The bio-economy: definitions and measurement

Jirka van de Pas
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Abstract

This paper aims to measure the income and employment realized with the production of food, feed, fibre, bio-based products and bio-energy in different countries. In the measurement we take in account the backward and forward linkages the bio-economy has. The paper first presents some definitions and then presents the method of measurement and finally we compare the results for some countries both within and outside the European Union. With only a few exceptions we see independent of the definition used that the relative size of bio-economy is getting smaller over time and with the level of economic development. Further research still has to be done on what causes the differences between countries.

1. Introduction

February 2012, the European Commission (2012) presented a strategy proposing a comprehensive approach to address the ecological, environmental, energy, food supply and natural resource challenges that Europe and the world are facing. The European Commission wants to realize this by establishing a bio-economy. The European Commission (2012 and 2014), uses the term bio-economy for an economy where production of food, feed, fibre, bio-based products and bio-energy is efficient and sustainable, and done with renewable resources from land, fisheries and aquaculture environments including the related public goods. Where efficient and sustainable primary production and processing satisfies industry demand, consumers' needs and at the same time tackles environmental challenges such as climate change (European Commission, 2014).

This framework is a result from the Rome Conference in 1998 on sustainable development. The OECD (2000) wrote a report on the basis of this conference. It emphasized the importance of a strong framework for sustainable development, including policy goals and indicators for economic, environmental and social demographics.

To make adequate policy and investment choices and to assess their effects it is relevant to have operational definitions that allow for measurement of the importance of the bio-economy and its components. Agriculture being one of these components makes its size a subject of debate. Olson (1985), Swinnen and van der Zee (1993) and Oskam et al. (2010) are just a few researchers which stated that the rate of subsidies and protection compared to the size of agriculture in a nation's economy is debatable. In traditional economics, the share of agriculture in Gross Domestic Product is used to measure its size. Other indicators that could be included to measure the size of the bio-economy are its share in employment and environmental pollution (OECD, 2000).

This paper aims to take a first step in an attempt to measure the size of the bio-economy. In this first step we measure the income and employment realized with the production of food, feed, fibre, bio-based products and bio-energy in different countries. In this paper we first present some definitions and then present the method of measurement. Therefore, value added of the bio-economy and the number of people engaged in the bio-economy will be used as indicators. These indicators then represent the relative importance of the bio-economy in a nation's economy. In the measurement we take into account the backward and forward linkages the bio-economy has. Finally, we compare the results for 12 countries both within and outside the European Union and analyse the development over time.

2. Model

2.1 Definitions

In this research, five definitions are presented in order to be able to calculate the size of the bio-economy. Here two definitions and in appendix I three additional definitions are presented.

In the first definition the bio-economy exists of agriculture, the food industries that process agricultural products in the first stage (both domestically produced and imported) and the direct and indirect input delivering industries for both agriculture and the food industries (Peerlings, 1993). The idea behind this definition is: how much value added would disappear if there would be no domestic agriculture and

agricultural imports anymore. In other words, how much would the economy shrink in terms of GDP. We only take the first stage of processing because without agriculture and the domestic food industry people would still eat, but the food would be imported. The disadvantage of the first definition is that in the bio-economy it could be that other industries than the food industry use agricultural inputs, e.g. the chemical sector. So, in the second definition we add to the first definition all the industries processing agricultural products, but only partly. The degree at which processing industries belong to the bio-economy is determined by the share of both domestically produced and imported agricultural inputs in the total value of variable inputs (both domestically produced and imported).

2.2 Indicators

The size of the bio-economy will be measured by means of the value added it creates and the employment it holds. These are shown in Appendix III, separate for the agricultural and food processing industries.

The gross value added of the bio-economy adds the rewards of the production factors and capital depreciation in the bio-economy. Its share in total GDP represents therefore its share in income generated (Gardebroek & Peerlings, 2013). As an indicator of economic importance, there are some caveats. Researchers are increasingly debating the relevance of GDP. Costanza et al. (2014) even suggest it is time to leave GDP behind, because it does not include social costs, environmental impacts and income inequality. In this research, GDP is used as an indicator for economic importance of the bio-economy, and therefore only a first step in measuring its size.

The share of the bio-economy in total employment can be used as a measure of relative importance. For the supplier of labour, this is their source of income. But also employment holds some caveats. People would probably not work, if it was not necessary to earn income. So, employment should not automatically be valued as positive. Besides that, it is unfavourable for economic welfare to maintain employment with subsidies (Gardebroek & Peerlings, 2013). This reduces income inequality and increases government expenditures. In this research, employment is used as one of the indicators for importance of the bio-economy and therefore only a first step towards measuring its size.

2.3 Method

The method used is based on input-output analysis (see appendix II for an explanation) and developed by Harthoorn (Harthoorn and Wossink, 1987; Harthoorn, 1988; Peerlings, 1993). We have potentially the problem of double-counting, for example, agriculture belongs directly to the bio-economy but it also delivers inputs to the processing industry, so it should be avoided to count it twice; as agriculture and as an input-delivering industry to processing industries. We first define selection vectors (s_m) and residual vectors (r_m).

$$s_m(n) = \begin{cases} 1 \; \forall_n \in T_m \\ 0 \; \forall_n \notin T_m \end{cases} \tag{2.1}$$

$$r_m = i - \sum_{j=1}^{m} s_j \tag{2.2}$$

Where $s_m(n)$ is a selection vector, r_m a residual vector, T_m a subset m of industries in the input-output table, i a vector with ones. S_m and R_m are defined as the diagonal matrices of s_m and r_m, respectively.

Agriculture forms subset 1, the industries that process agricultural products are subset 2. The subsets are disjoint. The residual vectors are the complements of the sum of those selection vectors of which subscripts are lower or equal to m.

To illustrate selection and residual vectors suppose we have four industries in an input-output table, where the first industry is agriculture and the third is the food processing industry.

Selection Vector s_1	Residual Vector r_1	Selection Vector s_2	Residual Vector r_2
$\begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \end{bmatrix}$	$\begin{bmatrix} 0 \\ 1 \\ 1 \\ 1 \end{bmatrix}$	$\begin{bmatrix} 0 \\ 0 \\ 1 \\ 0 \end{bmatrix}$	$\begin{bmatrix} 0 \\ 1 \\ 0 \\ 1 \end{bmatrix}$

Value added and employment of the bio-economy are assumed to be linked to its total production. Total production can be decomposed in the production of agriculture, production linked to direct and indirect input deliveries to agriculture, production of processing industries and production linked to direct and indirect input deliveries to the processing industries. In each subsequent step double-counting is avoided.

The production of agricultural industries is:

$$y_1 = S_1.\left(I - \hat{A}\right)^{-1} f \tag{2.3}$$

Where $\hat{A}$ is a matrix of input-output coefficients, I an identity matrix, $\left(I - \hat{A}\right)^{-1}$ Leontief inverse, f a vector of final demand.

Production linked to the direct and indirect deliveries to agriculture is given by:

$$y_2 = \left(I - R_1\hat{A}R_1\right)^{-1} R_1\hat{A}S_1\left(I - \hat{A}\right)^{-1} f \tag{2.4}$$

Production of the food processing industries equals:

$$y_3 = S_2\left(I - R_1\hat{A}R_1\right)^{-1} f \tag{2.5}$$

The production linked to the direct and indirect deliveries to the food processing industries is:

$$y_4 = \left(I - R_2\hat{A}R_2\right)^{-1} R_2\hat{A}S_2\left(I - R_1\hat{A}R_1\right)^{-1} f \tag{2.6}$$

Total production (y) of the bio-economy is the sum of equations 2.3 – 2.6:

$$y = (y_1 + y_2 + y_3 + y_4) \tag{2.7}$$

Value added and employment of the bio-economy can be calculated from the total production using the following equations:

$$v = Vy \tag{2.8}$$

$$l = Ly \tag{2.9}$$

Where v is a vector of value added per industry, V a diagonal matrix with input-output coefficients of value added, l a vector of employment per industry, L a diagonal matrix with input-output coefficients of employment.

2.4 Explaining developments

To analyse the results in terms of the share of agriculture in total GDP and employment we decompose these shares (Gardebroek & Peerlings, 2013) for the second definition. We do not make a decomposition for all definitions, since similar developments can be expected.

The share of value added of agriculture in total GDP can be expressed as:

$$\frac{GVA_{agr}}{GDP} = \frac{GVA_{agri}}{Y_{agri}} \times \frac{Y_{agri}}{Y_{food}} \times \frac{Y_{food}}{C_{food}} \times \frac{C_{food}}{C_{tot}} \times \frac{C_{tot}}{GDP} \tag{2.10}$$

Where GVA is gross value added, GDP gross domestic product, Y production, C consumption, *agri* agriculture, *food* food or processing industries, *tot* total economy.

The ratios of the expression give insight in the contribution of agriculture to GDP:

- The ratio of value added and production value of agriculture is expected to decrease over time. This is due to differentiation in the production column in order to achieve scale advantages. This results in a faster increase in production than value added. Moreover, a relative high productivity of agriculture has resulted in an increase in production. With only a small growth of demand, this led to lower prices of agricultural products. Overall this results in a decrease of value added of agriculture compared to its production.
- The ratio between agricultural production and food production is also expected to decrease as demand for processed products is expected to grow faster than that of unprocessed products when an economy is growing. In a growing economy consumption of food products is expected to increase.
- The change in the ratio between food production and consumption (i.e. self-sufficiency) can both decrease or increase depending on the ability of the processing sector to meet changes in domestic demand. An increase in self-sufficiency of a country increases the contribution of agriculture to the GDP.
- The ratio between food consumption and total consumption is expected to fall due to Engel's Law. So, with an increasing income per capita, the share of food in total consumption decreases.
- The development of the ratio of food consumption and GDP depends on the development of total consumption in total final demand. Where final demand equals consumer expenditure, government expenditure, investment demand and exports.

Since agriculture and food processing industries are highly linked to the bio-economy, it is expected that most conclusions drawn from equation (2.10) also hold for the bio-economy. Rewriting the equation then gives:

$$\frac{GVA_{bio}}{GDP} = \frac{GVA_{bio}}{Y_{agri}} \times \frac{Y_{agri}}{Y_{food}} \times \frac{Y_{food}}{C_{food}} \times \frac{C_{food}}{C_{tot}} \times \frac{C_{tot}}{GDP} \tag{2.11}$$

Where *bio* are industries in the bio-economy, *agri* are agricultural industries and their deliveries, *food* are food processing industries and their deliveries, *Cfinal* is total domestic food consumption, C*total* is total domestic consumption.

The new equation gives insight in the contribution of the bio-economy to GDP. Only the first ratio differs from equation 2.10. The ratio of value added of the bio-economy and production value of agriculture is expected to decrease over time. Also here, scale advantages result in a faster increase in agricultural production than value added of the bio-economy. The price of agricultural products drops when high productivity increases production and there is only a small growth of demand. This results in a decrease in the value added of the bio-economy.

The share of the bio-economy in total employment can be expressed as:

$$\frac{E_{bio}}{E_{tot}} = \frac{E_{bio}}{Y_{bio}} \times \frac{Y_{bio}}{Y_{tot}} \times \frac{Y_{tot}}{E_{tot}} = \frac{\frac{Y_{tot}}{E_{tot}}}{\frac{Y_{bio}}{E_{bio}}} \times \frac{Y_{bio}}{Y_{tot}} = \frac{L_{tot}}{L_{bio}} \times \frac{Y_{bio}}{Y_{tot}} \tag{2.12}$$

Where: E employment, L labour productivity (production divided by employment).

The expected changes in the ratios in equation 2.11 depend on:

- The ratio of labour productivity of the bio-economy and labour productivity in the total economy is expected to fall because labour productivity in the bio-economy increases more than in the total economy. This is expected because productivity in industrial sectors grows more than in service sectors in a growing economy.
- The contribution of the bio-economy to total employment decreases when the share of the bio-economy in the total value of production decreases. This can be expected as in a growing economy demand, and therefore, production for industrial products increases less than production of services (see equation 2.10).

3. Data

Harthoorn's (1988) method has been applied using input-output tables from the World Input-Output Database (WIOD, 2014). This database includes national input-output tables and employment data from forty countries for the period 1995-2011. Input-output tables are based on national accounts statistics, supply and use tables, and international trade statistics. The methods used to construct the input-output tables and employment data are explained by Timmer (2012). Employment is based on the number of people engaged per sector instead of hours worked per sector, because of a lack of data. The employment data are revised by Gouma et al. (2014), based on growth trends in EUROSTAT National Accounts data and individual data for non-European countries. Resulting data are available for the period 1995-2011.
Using the collected data allows to calculate and compare value added and employment of the bio-economy over time and between countries. Here we will present results for Belgium, Brasil, China, France, Germany, Hungary, Indonesia, Japan, the Netherlands, Russia, the United Kingdom and the United States. These countries are chosen to give the best representation possible of developed/non-developed and European/non-European, with the available data.

4. Results

4.1 Analysis
Table 1 presents the share of value added and table 2 presents the employment of the bio-economy, both per country for the years 1995 and 2011. The results for both definitions are decomposed to indicate how much each part of the bio-economy contributes to the total. The value added and employment of the bio economy for all its definitions are given in appendix IV.

Table 1. Value Added of the bio-economy in percentage of GDP (v^1: value added of agriculture, v^2: value added of input-delivering industries to agriculture, v^3: value added of processing industries, v^4: value added of input-delivering industries to processing industries).

		Definition 1					Definition 2				
		v^1	v^2	v^3	v^4	**v**	v^1	v^2	v^3	v^4	**v**
Belgium	1995	1.5	0.9	2.5	2.3	**7.2**	1.5	0.9	2.8	2.3	**7.5**
	2011	0.7	0.5	1.8	2.1	**5.1**	0.7	0.5	2.2	2.1	**5.5**
Brazil	1995	5.8	1.5	2.8	2.5	**12.6**	5.8	1.5	3.4	2.5	**13.2**
	2011	5.6	1.8	2.2	2.7	**12.3**	5.6	1.8	2.8	2.7	**12.9**
China	1995	20.0	4.9	3.9	0.2	**30.8**	20.0	4.9	6.3	4.4	**35.6**
	2011	10.1	2.9	3.3	1.8	**18.1**	10.1	2.9	4.7	3.7	**21.4**
France	1995	3.3	1.5	1.8	2.1	**8.7**	3.3	1.5	2.6	2.1	**9.5**
	2011	2.1	1.2	1.2	2.3	**6.7**	2.1	1.2	1.7	2.2	**7.1**
Germany	1995	1.3	0.9	2.0	2.1	**6.3**	1.3	0.9	2.5	2.1	**6.7**
	2011	1.0	0.8	1.4	1.7	**4.9**	1.0	0.8	2.0	1.7	**5.5**
Great-Britain	1995	1.8	1.0	2.7	2.1	**7.6**	1.8	1.0	3.1	2.1	**8.0**
	2011	1.0	0.5	1.8	1.3	**4.7**	1.0	0.5	2.1	1.3	**4.9**
Hungary	1995	8.0	3.1	3.4	2.6	**17.1**	8.0	3.1	5.1	2.5	**18.7**
	2011	5.7	1.9	2.1	1.4	**11.1**	5.7	1.9	3.4	1.4	**12.4**
Indonesia	1995	15.4	1.6	6.2	2.2	**25.4**	15.4	1.6	8.2	3.5	**28.8**
	2011	14.7	1.8	7.0	1.9	**25.4**	14.7	1.8	10.6	3.3	**30.4**
Japan	1995	1.7	0.9	2.9	1.9	**7.5**	1.7	0.9	3.4	1.9	**8.0**
	2011	1.3	0.7	3.0	1.8	**6.9**	1.3	0.7	3.4	1.8	**7.3**
Netherlands	1995	3.5	1.7	3.1	2.9	**11.1**	3.5	1.7	3.6	2.9	**11.7**
	2011	1.8	1.1	3.0	2.5	**8.4**	1.8	1.1	3.5	2.5	**8.9**
Russia	1995	7.8	3.2	2.9	2.1	**16.0**	7.8	3.2	4.2	2.0	**17.3**
	2011	4.2	2.2	2.1	2.3	**10.8**	4.2	2.2	3.1	2.2	**11.8**
United States	1995	1.2	1.1	1.6	1.8	**5.7**	1.2	1.1	1.9	1.7	**6.0**
	2011	1.2	0.8	1.4	1.4	**4.8**	1.2	0.8	1.7	1.4	**5.0**

Table 1 shows that definition 2 gives a larger size than definition 1 as it includes more processing industries (v^3) and input deliveries to these industries (v^4). In 1995 China had the largest share of the bio-economy in GDP, but the share decreased relatively the most over the years. This represents a fast growing economy and increased productivity in agriculture. In 2011 Indonesia had the bio-economy with the largest share in GDP. This represents that it is a less developed country compared to the other countries. The United States had the lowest share in 1995. In 2011, the share of value added in GDP of the bio-economy in Belgium, Germany, Great-Britain and the United States is comparable. Results show further that the share of value added in GDP of the bio-economy decreased in all countries in the period from 1995 to 2011, except Indonesia. The share of value added in GDP of production in the agricultural industries in Indonesia decreased, but it increased for the processing industries, especially for the food processing industries. This increase is not found for the other countries.

Table 2. Employment in the bio-economy in percentage of total employment (l^1: employment in agriculture, l^2: employment in input-delivering industries to agriculture, l^3: employment in processing industries, l^4: employment in input-delivering industries to processing industries).

		Definition 1					Definition 2				
		l^1	l^2	l^3	l^4	**l**	l^1	l^2	l^3	l^4	**l**
Belgium	1995	2.5	0.9	2.4	2.4	**8.2**	2.5	0.9	2.8	2.4	**8.6**
	2011	1.5	0.6	1.8	2.2	**6.0**	1.5	0.6	2.3	2.1	**6.5**
Brazil	1995	26.0	1.2	2.2	2.4	**31.7**	26.0	1.2	2.9	2.3	**32.5**
	2011	15.6	1.6	2.1	2.8	**22.0**	15.6	1.6	2.8	2.8	**22.8**
China	1995	52.2	2.3	1.4	1.0	**56.9**	52.2	2.3	3.0	2.2	**59.7**
	2011	33.8	1.9	1.7	1.3	**38.7**	33.8	1.9	3.4	2.7	**41.8**
France	1995	4.6	1.5	2.3	2.0	**10.4**	4.6	1.5	3.4	2.0	**11.5**
	2011	2.9	1.2	1.8	2.3	**8.2**	2.9	1.2	2.4	2.3	**8.8**
Germany	1995	2.9	0.9	2.4	1.9	**8.0**	2.9	0.9	2.9	1.9	**8.6**
	2011	2.1	0.9	1.8	2.2	**7.0**	2.1	0.9	2.3	2.2	**7.5**
Great-Britain	1995	2.0	0.9	1.9	2.0	**6.9**	2.0	0.9	2.5	2.0	**7.4**
	2011	1.8	0.5	1.4	1.2	**4.9**	1.8	0.5	1.8	1.2	**5.2**
Hungary	1995	14.8	2.7	3.7	2.3	**23.5**	14.8	2.7	5.6	2.2	**25.4**
	2011	9.7	1.9	4.1	1.2	**17.0**	9.7	1.9	5.7	1.2	**18.6**
Indonesia	1995	46.4	0.9	4.2	1.7	**53.3**	46.4	0.9	5.6	2.6	**55.6**
	2011	46.7	1.5	2.4	2.5	**53.0**	46.7	1.5	10.3	3.8	**62.4**
Japan	1995	7.2	0.8	2.3	1.8	**12.0**	7.2	0.8	3.1	1.8	**12.9**
	2011	4.8	0.7	2.5	1.8	**9.7**	4.8	0.7	3.2	1.8	**10.4**
Netherlands	1995	4.0	1.6	2.2	3.2	**10.9**	4.0	1.6	2.8	3.2	**11.5**
	2011	2.9	1.1	1.7	2.8	**8.6**	2.9	1.1	2.3	2.8	**9.2**
Russia	1995	27.7	1.8	2.0	1.1	**32.5**	27.7	1.8	3.3	1.1	**33.8**
	2011	21.1	1.5	2.2	1.6	**26.4**	21.1	1.5	3.4	1.6	**27.6**
United States	1995	2.1	0.8	1.3	1.5	**5.7**	2.1	0.8	1.8	1.5	**6.1**
	2011	1.5	0.5	1.2	1.2	**4.3**	1.5	0.5	1.6	1.2	**4.7**

Overall, the size of the bio-economy in terms of employment is higher than in terms of value added. Relative differences over time are higher in less developed countries. This development will be discussed in more detail in the next paragraph. In 1995 agriculture had the largest share in total employment in China, followed by Indonesia, Russia, Brasil and Hungary respectively. But China's rate decreased relatively the most over the years, representing a growing economy and increased productivity in agriculture. Except Indonesia, the size in terms of employment remained fairly constant in the agricultural industries, but it increased for the food processing industries. Also in terms of employment the United States had the lowest share in 1995. In 2011, the employment rate in Great-Britain decreased to a similar level as in the United States.

Table 2 also shows that definition 2 gives a larger size than definition 1 in terms of employment. The biggest difference between the two definitions is in Indonesia in 2011. This is due to the high increase in employment in the non-food industries.

4.2 Explaining developments

Table 3 explains the development of the share of the bio-economy in total value added and table 4 explains the development of the share of the bio-economy in total employment, both per country for the years 1995 and 2011. The results for both definitions are decomposed in the ratios as given in equations 2.11 and 2.12.

Table 3. Development share of value added of the bio-economy in total GDP

		$\frac{GVA_{bio}}{Y_{agri}}$	$\frac{Y_{agri}}{Y_{food}}$	$\frac{Y_{food}}{C_{food}}$	$\frac{C_{food}}{C_{tot}}$	$\frac{C_{tot}}{GDP}$	$\frac{GVA_{bio}}{GDP}$
Belgium	1995	1.236	0.349	2.568	0.091	0.742	**0.075**
	2011	1.490	0.242	3.182	0.059	0.801	**0.055**
Brazil	1995	1.092	0.663	2.090	0.118	0.740	**0.132**
	2011	0.925	0.778	2.087	0.114	0.753	**0.129**
China	1995	0.771	1.365	2.902	0.080	1.450	**0.356**
	2011	0.812	0.864	2.712	0.061	1.836	**0.214**
France	1995	0.943	0.778	2.355	0.070	0.787	**0.095**
	2011	0.913	0.630	2.445	0.066	0.764	**0.071**
Germany	1995	1.503	0.380	2.599	0.064	0.707	**0.067**
	2011	1.278	0.424	3.082	0.044	0.753	**0.055**
Great-Britain	1995	1.355	0.425	2.495	0.071	0.790	**0.080**
	2011	1.559	0.382	3.020	0.036	0.756	**0.049**
Hungary	1995	0.671	1.022	2.072	0.141	0.936	**0.187**
	2011	0.636	1.216	2.394	0.083	0.806	**0.124**
Indonesia	1995	1.301	0.747	2.685	0.148	0.744	**0.288**
	2011	1.322	0.691	2.694	0.160	0.773	**0.304**
Japan	1995	1.574	0.419	2.737	0.053	0.840	**0.080**
	2011	1.663	0.345	2.586	0.060	0.825	**0.073**
Netherlands	1995	1.044	0.550	2.498	0.116	0.699	**0.117**
	2011	1.203	0.413	2.973	0.087	0.689	**0.089**
Russia	1995	0.761	1.297	2.191	0.097	0.826	**0.173**
	2011	0.853	0.921	2.555	0.066	0.887	**0.118**
United States	1995	1.133	0.517	2.246	0.061	0.750	**0.060**
	2011	1.134	0.517	2.173	0.058	0.683	**0.050**

The ratio of value added of the bio-economy and production value of agriculture was expected to decrease over time. In most countries the ratio increased. A small decrease is shown in France and Hungary. A bigger decrease is shown in Brasil and Germany. This represents a relatively large increase in productivity of the agricultural industry for both countries. A fast increase in production in Brasil was necessary to meet to the increased international demand.

The ratio between agricultural production and processed food production was also expected to decrease, especially in a growing economy. This is shown with China having the relative highest decrease as a country with a fast growing economy. The ratio increased in Brasil, Germany and Hungary. This could be explained by their high productivity in the agricultural industry, resulting in relative low prices of unprocessed products.

Self-sufficiency decreased in almost all countries. Their processing sectors where not able to meet the increased domestic demand of processed goods. Brasil and Indonesia are fairly self-sufficient. The ratio between food production and consumption of China, Japan and the United States increased. In both cases, either their domestic demand did not change or the processing sector was able to meet the changes.
Engel's Law holds for all countries except Indonesia and Japan. In both countries a larger share of their income was spend on food. In Indonesia, this could be due to a decrease in income per capita or relative increasing food prices. Japan is not a developing country as Indonesia. A reason why they spend a larger share of their income on food, is due to the devaluation of their money. The income spend on food than relatively increases.
The development of the ratio of total consumption and GDP is quite equally spread. For six countries the ratio increased and for six it decreased. Highest increase is in China. Highest decrease is in Hungary.
Multiplying these ratios, results in a decrease in the size of the bio-economy in terms of the share of value added of the bio-economy in total GDP in all countries, except in Indonesia.

Table 4. Development employment

		$\frac{Y_{bio}}{E_{bio}}$	$\frac{Y_{tot}}{E_{tot}}$	$\frac{L_{tot}}{L_{bio}}$	$\frac{Y_{bio}}{Y_{tot}}$	$\frac{E_{bio}}{E_{tot}}$
Belgium	1995	181.169	146.273	0.807	0.106	**0.086**
	2011	293.797	245.884	0.837	0.077	**0.065**
Brazil	1995	8.534	17.153	2.010	0.161	**0.325**
	2011	27.280	37.805	1.386	0.164	**0.228**
China	1995	1.432	2.775	1.938	0.308	**0.597**
	2011	12.310	27.544	2.237	0.187	**0.418**
France	1995	124.517	121.447	0.975	0.118	**0.115**
	2011	228.059	198.316	0.870	0.101	**0.088**
Germany	1995	115.795	114.085	0.985	0.087	**0.086**
	2011	157.140	161.316	1.027	0.070	**0.072**
Great-Britain	1995	100.899	75.278	0.746	0.099	**0.074**
	2011	147.227	134.367	0.913	0.057	**0.052**
Hungary	1995	21.011	22.702	1.080	0.235	**0.254**
	2011	58.075	76.918	1.324	0.140	**0.186**
Indonesia	1995	2.572	5.289	2.056	0.270	**0.556**
	2011	8.779	14.466	1.648	0.288	**0.475**
Japan	1995	104.872	147.648	1.408	0.091	**0.129**
	2011	165.981	196.124	1.182	0.088	**0.104**
Netherlands	1995	144.947	109.983	0.759	0.152	**0.115**
	2011	235.555	188.174	0.799	0.115	**0.092**
Russia	1995	4.994	8.141	1.630	0.207	**0.338**
	2011	21.981	42.704	1.943	0.142	**0.276**
United States	1995	139.567	100.577	0.721	0.085	**0.061**
	2011	285.645	184.943	0.647	0.073	**0.047**

The ratio of labour productivity of the bio-economy and labour productivity in the total economy was expected to fall. This holds for Brasil, France, Indonesia, Japan and the United States. Here labour productivity in the bio-economy increased more than in the total economy, with Brasil and Indonesia having the highest increase. In the other countries the labour productivity ratio decreased. China, Hungary and Russia had the highest labour productivity decrease. Normally, technological changes make productivity in industrial sectors grow more than in service sectors in a growing economy. An explanation could be that the price of labour in these countries is relatively low, holding back technological changes to increase productivity per person engaged.
The share of the bio-economy in the total value of production was expected to decrease as well. This was the case in all countries except Brazil and Indonesia, as stated in the previous paragraph.
Multiplying these ratios, results in a decrease in the size of the bio-economy in terms of employment in all countries over time.

5. Discussion and Conclusions

This paper aims to measure the income realized with the production of food, feed, fibre, bio-based products and bio-energy in different countries. In the measurement we take in account the backward and forward linkages the bio-economy has. The paper first presents some definitions and then presents the method of measurement and finally we compare the results for some countries both within and outside the European Union. With only a few exceptions we see independent of the definition used that the relative size of bio-economy is getting smaller over time and with the level of economic development. Indonesia is an exception to this rule in terms of the share of the bio-economy in GDP. In terms of employment the relative size of the bio-economy differs more between countries, but the size decreases over time in all countries. Further research could be done on what causes the differences between countries with a different level of economic development.
This research has some caveats. First, the input-output tables of the WIOD have a high level of aggregation of industries. This probably overestimates the size of the bio-economy. Second, the input-output tables of the WIOD mainly include developed countries making it more difficult to analyse the effects of economic development on the relative size of the bio-economy. Third, employment ratios are calculated for the bio-economy as a whole. Different labour productivity changes may hold for the agricultural industry and the processing industry. It might be interesting to separate these. Fourth, we considered value added and employment but also other indicators might be relevant, e.g. environmental impact. Finally, the decomposition is somewhat misleading as some industries are both input-delivering industries and processing industries but the method first considers them to be agricultural then input-delivering to agriculture, then processing industries and then input-delivering to processing industries. Despite these caveats this paper gives valuable insights in the economic importance of the bio-economy.

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Appendix I

Besides to two definitions considered in the main text we introduce three additional definitions. This gives us five definitions:

1) The first definition is as stated in section 2.1: agriculture, the food industries that process agricultural products in the first stage (both domestically produced and imported) and the direct and indirect input delivering industries for both agriculture and the food industries.

2) The second definition of a bio-economy is similar to the first definition. The difference is that we consider only that part of the food industry that depends on the input of domestically produced agricultural products. Dependence is measured by dividing domestically produced agricultural inputs of the food industry by the sum of domestically produced agricultural inputs and imported agricultural inputs.

3) In the third definition the bio-economy consists of agriculture and agricultural products processing industries but only partially. The share is determined by the share of both domestically produced and imported agricultural inputs in the total value of variable inputs (both domestically produced and imported).

4) The fourth definition combines the first and the third definition and is the second definition in section 2.1.

5) The fifth definition of agro-complex represents the production that depends on the final demand of agricultural and food products. This is done by regular input-output analysis where in the final demand vector only final demand for agricultural and food processed products is included. Table 2 presents the results.

Appendix II

The method used is based on input-output analysis and developed by Harthoorn (Harthoorn and Wossink, 1987; Harthoorn, 1988; Peerlings, 1993). We have potentially the problem of double-counting, for example, agriculture belongs directly to the bio-economy but it also delivers inputs to the processing industry, so it should be avoided to count it twice; as agriculture and as an input-delivering industry to processing industries. We first define selection vectors (s_m) and residual vectors (r_m).

$$s_m(n) = \begin{cases} 1 \; \forall_n \in T_m \\ 0 \; \forall_n \notin T_m \end{cases} \tag{2.1}$$

$$r_m = i - \sum_{j=1}^{m} s_j \tag{2.2}$$

Where: $s_m(n)$ selection vector, r_m residual vector, T_m subset m of industries in the input-output table, i vector with ones.
S_m and R_m are defined as the diagonal matrices of s_m and r_m respectively.

Agriculture forms subset 1, the industries that process agricultural products are subset 2. The subsets are disjoint. The residual vectors are the complement of the sum of those selection vectors of which subscripts are lower or equal to m.

Per definition the set of elements per vector is different. The selection and residual vectors of the first definition can be used as an example. The first four industries of the input-output tables are included, where the first industry is agriculture and the third is the food processing industry.

Selection Vector s_1	Residual Vector r_1	Selection Vector s_2	Residual Vector r_1
$\begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \end{bmatrix}$	$\begin{bmatrix} 0 \\ 1 \\ 1 \\ 1 \end{bmatrix}$	$\begin{bmatrix} 0 \\ 0 \\ 1 \\ 0 \end{bmatrix}$	$\begin{bmatrix} 0 \\ 1 \\ 0 \\ 1 \end{bmatrix}$

For the first definition the selection vectors and residual vectors are the same for all countries in all years, because the total agricultural production is taken into account. A new set of elements per vector has to be made per year, per country for the other definitions, because in these definitions actual agricultural production shares are taken into account.

Value added and employment of the bio-economy are assumed to be linked to its total production. Total production can be decomposed in the production of agriculture, production linked to direct and indirect input deliveries to agriculture, production of processing industries and production linked to direct and indirect input deliveries to the processing industries. In each subsequent step double-counting is avoided.

The production of agricultural industries is:

$$y_1 = S_1 . \left(I - \hat{A}\right)^{-1} f \tag{2.3}$$

Where: $\hat{A}$ matrix of input-output coefficients, I identity matrix, $\left(I - \hat{A}\right)^{-1}$ Leontief inverse, f vector of final demand.

When dividing the intermediate flows from an input-output table by the corresponding column total, one gets the elements of the matrix of input-output coefficients (Ã). A Leontief inverse represents the production necessary to produce one unit of output in an industry. Multiplying this with the selection matrix for subset 1 (S_1) and the vector for final demand (*f*) one gets the production of agriculture.

The equation for direct deliveries to agriculture is:

$$R_1\hat{A}S_1\left(I-\hat{A}\right)^{-1}$$

To avoid the problem of double counting, all industries in the matrix of input-output coefficients which are elements of S_1 are erased in the indirect equation. This can be conducted by multiplying the matrix with the residual vector R_1. Resulting in the adjusted Leontief inverse for subset 1:

$$\left(I-R_1\hat{A}R_1\right)^{-1}$$

Production linked to the direct and indirect deliveries to agriculture is then given by:

$$y_2=\left(I-R_1\hat{A}R_1\right)^{-1}R_1\hat{A}S_1\left(I-\hat{A}\right)^{-1}f \tag{2.4}$$

Production of the food processing industries equals:

$$y_3=S_2\left(I-R_1\hat{A}R_1\right)^{-1}f \tag{2.5}$$

This equation is similar to equation (2.3). Multiplying the Leontief inverse for subset 1 with the selection matrix for subset 2 (S_2) and the vector for final demand (*f*) to get the production of the processing industries. By using the Leontief inverse, production is corrected for direct and indirect deliveries to agriculture.

The production linked to the direct and indirect deliveries to the food processing industries is similar to equation (2.4):

$$y_4=\left(I-R_2\hat{A}R_2\right)^{-1}R_2\hat{A}S_2\left(I-R_1\hat{A}R_1\right)^{-1}f \tag{2.6}$$

The equation for direct deliveries to the processing industries is multiplied by the adjusted Leontief for subset 2 and *f*. All industries in the matrix of input-output coefficients which are elements of S_2 are erased and multiplied with the residual vector R_2.

Total production (y) of the bio-economy is the sum of equations (2.3 - 2.6):

$$y=(y_1+y_2+y_3+y_4) \tag{2.7}$$

Value added and employment of the bio-economy can be calculated from the total production using the following equations:

$$v=Vy \tag{2.8}$$

$$l=Ly \tag{2.9}$$

Where: v vector of value added per industry, V diagonal matrix with input-output coefficients of value added, l vector of employment per industry, L diagonal matrix with input-output coefficients of employment.

Appendix III

Table 6. Value added agriculture and food processing industries in million US dollars and as share of GDP. Employment agriculture and food processing industries in number of people engaged and as share of total employment.

		Value Added		GDP	Employment		Total
		Agriculture	Processing		Agriculture	Processing	
Belgium	1995	3.887	6.782	256.265	95.832	99.658	3.867.180
		0.015	*0.026*		*0.025*	*0.0026*	
	2011	3.222	8.328	458.988	66.323	84.446	4.530.339
		0.007	*0.018*		*0.015*	*0.018*	
Brazil	1995	38.826	19.407	672.762	19.101.084	1.653.679	73.545.222
		0.058	*0.029*		*0.260*	*0.022*	
	2011	115.075	46.573	2.060.484	16.481.749	2.273.775	105.833.154
		0.056	*0.023*		*0.156*	*0.021*	
China	1995	145.326	32.603	728.005	355.300.000	10.592.064	680.650.000
		0.200	*0.045*		*0.522*	*0.016*	
	2011	738.563	279.318	7.302.547	273.465.474	16.426.536	808.564.772
		0.101	*0.038*		*0.338*	*0.020*	
France	1995	46.734	26.516	1.405.135	1.051.100	538.100	22.694.100
		0.033	*0.019*		*0.046*	*0.024*	
	2011	52.421	31.800	2.529.328	472.631	744.797	25.565.751
		0.021	*0.013*		*0.018*	*0.029*	
Germany	1995	29.060	47.218	2.283.991	1.079.000	914.000	37.601.000
		0.013	*0.021*		*0.029*	*0.024*	
	2011	33.532	45.600	3.281.726	866.004	780.938	41.986.635
		0.010	*0.014*		*0.021*	*0.019*	
Great-Britain	1995	19.352	28.823	1.047.517	571.000	552.979	27.913.388
		0.018	*0.028*		*0.020*	*0.020*	
	2011	22.376	41.337	2.205.272	596.248	468.436	32.888.394
		0.010	*0.019*		*0.018*	*0.014*	
Hungary	1995	3.112	1.472	38.823	596.740	165.303	4.025.461
		0.080	*0.038*		*0.148*	*0.041*	
	2011	6.905	2.833	122.202	391.414	181.176	4.021.886
		0.057	*0.024*		*0.097*	*0.045*	
Indonesia	1995	37.213	15.293	241.322	40.515.407	3.764.176	87.271.197
		0.154	*0.063*		*0.464*	*0.043*	
	2011	124.895	62.441	848.132	40.792.927	2.181.788	114.669.972
		0.147	*0.074*		*0.358*	*0.019*	
Japan	1995	91.140	158.864	5.239.622	4.792.251	1.568.339	66.857.749
		0.017	*0.030*		*0.072*	*0.023*	
	2011	78.761	181.110	5.866.101	2.782.780	1.480.408	57.786.890
		0.013	*0.031*		*0.048*	*0.026*	
Netherlands	1995	13.170	12.241	378.721	283.078	162.088	7.154.972
		0.035	*0.032*		*0.040*	*0.023*	

	2011	13.434 *0.018*	23.266 *0.031*	755.169	252.394 *0.029*	158.364 *0.018*	8.816.198
Russia	1995	24.723 *0.078*	9.796 *0.031*	315.028	20.758.281 *0.277*	1.623.030 *0.022*	75.064.020
	2011	67.967 *0.042*	35.440 *0.022*	1.603.619	16.127.975 *0.211*	1.761.854 *0.023*	76.402.478
United States	1995	91.860 *0.012*	125.494 *0.017*	7.421.307	2.751.558 *0.021*	1.843.672 *0.014*	133.979.321
	2011	178.955 *0.012*	221.187 *0.015*	15.088.077	2.114.428 *0.015*	1.754.882 *0.012*	145.548.485

Appendix IV

Table 7. Value added of the five bio-economy definitions in percentage of GDP

		Definition 1					Definition 2					Definition 3					Definition 4					Def. 5
		v^1	v^2	v^3	v^4	**v**	v^1	v^2	v^3	v^4	**v**	v^1	v^2	v^3	v^4	**v**	v^1	v^2	v^3	v^4	**v**	**v**
Belgium	1995	1.5	0.9	2.5	2.3	**7.2**	1.5	0.9	1.5	2.4	**6.4**	1.5	0.9	1.1	2.5	**6.0**	1.5	0.9	2.8	2.3	**7.5**	**6.3**
	2011	0.7	0.5	1.8	2.1	**5.1**	0.7	0.5	0.6	2.2	**4.1**	0.7	0.5	0.8	2.2	**4.2**	0.7	0.5	2.2	2.1	**5.5**	**4.5**
Brazil	1995	5.8	1.5	2.8	2.5	**12.6**	5.8	1.5	2.7	2.6	**12.5**	5.8	1.5	1.9	2.7	**11.9**	5.8	1.5	3.4	2.5	**13.2**	**10.3**
	2011	5.6	1.8	2.2	2.7	**12.3**	5.6	1.8	2.1	2.7	**12.2**	5.6	1.8	1.6	2.9	**11.9**	5.6	1.8	2.8	2.7	**12.9**	**10.4**
China	1995	20.0	4.9	3.9	0.2	**30.8**	20.0	4.9	3.8	0.2	**30.6**	20.0	4.9	4.7	3.7	**33.3**	20.0	4.9	6.3	4.4	**35.6**	**24,3**
	2011	10.1	2.9	3.3	1.8	**18.1**	10.1	2.9	3.1	1.8	**17.8**	10.1	2.9	3.1	3.0	**19.1**	10.1	2.9	4.7	3.7	**21.4**	**11.6**
France	1995	3.3	1.5	1.8	2.1	**8.7**	3.3	1.5	1.7	2.1	**8.6**	3.3	1.5	1.5	2.2	**8.5**	3.3	1.5	2.6	2.1	**9.5**	**7.3**
	2011	2.1	1.2	1.2	2.3	**6.7**	2.1	1.2	1.1	2.3	**6.6**	2.1	1.2	0.8	2.4	**6.4**	2.1	1.2	1.7	2.2	**7.1**	**5.8**
Germany	1995	1.3	0.9	2.0	2.1	**6.3**	1.3	0.9	1.6	2.1	**5.9**	1.3	0.9	1.2	2.2	**5.5**	1.3	0.9	2.5	2.1	**6.7**	**5.2**
	2011	1.0	0.8	1.4	1.7	**4.9**	1.0	0.8	0.8	1.7	**4.4**	1.0	0.8	1.1	1.7	**4.6**	1.0	0.8	2.0	1.7	**5.5**	**4.3**
Great-Britain	1995	1.8	1.0	2.7	2.1	**7.6**	1.8	1.0	2.4	2.2	**7.4**	1.8	1.0	1.3	2.4	**6.4**	1.8	1.0	3.1	2.1	**8.0**	**5.5**
	2011	1.0	0.5	1.8	1.3	**4.7**	1.0	0.5	1.5	1.3	**4.3**	1.0	0.5	0.7	1.4	**3.7**	1.0	0.5	2.1	1.3	**4.9**	**3.3**
Hungary	1995	8.0	3.1	3.4	2.6	**17.1**	8.0	3.1	3.2	2.6	**16.9**	8.0	3.1	3.2	2.7	**17.1**	8.0	3.1	5.1	2.5	**18.7**	**15.1**
	2011	5.7	1.9	2.1	1.4	**11.1**	5.7	1.9	1.9	1.4	**10.9**	5.7	1.9	2.3	1.5	**11.3**	5.7	1.9	3.4	1.4	**12.4**	**9.6**
Indonesia	1995	15.4	1.6	6.2	2.2	**25.4**	15.4	1.6	5.8	2.1	**24.9**	15.4	1.6	6.0	2.8	**25.9**	15.4	1.6	8.2	3.5	**28.8**	**20.6**
	2011	14.7	1.8	7.0	1.9	**25.4**	14.7	1.8	6.5	1.8	**24.8**	14.7	1.8	7.4	2.9	**26.8**	14.7	1.8	10.6	3.3	**30.4**	**19.8**
Japan	1995	1.7	0.9	2.9	1.9	**7.5**	1.7	0.9	2.7	1.9	**7.3**	1.7	0.9	1.5	2.1	**6.3**	1.7	0.9	3.4	1.9	**8.0**	**5.6**
	2011	1.3	0.7	3.0	1.8	**6.9**	1.3	0.7	2.5	1.9	**6.5**	1.3	0.7	1.3	2.2	**5.5**	1.3	0.7	3.4	1.8	**7.3**	**5.3**
Netherlands	1995	3.5	1.7	3.1	2.9	**11.1**	3.5	1.7	2.2	3.0	**10.3**	3.5	1.7	1.5	3.1	**9.8**	3.5	1.7	3.6	2.9	**11.7**	**10.3**
	2011	1.8	1.1	3.0	2.5	**8.4**	1.8	1.1	1.6	2.6	**7.1**	1.8	1.1	1.2	2.7	**6.8**	1.8	1.1	3.5	2.5	**8.9**	**7.7**
Russia	1995	7.8	3.2	2.9	2.1	**16.0**	7.8	3.2	2.8	2.1	**15.9**	7.8	3.2	2.5	2.3	**15.9**	7.8	3.2	4.2	2.0	**17.3**	**14.4**
	2011	4.2	2.2	2.1	2.3	**10.8**	4.2	2.2	2.0	2.3	**10.7**	4.2	2.2	1.7	2.5	**10.6**	4.2	2.2	3.1	2.2	**11.8**	**9.9**
United States	1995	1.2	1.1	1.6	1.8	**5.7**	1.2	1.1	1.5	1.8	**5.6**	1.2	1.1	0.8	1.9	**5.1**	1.2	1.1	1.9	1.7	**6.0**	**4.2**
	2011	1.2	0.8	1.4	1.4	**4.8**	1.2	0.8	1.3	1.4	**4.7**	1.2	0.8	0.7	1.5	**4.3**	1.2	0.8	1.7	1.4	**5.0**	**3.6**

Table 8. Employment of the five bio-economy definitions in percentage of total employment

		Definition 1					Definition 2					Definition 3					Definition 4					Def. 5
		]1	]2	]3	]4	**1**	]1	]2	]3	]4	**1**	]1	]2	]3	]4	**1**	]1	]2	]3	]4	**1**	**1**
Belgium	1995	2.5	0.9	2.4	2.4	**8.2**	2.5	0.9	1.5	2.5	**7.4**	2.5	0.9	1.2	2.6	**7.1**	2.5	0.9	2.8	2.4	**8.6**	**6.4**
	2011	1.5	0.6	1.8	2.2	**6.0**	1.5	0.6	0.6	2.3	**5.0**	1.5	0.6	0.9	2.3	**5.2**	1.5	0.6	2.3	2.1	**6.5**	**4.5**
Brazil	1995	26.0	1.2	2.2	2.4	**31.7**	26.0	1.2	2.1	2.4	**31.7**	26.0	1.2	1.7	2.5	**31.4**	26.0	1.2	2.9	2.3	**32.5**	**25,8**
	2011	15.6	1.6	2.1	2.8	**22.0**	15.6	1.6	2.0	2.8	**22.0**	15.6	1.6	1.7	2.9	**21.8**	15.6	1.6	2.8	2.8	**22.8**	**18.7**
China	1995	52.2	2.3	1.4	1.0	**56.9**	52.2	2.3	1.3	1.0	**56.8**	52.2	2.3	2.4	1.9	**58.8**	52.2	2.3	3.0	2.2	**59.7**	**44,5**
	2011	33.8	1.9	1.7	1.3	**38.7**	33.8	1.9	1.6	1.2	**38.5**	33.8	1.9	2.6	2.2	**40.4**	33.8	1.9	3.4	2.7	**41.8**	**24.6**
France	1995	4.6	1.5	2.3	2.0	**10.4**	4.6	1.5	2.1	2.0	**10.2**	4.6	1.5	2.0	2.1	**10.2**	4.6	1.5	3.4	2.0	**11.5**	**8.8**
	2011	2.9	1.2	1.8	2.3	**8.2**	2.9	1.2	1.6	2.3	**8.0**	2.9	1.2	1.1	2.4	**7.6**	2.9	1.2	2.4	2.3	**8.8**	**7.2**
Germany	1995	2.9	0.9	2.4	1.9	**8.0**	2.9	0.9	1.9	2.0	**7.6**	2.9	0.9	1.3	2.1	**7.1**	2.9	0.9	2.9	1.9	**8.6**	**6.7**
	2011	2.1	0.9	1.8	2.2	**7.0**	2.1	0.9	1.5	2.2	**6.7**	2.1	0.9	1.1	2.3	**6.4**	2.1	0.9	2.3	2.2	**7.5**	**5.8**
Great-Britain	1995	2.0	0.9	1.9	2.0	**6.9**	2.0	0.9	1.7	2.0	**6.7**	2.0	0.9	1.1	2.2	**6.2**	2.0	0.9	2.5	2.0	**7.4**	**5.0**
	2011	1.8	0.5	1.4	1.2	**4.9**	1.8	0.5	1.1	1.2	**4.6**	1.8	0.5	0.7	1.3	**4.3**	1.8	0.5	1.8	1.2	**5.2**	**3.3**
Hungary	1995	14.8	2.7	3.7	2.3	**23.5**	14.8	2.7	3.5	2.3	**23.3**	14.8	2.7	3.6	2.4	**23.6**	14.8	2.7	5.6	2.2	**25.4**	**20.7**
	2011	9.7	1.9	4.1	1.2	**17.0**	9.7	1.9	3.8	1.3	**16.7**	9.7	1.9	3.5	1.4	**16.5**	9.7	1.9	5.7	1.2	**18.6**	**14.8**
Indonesia	1995	46.4	0.9	4.2	1.7	**53.3**	46.4	0.9	4.0	1.6	**52.9**	46.4	0.9	4.1	2.1	**53.5**	46.4	0.9	5.6	2.6	**55.6**	**41.8**
	2011	46.7	1.5	2.4	2.5	**53.0**	46.7	1.5	2.2	2.3	**52.7**	46.7	1.5	9.3	2.9	**60.4**	46.7	1.5	10.3	3.8	**62.4**	**30.5**
Japan	1995	7.2	0.8	2.3	1.8	**12.0**	7.2	0.8	2.1	1.8	**11.9**	7.2	0.8	1.6	1.9	**11.5**	7.2	0.8	3.1	1.8	**12.9**	**8.8**
	2011	4.8	0.7	2.5	1.8	**9.7**	4.8	0.7	2.1	1.8	**9.4**	4.8	0.7	1.5	2.0	**9.0**	4.8	0.7	3.2	1.8	**10.4**	**7.2**
Netherlands	1995	4.0	1.6	2.2	3.2	**10.9**	4.0	1.6	1.5	3.2	**10.3**	4.0	1.6	1.3	3.3	**10.2**	4.0	1.6	2.8	3.2	**11.5**	**10.4**
	2011	2.9	1.1	1.7	2.8	**8.6**	2.9	1.1	0.9	2.9	**7.9**	2.9	1.1	1.0	3.0	**8.0**	2.9	1.1	2.3	2.8	**9.2**	**8.2**
Russia	1995	27.7	1.8	2.0	1.1	**32.5**	27.7	1.8	1.9	1.1	**32.5**	27.7	1.8	2.1	1.3	**32.8**	27.7	1.8	3.3	1.1	**33.8**	**29.2**
	2011	21.1	1.5	2.2	1.6	**26.4**	21.1	1.5	2.1	1.7	**26.3**	21.1	1.5	1.9	1.8	**26.3**	21.1	1.5	3.4	1.6	**27.6**	**23.9**
United States	1995	2.1	0.8	1.3	1.5	**5.7**	2.1	0.8	1.2	1.6	**5.6**	2.1	0.8	0.9	1.7	**5.4**	2.1	0.8	1.8	1.5	**6.1**	**4.3**
	2011	1.5	0.5	1.2	1.2	**4.3**	1.5	0.5	1.0	1.2	**4.2**	1.5	0.5	0.8	1.3	**4.1**	1.5	0.5	1.6	1.2	**4.7**	**3.3**