"European Framework for Measuring Progress"

e-Frame

www.eframeproject.eu

SP1-Cooperation
Coordination and support actions (Coordinating actions)
FP7 SSH-2011-3

Grant Agreement Number 290520
SSH.2011.6.2-1

Deliverable 6.3

Dissemination level: PU

Workshop "The Wealth of Nations in a Globalizing World"
Organizer/s: University of Groningen, Bart Los and Marcel Timmer

Author/s of the report: Bart Los and Marcel Timmer

October 4, 2013

This project is funded by the European Union under the
7th Research Framework Programme (Theme SSH-2011-3)
Grant Agreement nr 290520

Deliverable 6.3

Workshop: The Wealth of Nations in a Globalizing World"

Summary

The aim of the workshop "The Wealth of Nations in a Globalizing World" was to take stock of the current state of affairs in measuring the effects of intensifying international trade on the distribution of income and jobs, both between and within countries and the effects this intensification of trade on shifts in environmental pressures of various sorts. Furthermore, opportunities for progress in the upcoming years were discussed. Leading academic experts, representatives of national statistical institutes, and delegates of international organizations came together to contribute to these objectives.

The main conclusions are that a lot of progress has been made in recent years. Although the information and communication technology revolution enabled firms to disperse stages of production processes geographically some time ago already, it was impossible to obtain reasonably accurate estimates of the macroeconomic consequences of this drastic change. Anecdotal evidence was available from case studies into the production processes of specific products (such as high-end electronics), but it remained unclear to which extent the findings of these studies could be generalized. The recent availability of a number of sets of global input-output tables has changed this situation. During the workshop several presentations reflected on the strengths and weaknesses of studies based on tables like these. One of the most important remaining problems relates to the variability of the results that are obtained using the various databases. In view of the sensitivity of the debates regarding climate change and regulations to curb this, estimates of carbon footprints (the worldwide CO_2 emissions associated with consumption by households in a specific country) can only have an impact on policy-making if the estimates are within a narrow bandwidth. If not, it should at least be very clear where differences stem from.

Another issue that surfaced several times is the possibility to extend the range of questions that can be addressed by constructing novel types of data that can be appended to the global input-output data. Footprint analysis is no longer conducted for carbon emissions anymore, as Manfred Lenzen showed in his keynote lecture. Even issues like loss of biodiversity can be studied and some preliminary results for the effects of changing trade patterns on occupational health have been obtained already. In the economic realm, many more insights into the differential effects of trade intensification would be gained if information on the offshoring of specific business functions could be merged with global input-output tables. Moreover, additional insights could be gained if information would be available about ownership of (tangible and intangible) capital that earns profits. Currently, these profits can only be linked to the country in which these are earned, but systematic information about the country to which this income flows is not available. Such information is indispensable if a more complete picture of the impacts of globalization on international income distributions is pursued.

The main future actions as identified above have immediate impacts on future actions. A number of the workshop participants are actively involved in the Réunion-project. This project brings representatives of various groups working on the construction of global input-output tables together. In the past two years, the focus of the meetings has been on exchanging information about procedures, problems, solutions to these, etc., in order to learn from each other. A new grant from the Australian Research Council has enabled the members of the project to start a so-called Virtual Laboratory, a software platform that enables researchers to contribute data and procedures. This Virtual Laboratory, which benefits from recent advances in information and communication technology, fosters efficient cooperation between the project members and allows for capital- rather than labor-intensive production of global input-output tables, while maintaining the diversity of approaches. This diversity is important, since very different research questions should be dealt with. The timeliness of tables will also be improved, provided that solutions can be found to work around fundamental changes in statistical reporting practices (SNA2008 vs. SNA1993, for example) and product and industry classifications. The Virtual Laboratory will also be an excellent location to delve much deeper into the uncertainty issue described above, since all raw data will be available at one place and the effects of differences in construction methods can be separated from differences in underlying data.

Some workshop participants are also very active in convincing international organizations that additional data (often of a micro-economic nature) could lead to deeper insights. Eurostat has launched work on collecting data on the offshoring of business functions, for example. Many other data collection efforts would be worthwhile, but it is essential to understand that individual researchers cannot get such jobs done. These require inputs from international research consortia. Hence, fast progress in measuring the economic and environmental impacts of ongoing globalization is almost impossible without continued funding from international organizations. The proof-of-concept of the feasibility and desirability of particular databases has been (and continues to be) delivered by the academic community. And this should be firmly grounded in active follow up by national and international statistical institutes. Continuing dialogue between policy makers, the statistical communities and the academic community are needed. While this is a long and arduous process, it seems to be the most promising way of arriving at evidence-based policies. The potential gains are clear.

Index

1. Introduction: aim of workshop

It is frequently argued that globalization has entered a new phase. In the early 20th century rapidly falling transport costs ended the need for co-location of production and consumption. More recently, fostered by diminishing communication and coordination costs, the production process itself was unbundled as the various stages of production need not be performed near to each other anymore. In this new phase, international competition increasingly plays itself at the level of tasks within firms, rather than at the level of products (Baldwin 2006). This process of unbundling of production is creating new challenges for the measurement and analyses of the effects of globalization on welfare within and across countries.

In this workshop, and more broadly in workpackage 6 of the eFrame project, we focus on two specific sets of issues related to the increasing interaction between countries through trade of intermediates in the world economy:

1. Measuring the effects on income and job generation in production across and within countries (socio-economic indicators)
2. Measuring the effects on natural resource use and the shifting location of pollution associated with production (environmental indicators).

The aim of the workshop was to take stock of the progress being made so far, and to discuss opportunities for further developments. It might seem strange at first glance to combine these two types of indicators in one workshop, but the common background is that several socio-economic and environmental indicators are currently being constructed with the same type of data, namely input-output tables. Previous work in the FP7 World Input-Output Database project (WIOD) highlighted that much progress could be made by considering both sets of indicators together within a similar data framework, and using similar methodologies. Not only did it improve both types of measures, it also provided the opportunity to for the first time to link both sets in a coherent framework.

By bringing together various researchers, national statistical institutes, the OECD and other stakeholders (see list of participants), the workshop provided a platform to showcase on-going efforts both within FP7 funded projects such like WIOD, EXIOPOL and CREA and other initiatives. In particular there was a major effort to coordinate future developments in the creation of a common global input-output database that would encompass all the separate efforts currently undertaken. This database could be used by the public to answer a variety of questions, and to derive new indicators. In particular, national statistical institutes were interested to participate, given that the data needed for deriving these international indicators cannot be collected by themselves, and is currently not available through a public international statistical source (such as Eurostat, OECD or WTO). Thus, for example, in order to calculate carbon footprints, each NSI needs to make assumptions about the production technology and CO_2 emission intensities of imports. The standard assumption is to assume that foreign production processes are the same as the national ones (the “domestic technology assumption”), but this is clearly a gross mistake. Without information on production technology and CO_2 emission intensities in other countries, no proper estimations can be made. This highlights the importance of creating a common database that can be

used by all NSIs. While preferably this should be established in an official statistical body, it is clear that much more research and testing are needed before such an endeavor could succeed. The workshop aimed to contribute to this.

This report is structured as follows. In Section 2 we take stock of current activity in this field. It should be obvious that we will not provide an overview of past developments. Overviews of these were written last year by OFCE (Deliverable 6.1) on socio-economic indicators and trade in value added, and by Statistics Netherlands (Deliverable 6.2) on environmental accounts. This will not be repeated here. Instead, we will focus on new work and some highlights from the research that was presented during the workshop. In Section 3 we will discuss the open issues regarding future developments of the indicators. It seems clear that by now the methods and frameworks to derive the indicators are well established. The main concern is that the accuracy of the empirical implementation will depend on the quality of the data. Another (related) concern is that findings could significantly differ if different databases and assumptions are used. At the conference much attention was paid to this issue. In particular we will report on the ongoing discussions amongst a worldwide research consortium (led by Manfred Lenzen of the University of Sydney, with participation of FP7-funded researchers like Arnold Tukker and Bart Los, among many others) to establish a meta-database of global input-output tables. This section will also include a discussion of future research needs at the European level. Section 4 will conclude the report.

2. Main findings of the workshop

In this section we provide the main findings of the workshop by highlighting new research that was presented and discussed at the workshop. Section 2.1 covers the socio-economic indicators, and section 2.2 the environmental indicators.

2.1 Indicators of income and jobs in the global economy

The competitiveness of nations is a topic that frequently returns in mass media, governmental reports and discussions of economic policy. While specific definitions of national competitiveness are much debated, most economists would agree that the concept refers to a country's ability to realize income and employment growth without running into long-run balance of payments difficulties. The ability of advanced nations to maintain "good jobs" in the face of rising global competition is a longstanding concern. The unleashing of the market economy in China and India added to global competitive pressures, casually linked to dwindling manufacturing employment in traditional strongholds in Western Europe, Japan and the US and curtailing development opportunities for other emerging economies such as in Eastern Europe. Slow recovery after the global financial crisis in 2008 fuelled demands for more active industrial policies to restore competitiveness around the world. Rebuilding the competitive strengths of Europe, and in particular curbing the divergence between Northern and Mediterranean countries, is therefore high on the European policy agenda (see e.g. Bobeica and di Mauro, 2013).

To track developments in competitiveness, shares in world export markets are traditionally used as the main indicator. However, this measure is increasingly doubted in a world with increasing fragmentation of production across borders. To reflect this change in the nature of competition, a new measure of competitiveness is needed that is based on the value added in production by a country, rather than the gross output value of its exports. Or as put by Grossman and Rossi-Hansberg (2006, p.66-67): "[But] such measures are inadequate to the task of measuring the extent of a country's international integration in a world with global supply chains…we would like to know the sources of the value added embodied in goods and the uses to which the goods are eventually put." While this problem is known to exist for quite a while, only recently new methods and datasets have been developed that allows one to approach this issue. An overview of the state-of-the-art in this field was written last year by OFCE (Deliverable 6.1) and will not be repeated here. Instead, we will discuss developments since then, and in particular relying on a large scale study of European compeittiviness carried out by Timmer, Los, Stehrer and de Vries (2013) which was presented at the workshop. This work is building upon the method developed in a previous FP7 project (The World Input-Output Database -WIOD- project was funded by the European Commission, Research Directorate General as part of the 7th Framework Programme, Theme 8: Socio-Economic Sciences and Humanities. Grant Agreement no: 225 281).

Timmer et al. (2013) introduced a new concept that allows one to analyze the value that is added in various stages of regionally dispersed production processes. It is defined as the income generated in a country by participating in global manufactures production, abbreviated by the term *GVC income*. Compared to traditional competitiveness indicators like a country's share in world exports, this new metric has three advantages. First, it indicates to what extent a country can compete with other nations in terms of *activities* related to global manufacturing, rather than competing in manufacturing *products* as measured by exports. These activities take place in manufacturing industries, but also in services industries. Second, it is a reflection of an economy's strength to compete in both domestic and global markets. Third, income and employment effects of trade in tasks for separate groups of workers (such as low- and high-skilled) can also be determined in the same unified framework, called *GVC jobs*.

2.1.1 Methods and data

At the workshop, the authors first explained how one could model the concept of GVC incomes and GVC jobs (see Figure 1). A global value chain of a final product is defined as all tasks that are directly and indirectly needed to produce it. This GVC is identified by the industry-country where the last stage of production takes place before delivery to the final user (e.g. iPods from Chinese electronics manufacturing, or cars from German transport equipment manufacturing). The price paid by final users for a particular product will end up as income for all labor and capital employed in its GVC. This is illustrated in Figure 1. It depicts a simplified GVC of a final product from country 3, which includes tasks in country 3, as well as in countries 1 and 2. To produce the good, domestic labor and capital is needed in the industry where the last stage of production takes place and in other domestic industries that deliver intermediates. By summing overall value that is added by domestic labor and capital, the domestic value added content of the product can be calculated. Embodied in imported intermediates, capital and labor in country 2 also contribute to the value of the final product, and similarly value is added in country 1, together making up foreign value added. By construction, the sum of domestic and foreign value added will equal the final product value.

Subsequently, the authors showed how GVC income can be derived empirically from a world input-output table. By modeling the world economy as an input-output model in the tradition of Leontief (1936), they can use his seminal insight and trace the amount of factor inputs needed to produce a certain amount of final demand. As this method is at the heart of much research done in this tradition and hence in many of the work presented at the conference, it makes sense to explain this method briefly. Leontief started from the fundamental input-output identity which states that all products produced must be either consumed or used as intermediate input in production. This is written as Q=BQ+C where Q denotes a vector of outputs by industry, C is a vector of consumption and investment demand levels by industry output and B a matrix with intermediate input coefficients that describe how much intermediates are needed to produce a unit of output of a given product. BQ is then the total amount of intermediates used. The identity can be rewritten as $Q=(I-B)^{-1}C$ with I an identity matrix. $(I-B)^{-1}$ is famously known as the Leontief inverse. It represents the gross output value of all products that are generated in all stages of the production process of one unit of consumption. To see this, let Z be a vector column of which the first element representing the global consumption of iPods produced in China, and all other elements are zero. Then BZ is the vector of intermediate inputs, both Chinese and foreign, needed to assemble the iPods in China, such as the hard-disk drive, battery and processors. But these intermediates need to be produced as well and B^2Z indicates the intermediate inputs directly needed to produce BZ. This continues until the mining and drilling of basic materials such as metal ore, sand and oil required to start the production process. Summing up across all stages, one derives the gross outputs generated in the production of iPods by $(I-B)^{-1}Z$.

To find the value added by factors the authors additionally need factor inputs per unit of gross output represented in matrix F. An element in this matrix indicates the value added by a particular production factor as a share of gross output. These are country- and industry-specific, for example the value added per dollar of output by labor in the Chinese electronics industry. To find the value added by all factors that are directly and indirectly involved in the production of a particular final good, they multiply F by the total gross output value in all stages of production given above such that: $K = F(I - B)^{-1}C$. A typical element in K indicates the value added in the production of final good c by a factor f located in country i. By the logic of Leontief's insight, the sum over value added by all factors in all countries that are directly and indirectly involved in the production of this good will equal the output value of that product. In this way, the authors have completed the decomposition of final output into the value added by various production factors around the world.

To implement the new GVC metrics, one needs to have a database with linked consumption, production and income flows within and between countries. For individual countries, this type of information can be found in input-output tables. However, national tables do not provide any information on bilateral flows of goods and services between countries. For this type of information researchers have to rely on datasets constructed on the basis of national input-output tables in combination with international trade data. Various alternative datasets have been built in the past of which the GTAP database is the most widely known and used (Narayanan and Walmsley, 2008). Other datasets are constructed by the OECD (Yamano and Ahmad 2006) and IDE-JETRO (2006) (see more on the coordination between these efforts in Section 3). However, all these databases provide only one or a limited number of benchmark year input-output tables, which precludes an

analysis of developments over time. Although national statistical agencies generally provide separate import matrices, there is no detailed break-down of imports by trade partner. For this paper the authors use a new database called the World Input-Output Database (WIOD) that aims to fill this gap. The WIOD provides a time-series of world input-output tables (WIOT) from 1995 onwards, distinguishing between 35 industries and 59 product groups. For the purpose of the project described here, WIOD was extended to cover also the years 2010 and 2011. The structure of a WIOT is given in Figure 2.

Another crucial element for this type of analysis are detailed value-added accounts that provide information on the use of various types of labour (distinguished by educational attainment level) and capital in production, both in quantities and values. While this type of data is available for most advanced OECD countries as a result of the FP6 EU KLEMS project (O'Mahony and Timmer, 2009), it is not for many emerging countries and additional daya was collected and also put up at the WIOD website.

2.1.2 Key findings

Below we discuss some novel findings based on the presentations at the conference, focusing on the European Union economies.

1. *Exports are not domestic incomes*

Figure 3 provides a comparison of real growth rates of manufactures GVC income and manufacturing exports between 1995 and 2008. They find that the strong export performance of some EU countries does not translate into income growth. Gross exports overestimate the competitiveness of countries that rely heavily on imported intermediates, such as Germany and small open economies. This can be understood from our GVC perspective. For example, real gross exports of manufacturing products from Germany increased by 98%, whereas German manufactures GVC income increased only by 7%. This is mainly due to two developments. First, the domestic value added content of German production dropped quickly due to offshoring and increasing imported intermediates (Marin, 2010). At the same time, an increasing share of domestic final demand of manufactures was served by imports as domestic producers could not compete with emerging producers elsewhere. Being "super competitive" in terms of exports does not necessarily generate high domestic incomes.

2. *European comparative advantage is shifting*

Traditional analyses of revealed comparative advantage (RCA) based on gross exports suggested that the European Union was stuck in low- and medium-tech industries (di Mauro and Forster (2008)). In contrast, they find strong changes in comparative advantages of the EU. RCA is calculated as the EU27 share in world GVC income for a product group divided by the EU27 share in world GVC income for all product groups. The EU's comparative advantage is increasingly in activities carried out in global production networks of non-electrical machinery and transport equipment, while declining in the production of non-durables (see Figure 4). EU specializes in high value–added activities such as software, design, branding, and system integration. China and other emerging countries are mainly involved in the assembling, testing and packaging activities that are poorly compensated.

3. Enhanced European specialization in skilled GVC jobs

Many policy concerns surrounding globalization issues are ultimately about "good" jobs. For the EU as a whole, the number of workers involved in the production of manufactures declined by 1.8 million. Based on additional information on the educational attainment level of workers, they analyze the skill level of these jobs. They find that during 1995-2008 there is enhanced specialization in Europe towards higher skilled jobs. The number of high-skilled jobs increased by almost 4 million, medium-skilled jobs grew barely while more than 6 million low-skilled jobs were lost (see Figure 5). This pattern was found in all old EU countries (except for Denmark) and perhaps surprisingly, also for the new EU12 member states. From the perspective of competitiveness, this increase of high-skilled GVC jobs is a clear indication of Europe's ability to realize employment growth in activities that are productive and relatively well paid in a highly competitive international environment. But it also indicates the uneven distributional consequences of fragmentation.

4. European specialization towards jobs in services

The disappearance of manufacturing jobs in advanced nations is occasionally linked to increased production fragmentation and associated offshoring of manufacturing activities. They find that only about half of the jobs involved in the production of manufactures are actually jobs in the manufacturing sector itself, and this is declining in almost all EU countries over the period 1995-2008. For the EU as a whole, the increase in services jobs related to manufactures is even bigger than the decline in manufacturing jobs (Figure 5). This might sound paradoxical but is simply a reflection of the fact that global value chains of manufactures include many activities in other sectors such as agriculture, utilities and business services that provide inputs at any stage of the production process.

5. Increasing value added shares of capital and high-skilled labor in manufactures GVCs

Next they turned to an analysis of the changes in the factor content of manufactures GVCs worldwide. Factor shares are very much present in the political debate as a measure of how the "benefits of globalization" are shared between capital and labor, and between various types of workers. Insofar as fragmentation is driven by arbitraging differences in wages across countries it is expected to have not only an impact on the cross-country distribution of income, but also on the cross-factor income distribution. They focus on the changes in factor shares from 1995 to 2008, a period when growth in Europe and the US was still steady, while booming in emerging countries. They found a strong bifurcation in the factor content of production. The shares of value added captured by capital and high-skilled workers increased by 6.5 per cent and 1.5 per cent, respectively. In contrast, the shares of low- and medium-skilled workers declined by 3.8 and 4.2 per cent. In Figure 6 they provide trends in the share of capital and high-skilled combined on the one hand, and the share of other labor on the other. In 1995, the difference between the two groups was ten percentage points, growing to twenty-five points in 2008. The divergent trend was monotonic with accelerating divergence at the end of the 1990s and again from 2003 to 2006. The latter period coincides with a step up in the global presence of China after its accession to the World Trade Organization in 2001.

2.2 Environmental accounts

Several presentations at the conference dealt with the environmental implications of globalization. Manfred Lenzen (University of Sydney) gave a broad overview of potential future developments in foot-printing research. This type of research traces the environmental implications of consumption.

To set the stage, Lenzen first discussed an article he recently published in *Nature*. It focuses on the link between consumption and biodiversity. He showed that globalization has led to a situation in which consumption by American households threatens 26 species in Australia, while consumption by Australians in its turn threatens 14 species in Malaysia. The international fragmentation of many production processes described in the previous section is a driving force of results like these: the consumption of furniture by Australians lead to deforestation (and hence a threat to the habitat of many types of monkeys, for example) in Malaysia, even if the final products (chairs and tables) are manufactured in Australia itself. In general, rich countries are "importers" of biodiversity threats: the US and Japan are the countries ranked highest on this list, followed by Germany and France. The countries that "export" the threats (i.e., those countries in which biodiversity might decrease most as a consequence of consumption abroad are Madagascar, Thailand and Indonesia. The analysis that led to the results of this biodiversity-footprint analysis is based on the Eora-global input-output tables. The construction philosophy behind the Eora-IO data (www.worldmrio.com) is different from that behind WIOD, but the structure of the dataset is similar (see Section 3 below).

The second application discussed by Manfred Lenzen dealt with carbon footprints for the UK. He showed that CO_2 emissions on UK soil remained stable over the period 1991-2005, or even decreased a bit (depending on the data source). These results for "production-based" emissions were not too bad in the light of international agreements on climate protection. If, however, CO2 emissions in foreign countries caused by UK consumers are considered (but emissions on British territory due to consumption abroad are subtracted), the trend is clearly upward. These so-called "consumption-based" emissions increased by about 14%, over the period analyzed. Apparently, many of the emissions related to consumption by UK households takes place outside the country. Again, this is to a large extent the consequence of increasing fragmentation of production processes, although increasing imports of consumer products (e.g. electronics from Asia) also plays a role. The analysis leading to these results (which had a large impact in British media and politics) was based on global input-output tables of the type depicted in Figure 2 above.

In his discussion of the road ahead for footprint research, Lenzen discussed five items:

1. *More indicators*

By linking other industry-level indicators than carbon emission intensities, job requirements per unit of output or biodiversity threats to global input-output tables, insights into many more phenomena can be obtained. Some of these types of studies have been undertaken recently, others have not been considered in a global input-output context yet. Examples are land and water use, phosphorus emissions, but also issues about occupational health and slavery footprints could be studied.

2. *Higher geographical resolution*

The policy implications of the fundamental differences between "production-based" indicators and "consumption-based" footprints are not only relevant in the international arena. At the subnational level, comparable issues are at stake, in particular when resources and/or consumers are not homogeneously dispersed over a country. Hence, footprint studies for smaller geographical entities would be very welcome. Manfred Lenzen briefly presented some preliminary results using regionalized input-output tables for water and energy footprints for hundreds of detailed districts in Australia, indicating where the consequences of consumption of downtown Sydney citizens are felt.

3. *Collaborative efficient multidisciplinary innovative research*

This issue will be discussed more extensively in Section 3. The cooperation between various groups currently involved in the construction of global input-output databases might lead to the adoption of best-practices, while still maintaining the diversity that makes some databases more appropriate for e.g. economic applications, while other databases are more suitable if environmental research questions must be addressed. Lenzen discussed a pioneering effort of a collaboration between research groups at several universities in Australia (the so-called Nectar-project), which uses advanced information and communication technology to facilitate this cooperation.

4. *Aligned standards/protocols*

Companies and governments still have a hard time in coming up with clear guidelines with regard to how footprints of firms should be measured. One of the issues at stake is the "boundary": which activities should still be considered to be "due to the firm" and which not. As long as no consensus has been reached in the forms of standards and protocols, or these are not sufficiently clear, researchers will also face problems in quantifying footprints of products or firms. A key problem is the trade-off between completeness and required efforts/costs. Figure 7 shows for several products how many activities ("nodes") should be taken into account to arrive at a percentage of the total footprint associated with a product. The fact that the horizontal axis is logarithmic adds strongly to the diminishing returns to taking more nodes into account. Continued cooperation between companies, governments and scientists is needed to arrive at clear standards and protocols. Without such standards, loopholes in reporting can easily decrease the incentives of companies to improve the performance of the supply chain they govern.

5. *Corporate accounting support*

If firms can be offered easily accessible and convenient tools to compute their environmental footprints, more companies (and especially those with 'clean' production processes) will be tempted to label their products. Such labeling (indicating the footprint) will raise awareness of consumers and hence contribute to alleviation of environmental pressures. Researchers can and should contribute to the development of such tools.

6. *Stronger global governance institutions*

Without strong global governance, it will be hard to arrive at consensus on the role that environmental footprints should play in international agreements to fight environmental degradation.

Although much of the disagreements are of a political nature, researchers could still contribute to increasing agreement among policy-makers, by reducing the uncertainty that surrounds footprint computations. Lenzen cited Glen Peters (CICERO, Oslo), who presented Figure 8 in his keynote address to the 2013 International Input-Output Conference. This figure shows estimates for the UK carbon footprint, based on a number of global input-output databases. The graph shows that there is quite some variation. Part of this is due to differences in the international input-output tables that are used (construction philosophies differ, more detailed choices in the construction differ, country coverage and industry detail vary, etc.), but differences in the environmental satellite data also play a role. If IO-tables are identical, but CO_2 emissions per unit of output vary across databases, carbon footprint estimates will not be identical. Peters found that differences in the emissions data are responsible for the biggest chunk of uncertainty, but the differences in global input-output tables are definitely not negligible.

At the workshop, Rutger Hoekstra and co-authors at Statistics Netherlands presented additional results regarding uncertainty. In a much-needed move towards making carbon footprints an official statistic for The Netherlands, the authors started from the WIOD data, but inserted the Dutch national input-output table into it, replacing the "Dutch part" of the WIOD data. They also added more trade data for The Netherlands, which is not available in internationally comparable bilateral trade statistics. After applying balancing procedures to get rid of inconsistencies introduced by this approach, Hoekstra and co-authors arrive at a global input-output table in which the Dutch data are closely resembling the official Dutch statistics, while all inconsistencies in the underlying data material are "moved" to the parts of the input-output table related to other countries. The authors then compute the Dutch carbon footprint and make comparisons with those obtained by using the original WIOD data. The results in Figure 9 suggest that there are differences indeed, in particular with respect to the difference in the extent to which the CO2 emissions associated with Dutch consumption are taking place domestically or elsewhere. The higher level of aggregation in WIOD and the different environmental indicators used do not explain much. Most probably, the differences are mainly due to the use of superior but not publicly available data on re-exports, which is an important phenomenon for The Netherlands. Reduction of uncertainties in estimates of footprints is one of the essential steps to be made in the near future. Section 3 will discuss steps to attain this, among other things.

3. Current initiatives to improve indicators and future research needs

Many of the participants at the workshop are active participants of the so-called Réunion-project, which brings researchers in various global input-output database construction efforts together. The project started in March 2011 and was initially funded by the Australian Research Council. The general aim of the project is to learn from each other and to proceed towards a cooperation that facilitates timely updates of global input-output tables, harmonization of methods when possible without harming the possibilities to address very different research questions and exchanging data and ideas. Just before the workshop, the group met for its third meeting, immediately following the 21st International Input-Output Conference in Kitakyushu, Japan. The participants were:

- Robbie Andrew (CICERO, Oslo; researcher contributing to the construction of global IO-tables based on GTAP-data)
- Arne Geschke ((University of Sydney; data constructor and hardware-expert in the Eora-project)
- Satoshi Inomata (IDE, Tokyo; leads various projects constructing IO-tables for East-Asia, also at subnational level)
- Manfred Lenzen (University of Sydney; leader of the Eora-project, initiated the Réunion-project)
- Bart Los (University of Groningen; co-leader of WIOD, FP7-funded)
- Bo Meng (IDE, Tokyo; participates in various projects constructing IO-tables for East-Asia, also at subnational level)
- Glen Peters (CICERO, Oslo; leader of projects to construct global IO-tables using GTAP-data)
- Arnold Tukker (TNO Delft and NTNU Trondheim; a.o. leader of EXIOPOL and CREA projects, both FP7-funded)
- Thomas Wiedmann (University of New South Wales, Australia; heavy user of global input-output tables for footprinting)
- Norihiko Yamano (OECD; heavily involved in OECD/WTO's Trade in Value Added database)

Erik Dietzenbacher (University of Groningen, co-leader of the WIOD-project) could not attend this meeting, but is one of the founders of the Réunion-project).

3.1 New developments regarding international input-output databases

The meeting started by taking stock of the various current projects related to the construction of global input-output tables. Arnold Tukker is involved in a large number of projects, with a strong focus on environmental applications. One of these projects is the *DESIRE*-project, which aims at developing indicators for a resource-efficient Europe. A workpackage is aimed at constructing a time series of environmentally extended input-output tables, largely following the approaches chosen in the EXIOPOL project. Specific attention will be paid to developing improved ways of estimating transport margins. The *CarbonCap*-project partly aims at doing uncertainty analyses for environmental footprints, but will also borrow from the *EXIOMOD*- and *EMINEM*-projects, which develop full-fledged computable general equilibrium models for policy evaluation. The *COMPLEX*-project also uses EXIOMOD for its economic module, but studies future environmental scenarios using agent-based modeling.

Other projects with a strong environmental flavor have been initiated at *CSIRO* in Australia, linking a material flow analysis database to the Eora database. *CICERO* (Glen Peters and Robbie Andrew) are linking GTAP to a temperature satellite account, translating lessons from climate model uncertainty to uncertainty surrounding estimates based on global input-output tables. *Defra* and *Statistics Netherlands* have started projects to integrate "superior" national data for the UK and The Netherlands into Eora and WIOD, respectively (see Section 2.2 above, for Statistics Netherlands' activities in this respect).

A few projects with a stronger focus on economic studies are running as well. OECD and WTO released a set of derived indicators on trade in value added (the *TiVA* database), based on global

input-output tables. The country coverage is more extensive than in WIOD. The global input-output tables themselves are not out yet. In collaboration with the UN, the HS and BEC classifications for bilateral trade in goods will be improved. UNCTAD adapted the Eora-database to make it suitable for studying trade in value added for developing and emerging countries. This *UNCTAD-Eora* database is not public. *GTAP* released version 8.1 of its database just before Summer. It aims to improve on the trade in services statistics. Finally, two important initiatives to analyze the effects of the increasing importance of Global Value Chains on (subnational) regions are about to start. As part of the EC-sponsored FP7-project Smartspec, a time-series of interregional IO-tables for a substantial part of the EU will be constructed. *IDE-JETRO* (in cooperation with the US International Trade Commission, and probably Tsinghua University and Nagoya University) started a similar project for regions in Japan, China and South Korea, which will not only focus on economic issues, but will also consider environmental questions.

3.2 Intensive cooperation project

The Australian Research Council (ARC) has funded a so-called Virtual Laboratory project to bring global input-output tables together in one collaborative environment, which will allow the participants of the Réunion-project to more effectively undertake comparisons between databases produce updates etc., and ultimately support policy. Manfred Lenzen, Arne Geschke and Thomas Wiedmann have positive experiences with the Industrial Ecology Virtual Laboratory, which is aimed at building an interregional environmentally extended supply and use framework for Australia. Participants contribute data in a cloud environment and indicate what constraints they would like to use to build the table. Such constraints provide information to the general and flexible data construction algorithm how large the supply and use table will be in terms of industries, products and regions. A different type of information conveyed to this algorithm by the constraints is how it should deal with inconsistencies in the data that are fed to it. For example, should it adapt bilateral trade to ensure that these are in line with national accounts data on trade (the choice made in the construction of the WIOD data), or should it rescale national accounts data in order to be compliant with bilateral trade data (as is roughly done in the construction of GTAP's data)? The development phase of the Industrial Ecology Virtual Laboratory is just over halfway. The Virtual Laboratory project for global input-output tables can benefit from knowledge about initial problems encountered in the IE Virtual Laboratory.

In order to get started, Réunion project representatives (at least those who are willing and in the position to contribute data) will send flowcharts of their data construction efforts to project leader Manfred Lenzen. Based on these charts, the group will try to arrive at a common set of definitions and labels, in order to facilitate efficient communication. Next to this, three PhD-students will visit the project groups, to get deeper insights into the construction methods and to discuss potential alternatives. Issues regarding Intellectual Property Rights have been discussed and might lead to less than full participation of one or two project groups.

If the Virtual Laboratory would turn out to be successful, at least two negative aspects of the current state of affairs could be addressed. First, the joint availability of data form various projects that go into the algorithm can be used to further assess the relative importance of sources of uncertainty in footprint calculations, which should be reduced in order to increase the relevance of the results of these calculations for policy-making (see Section 2.2). So far, uncertainty of results obtained for economic studies have not received as much attention, but this will most probably be

just a matter of time (USITC's Zhi Wang and co-authors recently were the first to compare some results regarding GDP for GTAP, WIOD and OECD). Second, the availability of the Virtual Laboratory should enhance the timeliness of the global input-output tables. Data constructors would no longer have to bother about the time-consuming construction steps, because these will be automated. Instead, they can try to find satisfactory solutions for more fundamental problems in producing time series of mutually comparable global input-output tables: the SNA2008 treats export processing activities (such as the maquiladora in Mexico, see Juan Carlos Castillo's contribution to the workshop, and in China's processing exports industry, see Yuwan Duan's presentation at the workshop) in a radically different way than the SNA1993, and the change from the industry classification ISIC3 to ISIC4 leads to equally problematic issues to cope with.

3.3 Desirable additional data

The discussions at the workshop also highlighted the limitations of the GVC income and jobs measures for a full understanding of the causes and effects of globalization on jobs and incomes. Various new initiatives were discussed, some of which are basically extensions of the current approach, whereas others would require a new framework for thinking and measuring. High on the agenda is the extension of the so-economic indicators by measures of job characteristics. While it is acknowledged that the educational attainment level of workers is an important element in devising various policies and strategies, there is an increasing need for more detailed characteristics of jobs. From an activity perspective on GVCs, one would like to know what type of activities workers carry out in GVCs. This would require data on the job characteristics such as can be found in occupation descriptions. Data on occupations is internationally standardized through the ISCO. The International Standard Classification of Occupations (ISCO) is one of the main international classifications for which ILO is responsible. It is a tool for organizing jobs into a clearly defined set of groups according to the tasks and duties undertaken in the job. It is felt that the current statistics fall short of this goal, however. One reason is that the ISCO classification has not been revised for a long time. Most statistics for the 1990s and 2000s are only available in the ISCO88, which was not detailed enough to capture the rapid changes in worker activity in this period. This was recognized and an updated classification was adopted in December 2007 and is known as ISCO-08. Many countries are now updating their national classification either based on ISCO-08, to improve alignment with the new international statistical standard. It will take a while before international comparable data will be available.

Other areas for improvement are in the domestic versus national concept of the analysis. Current analysis is based on the location where value is added. However, the location where the value is added is not necessarily identical to where the generated income will eventually end up. The building of global value chains is not only through arms-length trade in intermediate inputs, but also involves sizeable flows of investment and part of the value added in emerging regions will accrue as income to multinational firms headquartered in advanced regions. To analyze capital income on a national rather than a domestic basis as in this paper data on foreign ownership is needed. This type of information is notoriously hard to acquire, not in the least due to the notional relocation of profits for tax accounting purposes, and further research is needed in this area (Baldwin and Kimura, 1998; Lipsey 2010). A similar, but empirically less relevant issue is the nationality of workers and migrant labor. The OECD is developing initiatives to improve this type of data (OECD 2013).

Another area is the increasing importance of intangible investment. Traditionally, capital was considered mainly as a set of physical assets, such as machinery, transport equipment and buildings. Recent investment in advanced countries is increasingly directed towards intangible capital such as intellectual capital (including software and databases, R&D and design), brand names and organizational capital (which is specific to firms). Intangible assets are built up through investment just like tangibles, but in contrast to the latter often have the characteristic of non-rivalness: this implies that they can be employed by many users simultaneously, without diminishing the quantity available to any single user, such as a software system to automate orders. Various intangibles are proprietary knowledge and exhibit non-rivalness only within a firm's boundary, such as brand equity and organizational competencies. They are valuable, at least in part, because the firm is able to exclude competitors from gaining access to key information and technology. Deployment of intangibles typically gives rise to imperfect product markets and possibilities for mark-ups. When firms operating in such an environment enlarge their scale of operations, capital is likely to gain more relative to labor, as wages are determined in more competitive markets.

In a detailed data exercise Corrado et al. (2012) find that averaged over 1995 to 2009, investment in intangibles in the EU15 was about around 62 per cent of investment in tangibles. For the US, investment in intangibles was found to be even higher than in tangible capital. At the European level the INTAN-INVEST initiative (http://www.intan-invest.net/) is a follow-up to two FP 7 projects, and dedicated to create a harmonized dataset on intangible investments across the EU and the US. Further integration with this type of work would strengthen the current analyses and coordination is taking place through the Conference Board.

Finally, it is important to note that there is pioneering work going on at Eurostat in developing a new survey on business functions (http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/International_sourcing_of_business_functions). This new survey distinguish various sets of activities firms can carry out potentially, called *business functions:* Primary functions (leading to product intended for sale and yielding revenue) versus support functions (other indirect activities). An advantage is the fit with the activity-based view of GVC theory; Data seems to be relatively easy to collect through company information systems.

4. Conclusions

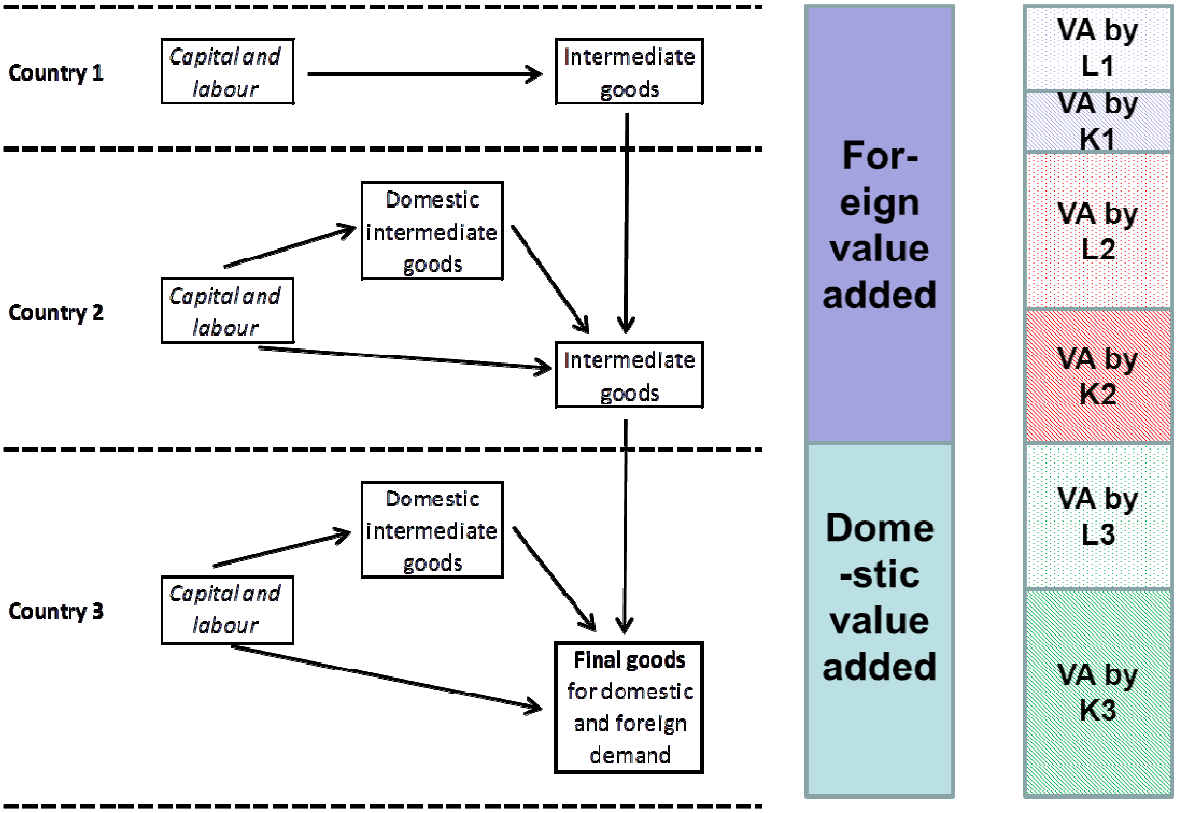
The workshop brought together a large number of people working in the field of empirical analysis of the impact of globalization on income, jobs, and the environment. It contributed to the common opinion that the recent construction of datasets with global input-output tables and associated indicators should only have been the start of lines of research that should yield much deeper insights and an increased capability to inform policy-makers. A number of new projects is underway and the open and collaborative relationships between research groups (as evidenced by the Réunion project and the more recent Virtual Laboratory initiative) leads to promising avenues for further progress.

Many other data collection efforts would be worthwhile, but it is essential to understand that individual researchers cannot get such jobs done. These require inputs from international research consortia. Hence, fast progress in measuring the economic and environmental impacts of ongoing globalization is almost impossible without continued funding from international organizations. The proof-of-concept of the feasibility and desirability of particular databases has been (and continues to

be) delivered by the academic community. And this should be firmly grounded in active follow up by national and international statistical institutes. Continuing dialogue between policy makers, the statistical communities and the academic community are needed. While this is a long and arduous process, it seems to be the most promising way of arriving at evidence-based policies. The potential gains are clear.

Appendix Figures

Figure 1 Factor content of a global value chain: graphical representation



Note: The lefthand side of this figure depicts a simplified flow of inputs needed in the production process of a final product that is completed in a particular country (country 3). The stacked bars at the right show how the value of this final product consists of the value added by labor (L) and capital (K) in the domestic economy (country 3) and by labor and capital in foreign countries that deliver intermediate inputs for production, either directly (country 2) or indirectly (country 1).

Figure 2 Schematic outline of World Input-Output Table (WIOT), three regions

		Country A Intermediate *Industry*	Country B Intermediate *Industry*	Rest of World Intermediate *Industry*	Country A Final domestic	Country B Final domestic	Rest of Final domestic	Total
Country A	*Industry*	Intermediate use of domestic output	Intermediate use by B of exports from A	Intermediate use by RoW of exports from A	Final use of domestic output	Final use by B of exports from A	Final use by RoW of exports from A	Output in A
Country B	*Industry*	Intermediate use by A of exports from B	Intermediate use of domestic output	Intermediate use by RoW of exports from B	Final use by A of exports from B	Final use of domestic output	Final use by RoW of exports from B	Output in B
Rest of World (RoW)	*Industry*	Intermediate use by A of exports from RoW	Intermediate use by B of exports from RoW	Intermediate use of domestic output	Final use by A of exports from RoW	Final use by B of exports from RoW	Final use of domestic output	Output in RoW
		Value added	Value added	Value added				
		Output in A	Output in B	Output in RoW				

Figure 3. Growth in real manufacturing exports and manufactures GVC income bettheyen 1995 and 2008 (%)

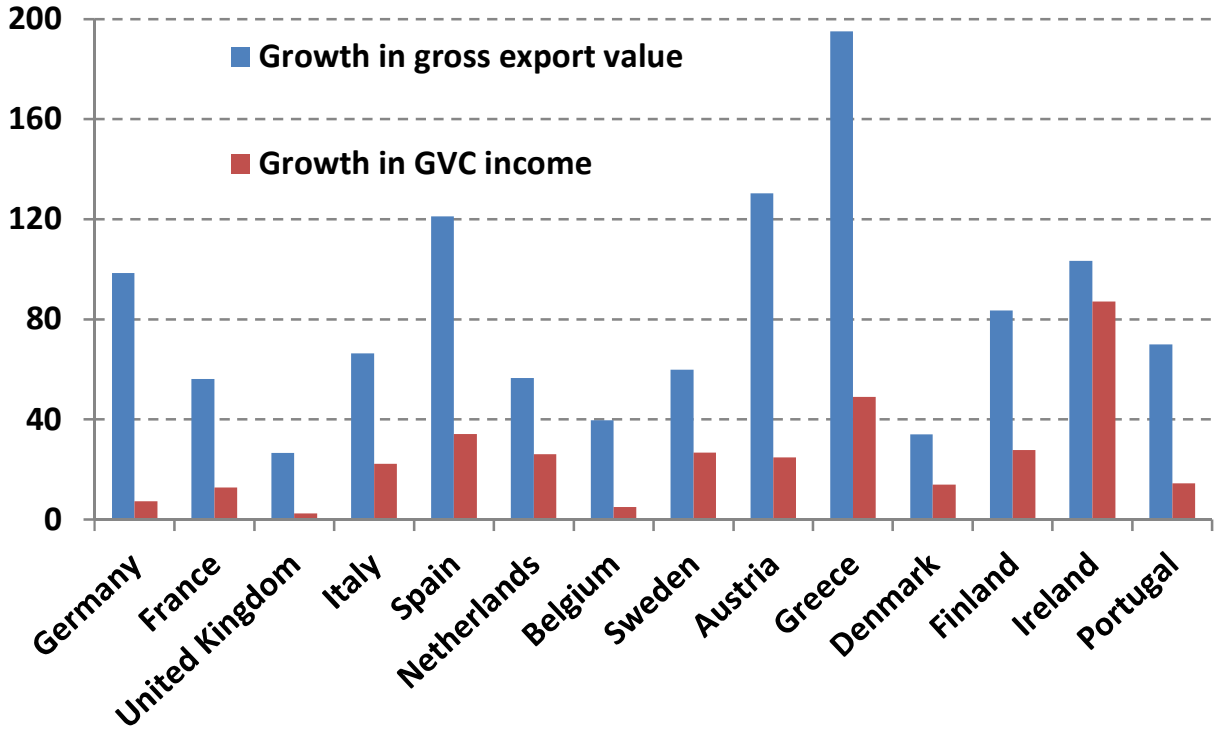
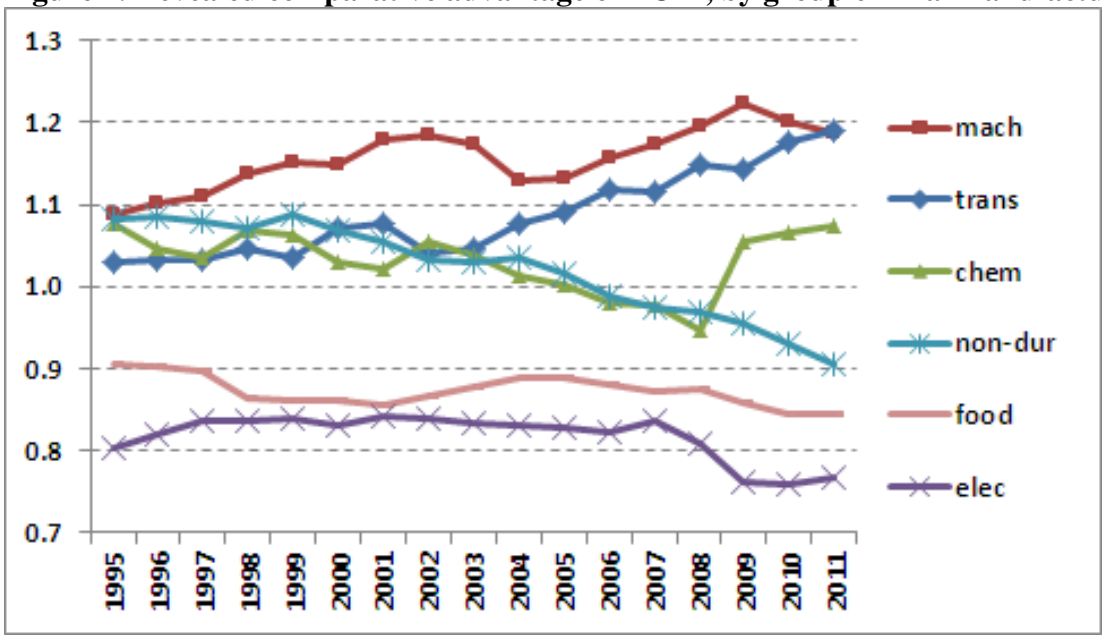


Figure 4. Revealed comparative advantage of EU27, by group of final manufactures (%).



Note: Final food manufacturing products, Other non-durable products; Chemical products; Machinery & metal products; Electrical machinery products and Transport equipment

Figure 5. Change in number of workers in the EU27 involved in manufactures GVCs by sector of employment and by level of educational attainment between 1995 and 2008 (in millions).

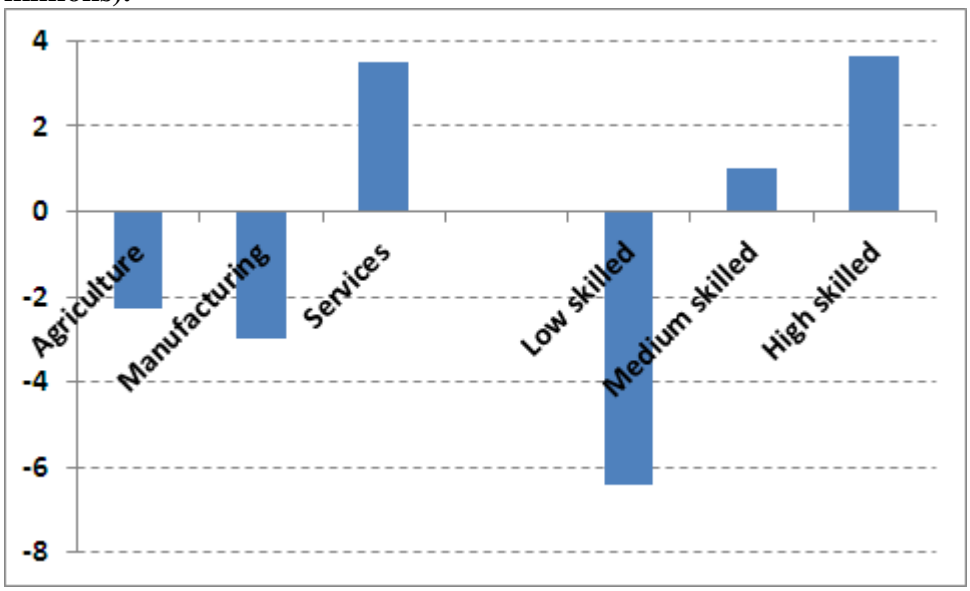
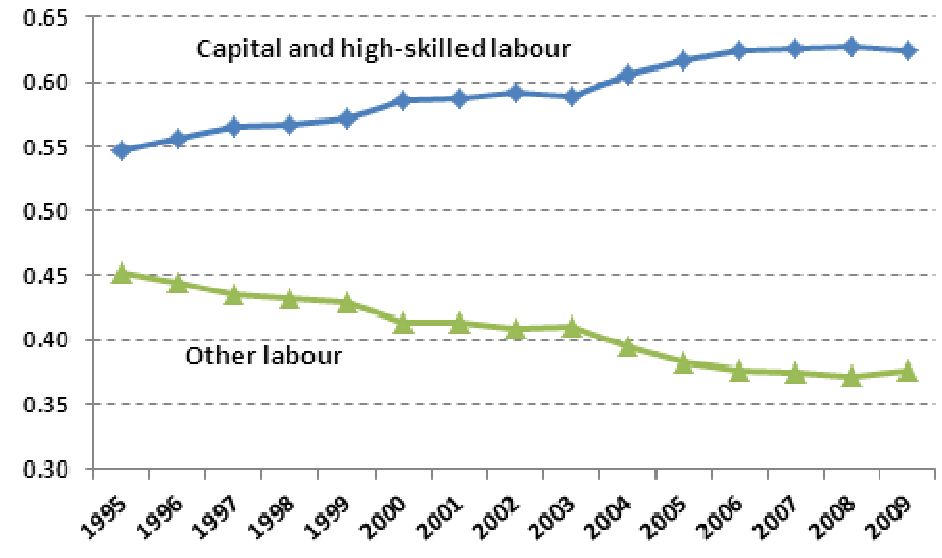
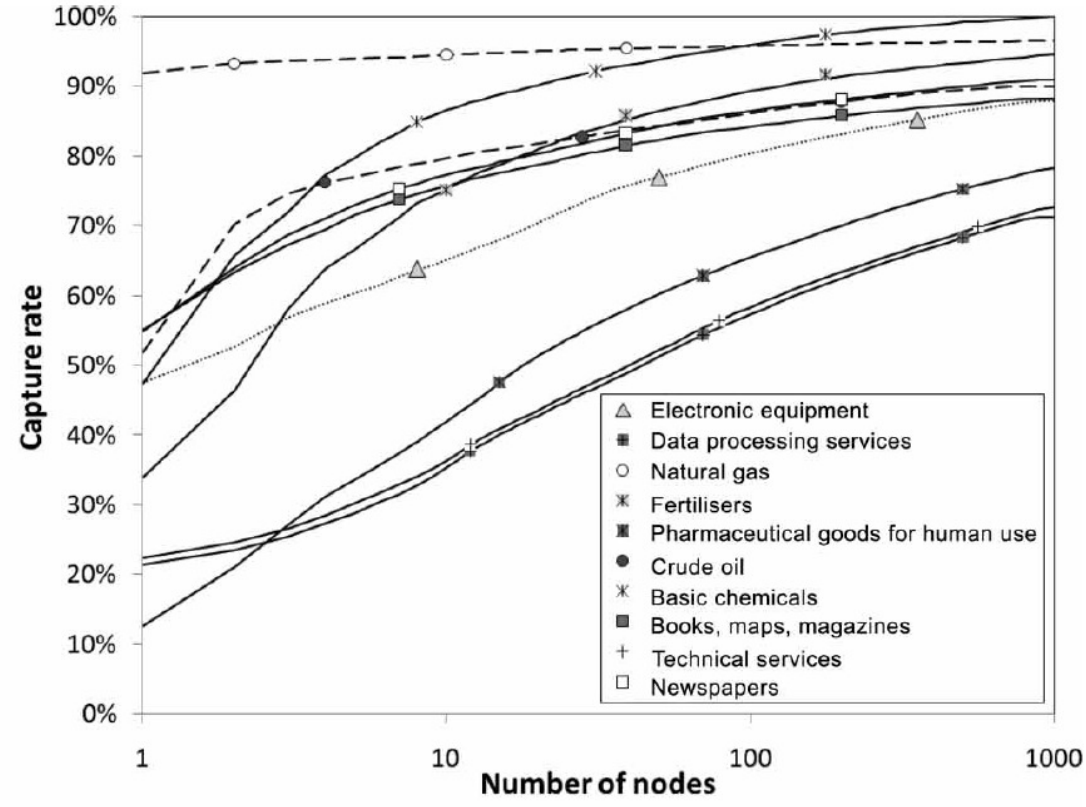


Figure 6 Value added by labour and capital (share of global final manufactures output).



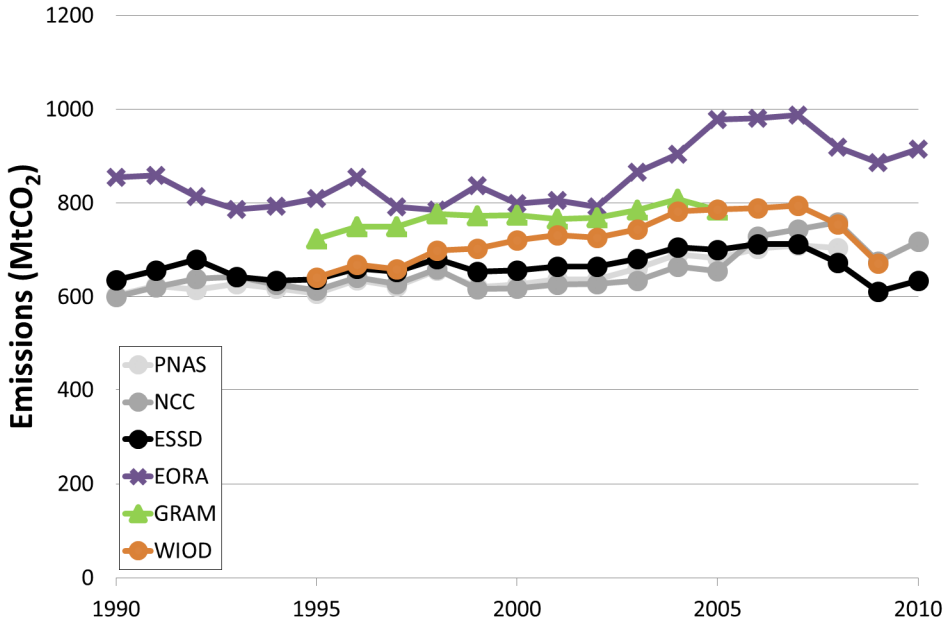
Notes: Value added to global output of final manufacturing goods. Value added by labor is measured as wages and salaries and other employer costs, and includes an imputation for self-employed workers. Capital compensation is residually defined as non-labor value added such that the labor and capital shares add up to one. High-skilled workers are defined as having college education or above.
Source: Author's calculations based on World Input-Output Database, April 2013.

Figure 7: Trade-off between completeness and costs of industry carbon footprints



Source: University of Sydney and Carnegie-Mellon University

Figure 8: Uncertainty in carbon footprint estimates for the UK (various databases)



Source: Glen P. Peters, keynote lecture at the 2013 International Input-Output Conference, Kitakyushu, Japan.

Figure 9: Sources of deviations in carbon footprint estimates for The Netherlands between SNAC (the Hoekstra et al. approach) and WIOD

	SNAC-footprint	Aggregation		CO_2 data		Original WIOD	
No. industries (IO calculations)	71	35		35		35	
CO_2 data	SNAC	SNAC		WIOD		WIOD	
Total Footprint	**198**	**205**	**3%**	**207**	**5%**	**210**	**6%**
Domestic indirect emissions	77	84	8%	86	11%	71	-8%
Domestic direct emissions	38	38	0%	38	0%	39	0%
Total Domestic	**116**	**122**	**5%**	**125**	**8%**	**109**	**-6%**
Total Foreign	**82**	**83**	**1%**	**83**	**1%**	**101**	**23%**

References and background literature

Acemoglu, Daron, and David H. Autor. 2011. "Skills, Tasks and Technologies: Implications for Employment and Earnings." In *Handbook of Labor Economics,* Volume 4B edited by David Card and Orley Ashenfelter, 1043-1171. Amsterdam: Elsevier.

Ali-Yrkkö, Jyrki, Petri Rouvinen, Timo Seppälä and Pekka Ylä-Anttila. 2011. "Who Captures Value in Global Supply Chains?" ETLA Discussion Papers 1240. Helsinki: ETLA.

Ando, Mitsuyo, and Fukunari Kimura. 2005. "The Formation of International Production and Distribution Networks in East Asia." In *International Trade in East Asia*, *NBER-East Asia Seminar on Economics*, Volume 14 edited by Takatoshi Ito, and Andrew K. Rose, 177-216. NBER.

Antràs, Pol and Esteban Rossi-Hansberg. 2009. "Organizations and Trade." *Annual Review of Economics*, 1 (1): 43-64.

Antràs, Pol, Davin Chor, Thibault Fally and Russell Hillberry. 2012. "Measuring the Upstreamness of Production and Trade Flows." *American Economic Review Papers and Proceedings*, 102(3): 412-416.

Autor, David H, Frank Levy and Richard J. Murnane. 2003. "The Skill Content of Recent Technological Change: An Empirical Exploration." *The Quarterly Journal of Economics*, 118 (4): 1279-1333.

Baldwin, Richard E. 2006. "Globalisation: The Great Unbundling(s)." In *Globalisation Challenges for Europe*, Helsinki: Office of the Prime Minister of Finland.

Baldwin, Robert E., and Fukunari Kimura. 1998. "Measuring U.S. International Goods and Services Transactions." In *Geography and Ownership as Bases for Economic Accounting* edited by Robert E. Baldwin, Robert E. Lipsey, and J. David Richardson, 49-80. Chicago: NBER.

Baldwin, Richard E. and Simon J. Evenett. 2012. "Value Creation and Trade in 21st Century Manufacturing: What Policies for UK Manufacturing?". In David Greenaway (ed.) *The UK in a Global World; How Can the UK Focus on Steps in Global Value Chains that Really Add Value?* (London: Centre for Economic Policy Research), 71-128.

Bems, Rudolfs, Robert C. Johnson, and Kei-Mu Yi. 2011. "Vertical Linkages and the Collapse of Global Trade." *American Economic Review* 101(3): 308–12.

Blanchard, Oliver J. 1997. "The Medium Run." *Brookings Papers on Economic Activity*, 28(2), 89-158.

Blinder, Alan S. 2009. "How Many US Jobs Might Be Offshorable?" *World Economics* 10 (2): 41–78.

Corrado, Carol, Charles Hulten, and Daniel Sichel. 2005. "Measuring Capital and Technology: An Expanded Framework." In *Measuring Capital in the New Economy,* edited by Carol Corrado, John Haltiwanger, and Daniel Sichel, 11-46. The University of Chicago Press.

Corrado, Carol, Jonathan Haskel, Cecilia Jona-Lasinio, and Massimiliano Iommi. 2012. "Intangible Capital and Growth in Advanced Economies: Measurement Methods and Comparative Results." CEPR Discussion Papers 9061.

Costinot, Arnaud, Jonathan Vogel, and Su Wang. 2012. "Global Supply Chains and Wage Inequality." *American Economic Review* 102(3): 396–401.

Deardorff, Alan V. 2001. "Fragmentation Across Cones." In Fragmentation. New Production Patterns in the World Economy, edited by Sven W. Arndt, and Henryk Kierzkowski. Oxford: Oxford University Press.

Dedrick, Jason, Kenneth L. Kraemer and Greg Linden. 2010. "Who Profits From Innovation in Global Value Chains? A Study of the iPod And Notebook PCs", *Industrial and Corporate Change*. 19 (1): 81-116.

Dietzenbacher, Erik, and Isidoro Romero. 2007. "Production Chains in an Interregional Framework: Identification by Means of Average Propagation Lengths." *International Regional Science Review*, 30(4): 362-383.

Dietzenbacher, Erik, Bart Los, Robert Stehrer, Marcel P. Timmer, and Gaaitzen J. de Vries. 2013. "The Construction of World Input–Output Tables in the WIOD Project." *Economic Systems Research* 25(1): 71-98.

Feenstra, Robert C. 1998. "Integration of Trade and Disintegration of Production in the Global Economy", *Journal of Economic Perspectives*, 12(4): 31–50.

Feenstra, Robert C. 2010. *Offshoring in the Global Economy: Microeconomic Structure and Macroeconomic Implications*. Cambridge: MIT Press.

Feenstra, Robert C., and Gordon H. Hanson. 1996. "Foreign Investment, Outsourcing and Relative Wages." In *The Political Economy of Trade Policy: Papers in Honor of Jagdish Bhagwati*, edited by Robert C Feenstra, Gene M. Grossman and Douglas A. Irwin. 89-127. Cambridge: MIT Press.

Feenstra, Robert C., and J. Bradford Jensen. 2012. "Evaluating Estimates of Materials Offshoring from U.S. Manufacturing." NBER Working Papers 17916.

Francois, Joseph, and Bernard Hoekman. 2010. "Services Trade and Policy." *Journal of Economic Literature* 48(3):642-692.

Fukao, Kyoji, Hikari Ishido and Keiko Ito. 2003. "Vertical Intra-Industry Trade and Foreign Direct Investment in East Asia." *Journal of the Japanese and International Economies*, 17(4): 468-506.

Gereffi, Gary. 1999, "International Trade and Industrial Upgrading in the Apparel Commodity Chain." *Journal of International Economics*, 48(1):37–70.

Goldberg, Pinelopi Koujianou, and Nina Pavcnik. 2007. "Distributional Effects of Globalization in Developing Countries." *Journal of Economic Literature* 45(1):39-82.

Gollin, Douglas. 2002. "Getting Income Shares Right." *Journal of Political Economy* 110(2): 458-474.

Gordon H. Hanson. 2012. "The Rise of Middle Kingdoms: Emerging Economies in Global Trade." *Journal of Economic Perspectives* 26(2): 41-64.

Grossman, Gene M, and Esteban Rossi-Hansberg. 2007. "The Rise of Offshoring: It's Not Wine for Cloth Anymore." In *The New Economic Geography: Effects and Policy Implications* Federal Reserve Bank of Kansas City

Grossman, Gene M, and Esteban Rossi-Hansberg. 2008. "Trading Tasks: A Simple Theory of Offshoring." *American Economic Review* 98(5): 1978-1997.

Hanson, Gordon H., Raymond J. Mataloni, and Matthew J. Slaughter. 2005. "Vertical Production Networks in Multinational Firms." *The Review of Economics and Statistics* 87(4): 664-678

Harrison, Ann, John McLaren, and Margaret McMillan. 2011. "Recent Perspectives on Trade and Inequality." *Annual Review of Economics* 3(1):261-289.

Haskel, Jonathan, Robert Z. Lawrence, Edward E. Leamer, and Matthew J. Slaughter. 2012. "Globalization and U.S. Wages: Modifying Classic Theory to Explain Recent Facts." *Journal of Economic Perspectives* 26(2): 119-40.

Helpman, Elhanan, and Paul Krugman. 1985. "Market Structure and Foreign Trade: Increasing Returns, Imperfect Competition, and the International Economy." Cambridge MA: MIT Press

Hummels, David., Jun Ishii, and Kei-Mu Yi. 2001. "The Nature and Growth of Vertical Specialization in World Trade." *Journal of International Economics*, 54(1): 75-96.

Johnson, Robert C., and Guillermo Noguera. 2012a. "Accounting for Intermediates: Production Sharing and Trade in Value Added." *Journal of International Economics* 86(2): 224-236.

Johnson, Robert C., and Guillermo Noguera. 2012b. "Fragmentation and Trade in Value Added over Four Decades." NBER Working Paper 18186.

Jorgenson, Dale W. 2001. "Information Technology and the U.S. Economy." *American Economic Review* 91(1): 1-32.

Koopman, Robert, Zhi Wang, and Shang-Jin Wei. Forthcoming. "Tracing Value-added and Double Counting in Gross Exports," *American Economic Review*

Krugman, Paul. 1995. "Growing World Trade: Causes and Consequences." *Brookings Papers on Economic Activity* 26(1): 327-377.

Lenzen M, Moran D, Kanemoto K, Foran B, Lobefaro L and Geschke A. 2012. International trade drives species threats, *Nature* **486**, 109–112

Lenzen M, Moran D, Kanemoto K and Geschke A. 2013. "Building Eora: A global multi-region input-output database at high country and sector resolution", *Economic Systems Research* 25 (1), 20-49, 2013.

Leontief, Wassily. 1936. "Quantitative Input-Output Relations in the Economic System of the United States." *Review of Economics and Statistics* 18(3): 105-125.

Lewis, W. Arthur. 1954. "Economic Development with Unlimited Supplies of Labour." *The Manchester School* 22 (2): 139–191.

Lipsey, Robert E. 2010. "Measuring The Location of Production in a World of Intangible Productive Assets, FDI and Intrafirm Trade." *Review of Income and Theyalth* 56(s1): S99-S110.

Los, Bart, Gaaitzen J. de Vries, and Marcel P. Timmer. 2013. "Made in Europe? Trends in International Production Fragmentation." GGDC Research Memorandum GD-131. Groningen: Groningen Growth and Development Centre, University of Groningen.

Marin, Dalia. 2011. "The Opening Up of Eastern Europe at 20: Jobs, Skills, and 'Reverse Maquiladoras'." In *International Handbook on the Economics of Integration, Volume I Competition, Spatial Location of Economic Activity and Financial Issues* edited by Miroslav N. Jovanovic. Edward Elgar.

McGrattan, Ellen R., and Edward C. Prescott. 2009. "Openness, Technology Capital, and Development." *Journal of Economic Theory* 144 (6): 2454–76.

Miller, Ronald E., and Peter D. Blair. 2009. "Input-output Analysis: Foundations and Extensions." Cambridge, Cambridge University Press.

O'Mahony, Mary, and Marcel P. Timmer. 2009. "Output, Input and Productivity Measures at the Industry Level: the EU KLEMS Database." *Economic Journal* 119(538): F374-F403.

Rodrik, Dani. (1997), "Has Globalisation Gone Too Far?" Washington DC: Institute for International Economics.

Timmer, Marcel P. ed. 2012. "The World Input-Output Database (WIOD): Contents, Sources and Methods." WIOD working paper 10. http://www.wiod.org/publications/papers/wiod10.pdf.

Timmer, Marcel P., Bart Los, Robert Stehrer and Gaaitzen J. de Vries. 2013. "Fragmentation, Incomes and Jobs. An analysis of European competitiveness." GGDC Research Memorandum GD-130. Groningen: Groningen Growth and Development Centre, University of Groningen.

Venables, Tony and Richard Baldwin, 2010. "Relocating the value chain: off-shoring and agglomeration in the global economy," CEPR Discussion Papers 8163, revised 2012

APPENDIX 1: Program of the workshop

(slides and papers are available online at http://www.rug.nl/research/ggdc/workshops/eframe/e-frame-workshop)

Thursday July 18

8.55 *Welcome*

Session 1 (Chair: Marcel Timmer)
9.00 – 9.35
Bruno Merlevede (Ghent University and HU Brussel) and Bernhard Michel (Federal Planning Office, Brussels)
Downstream Offshoring and Firm-Level Employment: Evidence for Belgian Manufacturing Firms

9.35 – 10.10
Eiichi Nakazawa (OECD, Paris), Norihiko Yamano (OECD, Paris) and Colin Webb (OECD, Paris)
Sources of Trade in Value Added of ICT Goods and Services: Does Skill Building Matter to Comparative Advantage?

10.10 – 10.25
Short Presentation Yuwan Duan (University of Groningen), Erik Dietzenbacher (University of Groningen) and Bart Los (University of Groningen)
Change of National Content in China's Exports

10.25 – 10.40
Short presentation Juan-Carlos Castillo (Maastricht University) and Gaaitzen de Vries (University of Groningen)
The Domestic Content of Mexico's Maquiladora Exports: 1981-2006

10.45 – 11.15
Coffee break

Session 2 (Chair: Marcel Timmer)
11.15 – 12.15
Keynote Lecture
Johannes van Biesebroeck (University of Leuven) and Alexander Schmitt (University of Leuven)
Relationship Governance in the Automotive Supply Chain

12.15 – 13.30
Lunch

Session 3 (Chair: Rutger Hoekstra)
13.30 – 14.05
Mark Meyer (GWS Osnabrück) and Martin Distelkamp (GWS Osnabrück)
Macroeconomic Modelling of the Global Economy-Energy-Environment Nexus

14.05 – 14.40
José Manuel Rueda-Cantuche (Pablo de Olavide University), Iñaki Arto (JRC-IPTS, Sevilla), Valeria Andreoni (JRC-IPTS, Sevilla), Ignazio Mongelli (JRC-IPTS, Sevilla), Aurélien Genty (JRC-IPTS, Sevilla) and Alejandro Villanueva (JRC-IPTS, Sevilla)
The Game of Trading Jobs for Emissions

14.40 – 15.15
Arnold Tukker (TNO, Delft, and NTNU, Trondheim)
CREEA - Compiling and Refining Environmental and Economic Accounts

15.15 – 15.45
Tea Break

Session 4 (Chair: Erik Dietzenbacher)
15.45 – 16.20
Marcel Timmer (University of Groningen), Abdul Azeez-Erumban (The Conference Board, Brussels, and University of Groningen), Bart Los (University of Groningen), Robert Stehrer (Vienna Institute for International Economic Studies WIIW) and Gaaitzen de Vries (University of Groningen)
Slicing Up Global Value Chains

16.20 – 16.55
Liza Archanskaia (SciencesPo-OFCE, Paris)
Proximity as a Source of Comparative Advantage

18.30
Workshop Dinner at Restaurant Louis XV

Friday July 19

Session 5 (Chair: Marcel Timmer)
9.30 – 10.10
Rutger Hoekstra (Statistics Netherlands, Voorburg), Bram Edens (Statistics Netherlands, Voorburg), Daan Zult (Statistics Netherlands, Voorburg), Harry Wilting (Netherlands Environmental Assessment Agency PBL), Oscar Lemmers (Statistics Netherlands, Voorburg), Ronghao Wu (Statistics Netherlands, Voorburg) and Aksshat Goel (Statistics Netherlands, Voorburg)
Producing Carbon Footprints within the Realm of Official Statistics

10.10 – 10.25
Short presentation Sebastiaan Deetman (Leiden University)
The Availability of Scarce Metal Resources: Estimating Global Societal Stocks and Flows Using Environmentally Extended Input-Output Analysis

10.25 – 10.40
Short presentation Yan Xu (University of Groningen)

Environmental Kuznets Curves: A Comparison between Consumption-and Production-Based CO_2 Emissions

10.40 – 11.00
Coffee Break

Session 6 (Chair: Bart Los)
11.00 – 11.35
Ellie Dawkins (University of York)
Linking Local-Level Production Impacts with Consumption

11.35 – 12.35
Keynote Lecture
Manfred Lenzen (University of Sydney)
An Outlook into a Possible Future of Footprint Research

12.35 – 13.40
Lunch

Session 7 (Chair: Bart Los)
13.40 – 14.15
Utz-Peter Reich (Mainz University of Applied Sciences)
Inequality in Global Production and Trade: A Proposal for Measurement

14.15 – 14.50
Gaaitzen de Vries (University of Groningen), Bart Los (University of Groningen) and Marcel Timmer (University of Groningen)
Globalization or Regionalization? A New Approach to International Fragmentation of Value Chains

14.50 – 15.10
Tea Break

Session 8 (Chair: Gaaitzen de Vries)
15.10 – 15.45
Luis Antonio Lopez (University of Castilla-La Mancha, Albacete), Guadalupe Arce (University of Castilla-La Mancha, Albacete) and Tobias Kronenberg (Bochum University of Applied Sciences)
Pollution haven hypothesis in emissions embodied in world trade: The relevance of global value chains

15.45 – 16.20
Robbie Andrew (CICERO, Oslo) and Glen Peters (CICERO, Oslo)
Optimal Carbon Policy from Supply Chain Analysis

16.20
Workshop Conclusion and Drinks

APPENDIX 2: List of workshop participants

Gerd	Ahlert	GWS Osnabrück
Robbie	Andrew	CICERO Oslo
Guadalupe	Arce Gonzalez	University of Castilla-La Mancha
Liza	Archanskaia	Sciences Po-OFCE
Marten	Berglund	Statistics Sweden
Sjoerd	Beugelsdijk	University of Groningen
Juan Carlos	Castillo	Maastricht University
Elena	Dawkins	University of York
Gaaitzen	De Vries	University of Groningen
Sebastiaan	Deetman	Leiden University
Erik	Dietzenbacher	University of Groningen
Martin	Distelkamp	GWS Osnabrück
Yuwan	Duan	University of Groningen
Bram	Edens	Statistics Netherlands
Abdul A.	Erumban	The Conference Board
Daniel	Gallardo	University of Groningen
Aksshat	Goel	Statistics Netherlands
Rutger	Hoekstra	Statistics Netherlands
Rick	Hölsgens	University of Groningen
Tristan	Kohl	University of Groningen
Addisu	Latishew	University of Groningen
Oscar	Lemmers	Statistics Netherlands
Manfred	Lenzen	University of Sydney
Luis	Lopez Santiago	University of Castilla-La Mancha
Bart	Los	University of Groningen
Phil	McCann	University of Groningen
Bruno	Merlevede	Ghent University
Mark	Meyer	GWS Osnabrück
Eiichi	Nakazawa	OECD
Michiya	Nozaki	University of Groningen
Jan	Oosterhaven	University of Groningen
Raquel	Ortega-Argiles	University of Groningen
Abdella	Oumer	University of Groningen
Paulo	Paixao	Campinas, Brazil
Marianna	Papakonstantinou	University of Groningen
Michael	Polder	Statistics Netherlands
Utz-Peter	Reich	Mainz University of Applied Sciences
Tommaso	Rondinella	ISTAT
José Manuel	Rueda-Cantuche	Pablo de Olavide University
Dirk	Stelder	University of Groningen
Marcel	Timmer	University of Groningen
Arnold	Tukker	Netherlands Organisation for Applied Scientific Research
Martin	Uebele	University of Groningen
Johannes	van Biesebroeck	University of Leuven
Joost	Veenstra	University of Groningen
Ilya	Voskoboynikov	University of Groningen
Harry	Wilting	PBL Netherlands Environmental Assessment Agency
Ronghao	Wu	Statistics Netherlands
Yan	Xu	University of Groningen
Xianjia	Ye	University of Groningen
Lu	Zhang	University of Groningen

APPENDIX 3: Book of Abstracts

Downstream Offshoring and Firm-Level Employment: Evidence for Belgian Manufacturing Firms

Bruno Merlevede (Ghent University and HU Brussel) and Bernhard Michel (Federal Planning Office, Brussels)
No abstract

Sources of Trade in Value Added of ICT Goods and Services: Does Skill Building Matter to Comparative Advantage?

Eiichi Nakazawa (OECD, Paris), Norihiko Yamano (OECD, Paris) and Colin Webb (OECD, Paris)
No abstract

Change of National Content in China's Exports

Short Presentation Yuwan Duan (University of Groningen), Erik Dietzenbacher (University of Groningen) and Bart Los (University of Groningen)
Abstract: Along with the deepening of global integration, production factors, especially capital, flow across borders more freely. Especially for China, the large flow of inward foreign investment is a typical characteristic of its economy. Accordingly, China's exports not only relies heavily on imports (as a large body of literature has already revealed), but also highly depends on the foreign-owned capital. In this way, value added generated by China's exports may include lots of gains from foreign-owned production factors, which are created in China but not owned by Chinese people. In contrast with the existed literature, which only emphasizes on value added, this paper will focus on the national income generated by China's exports and its change over time, by using China's national input-output tables which distinguish processing exports from other production. Besides, to provide more comprehensive insight on the change pattern of the benefits China gets from the global value chain, some decompositions will be further conducted. The paper finds that, the benefits foreign investors get from China's exports experienced a great increase over time. From 2002 to 2007, about 84% of total increment of China's value added in exports is ascribed to the increase of foreign investors' profits, while only 16% is due to the increase of China's national content in exports.

The Domestic Content of Mexico's Maquiladora Exports: 1981-2006

Short presentation Juan-Carlos Castillo (Maastricht University) and Gaaitzen de Vries (University of Groningen)
Abstract: This paper studies the domestic value added content of exports by Mexico's foreign assembly plants during the past 30 years. Mexico's industrial policy for export processing firms gradually shifted from providing employment towards promoting intermediate deliveries among upstream domestic firms and technological upgrading within maquiladora firms. We combine a recently released input-output table for maquiladora industries with detailed longitudinal data on output, domestic and imported intermediate inputs, and skill requirements to study the effects of these industrial policies. We find that domestic value added content differs across industries but did not change much over time. Structural changes in the composition of output drive changes in the domestic value added embodied in aggregate maquila exports. Changes in the industry composition of assembly plants appear related to external shocks such as the North American Free Trade Agreement (NAFTA) in the late 1980s and China's entry into the World Trade Organization in 2001. Within industries, we find few signs of increasing intermediate input deliveries by domestic firms or higher embodied value added and skill use in the production process among maquiladoras over time.
JEL Codes: C67, L6
Keywords: Domestic content, Industrial policy, Export processing, Mexico

Session 2

Relationship Governance in the Automotive Supply Chain

Keynote Lecture Johannes van Biesebroeck (University of Leuven) and Alexander Schmitt (University of Leuven)
No abstract

Session 3

Macroeconomic Modelling of the Global Economy-Energy-Environment Nexus

Mark Meyer (GWS Osnabrück) and Martin Distelkamp (GWS Osnabrück)
Abstract: The environmental accounting literature documented remarkable advancements in the development and analysis of Multi Region Input Output (MRIO) databases over the last years. See e.g. Tukker and Dietzenbacher (2013) for most recent references in this regard or the prominent reviews of Wiedmann (2009) and Wiedmann et al. (2007).

However, until now this literature predominantly featured static analyses whose empirical findings remained restricted to historical reporting periods. Referring to Wiedmann et al. (2011) and the related findings of the EIPOT project,1 we essentially presume two interacting causes in charge of this situation: First of all, dynamic simulation studies embody a huge amount of mutually interdependent processes which cannot be descriptively outlined by a couple of clearly arranged algebraic expressions. Thus, compared to elegant mathematical representations of static frameworks, dynamic models are usually exposed to a lack of transparency critique. Secondly, with regards to empirical calibration and verification issues, previous modelling attempts were hampered by an apparent lack of consistently harmonised historical time series databases with global coverage.

But when the GWS (Gesellschaft für Wirtschaftliche Strukturforschung mbH) started its latest revision of its GINFORS (Global INterindustry FORecasting System) model, the availability of global MRIO databases had changed tremendously.2 See, e.g., Tukker & Diezenbacher (2013, p.2) in this regard: “For the first time in history the entire global economy is captured in databases of unprecedented detail (EXIOPOL and EORA) and/or with time series in both current and previous year’s prices (WIOD).”

The actual model version (labeled GINFORS3 within this text) therefore represents our first GINFORS release which has been built upon a fully harmonized annual set of national Supply and Use Tables (SUT), i.e., the outcomes of the WIOD project (see Dietzenbacher et al. (2013) for details). GINFORS is a dynamic simulation model which facilitates ex ante analyses of the environmental impacts embodied in international trade. Most of its recent applications accrued from the resource efficiency literature (see, e.g., Giljum et al. (2008), Lutz (2010), Lutz (2011) or Meyer (2012) in this regard). Further notable modelling exercises refer to the energy economics literature (see, e.g., Lutz and Meyer (2009) or Lutz et al. (2012). A notable model feature is given by the fact that GINFORS contains most of the essential components of an impact assessment model for analysing sustainable economic, social and environmental development within a sustainable welfare model. Basic structures of such a model have been derived by Meyer et al. (2013).

However, as our buildup of GINFORS3 started only in autumn 2012, all of the just mentioned publications do refer to former model implementations. This paper is therefore intended to inform the MRIO research community about latest progress in our realignment works of the GINFORS model.

To keep our annotations in line with the usual extent of a journal article, we cannot aim at a self-contained model description. Therefore, we rather follow a pragmatic approach for this first publication of selected essential elements of the GINFORS3 version: Our outlook on the general model structure focuses the modelling of the sequence of accounts and balancing items, one of the core data sets within the System of National Accounts (SNA). According to our view, SNA

consistent modelling represents a crucial feature in integrated macroeconomic policy assessments. Thus, our audience will hopefully recognize our demonstration of the fully integrated sequence of accounts module and its linkages to the Input-Output (IO) module within GINFORS3 as a worthwhile contribution.

The Game of Trading Jobs for Emissions

José Manuel Rueda-Cantuche (Pablo de Olavide University), Iñaki Arto (JRC-IPTS, Sevilla), Valeria Andreoni (JRC-IPTS, Sevilla), Ignazio Mongelli (JRC-IPTS, Sevilla), Aurélien Genty (JRC-IPTS, Sevilla) and Alejandro Villanueva (JRC-IPTS, Sevilla)

Abstract: Following the debate on the implications of international trade for global climate policy, this paper introduces the topic of the economic benefits to exporting countries of products for exports in relation to the emissions generated in this production. In 2008, 24% of global GHG emissions and 20% of the employment around the world were linked to international trade. China exported 30% of emissions and hosted 37.5% of the jobs generated by trade worldwide. The European Union and the United States of America were the destination of 25% and 18.4% of the GHG emissions embedded in trade. The imports of these two regions contributed to the creation of 45% of the employment generated by international trade. This paper proposes the idea of including trade issues in international negotiations, taking into account not only the environmental burden generated by developed countries when displacing emissions to developing countries through their imports, but also the economic benefits of developing countries when releasing the emissions to produce goods delivered to developed countries. By analysing these opposing aspects, we aim to show how global emissions could be reduced effectively and with lower costs.

Keywords: Employment; Greenhouse gas emissions; Multiregional Input-Output Model.

CREEA - Compiling and Refining Environmental and Economic Accounts

Arnold Tukker (TNO, Delft, and NTNU, Trondheim)

No abstract

Session 4

Slicing Up Global Value Chains

Marcel Timmer (University of Groningen), Abdul Azeez-Erumban (The Conference Board, Brussels, and University of Groningen), Bart Los (University of Groningen), Robert Stehrer (Vienna Institute for International Economic Studies WIIW) and Gaaitzen de Vries (University of Groningen)

Abstract: Studies of the effects of production fragmentation on factor income distributions typically analyze changes at the country, region, industry or firm level. In this paper we take the perspective of a product, and focus on the discrete activities in distinct locations, which altogether form a production network starting at the conception of the product and ending at its delivery. We take a macro-perspective and analyze factor content patterns for a wide set of manufacturing product groups, and study their development over time. Using a decomposition technique originally introduced by Leontief (1936), we 'slice up the global value chains' and trace the value added by all labor and capital that is directly and indirectly used for the production of final manufacturing goods.

We find that the process of international fragmentation as measured by the foreign value-added content of production has rapidly increased since 1995 in most global value chains, but is still far from 'completed'. We then turn to an analysis of the value distribution across production factors, and find a strong shift towards value being added by capital and high-skilled labor, and away from less-skilled labor. We also find a major shift in the production location, as the overall value added in advanced countries did not increase over the period 1995-2008 and all growth was realized in other emerging countries. Finally, we present evidence on the importance of manufactures GVCs for employment. We show how advanced nations increasingly specialize in activities carried out by high-skilled workers. Taken together the results suggest that the increasing

possibilities for international production fragmentation had pervasive consequences for the factor income distribution both across and within countries.

Proximity as a Source of Comparative Advantage

Liza Archanskaia (SciencesPo-OFCE, Paris)

Abstract: This paper establishes that production unbundling has coincided with an inscreasing role of input costs in shaping the pattern of comparative advantage. I show that the wedge in the cost of the input bundle across countries in a multisectoral Ricardian model is given by a composite index of trade frictions incurred in sourcing inputs. As the cost share of inputs is sector-specific this wedge becomes source of comparative advantage whereby countries characterized by relatively high proximity to input suppliers specialize in sectors which use inputs more intensively. I find robust empirical evidence that the input cost channel has growing importance over 1995-2009. Nonetheless, consistently with the fundamental intuition of Ricardian models, the ranking of relative sectoral technology stocks still determines inter-sectoral specialization. Between 53-55% of intersectoral variation in relative sectoral exports is explained by technology while the contribution of the input cost channel increases from 3 to 8% in the full sample, and from 3 to 13% for the EU-15.

Keywords: Ricardian model, Intersectoral specialization, Trade costs
JEL codes: F10,F15

Session 5

Producing Carbon Footprints within the Realm of Official Statistics

Rutger Hoekstra (Statistics Netherlands, Voorburg), Bram Edens (Statistics Netherlands, Voorburg), Daan Zult (Statistics Netherlands, Voorburg), Harry Wilting (Netherlands Environmental Assessment Agency PBL), Oscar Lemmers (Statistics Netherlands, Voorburg), Ronghao Wu (Statistics Netherlands, Voorburg) and Aksshat Goel (Statistics Netherlands, Voorburg)

Abstract: Since the early 1990's the concept of footprint indicators was popularized by the introduction of the "ecological footprint". In later years, carbon, water, material and land footprints were also developed. Initially these calculations were rarely done using input-output techniques or data, but recently the availability of multiregional input-output (MRIO) and environmental accounting data has changed this situation drastically. However, for some countries such as the Netherlands the MRIO-based footprints show substantially different levels and developments.

This paper explores first how carbon footprints can be calculated in such a way that they are consistent to official statistics of a single country. The paper shows an application for the Netherlands for the year 2009. The WIOD database is adjusted to conform to the Dutch national and environmental accounts that are published by Statistics Netherlands. Detailed trade data is also used to calculate the adjusted footprint which is referred to as a "singlecountry national accounts consistent" footprint ("SNAC-footprint"). The method is generic in the sense that other countries can re-use the procedure to adapt WIOD to their own official statistics.

The preliminary results show that the SNAC-footprint for the Netherlands is generally lower than the footprint of other MRIO-based studies estimates because of a significantly lower foreign footprint. The calculations also show a much lower fraction of the footprint is attributable to China. However, the methodology still has to undergo a detailed review before the results are definitive. The paper also provides an overview of the challenges that lie ahead in bringing the footprint calculations within the realm of official statistics.

Keywords: multi-regional input-output analysis, carbon footprint, water footprint, ecological footprint, carbon leakage, pollution haven hypothesis, production perspective, consumption perspective, official statistics, MRIO, GTAP, EXIOPOL, EXIOBASE, CREEA, WIOD and EORA

The Availability of Scarce Metal Resources: Estimating Global Societal Stocks and Flows Using Environmentally Extended Input-Output Analysis

Short presentation Sebastiaan Deetman (Leiden University)

Abstract: Assessment of critical materials noticeably shows that precious specialty metals with small mass flows could potentially have a limited future supply. Such metals are becoming increasingly indispensable in new technologies, but the flows of these low-volume and high-value metals are usually not well described in Environmentally Extended Input-Output (EE IO) databases. The DESIRE FP7 project aims to use detailed descriptions of metal content of intermediate goods and consumer products to come up with an initial estimate of global societal stocks and flows. We will particularly focus on the application of critical metals in renewable energy technologies, because these are expected to radically influence future demand of these metals. Future demand is inherently uncertain, as endorsed by the plethora of renewable energy scenarios generated over the last few years. However, we feel that integrated assessment of climate and dematerialization policies may guide sensible policy choices. We propose to combine insights from stocks and flows assessment with dynamic demand modeling to identify possible gaps in required production, waste treatment and recycling capacity and develop indicators that cover a range of policy concerns.

Environmental Kuznets Curves: A Comparison between Consumption-and Production-Based CO2 Emissions

Short presentation Yan Xu (University of Groningen)

Abstract: The 'environmental Kuznets curve' (EKC) refers to an inverted-U-shaped relationship between some pollutant level and per capita income. Since the early 1990s, a considerable number of empirical studies have been conducted on the EKC. However, almost all the previous studies search for evidence of EKC with the production-based emissions. With the increase of globalization in past decade, there are more and more emissions embodied in trade, which leads to a considerable gap between consumption- and production-based emissions. Compared to the production-based studies, a consumption-based study is more relevant for the purpose of global emission control and reduction. This study estimated the EKC with consumption- and production-based CO2 emission for 40 countries during the period 1995 to 2009. We find that when the trade effects are excluded (consumption-based estimation), the EKC becomes flatter and the turning point moves to the right. This indicates that the income's effect on emission reduction is over-estimated by the production-based estimations. The inverted-U shaped relationship still exists, but the GDP per capita of the turning point are higher if we take the international trade into consideration.

Keywords: environmental Kuznets curve, consumption-based emission, CO2 emission.

Session 6

Linking Local-Level Production Impacts with Consumption

Ellie Dawkins (University of York)

No abstract

An Outlook into a Possible Future of Footprint Research

Manfred Lenzen (University of Sydney)

No abstract

Session 7

Inequality in Global Production and Trade: A Proposal for Measurement

Utz-Peter Reich (Mainz University of Applied Sciences)

Abstract: Inequality is traditionally considered as a problem concerning the distribution of disposable income. Production and trade, in contrast, are deemed to be distributionally neutral. With the new World Input Output Database, at hand, it is now possible to challenge such division of topics. The paper shows how, by joining purchasing power parities to WIOD, one can define and substantiate a measure of inequality in international trade. The measure is then used to review two old theories about inequality in world trade, in the first part of the paper, and in its second part an experimental compilation of trade between eight major countries demonstrates how the size of real value added, in each country, is affected by inequality in the terms at which its products are exchanged, with other countries.

Globalization or Regionalization? A New Approach to International Fragmentation of Value Chains

Gaaitzen de Vries (University of Groningen), Bart Los (University of Groningen) and Marcel Timmer (University of Groningen)

Abstract There is increasing evidence of denser networks of intermediate input flows between countries suggesting ongoing fragmentation of production chains. But to what extent is this process mainly regional, taking place between countries within a region, or mainly global, involving countries outside the region? We provide new macro-economic evidence regarding this issue, by extending the Feenstra and Hanson (1999) measure of fragmentation to a multi-country setting. We identify the value chain of a product by the country and industry in which the last stage of production takes place. Based on an input-output model of the global economy we derive the distribution of value added by all countries involved in its production. Using a new dataset of world input-output tables covering forty countries and fourteen manufacturing product groups, we find that in almost all product chains the share of value added outside the country is increasing since 1995. The share of value added outside the region has been increasing much faster though. These tendencies were only briefly interrupted by the financial crisis in 2008. Based on a cross-entropy measure of fragmentation we find that despite these trends, the scope for further international fragmentation is still large.

Keywords: International fragmentation of production; Value chains; World input-output tables
JEL classification: F14, F60, O19

Session 8

Pollution haven hypothesis in emissions embodied in world trade: The relevance of global value chains

Luis Antonio Lopez (University of Castilla-La Mancha, Albacete), Guadalupe Arce (University of Castilla-La Mancha, Albacete) and Tobias Kronenberg (Bochum University of Applied Sciences)

Abstract: Pollution haven hypothesis (PHH) occurs when the growth of international trade leads to an increase in emissions because countries specialize in producing polluting goods. The avoided emissions balance between a country with other countries of the world, i.e. the difference between the emissions embodied in exports in the country minus imports avoided by imports, allows us to evaluate if PHH occurs or not. A positive balance indicates that the country's trade increases global emissions. In contrast, a negative balance indicates that emissions trading by this country are reduced because the country specializes in less polluting products. However, the trade growth cannot be explained only by the increase of final goods and raw materials trade, it is also explained by the increasing fragmentation of production at different production stages and, therefore, trade in inputs that are part of successive stages of production. In this paper we propose a multi-regional

input-output model (MRIO) that disaggregates the avoided emissions balance and allows us to analyze how much the trade in final goods or inputs linked to global value chains are responsible or not in the generation of PHH. The implementation of the multi-regional model proposed involves the use of World Input-Output Database (WIOD), which provides information on input-output tables for 3 and 7 regions between 1995 and 2009, with a disaggregation to 35 industries, well as information about energy goods consumption and CO2 emissions by industry.
Keywords: Pollution Haven Hypothesis, Global Value Chain, multiregional input-output.

Optimal Carbon Policy from Supply Chain Analysis

Robbie Andrew (CICERO, Oslo) and Glen Peters (CICERO, Oslo)
Abstract: In the absence of globally harmonized policy for climate mitigation, a minority of countries and regions have implemented regulations and measures with relatively limited scope. Most of these measures are based on emissions within the regulated territories, with little account for emissions associated with traded goods. Border carbon adjustments have been discussed as a means of protecting regulated industries, incidentally shifting production-emissions accounting measures to a consumption basis. The prospect of regulation of extraterritorial emissions leads to questions of equity that may run counter to the UNFCCC's goal of 'common but differentiated responsibilities'. We examine the supply chain emissions and accrual of value-added of two traded commodities, meat and clothing, and find that sharp contrasts between the characteristics of the two supply chains lead to quite different conclusions about the carbon policy options that are likely to be most effective. In addition, we see large disparities between the accumulation of value-added and emissions responsibilities.