

4.

Sustainability:
quantifying
CO₂-emissions
according to the
control-criterion

Authors

Maarten van Rossum

Cor Graveland

Sjoerd Schenau

Bram Edens

Globalisation has all kinds of socio-economic as well as environmental effects. There are different ways of attributing responsibility for greenhouse gas emissions to individual countries. In this paper we introduce a new approach whereby we attribute CO₂-emissions according to the country of the ultimate controlling enterprise. We find that total emissions of Dutch controlled companies are a lot larger than emissions in the Netherlands itself, both according to a production approach – the Dutch air emission accounts – or the territory-based Kyoto figures. This study is experimental and is still in the learning phase.

4.1 Introduction

There are many mechanisms through which globalisation affects the natural environment (OECD, 2002). For example, globalisation expands production and world economic output. This can lead to growing pressures on the environment due to increased pollution and natural resource use. In addition, globalisation is characterised by a reallocation of production and consumption across sectors and countries, with different consequences for the natural environment in each country. At the same time, globalisation is paired with the development and diffusion of new technologies, resulting in new products and services as well as more efficient production processes which may have a beneficial impact on the environment (Fortanier and Maher, 2001). In an earlier edition of the Internationalisation Monitor, Delahaye and Schenau (2009) already addressed several elements, in particular the dependency of the Dutch economy on external sources of energy, its development over time, and the variation across energy sources, sectors, and geographic regions. Here we will address the topic how to allocate emissions to different countries in a globalising world economy. We will concentrate on carbon dioxide (CO₂) emissions, as the main greenhouse gas.

There are different ways of attributing responsibility for carbon dioxide emissions to individual countries (Peters 2008). Well-known are the territory-based approach which underlies Kyoto Reporting, the production-based approach which is followed in the System of Environmental-Economic Accounting (SEEA, UN et al. 2012) and the consumption-based approaches using environmentally-extended input-output analysis (Peters and Hertwich 2008). From a production point of view, globalisation leads to an increase in international transportation and tourism. In addition, developed countries may also 'export' their pollution by decreasing domestic production of pollution intensive products and increasing imports of these goods.

In contrast, the consumption approach considers global pollution as a result of consumption demands. Until now most policies regarding climate change, for example the Kyoto protocol, focus on reducing CO₂-emissions that occur during the production processes. However, the Social and Economic Council of the Netherlands advises the government to promote sustainable consumption by taking the (global) production chain into account (cf. SER, 2008).

Due to the advancement of globalisation, these different perspectives yield different estimates. There is by now a large amount of literature around "carbon leakage" (IPCC, 2007)) which investigates whether developed economies, with adopted carbon mitigation policies and national emission ceilings, shift environmental burden towards developing economies. Globalisation poses a number of challenges for allocation of emissions according to the different approaches.

In this chapter we explored a new approach to account for responsibility by attributing emissions by the criterion 'span of control' or ultimate controlling institute (UCI). We include emissions abroad in case the UCI is a Dutch resident company, while we exclude domestic emissions by foreign controlled companies. The main intuition here is that in a globalising world, the controlling units not only are most likely to receive most of the profits, but they also decide on the location of polluting activities.

The main research question of this study is to assess CO₂-emissions according to the criterion 'span of control' by enterprises and compare them with alternative approaches for attributing emissions.

This chapter is structured as follows. Section 2 discusses the data and methodology used. It starts by explaining how we allocated total Dutch production emissions to Dutch span of control and foreign control. Subsequently it explains the compilation of figures for emissions related to Dutch span of control production activities abroad. Section 3 presents the results of these compilations. Section 4 summarises the main findings and suggests several areas of further research to improve the estimates, as this study is experimental and is still in the learning phase.

4.2 Data and methodology

Globalisation can be monitored using the concept of enterprise control. Enterprise control is based on the concept of the Ultimate Controlling Institute (UCI). Thus, all enterprises can be classified according to country of control. The chosen reporting year is 2008, as this is the most recent reporting year for which all the required data is readily available. Results are presented at meso level according to industry classification NACE Rev.2.

The span of control analysis consists of two parts, dividing the domestic emissions between Dutch and foreign span of control and estimating the Dutch control emissions abroad. The former is determined in three steps. First, we calculated stationary emissions of enterprises based on micro information. This data is based on energy use data available at enterprise level, and includes information about energy-related emissions. Using the UCI, the micro-based emissions are assigned to either the category of foreign controlled enterprises or to the Dutch controlled enterprises. Secondly, we added emissions from mobile sources, which are available only at the industry level, following the ratio Dutch/foreign of stationary emissions derived in the first step. Thirdly, remaining emissions (total minus stationary and mobile) for enterprises that were not dealt with in the previous steps are distributed among industries proportionally to employment data. As a result the total emissions of residents in the Netherlands are split into emissions by foreign controlled and Dutch controlled enterprises.

The Dutch span of control emissions abroad are estimated as follows. First, note that it is very important to have the information by industry because this enables us to estimate the level of emissions associated with the activities of the Dutch controlled enterprises. Some industries are very emission intensive while others are less so. One employee in the chemicals and chemical product industry tends to generate more emissions than an employee in the financial intermediation industry.

Direct information on emissions by these enterprises abroad is not available and therefore has to be derived using a number of assumptions. Emissions in the Netherlands per NACE class are known due to the Dutch environmental accounts. Per NACE class one can calculate the emissions per unit employment ('emission-intensity'). First it is assumed that the emission intensity of Dutch controlled enterprises abroad is the same as the emission intensity of the similar industry in the Netherlands. Emissions of foreign enterprises controlled by Dutch residents can now easily be calculated by multiplying the emission-intensity (based on employment) with employment in a given industry and country.

However, Dutch emission coefficients may not be representative for foreign economies. Therefore, we have estimated two variants of the Dutch controlled foreign emissions. The first assumes that enterprises abroad have the same emission intensity as their counterparts in the Netherlands. The second uses country- and industry-specific information. In order to calculate the latter, the former emissions have been multiplied with correction factors. The correction factor is based on the ratio of emission intensities in foreign economies and the emission-intensity in Netherlands for each NACE class. These emission intensities have been calculated using the World Input Output Database (WIOD, 2012) that contains the necessary information on emissions and production on industry and country level. The correction factors are therefore NACE and country-specific.

The employment data is used as a proxy for the size of the economic activity of an industry and this proxy is combined with emission coefficients in order to estimate the emissions of these industries. This is applied for both variants. The Inward Foreign Affiliates Statistics (Inward FATS) of other EU member states contains employment data about Dutch controlled enterprises in EU countries. The Outward FATS contains employment data about Dutch controlled enterprises in non-EU countries (outward FATS). Together, this yields employment data for about 35 NACE classes and all countries.

We put a high priority on the analyses of the manufacturing industries because they are more emission-intensive than the average industry. It is also important to analyse the electricity companies in depth as they form by far the most emission-intensive industry. Eurostat data makes explicit to what extent Dutch companies have control over foreign European energy companies. It is quite important to determine whether these companies indeed produce electricity (emission intensive) or distribute gas and/or electricity or execute network activities (far less emission intensive). After consulting a few experts and an online search we concluded that the Dutch controlled energy companies in foreign economies predominantly deal with distribution and network activities rather than with electricity production. Emissions of these distribution and network activities are limited. Therefore we assume that Dutch controlled energy companies in Europe solely engage in distribution and network activities. Mining is also responsible for large amounts of emissions. Dutch controlled companies engaged in exploration activities also belong to the NACE class Mining, which unfortunately is not homogenous. Extraction activities cause particularly much emission while exploration activities are emission-extensive. Companies engaged in exploration are very active abroad and control a lot of companies in foreign economies.

The necessary actions are discussed in more detail in the underlying report of Van Rossum et al. (2012).

4.3 Results

This section will first present emissions by the Dutch economy disaggregated by Dutch and foreign UCI and next the emissions of Dutch controlled enterprises abroad. The results for emissions abroad will be presented in two variants: one, assuming that industries abroad have the same emission intensities as in the Netherlands, and a second one, using country-specific emission intensities. Because the emission intensities for EU-countries are very different from those for non-EU countries, the results for EU and non-EU countries are presented separately first. Only in the last paragraph they are being aggregated to arrive at the total emissions of Dutch controlled enterprises in the Netherlands and abroad.

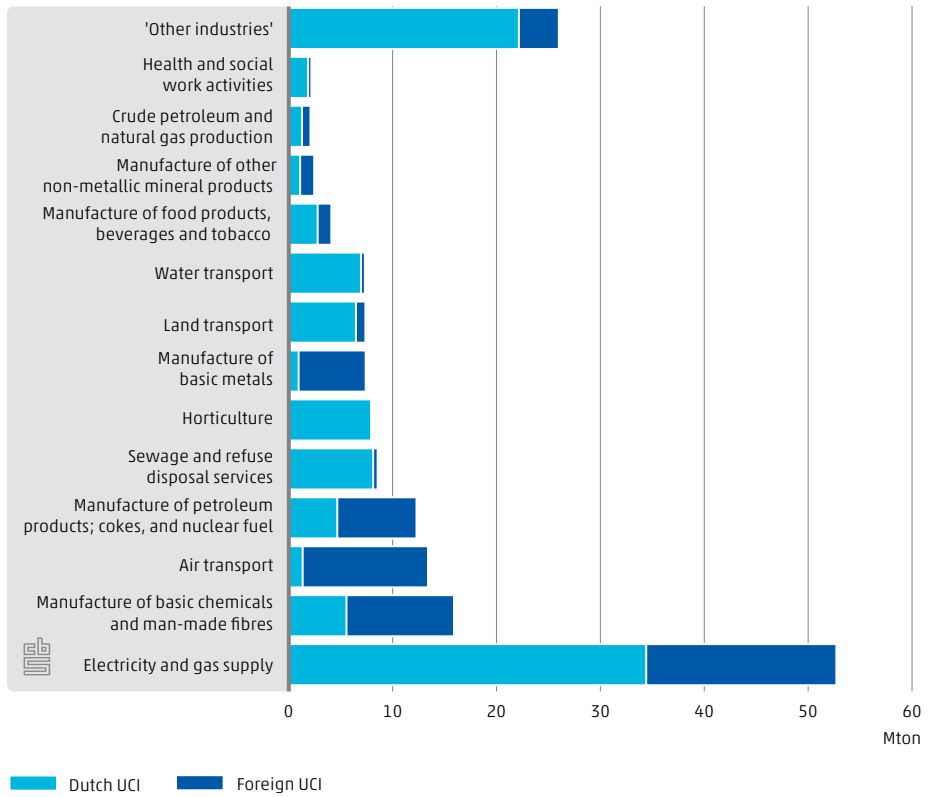
Domestic emissions related to Dutch and foreign control

In 2008, enterprises in the Netherlands emitted 168 Mton CO₂. Dutch controlled enterprises emitted 62 percent of this amount and foreign controlled enterprises emitted 38 percent. As figure 4.3.1 indicates, electricity and gas supply had by far the largest CO₂-emissions. This industry is responsible for almost one third of CO₂-emissions by enterprises in the Netherlands. It emitted 53¹⁾ Mton, of which 34 Mton by Dutch controlled enterprises and 18 Mton by foreign controlled enterprises. Most power stations burn fossil fuels to generate electricity, and in this process CO₂ is generated and emitted.

Figure 4.3.1 shows that within electricity production and the more emission intensive manufacturing industries, significant emissions are caused by production activities and entities that are under foreign span of control. For the Dutch economy as a whole the production activities under foreign control are responsible for 38 percent (64 Mton) of the overall emission caused by production activities within the Dutch economy.

¹⁾ Due to rounding, numbers do not add up.

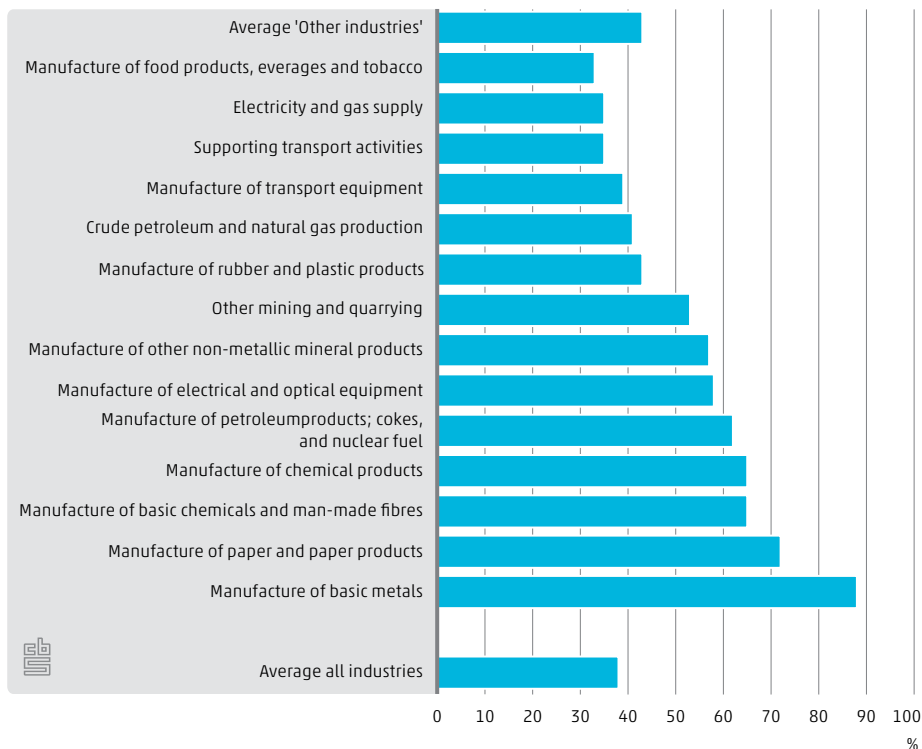
4.3.1 CO₂-emissions of Dutch industries with span of control (UCI), 2008



38% of CO₂ emissions from production in the Netherlands are by foreign controlled enterprises



4.3.2 Shares of CO₂-emissions by industry under foreign control, by industry, 2008

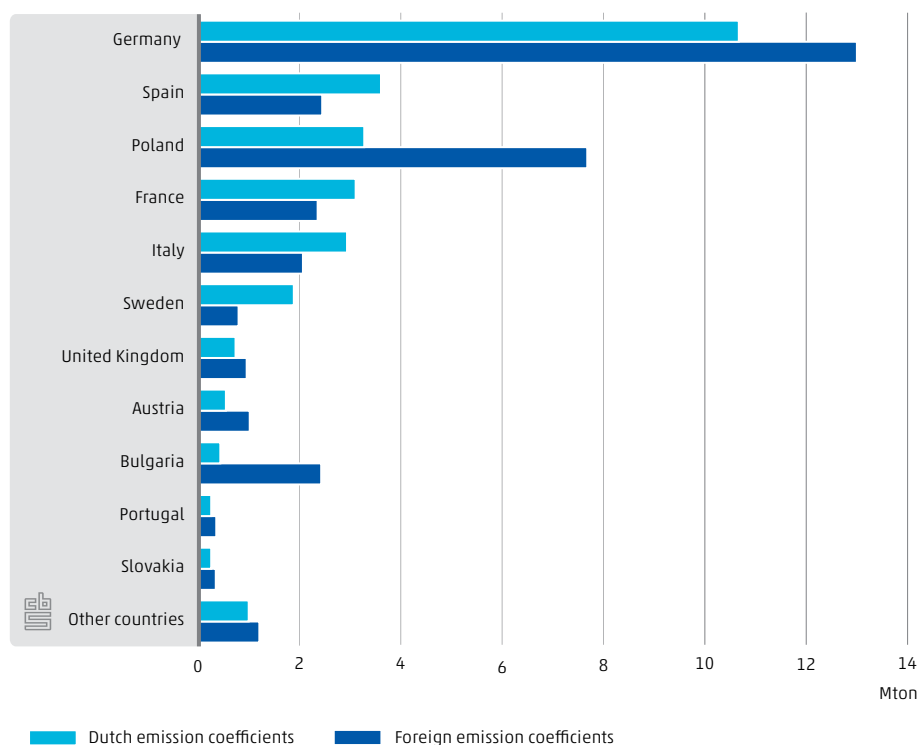


Source: Van Rossum et al. (2012).

Emissions in the European Union related to Dutch span of control

Emissions attributed to Dutch controlled enterprises in the European Union equalled 28 Mton CO₂ in 2008 (using Dutch emission coefficients). Especially in Germany there are a lot of emissions associated by activities of Dutch controlled enterprises. This is due to the fact that a lot of Dutch controlled employment is located in Germany. It is also partly explained by the emission-intensive nature of the activities in Germany under Dutch control. Activities such as the manufacture of basic metals, of chemicals and chemical products, of basic pharmaceutical products and pharmaceutical preparations and of food products are very important in this respect. In Spain the activities manufacture of chemicals and chemical products and of basic pharmaceutical products and pharmaceutical preparations play a relative big role. In Poland the manufacture of basic pharmaceutical products and pharmaceutical preparation, of food products and of other non-metallic mineral products are especially important industries.

4.3.3 CO₂-emissions of Dutch controlled enterprises in the EU, 2008

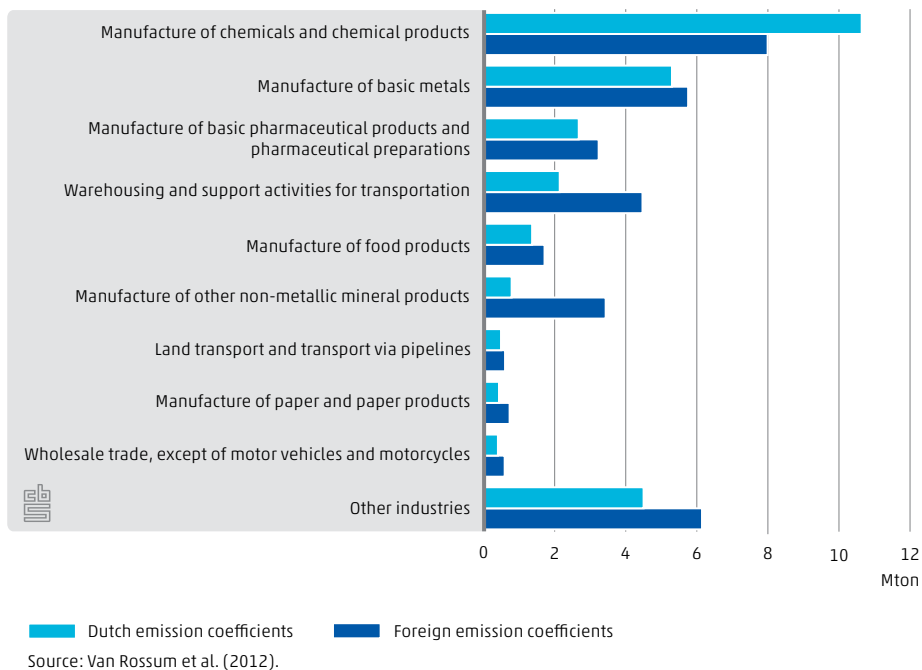


Source: Van Rossum et al. (2012).

The emissions of Dutch controlled enterprises in the European Union are for a large part in manufacturing of chemicals and chemical products; 11 Mton CO₂ using Dutch emission coefficients. Another industry that plays a significant part is the manufacture of basic metals, with 5 Mton of emissions.

As figure 4.3.2 showed, there are sometimes large differences between emissions using Dutch or foreign emission coefficients. For example, for the manufacturing of chemicals and chemical products industry, the difference is 2.6 Mton, or one quarter of the emissions using Dutch emission coefficients. There are several explanations. First, it is likely that processes in different countries cause different emissions, due to different methods and efficiency. Secondly, the Dutch enterprises in a specific industry may have a different specialisation than the foreign enterprises, with different production processes and corresponding emission patterns.

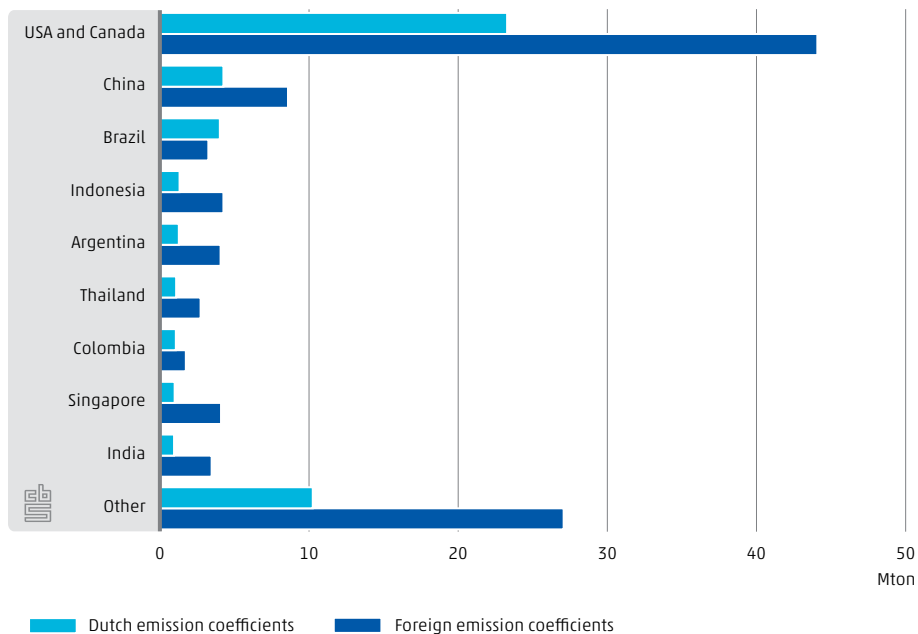
4.3.4 CO₂-Emissions of Dutch controlled enterprises in the EU, by industry, 2008



Emissions outside the European Union related to Dutch span of control

Emissions attributed to Dutch controlled enterprises outside the European Union equalled 49 Mton CO₂ in 2008, using Dutch emission coefficients. Especially in the USA a large number of emissions stem from Dutch controlled enterprises, as a substantial part of Dutch controlled employment was located there. Moreover, the nature of the activities in USA under Dutch control is highly emission-intensive. The manufacture of chemicals and chemical products, mining and the manufacture of food, beverages and tobacco were all very prominent in this respect. Also in Brazil, China and Canada there were a lot of emissions controlled by Dutch enterprises. In China and Brazil the manufacture of chemicals and chemical products is mainly responsible for these emissions.

4.3.5 CO₂-emissions of Dutch controlled enterprises in non-EU countries, 2008

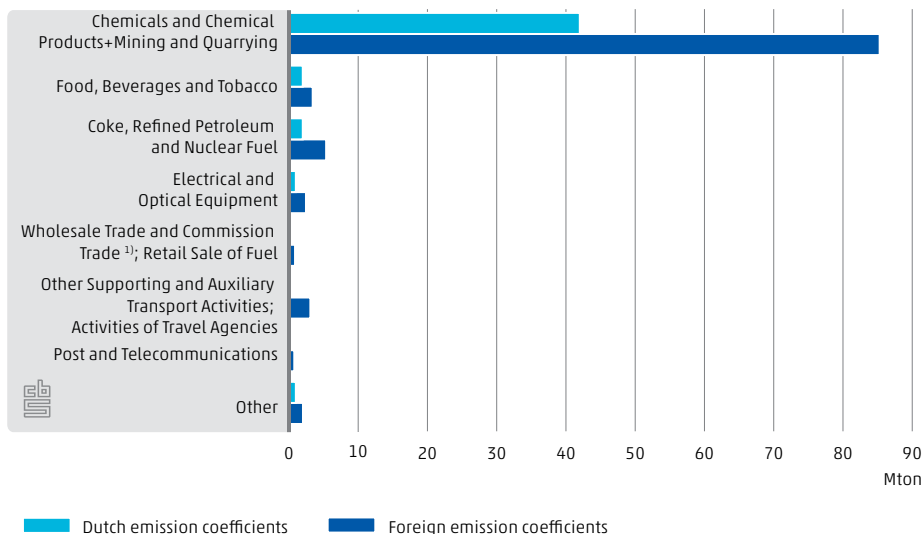


Source: Van Rossum et al. (2012).

N.B. To keep data of individual enterprises confidential, we had to aggregate the totals of the United States of America and Canada.

Almost all of the emissions attributed to Dutch controlled enterprises outside the European Union stem from two industries: manufacturing of chemicals and chemical products, and mining and quarrying. Together they emitted 42 Mton CO₂ (using Dutch emission coefficients), 87 percent of Dutch controlled emissions outside the European Union. Using foreign emission coefficients does not change this picture.

4.3.6 CO₂-emissions of Dutch controlled enterprises in non-EU countries, by industry, 2008



Source: Van Rossum et al. (2012).
¹⁾ Except of Motor Vehicles and Motorcycles+Sale, Maintenance and Repair of Motor Vehicles and Motorcycles.
 N.B. To keep data of individual enterprises confidential, we had to aggregate the totals of the chemical industry and the Mining and Quarrying industry.

Total emissions of Dutch controlled enterprises in the Netherlands and abroad

In presenting the total picture we advocate the use of the foreign emission coefficients instead of the Dutch emission coefficients because this seems more realistic. Using Dutch emission coefficients we would probably underestimate the emissions of Dutch controlled foreign enterprises. Still there is substantial uncertainty in the outcomes, especially for countries outside the EU.

Using the results from the previous sections, total emissions of Dutch controlled non-residents can now be calculated. Using foreign emission coefficients, emissions attributed to Dutch controlled enterprises outside the European Union equal 103 Mton CO₂, while emissions attributed to Dutch controlled enterprises in the European Union equal 35 Mton CO₂. Together this makes 138 Mton CO₂ attributed to activities of Dutch controlled enterprises in foreign economies (77 Mton CO₂ using Dutch emission coefficients).

4.3.7 Dutch CO₂-emissions according to different approaches, 2008

Type of emissions		CO ₂ -emissions	
		Mton CO ₂	
I	Emissions of Dutch controlled enterprises, residents in the Netherlands	104	I = V - IV
II	Emissions of Dutch controlled enterprises, foreign residents outside the Netherlands	138	
III	Total emissions of Dutch controlled enterprises	242	III = I + II
IV	Emissions of foreign controlled enterprises, residents in the Netherlands	64	
V	Emissions according to the residents principle (SEEA type emissions)	168	V = I + IV

Source: Van Rossum et al. (2012).

The different approaches and aggregations for assessment of CO₂-emissions yield considerable different results. Table 4.3.7 shows that total emissions of Dutch controlled enterprises in the Netherlands and abroad are equal to 242 Mton CO₂. Approximately 43 percent of these Dutch controlled emissions are emitted by Dutch residents and 57 percent is emitted by foreign residents in foreign economies. In the Netherlands, approximately 62 percent of all emissions from production in the Dutch economy (production approach, 104 Mton of 168 Mton) are emitted by Dutch controlled enterprises. The other 38 percent of emissions stemming from Dutch production (SEEA type) are by foreign controlled enterprises active in the Netherlands.

Also note that CO₂-emissions of Dutch controlled enterprises in the Netherlands and abroad together are 44 percent larger than the CO₂-emissions according to the SEEA production approach (excluding households). And they are 27 percent larger than the CO₂ emissions according to the consumption approach.

CO₂ emissions according to different frameworks

CO₂ emissions according to the IPCC regulation ('territory principle')

The IPCC (Intergovernmental Panel on Climate Change) has drawn up specific guidelines to estimate and report on national inventories of anthropogenic greenhouse gas emissions and removals (IPCC, 1996). "Anthropogenic" refers to greenhouse gas emissions and removals that are a direct result of human activities or are the result of natural processes that have been affected by human activities. In general the IPCC records all emissions that occur on the Dutch territory, with a few specificities. Emissions originating from the so-called short cyclic carbon cycle, such as the combustion of biomass and emission from biochemical processes, are left aside in the IPCC calculations (see for more information the website of UNFCCC).

CO₂ emissions by the Dutch economy (SEEA-production type emissions)

Statistics Netherlands annually publishes the total greenhouse gas emissions by economic activities, which are calculated according to the national accounting principles. These include all emissions caused by the residents of a country, regardless where the emissions take place. For stationary emission sources the resident principle will generally converge with emission data as recorded in the emission inventories. There may however be substantial differences for mobile sources. Transport activities by residents, like road transport, shipping and air transport, and related emissions to air may also occur abroad. Likewise, non-residents may cause pollution within the Dutch territory (see for more information Statistics Netherlands (2010)).

Global CO₂ emissions from Dutch consumption needs

The *production approach* according to SEEA considers greenhouse gas (GHG) emissions caused during the economic activities of a country's residents. However, the production approach does not take into account GHG emissions that occur abroad, during the production of products that are consumed in the home country²⁾, the so called embodied or indirect emissions. The approach in which GHG emissions are related to the consumption requirements of countries is referred to as the *consumption approach* or carbon footprint. The Dutch emissions according to the consumption approach consist of the emissions embodied in imports for domestic use plus a part of the domestic GHG emissions, namely those inherent in the production of products destined for domestic final consumption. The remaining domestic GHG emissions that occur during the production of products destined for export are attributed to consumption abroad (see for more information Statistics Netherlands (2010)).

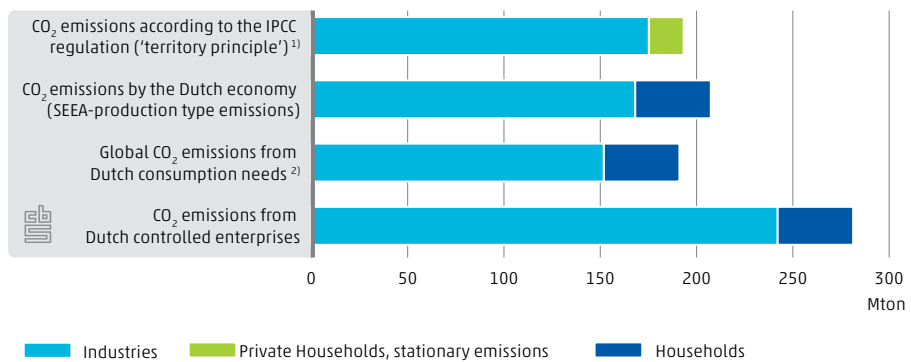
CO₂ emissions from Dutch controlled enterprises

In this chapter we have explored a new approach to account for responsibility by attributing emissions by the criterion 'span of control' or ultimate controlling institute (UCI) of enterprises. We include emissions abroad in case the UCI is a Dutch resident company, while we exclude domestic emissions by foreign controlled companies. The main intuition here is that in a globalising world, the

²⁾ A wide definition of consumption is used here that consists of all final demand categories minus exports: final consumption by households, final consumption by government, investments and changes in inventories

controlling units not only are most likely to receive most of the profits, but they also decide on the location of polluting activities. The UCI is defined as an institutional unit, starting from a foreign affiliate's chain of control, which is not controlled by another institutional unit. Therefore, foreign controlled enterprises have a centre of control outside the Netherlands, whereas Dutch controlled means that the locus of control is in the Netherlands. 'Control' is defined as the ability to determine general corporate policy by appointing appropriate directors.

4.3.8 'Dutch' CO₂-emissions 2008 following different frameworks and concepts, 2008



Source: Van Rossum et al. (2012).

¹⁾ Private households: A collection of one or more people sharing the same living space, who provide their own everyday needs in a private, non-commercial way. Here only stationary emissions are presented separately, as emissions from transport are excluded because not separately distinguished.

²⁾ Figure based upon actual figure for emissions by residents in 2008 and the surplus of the 'Emission balance of trade' in 2009.

4.4 Conclusions and recommendations for further research

The main finding of our study is that total emissions of Dutch controlled companies are a lot larger than emissions according to alternative frameworks such as the Dutch air emission accounts or the territory based Kyoto figures. The interpretation that we give to this approach is as follows.

In the System of National Accounts (SNA), residency is defined in terms of predominant economic interest. In practice this means that a Dutch resident is an enterprise or person 'predominantly' present within the Netherlands. Following the SEEA production approach (UN et al, 2012); pollution of these enterprises is accounted for as emissions caused by and to be assigned to the production of the Dutch economy. In this way these emissions can be compared with economic aggregates like GDP. However, many of the residents engaged in polluting activities are not controlled by Dutch residents. Economic activities under Dutch control both generate value but cause (CO₂) emissions as well. In many cases exercising control results in income transfers (for example dividends in the case of securities) which will be reflected in a country's national income. The value added of a 'span of control' analysis in a globalisation context is that income and the global effect on the environment of Dutch enterprise control can be evaluated. In that sense, this approach would be closer to an income perspective³⁾.

The results presented in this study may therefore be relevant for policy makers – as it takes into account that economies and power do not stop at borders – and can help policy makers in fact based decision-making dealing with environmental issues in a globalising world.

We conclude by discussing some recommendations for further research, analysis and improved estimates, as this study is still in the learning phase.

The study presents a 'span of control' analysis for emissions for one single year and can be improved presenting a time series. Dynamics in activities relevant for span of control abroad and domestically are very interesting to monitor over time. In order to gain insight in the dynamics of span of control (changes in UCI), in quality of the data and the methods applied it is recommended to repeat the analysis for another year. To enhance relevance for policy we recommend compiling time series data for emissions based on the criterion 'span of control'. Such time series data can eventually help in answering questions regarding 'carbon leakage'.

We recommend exploring more alternative data sources for emission coefficients besides the WIOD data used in this study. Such emission coefficients can be more detailed and/or accurate for certain activities in certain regions/countries. Because the coefficients used in this study are not directly based on observed data, instead we make use of computing techniques using data on different emission coefficients and economic information on foreign control which is available at Statistics

³⁾ In the SNA national income is an aggregate which takes also income transfers with the rest of the world into account.

Netherlands and Eurostat. Note that the quality of the assessment of foreign controlled emissions in the Netherlands is better than the quality of the data on emissions of Dutch controlled emissions in foreign economies. Because the former is mainly based on observations and partly on modelling making use of some rule of thumb assumptions.

It would be very interesting to link "span of control emissions" and national income. Emission intensity of an economy, the ratio of emissions to GDP, is nowadays very often monitored over time in many countries. For example the Green Growth framework of the OECD (2011) recommends monitoring this indicator over time. As an extension to emission intensities calculated from production type emissions and GDP, we recommend monitoring emission-intensity based upon a quite different concept for both the 'physical' part as well as the 'economy' part. In this study we made an attempt to calculate emissions related to span of control. These 'span of control emissions' would be the new numerator. These 'controlled' emissions can best be confronted, from a conceptual point of view, with national income of a country. National income will in this case be the new denominator. To make this new indicator, we would need information on income transfers with destination 'the Netherlands' by industries in foreign economies which are Dutch controlled (inflow of income). Vice versa, we also need information on income transfers from foreign controlled enterprises in the Netherlands having destination 'abroad' (outflow of income).