation of environmental variables into (existing) macro-economic models. In order to be consistent with national accounts rules, similar concepts and classifications have to be introduced into environmental statistics. This section discusses the consequences of national accounts principles for environmental accounting as presented in the NAMEA framework (see table 1).

In the NAMEA a strict borderline is maintained between economy and environment. The economic system is accounted for in terms of money while the environmental accounts are denominated in different types of units, i.e., kilograms, cubic meters or joules but not in terms of money. The environmental accounts show, for example, the material withdrawals from the environment into the economic system and subsequently, the disposal of unwanted residuals back into the environment. These flows are not considered as economic transactions and for that matter not represented in the standard national accounts.

So from an environmental perspective, the NAMEA table exposes the system's boundaries of the core national accounts. At the same time, the physical accounts clearly expand these boundaries. The National Accounts Matrix (NAM) helps to trace down the points of connection of environmental information to the system of national accounts, or so to speak, the environmental "hot spots" in the national accounts.

The NAMEA distinguishes two main groups of activities, households (see table 1, account 2) and industries (account 3) including public services.[2,3] The NAMEA systematically connects physical in- and outputs to those economic activities that are directly responsible. For example, emissions to air from waste incineration plants are connected to environmental services industries and are not allocated to all those activities responsible for the generation of waste. The reduction of waste that results from waste incineration is equally accounted for by the environmental services industries. This registration method seems to be most appropriate for analytical purposes.

Emission totals in regular emission statistics are usually bounded from a geographical perspective. The Dutch Emission Register [20] records the emissions from all sources on Dutch territory. The economic actors in the national accounts include all households, corporations and government units that have their centre of economic interest in the economic territory of a country (this includes besides domestic territory also airspace, territorial waters, etc.). All land and buildings are by definition owned by resident entities.

Emission data from the Dutch Emission Register are largely consistent with national accounts with the exception of international transport. The transport of goods and people from one country to another (as an economic activity) is recorded in the national accounts of the country of the resident unit carrying out the transport service. The same holds for the total energy consumption of these transport services. Therefore, mobile pollution sources related to international transport carried out by planes, ships, and cars belonging to the national economy may result in pollution outside the domestic or economic territory.

The following example shows that these differences in definition may result in divergent estimates. CO_2 emissions are usually estimated according to the IPCC [13] guidelines which supports the UN Framework Convention on Climate Change approved upon in Rio de Janeiro in 1992. The IPCC guidelines focus on the national responsibility for the global CO_2 problem. According to IPCC guidelines, the following transportation activities are included in the national CO_2 burden:

[1] See: [2] and [4, tables X7 and X8]. CBS [2] also provide a methodological description.

[2] Pollution from governments is attached to government production.

[3] Table 1 is an aggregated presentation. Each account can be further broken down according to classifications indicated between brackets. The production account is classified by branches of industry (SBI-93).

– *aviation*, all domestic landing and take off and domestic traffic regardless the nationality of airline companies;
– *shipping*, all ships (all nationalities) sailing between one national port and another national port;
– *road transport*, all motor fuel sold in one country.

At this moment, the integration of energy accounts and the national accounts is being investigated at Statistics Netherlands. In comparison to IPCC directions, preliminary results based on national accounts definitions indicate at a 3% higher estimate of total CO_2 emission (182 versus 177 billion kg) in 1995. In the case of Denmark rough estimates for 1990 showed that CO_2 emissions related to civil aviation according to national accounts rules were approximately 1.8 billion kg instead of 0.07 billion kg estimated according to IPCC regulations [12]. The IPCC reporting instructions include also emissions from international traffic, but these emissions are not allocated to any country estimates. Theoretically, national income estimates of approximately all 170 countries consistently sum up to "global income". One may conclude that national accounting principles are useful in systematically allocating the global wide human induced emission of CO_2 and other pollutants to individual countries.

It is quite obvious that different emission estimates may be applied for different types of uses. Sometimes emissions will be adjusted for incidental changes such as differences in the average annual temperatures. In other cases, emission figures estimated according to a geographical criterion will be used besides figures estimated according to the residence criterion. A simple way to avoid misunderstandings is to publish these figures together with straightforward bridge tables with clearly explain these differences. Such tables are equally regularly published in the Dutch national accounts to explain differences in various income measures such as gross domestic product, net national income and net national disposable income.

The NAMEA contains two types of physical accounts. The substances account (11) explains the relationship between the amount of environmental stress attached to current economic transactions and the amount of environmental stress that potentially threatens all properties of resident entities including economic assets, health and the national ecological heritage. Differences between the two are made up by:

1. Other pollution not attributed to current transactions (+).
2. Cross border pollution from the rest of the world (r.o.w.) (+)
   – pollution from foreign transport,
   – transportation of pollution by environmental media (surface water, air).
3. Absorption by producers (−), clean up actions such as waste incineration and recycling.
4. Cross border pollution to the r.o.w. (−)
   – pollution of Dutch transport in other countries,
   – transportation of pollution by environmental media (surface water, air).

In the environmental themes account (12), substances are grouped and aggregated in accordance to their type of environmental stress and subsequently represented in a limited number of aggregated theme indicators. Most themes correspond to national or local environmental problems and the corresponding indicators reflect the net accumulation of pollutants within the country's borders. For global environmental themes, i.e., greenhouse effect and ozone layer depletion, the indicators only review the weighted pollution generated by economic agents that belong to the national economy, representing the national contribution to these global problems. Consequently, for some of the environmental themes it is relevant and possible to determine the total amount of pressure that is put on the national environment in a single accounting period. However, the accounts do not show the actual damages that may result (now or later) from these pressures.

3. Environmental impact assessment of the national economy

At the highest level, the NAMEA contains besides all conventional economic aggregates, a set of summary environmental indicators. For each economic activity the system enables a comparison between the contribution to conventional policy goals (GDP, exports, employment, etc.) and their contribution to major environmental problems fields (greenhouse effect, ozone layer depletion, acidification, etc.).

A straightforward NAMEA application is the comparison of direct contributions to economic and environmental performance indicators, sometimes referred to as industrial profiles. In most industrial countries these profiles show rather similar patterns. Agriculture and manufacturing show relatively high shares in environmental themes in comparison to their contribution to employment and value added. The reverse pattern shows up in the services industries, which in the Netherlands contributes for more then 60% to total employment and value added. In a more detailed comparison based on the NAMEAs of Germany, Japan, the Netherlands, Sweden and the United Kingdom, De Haan [10] revealed a number of unclear differences which may in fact reflect statistical discrepancies of the accounts. A further harmonisation of statistical methods applied in the NAMEA may turn out to be very useful for the international comparison and benchmarking of similar industries in different countries.

The profiles show that total pollution is not only determined by the size of a country's economy but also by its economic structure. An economy dominated by agriculture or manufacturing industries will often have relatively substantial natural resources requirements and subsequently a

Table 1
An aggregated NAMEA (account 1–10 in million guilders), 1995.

ACCOUNT (classification)		Goods and services (product-groups)		Consumption of households (purposes)		Production (industry)	Generation of income (value added categories)	Distribution of income and consumption (sectors)	Capital	Taxes (types)		Rest of the world, current
				Envir. ment	Other purposes					Environ-mental taxes	Other taxes	
		1a	1b	2a	2b	3	4	5	6	8a	8b	9
Goods and services (product groups)		Trade and transport margins		Consumption of households		Intermediate consumption		Consumption of government	Gross capital formation			Exports (fob)
Environmental cleansing services	1a			360		6640		1550				
Other goods and services	1b	–	–	590	381250	558130		90250	121400			339570
Consumption of households (purposes)								Consumption of households				
Environment	2a							950				
Other purposes	2b							381250				
Production (industry)	3	Output at basic prices										
		8090	1130940									
Generation of income (value added categories)	4					Net value added at factor costs					VAT not handed over to the government	Compensation of employees from r.o.w.
						494640					1570	1070
Distribution of income and consumption (sectors)	5						Net national generated income at factor costs	Property income and current transfers		Taxes less subsidies		Property income and and current transfers from r.o.w.
							495960	706300		6600	146370	59170
Capital	6					Consumption of fixed capital		Net national savings				
						73610		84680				
Financial balance	7								Net lending (+) or net borrowing (-)			
									32760			
Taxes (types)		Taxes less subsidies on products				Other taxes less subsidies on production		Current taxes on income and wealth	VAT on land and levies on fixed capital goods			Current taxes on income and wealth to r.o.w.
Environmental taxes	8a	–	1340			1410		3850				
Other taxes	8b	460	62060			4600		78480	1530			1040
Rest of the world, current	9	Imports (cif)					Compen-sation of employees to r.o.w.	Property income and current transfers to r.o.w.		Current taxes on income and wealth to r.o.w.		
			296850				1320	67090			230	
Rest of the world, capital	10								Capital transfers to r.o.w.			
									4220			
Substances						Absorption by producers						Cross border pollution to r.o.w.
CO_2	11a											
N_2O	11b											
CH_4	11c											
CFC's and halons	11d											
NO_X	11e											442
SO_2	11f											136
NH_3	11g											34
P	11h					14						25
N	11i					84						653
Waste	11j					3100						.
Waste water	11k					.						.
Natural gas	11l					2480						
Crude oil	11m					119						
Environmental themes									Environmental indicators			
Greenhouse effect (CO_2-equivalents)	12a								227760			
Ozonelayer depletion (CFK11-equivalen	12b								1250			
Acidification (AEQ)	12c								145			
Eutrophication (EEQ)	12d								243			
Waste (kg)	12e								12540			
Waste water (i.e.)	12f								.			
Changes of natural resources												
Fossil fuels (p.j.)	12g								-1624			
TOTAL		Supply at purchasers' prices		Consumption of households		Input at basic prices	Destination of generated income	Current expenditures	Capital expenditures	Tax receipts (less subsidies)		Current receipts from the rest of the world
		8550	1491190	950	381250	1139030	497280	1414400	159910	6600	148170	400850

Table 1
(Continued.)

	Rest of the world, capital	Substances[a]													Environmental themes							Changes of natural resources	TOTAL
		CO_2	N_2O	CH_4	CFC's and halons	NO_X	SO_2	NH_3	P	N	Waste	Waste water	Gas	Oil	Accumulation of substances to the environment	Greenhouse effect	Ozone-layer depletion	Acidification	Eutrophication	Waste	Waste water	Fossil fuels	
	10	11a	11b	11c	11d	11e	11f	11g	11h	11i	11j	11k	11l	11m	12	12a	12b	12c	12d	12e	12f	12g	
																							Use at purchasers' prices
																							8550
																							1491190
Emission of pollutants by consumers		36370	4	22	81	125	4	7	10	50	5180	.											Consumption of households
																							950
																							381250
Emission of pollutants by producers		140240	60	671	1057	373	142	145	147	1292	10460	.											Output at basic prices 1139030
																							Origin of generated income 497280
																							Current receipts 1414400
Other domestic emission of pollutants and changes of natural resources	Capital ransfers from r.o.w. 1620	320	.	479	32				.	.		.	1080	-105									Capital receipts 159910
	Net lending from the rest of the world -32760																						–
																							Tax payments (less subsidies)
																							6600
																							148170
Cross border pollution from r.o.w.	Surplus of the nation on current transactions 35360					79	100	21	21	434	.	.											Current payments to the rest of the world 400850
																							Capital payments to the rest of the world 4220
Contribution of pollutants to environmental themes																							Destination of substances
															176930	176930							176930
															64	19730							64
															1172	24620							1172
															1170	6480	1250						1170
															135			29					577
															110			34					246
															139			82					173
															139				139				178
															1039				104				1776
															12540					12540			15640
															.						.		.
															-1400							-1400	1080
															-224							-224	-105
																							Theme-equivalents
																							227760
																							1250
																							145
																							243
																							12540
																							.
																							-1624
Origin of substances / Theme-equivalents	Capital receipts from the rest of the world 4220	176930	64	1172	1170	577	246	173	178	1776	15640	.	1080	-105		227760	1250	145	243	12540	.	-1624	

[a] CFCs and halons in 1000 kg, waste water in 1000 inhabitant-equivalents (1000 i.e.), gas en oil in petajoules (p.j.). Other substances in mln kg. Source: [4].

high output of unwanted residuals. Within these countries, a stringent environmental policy may result in reducing the outputs of these industries. When the resulting environmental burdens are occurring within the country's borders, this might be a rational policy choice. On the other hand, if these industries are forced to close down, they may continue their production and pollution in countries with less strict legislation. Therefore, it is relevant to compare the eco-efficiency of industry branches among countries, especially concerning continental or global environmental threats. The availability of NAMEAs is particularly useful in this regard. Consequently looking at the situation of one particular country, the policy relevance of a cross section comparison of industries should not be exaggerated. For example, production of electricity in the Netherlands contributes for only 1% to employment and 25% to the total emission of CO_2. However, unemployment would certainly rise with more then 1% without the availability of electricity. On the other hand, intertemporal presentations of industrial profiles [3, table 6.5] display the eco-efficiency developments in different industries. This information seems highly relevant in analysing macroeconomic policy scenarios related to sustainable economic development.

The calculation of cumulative environmental pressures as presented in table 2 takes into account the interdependencies between industries. With the help of input–output analysis, pollution from all producers is systematically allocated to final production, i.e., consumption, investment and export.

Table 2

Cumulative pollution per unit of final demand relative to the aggregate cumulative pollution per unit of final demand (1994).

	Labour volume	Greenhouse effect	Ozone layer depletion	Acidification	Eutrophication	Solid waste
	ratios					
Production						
Agriculture and forestry	1.77	2.92	1.00	8.32	14.23	1.69
Fishing	0.05	0.03	0.05	0.05	0.01	0.13
Mining and quarrying excluding crude petroleum and natural gas	0.02	0.03	0.01	0.02	0.00	0.11
Crude petroleum and natural gas	0.05	0.54	0.04	0.10	0.02	0.03
Manufacturing						
Food products, beverages and tobacco	1.09	4.70	4.09	8.83	14.97	6.62
Textile and leather products	0.31	0.26	0.39	0.12	0.21	0.33
Paper and paper products	0.17	0.31	0.06	0.11	0.20	0.78
Publishing and printing	0.62	0.11	0.09	0.06	0.04	0.18
Petroleum products	0.07	2.23	0.10	3.03	0.11	0.17
Chemical products	0.56	5.99	5.17	2.43	0.83	4.69
Rubber and plastic products	0.23	0.23	0.86	0.10	0.04	0.25
Basic metals	0.19	1.32	0.14	0.78	0.09	0.45
Fabricated metal products	0.63	0.27	0.15	0.15	0.07	0.25
Machinery n.e.c.	0.56	0.35	0.29	0.21	0.12	0.43
Electrical equipment	0.68	0.38	0.86	0.20	0.12	0.35
Transport equipment	0.37	0.34	0.35	0.19	0.12	0.39
Wood and wood products	0.13	0.04	0.02	0.02	0.01	0.11
Construction materials	0.24	0.29	0.05	0.26	0.04	0.31
Other manufacturing	0.29	0.28	3.04	0.10	0.06	0.43
Electricity, gas and water supply						
Electricity supply	0.25	4.84	0.08	1.45	0.16	0.29
Gas and water supply	0.06	0.09	0.02	0.03	0.01	0.12
Construction	2.83	1.87	8.68	1.41	0.36	8.31
Trade and repair of motor vehicles	0.85	0.13	0.09	0.08	0.05	0.10
Wholesale trade exluding motor vehicles	2.63	0.28	0.12	0.13	0.05	0.16
Retail trade, repair (excl. motor vehicles), hotels and restaurants	4.40	0.56	0.41	0.53	0.73	0.60
Land transport	1.26	1.05	0.74	1.69	0.25	0.31
Water transport	0.12	0.62	0.17	2.36	0.20	1.45
Air transport	0.16	0.25	0.11	0.21	0.09	0.10
Supporting transport activities	0.43	0.20	0.10	0.10	0.06	0.15
Business services	6.49	0.90	1.46	0.66	0.44	1.65
Public administration and social security	3.13	1.21	2.50	0.85	0.89	2.44
Education	1.84	0.37	0.33	0.17	0.14	0.49
Health and social work activities	3.65	0.87	0.88	0.52	0.72	1.05
Sewage and refuse disposal services	0.09	0.59	3.25	0.20	1.27	0.14
Other services n.e.c.	1.56	0.79	0.32	0.29	0.18	0.72
Total, production	1.00	1.00	1.00	1.00	1.00	1.00

Source: [16, table 3].

This means that, for example, pollution from electricity production is systematically attributed to the (final) demand of industries, in accordance with their shares in electricity consumption. The estimates in table 2 are based on the assumption that emissions "embodied" in imports are equal to domestically produced goods and services. Table 2 shows for each industry the deviation of cumulated pollution per unit of final demand in relation to the average over all industries. The first column contains similar estimates for employment in terms of labour inputs.

The cumulation process generates a substantial redistribution of pollution and employment over industries. For example, a huge amount of direct pollution from agriculture winds up in food processing products. This is indicated by the relatively high pollution intensities for the typical agriculture related themes such as acidification and eutrophication. For food processing these intensities appears to be similar to those of agriculture which proves that food processing industries rely heavily on inputs from agriculture. Figures on cumulated pollution show which products have, at the stage of production, economy wide the highest environmental impacts. Estimates on cumulated pollution are, for example, useful in tuning environmental taxes on production or products, taking complete product chains into consideration. At the same time, the cumulated employment coefficients can contribute to analysing the consequences on total employment of these fiscal measures.

Table 3 places the analysis on direct and cumulated emission of greenhouse gases (excluding CFCs) in a macroeconomic perspective. This table shows "who is polluting for who". The origins are firstly determined by the direct emissions from households and industries, and secondly by the emissions attributable to imports. With respect to the latter, again the assumption applies that emissions "embodied" in imports are equal to domestically produced goods and services. Consumption, investment and export make up total destination. Greenhouse emissions attributable to exports appear to be substantial higher then for imports. When these figures are related to the corresponding money values, it appears that total greenhouse gases per guilder export exceeds imports with approximately 30%. A major part of Dutch export exists of products with relatively high-energy requirements: transport services, products from horticulture, food processing and chemical industries.

Between 1993 and 1997 the total emission of greenhouse gases raise by 4.5%. Three effects determine this increase. Firstly, this increase was caused by a total volume growth of GDP of approximately 18% in this period. However, shifts in expenditure from products with relatively high pollution intensities to products with lower intensities resulted in a "volume" increase of greenhouse gases by only 12%. At the same time, efficiency improvements had a downward effect of 7.5%, which finally resulted in an overall increase of 4.5%. So table 3 reviews the underlying forces which have determined the development of greenhouse gas pollution. These types of decompositions are required for future projections on pollution.

The NAMEA has already frequently been applied in macroeconomic models for analysing the environmental impacts of structural economic changes. For example, the NAMEA was used in a linear programming model that produced a very rough and preliminary estimate for an environmentally sustainable national income [6]. In this model, the consequences of reducing pollution levels to the norms set by the Dutch Parliament were estimated, in a world without technological improvements. Bearing in mind this rather unrealistic assumption, it did not come as a surprise that the required "optimal" reduction in economic activity was enormous and very unevenly distributed by industry.

A similar model was applied in a study on sustainable economic development scenarios for the Netherlands until the year 2030 [22]. The main differences between these scenarios concerned the allowable degree of substitution be-

Table 3
Origin and destination of greenhouse gases (CO_2, N_2O and CH_4).

	Production structure 1993 and final demand 1993	Production structure 1997 and final demand 1993	Production structure 1997 and final demand 1997
	billion co2-eq		
Origin			
Netherlands			
production (direct)	164	155	173
consumption (direct)	38	33	38
rest of the world			
import (attributed)	87	79	92
total	289	268	302
Destination			
Netherlands			
consumption (direct + attributed)	135	126	139
investment (atributed)	24	21	26
rest of the world			
export (attributed)	130	121	138
total	289	268	302

Source: [3, table 6.6].

tween environmental, physical and human capital and assumptions regarding the direction and the speed of technical progress. Under the assumption of substantial eco-efficiency improvements, in each of the scenarios, it appeared feasible to reconcile sustainability with continued (albeit limited) GDP volume growth. Crucial in these types of modelling exercises is how interactions with the rest of the world are taken into account. Trade or import restrictions are somehow required to avoid ending up with an "empty" economy. Similarly, in order to avoid a modelling "solution" which amounts to transferring highly polluting industries to other countries, one may assume that the transformation to sustainability is simultaneously accomplished all over the world.

The results of these models are highly influenced by the assumptions on eco-efficiency improvements. Usually, these improvements are only achieved at considerable costs. De Haan [8] has connected the NAMEA with a database on estimated costs and emission reductions of a range of potential energy saving measures by industry in the Netherlands. Besides the direct costs and emission reductions of energy saving measures in the industries applying these measures, this model also calculated the revenues and emission changes in the rest of the economy (e.g., with the suppliers of the energy saving devices). After the cheapest measures were applied, overall economic costs would rise steeply and moreover the total emission reductions would be much smaller than the direct emission reductions. The production of energy saving devices also causes CO_2-emissions, which become increasingly important once the most efficient measures have already been implemented. At a certain stage, these indirect emission increases would even surpass the direct emission reductions, generating in total a negative environmental impact.

4. Future work

At present, the further development of the NAMEA in the Netherlands focuses on several aspects such as increasing its timeliness, coverage of environmental themes and subsequently the further integration with other accounting frameworks, in order to arrive at a comprehensive information system of environmental, economic and socio-demographic accounts.

Obviously, the NAMEA's policy relevance depends very much on its timeliness. Therefore, the investigation on preliminary estimates will be continued. Conceptually, these estimates are constructed on the basis of: (a) the structure of the most recent definitive NAMEA, (b) economic estimates from the preliminary national accounts, (c) early environmental data, if available, and (d) a series of assumptions on the emission coefficients. In this way, all relevant and available information is absorbed in the NAMEA-framework, which should result in the highest achievable reliability of the early environmental indicators. This systems approach is rather similar to the estimation methods applied in the quarterly accounts at the CBS.

Three more projects deal with broadening the NAMEA's scope. Presently, not all themes from the national Environmental Policy Plans are captured by the NAMEA, partly because of lack of data and partly because of conceptual problems. Recently, however, De Haan [9] has incorporated water accounts in the NAMEA. These water accounts are not restricted to water extraction, but also register the emission of pollutants to water. Unfortunately, the survey that provides the basic data for linking water use to economic activities just covers mining, manufacturing, electricity production and households, and is held only once every five years.

A second project deals with the dispersion of toxic substances. Here, the great number of substances and their aggregation to one ore a few pressure indicators poses a problem. Gorree [11] proposes two indicators to describe the emission of toxic substances. Both indicators are independent of policy goals, which is an important advantage. The first indicator weighs toxic substances by their impact on the ecological system. The second indicator weighs the toxic substances by their impact on human beings. Currently, the methodological discussion of the compilation of this indicator has not come to an end.

Thirdly, another highly relevant theme in case of the Netherlands concerns the use of space. Leurs and van Dalen [17] compiled land use accounts in which the use of land was allocated to different economic activities for three separate regions in the Netherlands. One conceptual problem that had to be solved in the accounts was the multiple use of space. At the same time the multiple use of space by different activities may contribute to a more efficient use of space in the Netherlands.

Finally, the heart of the policy debate gradually shifts towards the interrelations between environmental, economic and social issues. Analysis based on the integrated NAMEA and SAM demonstrated, for instance, that women and highly educated men are typically employed in industries which burden the environment less than the industries in which most lower educated men are working. Such a finding evidently has a bearing on the expected distributional consequences of more stringent environmental policies. For example, it is quite likely that production cutbacks in relatively polluting industries will be at the expense of low skilled jobs of male employees. However, the SESAME accounts do not only identify the type of jobs that may be effected by these types of environmental policy measures but also how resulting changes in income may influence the income distribution over different types of households. An important stimulus of the integration of economic, environmental and social statistics is currently the development of "SESAME": a "System of Economic and Social Accounting Matrices and Extensions".[4] The coherence of the SESAME allows data relations to be produced which may underwrite policy measures involving these phenomena.

[4] The SESAME-approach is set out in [15].

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