Modelling Sustainability in a Computable General Equilibrium Framework

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Abstract

This paper proposes a new tool for the measurement and projection of sustainability: the FEEM Sustainability Index (FEEM SI). This is an innovative measure of sustainability built within a dynamic computable general equilibrium model, the Intertemporal Computable Equilibrium System (ICES) in its adapted version to assess sustainability ICES SI. The FEEM SI combines indicators on economic, social, and environmental sustainability to construct a unique measure of overall sustainability. Thanks to its construction within a dynamic computable general equilibrium model, the FEEM SI is able to project indicators in time and evaluate sustainability in the future under different economic growth and policy scenarios. With the purpose to illustrate the methodology and highlight its potentials in making sustainability a more operative concept, this paper provides an example of the effects of the introduction of a composite policy aimed at improving overall sustainability and shows how the choices we make today can change our future.

Keywords: Computable General Equilibrium (CGE) Models, Sustainability, Millennium Development Goals
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1. Introduction

Achieving a sustainable growth has become one of the major challenges of modern societies. It is fundamental to better understand the problems and issues connected to sustainable development, as well as to obtain tools that allow measuring it. Sustainability indicators and aggregate indices can contribute to its assessment and to quantitatively measure such an abstract concept. However, these are usually constructed from past data and give only limited information on the consequences that a certain political choice may have on sustainability. In order to obtain more operative measures it has been proposed to calculate those indicators within applied economic models that also include an environmental measure.

Exercises of calculation of sustainability indicators within applied models are already present in the literature. Various computer models are commonly being used for the evaluation of sustainability impacts (Klaassen and Miketa, 2003) and, as argued by Böhringer and Löschel (2004), there is no specific model that would be suitable to assess all the impacts on sustainability. Nevertheless, the authors suggest that computable general equilibrium (CGE) models are flexible in a way that they can incorporate several key sustainability indicators in a single micro-consistent framework. CGE models provide an open framework for linkages to sector-specific models and important relationships to other disciplines adopting an integrated assessment approach and, thus, may be used as efficient tools for sustainability impact assessment (Ibid.). Bosetti et al. (2009) illustrate how models of different nature and type can be used to calculate sustainability indicators for different purposes. Beise-Zee and Rennings (2005) show how to calculate competitiveness indicators in a CGE framework. Hilderlink et al. (2008) calculate sustainability indicators within a complex framework that allows considering interrelations between social, economic and environmental developments. While these are all exercises to calculate sustainability indicators, Loh (2002) attempts to project an aggregate index, namely the Ecological Footprint, thereby obtaining projections for a single measure of sustainability.

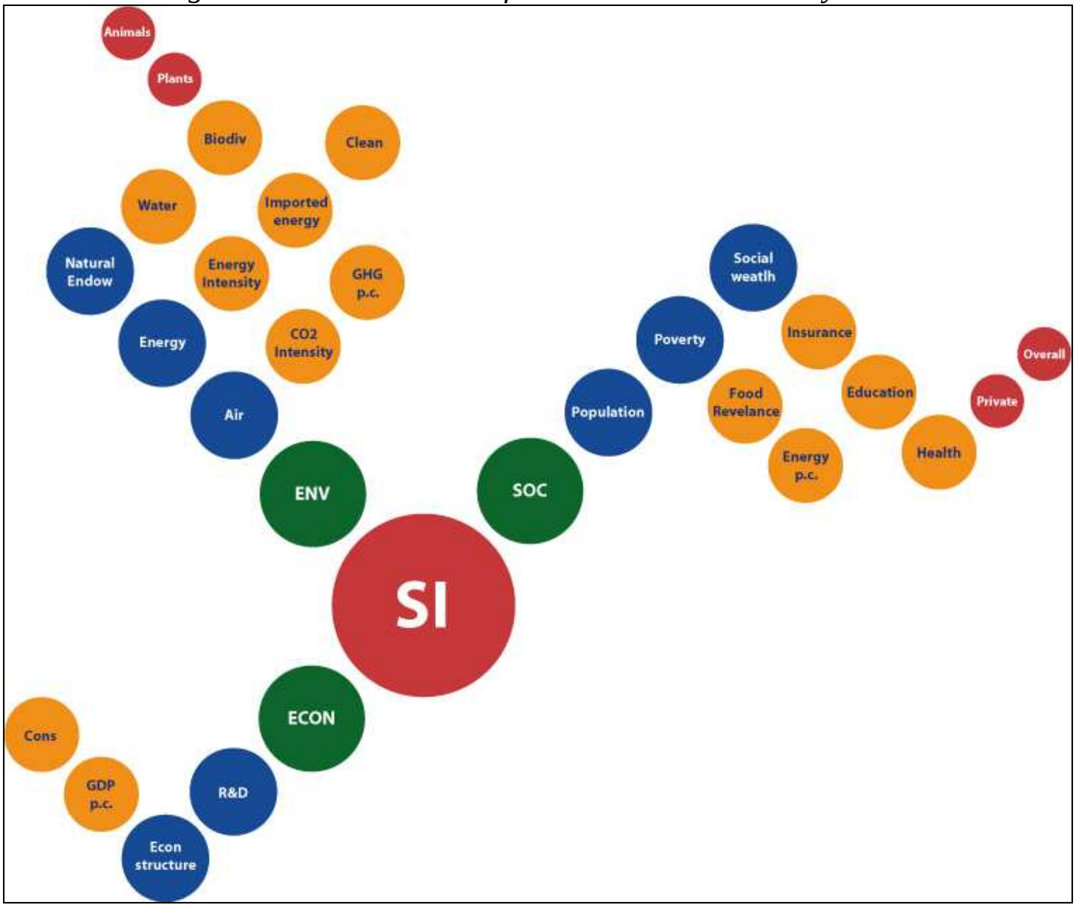
The present paper aims at improving the existing literature by constructing sustainability indicators and aggregating them to a sustainability index, the FEEM Sustainability Index (FEEM SI). This is a comprehensive measure of sustainability, based on indicators that cover the economic, social, and environmental components. Compared with the existing work, the FEEM SI is based on a detailed methodology that explains the calculation, the projection and the aggregation of the sustainability indicators. Furthermore, it incorporates the possibility to project and calculate the FEEM SI under different growth and policy scenarios.

The rest of this paper is structured as follows. Section 2 briefly describes the FEEM SI and its construction methodology. Section 3 presents the modelling framework, including the model description, the methodology for the calculation of the indicators, and the derivation of the baseline scenario. Section 4 illustrates the results, including those relative to the comparison between the policy and the baseline scenario. Section 5 concludes.

2. The FEEM Sustainability Index

Sustainability is a flexible notion that may be considered in different contexts and levels. It is also a multifaceted concept that contains the basic elements to envision an evolution of its components that should not constraint or hamper their future development, as described in the definition by the Bruntland Commission (1987). The FEEM SI framework is ideal to propose an index that can be used to evaluate the performance of countries considering simultaneously the three main pillars of sustainability, namely economic, social and environmental. The indicators chosen for the three components of the FEEM are the result of an extensive evaluation and review of existing indicators based on the main international sources (EU Sustainable Development Strategy, UN Conference on Sustainable Development, World Development Indicators). The selection of indicators has been constrained by the construction within a CGE model. Nevertheless, this also guarantees coherence between the data sources, as all indicators come from the CGE model database and projection. Figure 1 illustrates the detailed structure of the FEEM SI tree, with the list of indicators selected to calculate the mentioned pillars, divided by theme and subthemes, which are then combined to produce a single measure of sustainability.[1]

Figure 1: Tree structure of the FEEM Sustainability Index



The FEEM SI has been built on a comprehensive methodology divided in different steps. Indicators have been firstly selected following reliable and internationally-recognised literature, such as the EU SDS indicator list and the indicators from the Commission on Sustainable development of the United Nations. A set of possible indicators has been carefully evaluated to choose what we believe

[1] The list of indicators belonging to each subtheme is shown on Table A1.1 in Annex 1, while a more detailed description of the FEEM SI and additional information is available on the FEEM SI website at www.feemsi.org.

are the ones that best fit in the sustainability framework within the potentials of the general equilibrium framework of the ICES SI model.

The main pillars are derived from a tree structure whose leaves are the indicators selected. The economic component is a combination of Research and Development activities with indicators related to the Economic Structure such as GDP per capita and Consumption as share of GDP. For what regards the social pillar, it is derived from three sub levels taking into account the joint incidence of Population Growth Rates with Poverty and Social Wealth measures. Two are the indicators chosen for Poverty. First is Food relevance in primary consumption, which represents the proportion of national expenditure in primary goods spent on food, being is a proxy for a poverty indicator according to the Engel law. The second is Energy per capita, which is the amount of energy consumed per capita, a measure of the degree of connection to energy systems.

The environmental pillar is based on the role and contribution of natural ecosystems in the form of Air, Energy, and Natural Endowments subcomponents. Air is a composite index of carbon intensity of energy, and Greenhouse Gases per capita. Energy is calculated from three indicators (Energy Intensity, Imported Energy – a measure of energy security - and the proportion of Clean energy in overall energy consumption). Finally, the natural endowments are represented using indicators relative to Water (water use over total available renewable water resources) and Biodiversity, which combines the relative proportions of endangered species.

In order to achieve full comparability between indicators, we apply a normalisation procedure. This is done according to a policy target-based benchmarking methodology, where benchmarks have been derived from a wide policy review. Finally, indicators are aggregated onto a single sustainability measure according to a non-linear aggregation function. The aggregation methodology for the FEEM SI introduces a very novel approach in this field. It enhances the importance to consider the interactions between indicators by attributing weights to the single indicators as well as to all possible combinations of indicators belonging to the same theme or sub-theme. Weights are then combined with a special weighted average based on the Choquet integral, which is a tool particularly well-suited to deal with multi-attribute issues like sustainability.[2]

3. Modelling framework

The FEEM SI is constructed in the framework of a recursive dynamic general equilibrium model based on the Intertemporal Computable Equilibrium System (ICES). This model was developed with the main purpose to assess the final welfare implications of climate change impacts on world economies and was the starting point for the construction of the FEEM SI. In order to adapt the model to the structure of the index, new variables have been added and the regional and sectoral disaggregation has been augmented to create an enhanced version, which will be referred to as ICES SI.

The selected indicators are calculated from the output of ICES SI, which has been structured to be able to compute the desired indicators for each region and year. The fact that the indicators are constructed in an integrated framework and database introduces two main advantages and novelties. First of all, it guarantees coherence and correspondence between all the different indicators

[2] A sensitivity analysis can also be performed in order to verify the robustness of the aggregation methodology.

calculated. Contrarily to other indicators, the ones used for the FEEM SI are all derived from the same database, which being at the basis of a CGE model guarantees full coherence. Secondly, constructing indicators in a dynamic CGE model also allows projecting indicators in the future under different policy and growth assumptions.

The general equilibrium structure of the model allows capturing and highlighting the production and consumption substitution processes in a social-economic system. The model's core is based on a multi-country world CGE model founded on the GTAP framework (Hertel, 1997). Industries are modelled through a representative cost-minimizing firm while a representative consumer in each region receives income, defined as the service value of the national primary factors. Demand for production factors and consumption goods can be satisfied either by domestic or foreign producers which are not perfectly substitutable according to the "Armington" assumption.

The dynamic of the model is driven by two sources: one exogenous and the other endogenous. The first stems from exogenously imposed growth paths for some key variables - population, labour stock, labour productivity and land productivity. The second concerns the process of capital accumulation, according to which capital stock is updated over time in order to take into account endogenous investment decisions. A more detailed description of the model baseline is given in the next sub section. The time dimension is in fact very important for the development of the FEEM SI and its indicators over time, as sustainability should be evaluated as a long-term process rather than short periods.

3.1. Additions to the model

In order to construct the FEEM SI in the ICES framework, it has been necessary to enhance the model it in two different ways. First of all, the sectoral disaggregation has been changed to a finer one including some sectors, which were fundamental for the construction of the sustainability indicators. Secondly, new variables have been included to enrich the model and to calculate the sustainability indicators related to them. For this purposes, changes have been made both to the database and to the model itself.

3.1.1. Adding new sectors in the database

Most of the sectors used for the construction of the index are simply obtained aggregating the 57 sectors that are part of the GTAP-6 database. However, to construct the indicators according to the structure of the FEEM-SI, it has been necessary to modify the original data, and to aggregate some sectors. The final sectoral aggregation for the ICES SI includes 17 sectors, with a detailed disaggregation of the energy, and non market services sectors.[3] Moreover, some indicators, namely Research and Development, Education and Health were not individually present in the original GTAP database, though they were part of other more aggregate sectors. Thus, they have been divided with the aid of the SplitCom[4] utility.

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[3] Table A3.1 describes the sectoral aggregation of the model in detail.

[4] SplitCom is a set of programs aimed at facilitating the addition of sectors to a standard GTAP database. With the use of external data, it is possible to split the existing GTAP sectors into a finer aggregation. Horridge (2005).

SplitCom allows the use of external data on trade flows, production and contribution to the sector by the different economic agents, namely households, firms and government, in order to disaggregate existing sectors. We used this utility to split the sector "obs", which includes real estate activities, renting of various types of machineries, computer-related activities, R&D and other business activities. Thus the former sector has been divided into the sectors "RD", including R&D expenditure, and "Tech", including the rest of the original "obs" sector.

Data from the World Development Indicators (World Bank, 2008) on the percentage of R&D in each country have been used to calculate the contribution of R&D to the sector "obs". Because no other data on trade flows is available, it has been assumed that there are no imports and exports in R&D. This assumption corresponds to the fact that R&D is usually a domestic activity, as the government and firms would invest in R&D only to benefit their own country or productivity. Percentages of R&D coming from Government, Firms, Foreign Investment and Other National sources obtained from the OECD Main Science and Technology Indicators were used to attribute R&D to the different economic agents.

A similar approach has been taken to split the GTAP sector "osg", which includes public administration and defence, sewage and refuse disposal, activities of membership organizations and extra-territorial organization and bodies, education and health. This sector has been divided into three new sectors, namely "Edu", including expenditure in education, "Hea", including expenditure in health, and "Pub", with the rest of the initial public expenditure that was included in the original "osg" sector. Data on overall expenditure in health and education have been obtained from the WDI dataset, while data for splitting the public and private sector have been taken from the World Health Organization. In this case, it has been assumed that imports and exports maintain the same proportions as the initial sector in all the new disaggregated sectors. This assumption is based on the idea that trade in public expenditure sectors will be similar within the different public areas, such as health and education.

3.1.2. Additional variables

Some of the indicators selected for the FEEM SI are related to variables that are not included in the GTAP-6 database, namely use of water, biodiversity and renewable energy. In fact, it has been necessary to include in the model external data relative to these variables. This has been done firstly by adding the variables to the dataset, and then linking them to the model. Linking exogenous variables to variables that are endogenous to the model allows simulating its future behaviour coherently with endogenous path generated by ICES-SI. In doing so it is feasible to obtain level values and percentage changes resulting from projections as well as comparative statics. In the specific case of the FEEM SI, it will be possible to calculate indicators over time. This section will explain how each of the indicators themes has been included in the ICES-SI.

Water

Water is already included in the GTAP-6 database. However, being related to trade and expenditure in water, it does not give a complete account of the availability and use of water, and thus of the sustainability of its use. This is why additional variables have been added to the model in order to obtain a better indicator for water use. Data related with water volumes from the Food and Agriculture Organization (FAO's Aquastat database) has been added to the database and includes use of water for all regions. The data is divided in: use of water in agriculture (WA), industry (WI) and by privates (WP). Then the total use of water (WT) is calculated as the sum of water used in the three sectors. Finally, Total Renewable Water Resources (WTR) have also been included in the model. These are kept constant throughout time, following the Aquastat indicator, which is also constant over time. Once added to the database, we linked the water data to variables to ICES SI. This is done firstly by finding the corresponding endogenous variables that water use is related with, and then adding new equations to the model. Water use in agriculture, industry and by privates, have been linked respectively with agricultural production, industrial production and population growth.

Biodiversity

Biodiversity is taken into account by adding an index which quantifies the number of highly endangered species for both animals (BAn) and plants (BPl). Variables related with the overall number of threatened species are also included (BAnT and BPlT). Data to construct these variables have been obtained from the World Conservation Union (IUCN) Red List of Threatened Species Database. Having both the number of endangered species and of existing species gives a quantitative account of the pressure that human activities put on the environment in terms of biodiversity.

The number of endangered species is linked to the model so that over time it is possible to see how, due to human activities, there are more and more species in danger of extinction. Selecting an endogenous variable to create a link to biodiversity has not been easy. Biodiversity loss can be caused by multiple human activities, such as extension of agricultural fields, forestry abatement, fishing, hunting, industrial activities, pollution or climate change. As it was not possible to take account of all the factors that influence biodiversity, climate change has been thought to be the most significant variable to consider. The effects of climate change, as well as the increase in CO_2 concentrations, lead to enormous changes to the ecosystems and generally to the endangering of many animal and vegetal species. According to a study published in Nature (Thomas et al, 2004), which focuses on 1,103 animal and plant species in sample regions covering some 20% of the Earth surface, 15 to 37% of the species risk extinction because of climate change scenarios at 2050. In order to proxy for climate change, the number of endangered species has been inversely linked to CO_2emission. Higher emissions lead to an increase in the number of endangered species both for the consequent effects of climate change and for the fact that they are linked to the level of industrial activity in a country. Although this method does not take into account all the several factors causing the loss of biodiversity, it is a simple way to include it in a CGE model that allows obtaining biodiversity indicators for the simulation period.

Renewable Energy

Volumes of energy included as from the GTAP-E, do not take into account renewable sources of energy (Dimaranan, 2006). Thus, data on volumes of energy produced with renewables and alterative energy sources in the base year (2001) are taken from the WDI Clean Energy Consumption indicator (World Bank, 2008) and included as a new variable (REN). These are then directly comparable with the other volumes of energy already included in the ICES-SI.

As before, it has been necessary to link the new variable on renewable energy to an endogenous variable in the model. In this case the endogenous variable is the regional domestic demand for electricity. Therefore, with more electricity demanded, there will also be more electricity generated from renewable sources. Once again, it should be noted that this is just an easy way to obtain a proxy for renewable energy and that a finer sectoral disaggregation including all renewable energy sources would be the ideal framework. Nevertheless, this allows us to calculate over-time projections for the use of renewable energy needed to construct the FEEM-SI.

3.2. Regional aggregation

For the FEEM-SI, the world economy is represented by 40 macro-regions aggregated from the original 87 regions of the GTAP 6 database. These consist either of single countries or groups of countries. Table A3.2 in Annex 3 illustrates the regional aggregation used in ICES SI. This aggregation includes countries that are part of the EU, OECD, Former Soviet Union and Annex I of the Kyoto Protocol. The rest of the world is aggregated in macro regions that group countries with similar characteristics and geographical location: Rest of Africa, North Africa, South East Asia, Rest of Latin America, Middle East and Rest of the World. This disaggregation has been chosen in order to focus on countries that are mostly engaging in environmental and climate policies, which we think is interesting for policy simulations.

3.3. Baseline scenario

The reference for future evaluations is a baseline scenario that has been simulated following assumptions intended to reproduce an intermediate growth level in a world where no significant policy has been implemented. This scenario has been built taking into account guidelines that represent a plausible future starting from present conditions, both economic and environmental. This reference point will be useful to compare and evaluate different policy options and also hypothesis about future economic, social and technological developments. Three are the main sources for the exogenous dynamics used to create the ICES-SI Baseline:

1. The WITCH (A World Induced Technical Change Hybrid) model that combines a detailed structure of the energy sector in its bottom up component linked with a top down description of the world economy divided in 12 world regions (Bosetti et al., 2006);
2. The United Nations World Population Prospects (UN, 2009); and
3. The IMAGE model, which is an integrated assessment model with a particular focus on land use, reporting information on seven crop yields for 13 world regions, from 1970 to 2100.

In the economic sphere, the GDP growth follows an intermediate growth path, whilst the environmental sphere considers a high emissions growth scenario corresponding to the absence of any climate policy implementation. In order to simplify the task, we have calibrated the model targeting the GDP and emissions levels from WITCH, which follows the growth and emission paths described. In fact, although the two models differ in structure we have attempted to harmonise the ICES-SI baseline with the Business as Usual scenario of WITCH, giving first priority to replicating the GDP, while calibrating CO2 emissions as close as possible to those of WITCH. Two reference years are considered for this process, 2010 and 2020, interpolating the remaining years. Due to the greater disaggregation of the ICES-SI model, it has been necessary to perform a downscaling to calibrate the GDP growth rates of the model taking into account the relative size of every region in economic terms and also using the downscaling of the IPCC scenarios proposed by IIASA (2009).

Additional exogenous drivers have been used for the baseline calibration: population, labour stock, labour productivity and land productivity. The values for these variables are taken from existing sources, available statistics or projections from other modelling exercises. The population (and labour stock) growth rates are taken from the United Nations World Population Prospects (UN, 2009). Labour productivities are calibrated to replicate as much as possible the GDP growth rate from the downscaling process derived from the WITCH model.

Energy sectors are one of the core components of ICES with a detailed aggregation based on fossil fuel sources. Because of this reason, during the calibration of a baseline it is critical to consider different projections and forecasts for fossil fuel prices, taking into account their current trends and also different editions of the World Energy Outlook (IEA, 2008, 2009), the International Energy Outlook (EIA 2008), and the Annual Energy Outlook (EIA, 2009). Table 2 shows the projections for oil, gas and coal prices for all the mentioned sources along with the ICES-SI price changes in percentage with respect to the base year (2001).

Table 2: Fossil fuel prices (% changes wrt 2001)

Oil Prices	2010	2020
WEO 2008	106.4	212.8
IEO 2008	49.8	99.5
AEO 2009	121.1	242.2
ICES-SI	**36.71**	**104.75**

Gas Prices	2010	2020
WEO 2008	100.0	199.9
IEO 2008	19.0	38.0
AEO 2009	33.2	66.5
ICES-SI	**7.47**	**27.07**

Coal Prices	2010	2020
WEO 2008	69.8	139.7
IEO 2008	2.9	5.8
AEO 2009	34.8	69.6
ICES-SI	**1.47**	**9.64**

Finally, whilst the calibration of the baseline model is aimed at supplying an average-growth no-policy scenario, the model will also be run according to policy scenarios. This will give the opportunity to calculate the FEEM-SI under different policy and growth assumptions, and thus to compare their sustainability implications.

4. Results

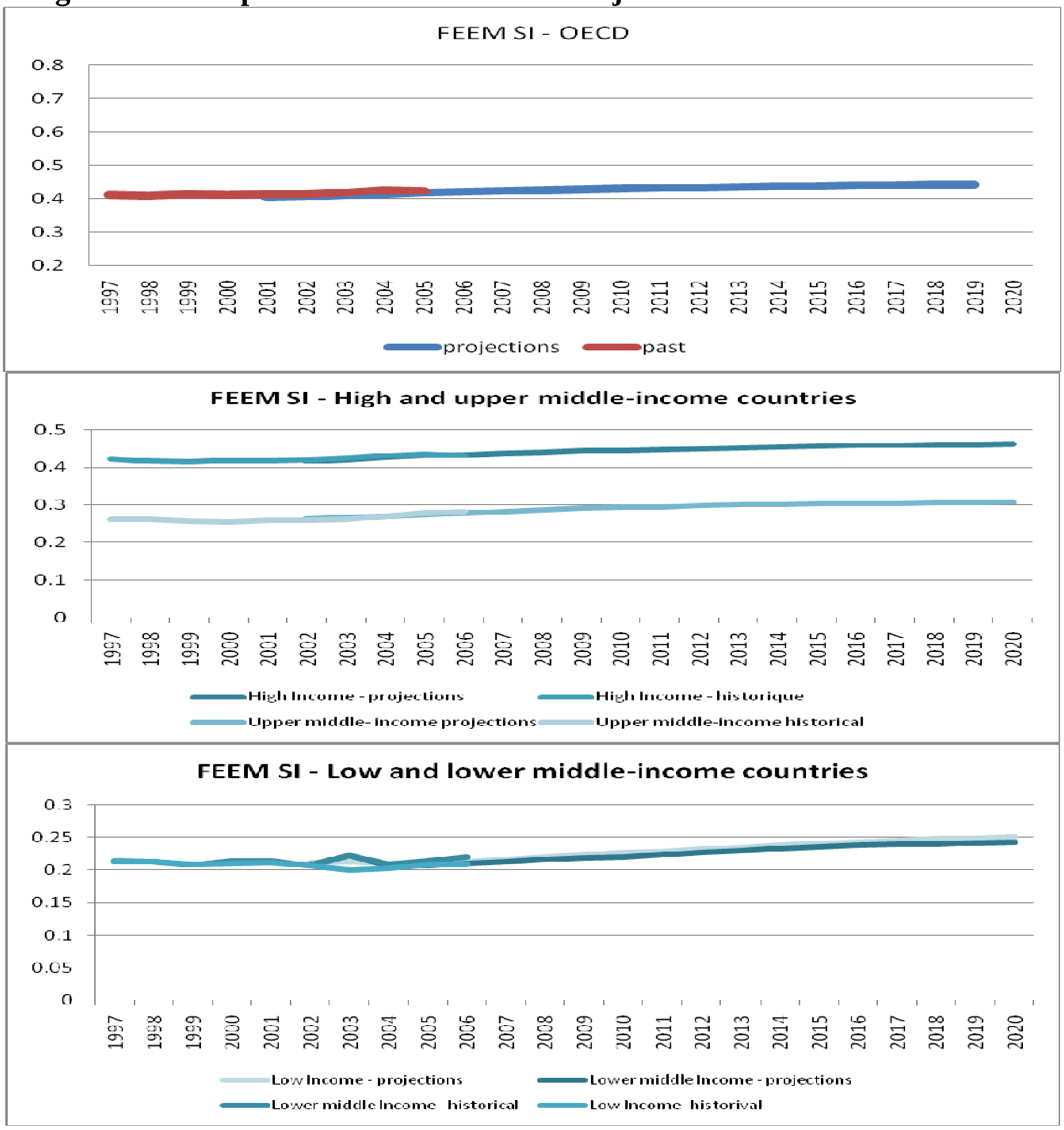
4.1. Comparison with past data

The risk of not using historical data is that projections may be different and not reliable. In calibrating the ICES SI model, we have attempted to respect the most reliable sources for economic projections. Furthermore, in order to check the robustness and significance of our projections we have gathered data to construct the index for the past years for which data is available. In fact the FEEM SI is based on a 2001 database from which projections are made for the period 2002-2020. Having this in mind, we have computed the FEEM SI for the period 1997-2006 to compare projected and historical data to check on the robustness of the index. For the calculation of the index in the past, only data from public sources have been taken (WDI by World Bank, UNCDB by United Nations, AQUASTAT by FAO and RedList by IUNC). If data was missing, especially for indicators which are dependent from the GTAP database, namely Food relevance in primary consumption and Expenditures in insurance and pensions as percentage of GDP, additional work was done starting from GTAP internal data of 2001 and obtaining time series using two other indicators (GDP and Consumption expenditure as percentage of GDP).

We present the data comparison aggregated by macro regions, as this simplifies the task of data gathering as well as for presentation purposes. The regions considered OECD countries, High-

Income Economies,[5] Upper Middle-Income Economies,[6] Lower Middle-Income Economies,[7] and Low-Income Economies.[8] Data is presented for the FEEM SI and its three main components. The graphs in Figure 2 illustrate that the results from the FEEM SI constructed with historical and projected data are very similar, supporting the robustness of the baseline projections of the ICES-SI model as well as its calibration.[9]

Figure 2 – Comparison of the FEEM SI Projections with Historical Data



[5] AUS, AUT, Baltic, BNLX, CAN, CHE, DNK, ESP, FIN, FRA, GCM, GER, ITA, JPN, MEast, NIR, NZL, PRT, RoEU, SWE, UKI, USA.

[6] ARG, Baltic, BRA, BUL, MEX, POL, RUS, ZAF, SEA, TUR, RoAfrica, RoE.

[7] CHN, FSU, IDN, IND, MEast, NorthAfrica, RoAfrica, RoAsia, RoE, RoLA

[8] FSU, MEast, SEA, RoAfrica, RoAsia, RoLA

[9] Although results are presented only for the FEEM SI and for some aggregate regions, we have preformed the comparison exercise for all regions and for all aggregation levels. Detailed results are available upon request from the authors or on the FEEM SI website at www.feemsi.org.

4.2. Baseline results

4.2.1. The sustainability ranking

The FEEM Sustainability Index can be calculated for each region and for each year. By comparing the FEEM SI scores it is possible to rank the regions' sustainability performances. Table 3 displays the ranking for the year 2009. The top regions are mainly Scandinavian Regions and European countries, while at the bottom are mostly Low-Income countries. Notwithstanding, the bottom of the ranking also includes fast-developing countries such as: China, India and Indonesia. Eastern European regions are also ranked low. Finally, Middle Eastern and Asiatic countries are in the bottom-10 countries.

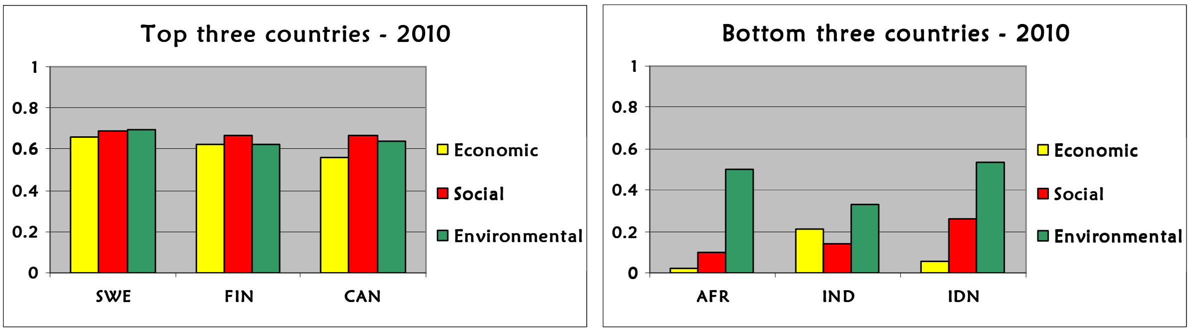
Table 3: Sustainability ranking for the year 2009

Rank	Country	FEEM SI	Rank	Country	FEEM SI	Rank	Country	FEEM SI	Rank	Country	FEEM SI
1	SWE	0.669	11	DNK	0.481	21	AUS	0.398	31	MEast	0.308
2	FIN	0.627	12	NZL	0.475	22	BRA	0.395	32	RoAsia	0.299
3	CAN	0.597	13	BNLX	0.465	23	PRT	0.392	33	SEA	0.288
4	UKI	0.569	14	USA	0.458	24	GCM	0.380	34	RoFSU	0.278
5	AUT	0.567	15	ITA	0.454	25	ARG	0.372	35	RoLA	0.275
6	CHE	0.566	16	RoEU	0.446	26	TUR	0.361	36	CHN	0.230
7	FRA	0.524	17	RUS	0.439	27	POL	0.353	37	NorthAFR	0.204
8	JPN	0.511	18	ESP	0.410	28	ZAF	0.343	38	IDN	0.198
9	NIR	0.510	19	Baltic	0.406	29	BUL	0.334	39	IND	0.189
10	GER	0.495	20	RoE	0.403	30	MEX	0.322	40	AFR	0.136

Therefore, it is mostly industrialised countries that are at the top of the sustainability ranking. At the bottom of the list we find instead either countries with low development levels – thus in which social and economic sustainability would be particularly low – or countries with high economic development but low regard for environmental sustainability.

Looking at the components of the FEEM SI allows a better understanding of the results on the sustainability ranking. In Figure 3, we compare their results in the three main components of sustainability, namely the Economic, Social, and Environmental Sustainability Pillars.

Figure 3: The three main components of the FEEM SI



The scores for the top-three countries are similarly high in the three main components of sustainability. Sweden has the highest values for every component with the most equal distribution among them, followed closely by Finland and Canada. For the bottom-three countries the components are very unequally distributed. Indonesia (3rd from the bottom) has a higher Environmental and Social Sustainability than the other two regions and the second highest score in the Economic Sustainability index. India (2nd from the bottom) reaches a high score in Economic Sustainability, while reaching the lowest in Environmental Sustainability. Finally, Africa (last) has the lowest level of Economic and Social Sustainability, yet its Environmental Sustainability is the second highest after Indonesia. Given that the aggregation methodology underlines the importance of all components of sustainability to have high scores; these countries have reached the lowest FEEM SI values.

4.2.2. Sustainability over time

The most important innovation of the FEEM SI is that it is an index that can be projected in the future. This section illustrates the baseline results on the developments of sustainability. The figures underline the fact that sustainability does not substantially change over time until the year 2020. This is not surprising given that changes in sustainability are based on changes in the economic, and social systems, as well as on the natural conditions of a country, which are all factors that take time to modify. In order to understand the changes in the FEEM SI over time, we look at its time development for some selected countries. Figure 4 illustrates the timelines for the top 10 regions in the ranking. The graph shows that Sweden outperforms all the other regions throughout the entire time frame of the analysis, although its mark-up from the score of the second most sustainable country shrinks slightly over time according to the FEEM SI. Denmark and Canada remain steadily in control of the second and third position respectively, while the relative positions of the other top ten countries are only slightly more variable.

Figure 4 – Timelines for top 10 countries

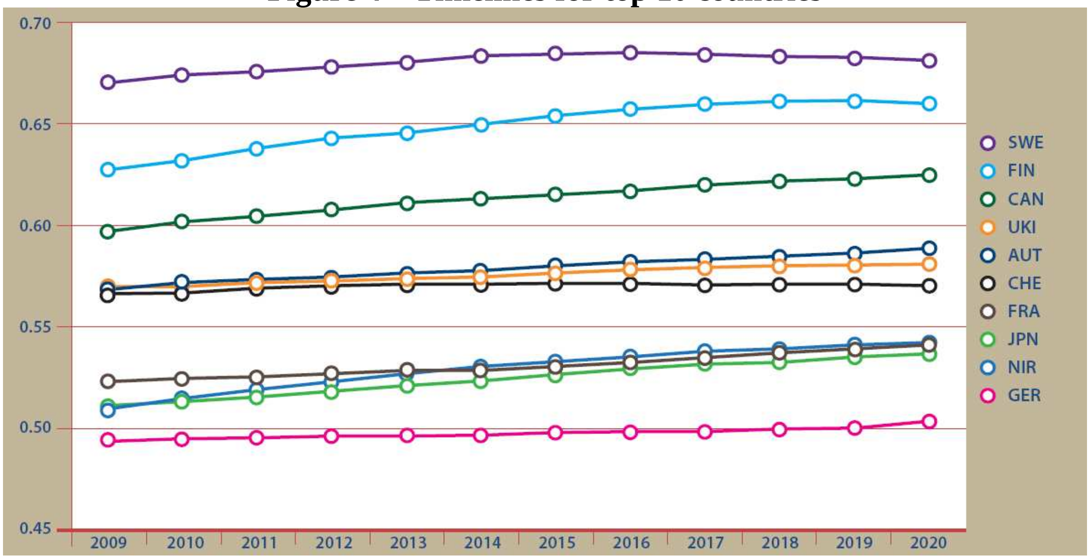
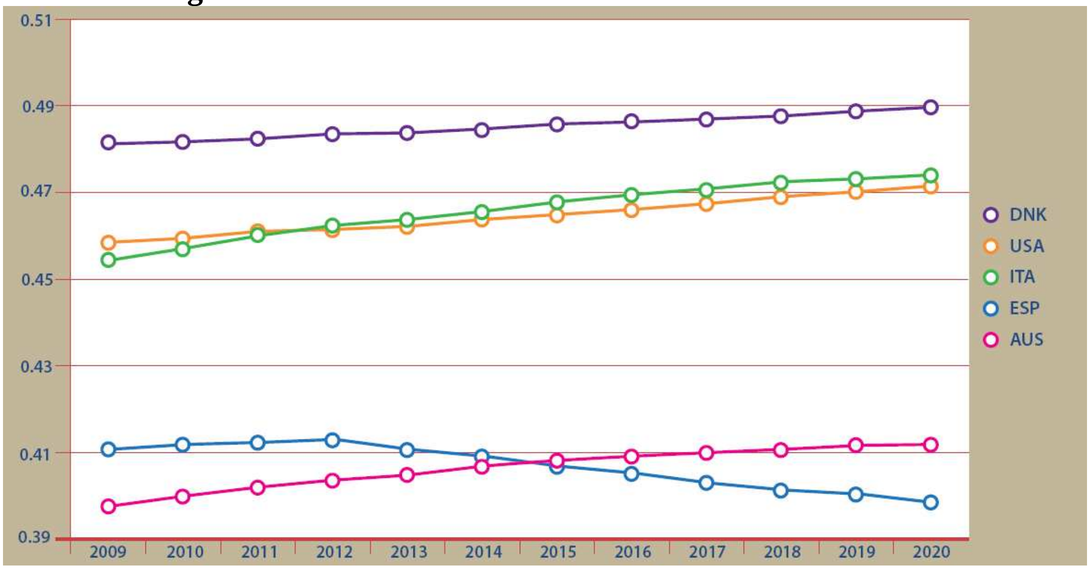


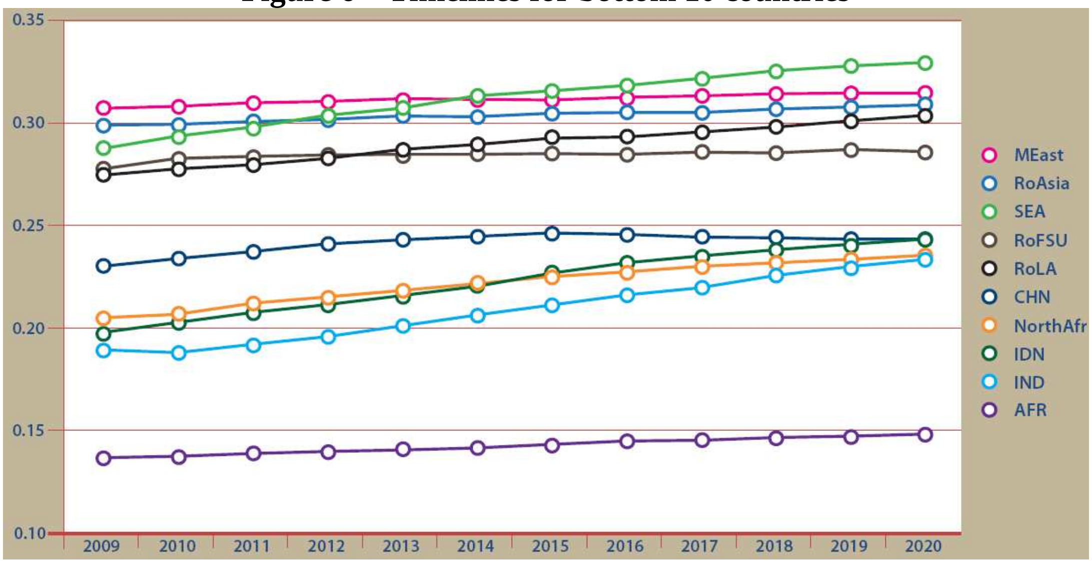
Figure 5 illustrates the sustainability performance for a subgroup of developed countries, which did not make the top 10 over the entire time span considered. The relative ranking of the five regions undergoes several changes throughout the period, with the USA and Italy; and Spain and Austria swapping positions. Denmark is the only country that constantly outperforms all these countries.

Figure 5 – Timelines for selected industrialised countries



As illustrated in Figure 6, the worst performers, African countries except Northern and South Africa (AFR) and India, ranked lowest throughout the time span, having their relative performance widen further apart in time, with India dramatically raising its overall FEEM SI score due to its outstanding improvement in the economic subcomponent of sustainability. A similar improvement is recorded for South East Asia (SEA) which moves up from the third to the first position of this group.

Figure 6 – Timelines for bottom 10 countries



4.3. Policy experiment

4.3.1. Policy description

Evaluating future sustainability is a difficult task, but a scenario analysis can be performed with the FEEM SI framework. This would offer a wide context in which country or regional policies can be contrasted against possible scenarios. To illustrate this, we present a policy scenario that considers major concerns about the different areas of sustainability. The ***Sustainable Development Policy*** scenario (SD) combines a set of policies aimed at improving sustainability in selected targets of the world's socio-economic sphere. This allows us to discover how sustainability could change in the future if the world were to implement such policies, and what trade-offs would be created between the different sustainability pillars. The policies aimed at improving different issues relevant to improve sustainability are combined in the SD scenario with the following storyline:

- *Climate Change (focused on curbing CO2 emissions)*: a world emissions trading scheme in which industrialised countries make the greater effort
- *Education*: subsidies to countries that have not yet achieved the Millennium Development Goals (MDG)
- *Health*: subsidies to countries that have not yet achieved the MDG
- *Improved Water Management*: 10% increase in water efficiency
- *Technology development and transfer (Research and Development)*: a subsidy to R&D and a technology transfer from industrialised to developing countries that leads to a 5% increase in productivity in energy generation, and education.

Clearly, the selected issues are all interlinked and have effects in the three sustainability Pillars. Aside from the interaction among these pillars there are regional interactions in the model that also affects the global sustainability. Following these concerns we imagine a scenario where all policies would enter force in the year 2010. Regarding climate policy, we have chosen one that could reflect the position based on the low-cooperation targets, in which only main industrialised countries would engage in climate policies. The policy models a cap and trade system, so that countries with a carbon target can trade with each other. The cap is imposed starting in 2010 and increases to 2020, when the overall targets shown in the Table 4 are met. The final overall reduction cap requires a reduction of 6-10% of the emissions in developed countries with respect to 1990 levels.

Regarding education and health, the policy aims at meeting the Millennium Development Goals. The financial resources needed to meet the MDG on Education are derived from the study "Achieving Universal Basic and Secondary Education: how much will it cost?" (Glewwe, et al., 2006). The authors estimate the costs of meeting the MDG on education for some macro-areas of developing countries. We use their costs for our regional aggregation to derive the additional resources needed for the main developing regions, in which the MDG has not yet met. The interested regions are Latin America, East and South East Asia, Middle East, and Sub-Saharan Africa. The resources are modelled through a subsidy, which is paid by the households in all the regions. All subsidies are imposed starting from 2010, and to 2020, when the levels are shown in the following table:

Table 4 – Education subsidies

Region	Market value	Subsidy	Subsidy (% market value)
ARG	17899.7	355.2	2.0
BRA	27712.0	549.9	2.0
CHN	45069.5	56996.3	126.5
IND	15430.2	19513.6	126.5
IDN	2867.3	3626.0	126.5
MEX	23710.0	470.5	2.0
MEast	33000.6	18905.2	57.3
NorthAfrica	16494.1	9449.0	57.3
ZAF	6938.5	17141.1	247.0
SEA	14542.1	18390.4	126.5
RoAfrica	7592.0	18755.7	247.0
RoAsia	38212.5	48324.7	126.5
RoLA	30714.0	609.5	2.0

A similar procedure has been used to calculate subsidies for health, for which the source is the Report of the Commission on Macroeconomics and Health "Macroeconomics and Health: Investing in Health for Economic Development" (WHO, 2001). For the health subsidies, also Eastern Europe and Central Asia are involved in the policy. The subsidies on health in 2020 are listed below:

Table 5 – Health subsidies

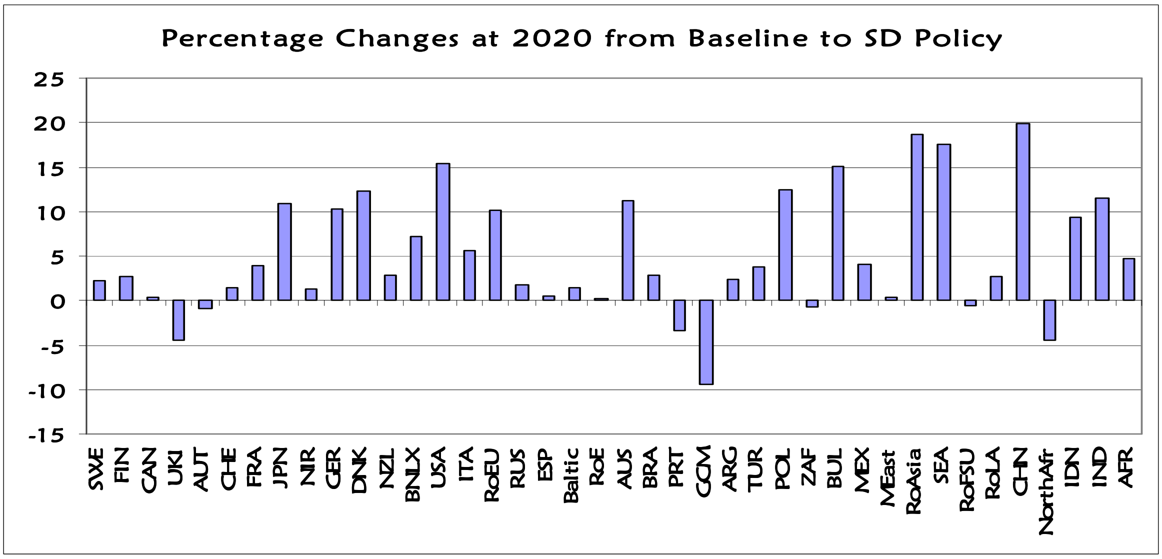
Region	Market value	Subsidy	Subsidy (% market value)
ARG	16992.9	122.4	0.7
BRA	34338.1	247.4	0.7
CHN	59975.5	8044.2	13.4
RoFSU	5223.0	125.4	2.4
IND	26308.6	3528.6	13.4
IDN	5206.7	698.3	13.4
MEX	25296.3	182.2	0.7
MEast	41403.7	20922.0	50.5
NorthAfrica	21223.2	10724.4	50.5
RUS	15499.4	372.1	2.4
ZAF	6896.8	4968.7	72.0
SEA	16425.5	2203.1	13.4
RoAfrica	10592.7	7631.3	72.0
RoAsia	56110.4	7525.8	13.4
RoE	1670.2	40.1	2.4
RoEU	10931.4	262.4	2.4
RoLA	34418.6	248.0	0.7

With respect to the Technology transfer policy a subsidy for R&D was imposed in developed countries (of an equal 10%) since 2010. As a consequence of that technology transfer, productivity was increased in developing countries gradually to 5% in 2020. Regarding water use, the policy chosen is a 10% water efficiency increase in all countries. In the baseline water efficiency is kept constant over time (namely the amount of production in agriculture and industry and the water use per capita are constant over time). In the policy, water use efficiency improves with an exogenous shock of a 10% increase in all countries. This does not mean that all indicators will change equally because they depend on the choices in production of the different countries. Furthermore, the water indicator used for the FEEM SI is “Water use as percentage of total renewable water resources”. Thus, the benefit from this policy will be higher for the countries with more water scarcity, and a lower value of the indicator.

4.3.2. Changes in the presence of a sustainable development policy

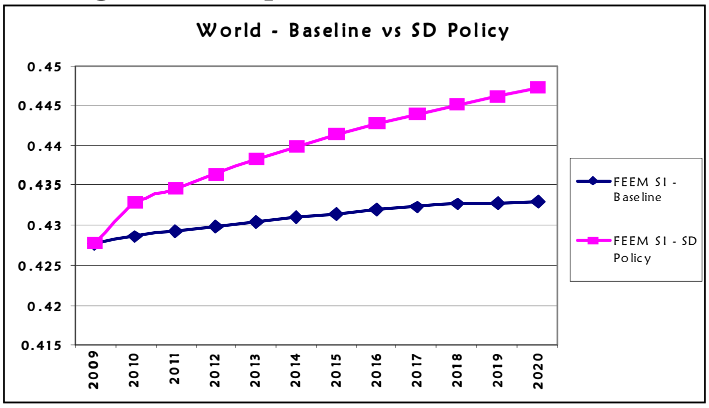
The described policies have unequal effects in different regions. This is due both to the fact that they are implemented differently according to wealth and environmental status of the region, and also to their specific characteristics. Figure 7 illustrates the changes in sustainability according to the FEEM SI in the SD Policy scenario compared to the baseline scenario.

Figure 7: FEEM SI Percentage Changes



It is possible to see that sustainability increases in most countries. The only exceptions are the UK, Austria, Portugal, Greece, Cyprus and Malta, and North Africa. This is mostly due to the fact that most of these are regions that do not get any extra support for the social sustainability, while being imposed environmental standards. As these regions do not have particularly strong social indicators in the baseline, sustainability decreases. Particularly strong growth takes place in regions such as China, South East Asia, Rest of Asia, India, Bulgaria, and Poland. These are all countries that are particularly favoured by the policies included in the scenario.

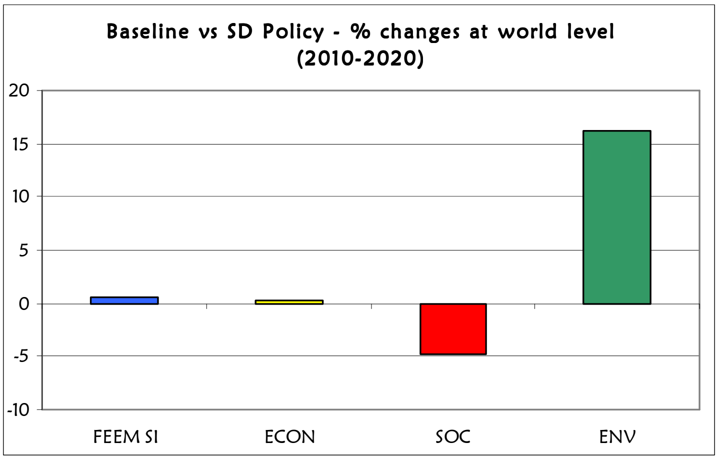
Figure 8: Comparison in time of FEEM SI



If we consider the effect of the SD Policy at world level, as illustrated in Figure 8, we find that there is a slight improvement in the FEEM SI. The best result is obtained in the Environmental pillar, which reflects the fact that the most stringent policy has been imposed in the environmental arena. As illustrated in Figure 9, the environmental sustainability increases its score of about 15% in only 10 years of policy simulation. A slight improvement occurs in the Economic pillar along with a deterioration of the Social one. These last results are mostly due to the decrease in social wealth in the countries that already had met the Millennium Development Goals.

It is interesting to point out that whereas usually the trade-off considered in terms of sustainability is relative to economic wealth, these results show that social sustainability is actually the real issue. Therefore, when implementing climate policies, it would be important to also consider social policies that limit the reallocation of resources from the social sphere.

Figure 9: Changes in FEEM SI and the three Pillars



Considering more in detail the effects at local level, we can see how the Sustainability ranking changes due to the imposition of the SD policy. In particular, it is interesting to note that the policy affects the sustainability ranking more than the overtime change. Table 6 illustrates the comparison of the rankings for the baseline and SD Policy. Nine countries out of forty are stable in their position after the policy implementation. This occurs at the extremes of the rank. Among the top-ten countries, five of them (Sweden, Finland, Canada, Switzerland, France) do not undergo any change like the last one (Africa). In the middle of the ranking there are no changes for Benelux, Turkey, and Rest of Latin America.

Table 6: Comparison of the FEEM SI ranking

Rank	Baseline 2020	SD Policy 2020			Rank	Baseline 2020	SD Policy 2020			Rank	Baseline 2020	SD Policy 2020			Rank	Baseline 2020	SD Policy 2020		
1	SWE	SWE	=	0	11	NZL	NIR	↓	-3	21	RoE	BUL	↓	-1	31	SEA	ZAF	↑	3
2	FIN	FIN	=	0	12	DNK	USA	↑	2	22	PRT	RoE	↓	-5	32	MEast	MEX	↓	-1
3	CAN	CAN	=	0	13	BNLX	BNLX	=	0	23	ESP	ARG	↓	-2	33	RoAsia	MEast	↑	4
4	AUT	JPN	↓	-1	14	RUS	NZL	↓	-3	24	ARG	POL	↑	1	34	RoLA	RoLA	=	0
5	UKI	AUT	↓	-3	15	ITA	RoEU	↓	-1	25	GCM	ESP	↓	-5	35	RoFSU	CHN	↓	-1
6	CHE	CHE	=	0	16	USA	ITA	↑	4	26	TUR	TUR	=	0	36	IDN	RoFSU	↓	-1
7	FRA	FRA	=	0	17	RoEU	RUS	↑	2	27	BUL	PRT	↑	6	37	CHN	IDN	↑	2
8	NIR	UKI	↓	-3	18	BRA	AUS	↓	-1	28	ZAF	SEA	↓	-3	38	NorthAfr	IND	↓	-1
9	JPN	GER	↑	5	19	Baltic	BRA	↓	-1	29	POL	RoAsia	↑	5	39	IND	NorthAfr	↑	1
10	GER	DNK	↑	1	20	AUS	Baltic	↑	2	30	MEX	GCM	↓	-2	40	AFR	AFR	=	0

To better understand the reasons for the changes in the FEEM SI, Table 7 presents variations in the main components of sustainability. Dark coloured countries are those which moved up or down more than one position; light coloured countries, moved only one step forward or behind. This table helps understanding the changes in the main components. Looking at these results we can see for instance that the improvement in China is mostly due to advances on the environmental component. Another example is the UK declining, which as anticipated before, is mostly due to the social component.

Table 7 – Comparison of the ranking of the three components of sustainability

Economic Pillar		Social Pillar		Environmental Pillar	
2020	2020 SD	2020	2020 SD	2020	2020 SD
FIN	SWE	CAN	CAN	NIR	NIR
USA	USA	USA	GER	SWE	SWE
SWE	FIN	GER	SWE	FIN	Baltic
CHE	CHE	SWE	FIN	CAN	FIN
GER	GER	DNK	RUS	ARG	AUT
JPN	DNK	BNLX	DNK	BRA	ARG
FRA	JPN	FIN	JPN	RoE	UKI
CAN	CAN	RUS	BNLX	RoLA	BRA
UKI	FRA	JPN	RoEU	AUT	CAN
AUT	UKI	NZL	AUT	Baltic	RoEU
BNLX	AUT	ITA	CHE	UKI	RoLA
DNK	AUS	AUT	ITA	CHE	RoE
AUS	BNLX	RoEU	NZL	FRA	JPN
ITA	ITA	UKI	FRA	SEA	FRA
NIR	NIR	AUS	USA	NZL	NZL
NZL	NZL	POL	AUS	JPN	CHE
RoE	RUS	FRA	ZAF	RoEU	BUL
RUS	RoEU	CHE	BUL	AFR	SEA
ESP	ESP	NIR	RoFSU	MEX	AFR
RoEU	RoAsia	BUL	NIR	RUS	USA
MEast	RoE	RoFSU	UKI	IDN	PRT
RoAsia	TUR	ZAF	POL	RoAsia	GER
PRT	BRA	PRT	ARG	GER	DNK
TUR	MEast	ESP	MEX	DNK	BNLX
GCM	POL	GCM	SEA	ITA	MEX
BRA	PRT	Baltic	IDN	BNLX	ITA
POL	ZAF	ARG	Baltic	PRT	ESP
Baltic	BUL	MEX	MEast	BUL	IDN
ZAF	Baltic	MEast	BRA	GCM	RUS
SEA	SEA	IDN	PRT	TUR	GCM
ARG	GCM	TUR	TUR	NorthAfr	TUR
IND	IND	BRA	GCM	IND	POL
BUL	ARG	RoE	ESP	USA	CHN
RoFSU	RoFSU	RoLA	RoLA	ESP	RoAsia
CHN	CHN	NorthAfr	RoE	AUS	AUS
MEX	MEX	SEA	RoAsia	ZAF	NorthAfr
RoLA	RoLA	CHN	NorthAfr	POL	IND
NorthAfr	NorthAfr	RoAsia	CHN	MEast	ZAF
IDN	IDN	IND	IND	RoFSU	MEast
AFR	AFR	AFR	AFR	CHN	RoFSU

worsening of more than 1 position
worsening of only 1 position
improvement of more than 1 position
improvement of only 1 position

5. Conclusion

This paper proposes a new methodology for the assessment of the sustainability performance of countries. We calculate individual indicators and an aggregate index, the FEEM SI, starting from the dynamic computable general equilibrium model ICES SI. Building the index within such a model allows the possibility to project it in the future according to different growth and policy assumptions. To illustrate the potentials of this methodology we present some selected results relative to the regional sustainability ranking for the year 2009, results relative to the changes in sustainability over time, and results showing the differences between a baseline and a policy scenario. For this purpose, we construct a hypothetical policy in which targets are set for different policy issues concerning with the three sustainability components, namely economic, social, and environmental. We find that such a policy aimed at improving sustainability can effectively change the world ranking. The methodology used is also a good example on the potential that applied economic models have to make the concept of sustainability more operative and suitable for policy making choices.

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Annex 1 - The FEEM Sustainability Index

Table A1.1: List of indicators for the FEEM SI

Theme	*Sub-theme*	*Indicator*
ECONOMIC	ECONOMIC STRUCTURE	1. GDP per capita
		2. Consumption expenditure as GDP
	COMPETITIVENESS	3. Total R&D expenditure as GDP
SOCIAL	POPULATION	4. Population growth
	POVERTY	5. Share of food in primary goods consumption
		6. Energy per capita
	PRIVATE EXPENDITURE ON SOCIAL SERVICES	7. Expenditure in insurance and pensions GDP
	EDUCATION	8. Public expenditure on education as GDP
	HEALTH	9. Health expenditure by privates as overall health expenditure
		10. Overall health expenditure as GDP
ENVIRONMENTAL	CLIMATE CHANGE	11. Carbon intensity of energy
		12. Growth rate GHG emission per capita
	WATER	13. Water use as total renewable water resources
	ENERGY	14. Energy intensity (energy/GDP)
		15. Imported energy as overall energy use
		16. Share of clean energy in primary energy consumption
	NATURAL RESOURCES	17. Biodiversity index-plants
		18. Biodiversity index-animals

Construction of the indicators

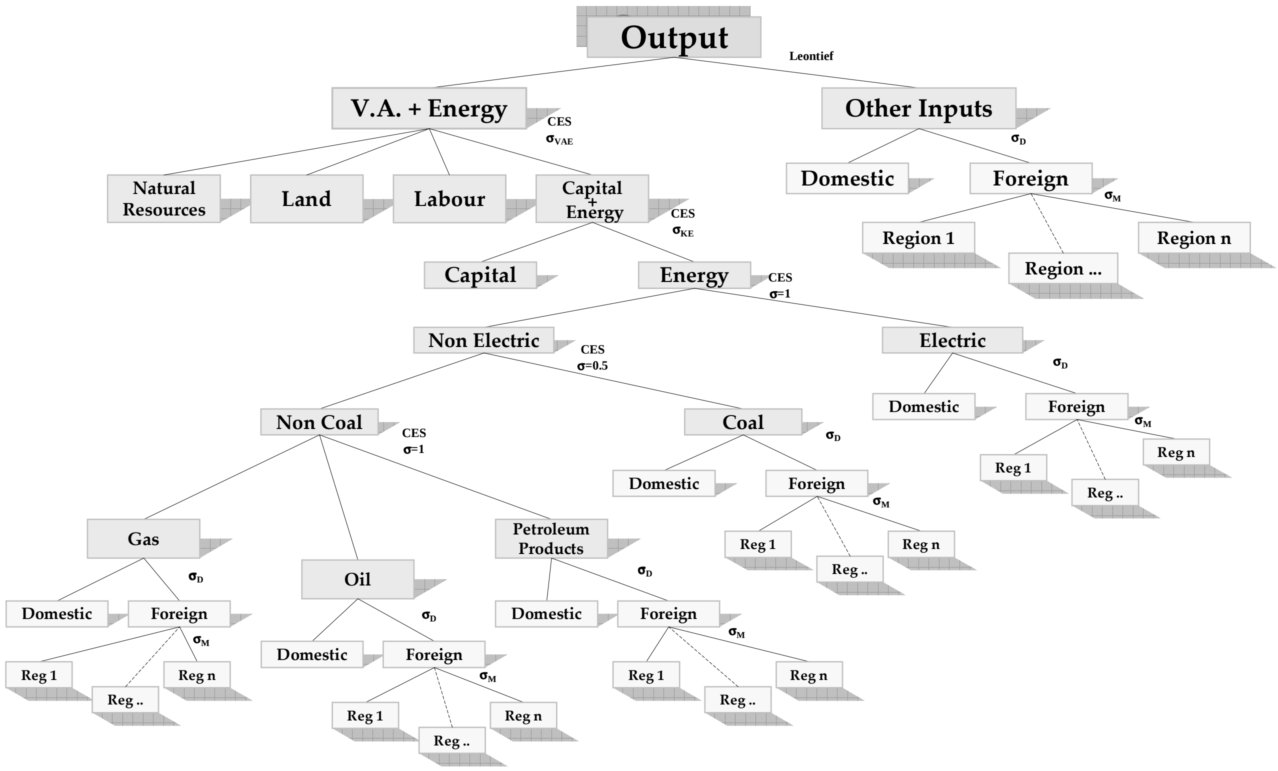
ICES SI has been modified, as explained above, in order to obtain variables for all the indicators selected for the FEEM SI. Once all the required modifications to the database and to the model have been done and all the additional variables have been included, it is possible to calculate the indicators that are at the basis of the FEEM SI. The indicators are constructed from variables included in the model and are calculated as explained in Table A2.

Table A1.2: indicators calculation

INDICATORS	DESCRIPTION
GDP p.c.	GDP / population
Consumption	Consumption / GDP * 100
R&D	R&D expenditure /GDP * 100
Population growth rate	Population growth rate
Food relevance	Expenditure in food / Total expenditure in primary consumption goods * 100
Energy p.c.	Energy volumes / Population
Insurance and pensions	Insurance expenditure / GDP *100
Education	Expenditure in education / GDP * 100
Health Privates	Private expenditure in health / Overall expenditure in health * 100
Health Expenditure	Health expenditure / GDP * 100
Carbon Intensity of Energy	CO_2 emissions / Energy volumes
GHG p.c.	N_2O+CH_4+CO_2 emissions / Population
Energy Intensity	Energy Use / GDP
Imported Energy	Imported Energy / Overall Energy Used * 100
Renewables	Renewable Energy Production / Overall Energy Use* 100
Water use	Water use / Total Renewable Water
Biodiversity Animals	Highly Endangered Species / Total Endangered Species * 100
Biodiversity plants	Highly Endangered Species / Total Endangered Species * 100

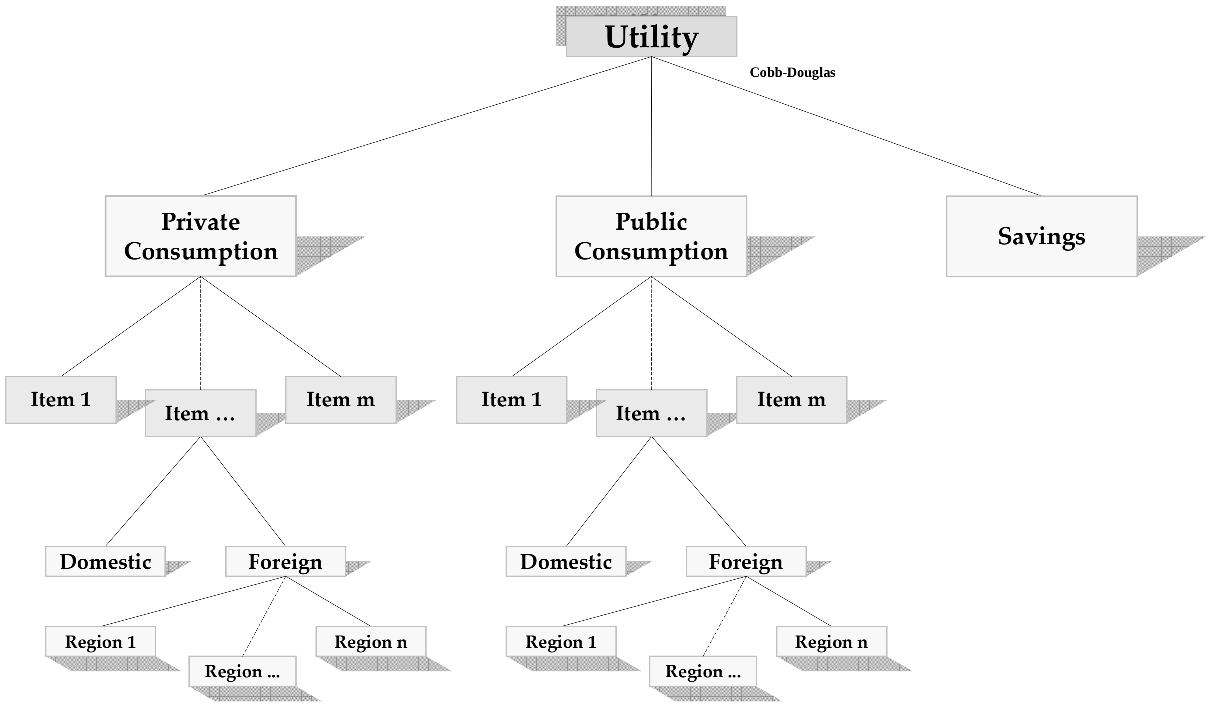
Annex 2 - **The ICES model**

The Intertemporal Computable Equilibrium System (ICES) model is multi-regional CGE model of the world economy, derived from a static CGE model named GTAP-EF (Roson, 2003; Bigano et al., 2006). The latter is a modified version of the GTAP-E model (Burniaux and Troung, 2002), which in turn is an extension of the basic GTAP model (Hertel, 1997). The model in its present version is calibrated in year 2001.
Industries are "typically" modelled through a representative cost-minimizing firm, taking input prices as given. In turn, output prices are given by average production costs. The production functions are specified via a series of nested CES functions. Peculiar to ICES is the "isolation" in the production tree of energy factors which are taken out from the set of intermediate inputs and are inserted as primary production factors in a nested level of substitution with capital. The following figure shows the production structure of the model.



Output is produced using a composite input from Value Added + Energy and Other inputs in the first level. The second level is formulated with a CES function that has Natural Resources, Land, Labour, and a Capital + Energy composite input produced in the Third level. Energy is produced using Electric and Non Electric commodities in the Fourth level, while the Non Electric commodity is produced in a previous level using Coal and Non Coal commodities. At the basic level in the supply side the Non Coal input is a composite commodity that contains Gas, Oil and Petroleum Products.
Notice that domestic and foreign inputs are not perfect substitutes, according to the so-called "Armington assumption", which accounts for - amongst others - product heterogeneity. In general, inputs grouped together are more easily substitutable among themselves than with other elements outside the nest. For example, imports can more easily be substituted in terms of foreign production

source, rather than between domestic production and one specific foreign country of origin. Analogously, composite energy inputs are more substitutable with capital than with other factors.
A representative consumer in each region receives income, defined as the service value of national primary factors (natural resources, land, labour, capital). Capital and labour are perfectly mobile domestically but immobile internationally. Land and natural resources, on the other hand, are industry-specific. This income is then used to finance three classes of expenditure: aggregate household consumption, public consumption and savings. The expenditure shares are generally fixed, which amounts to saying that the top-level utility function has a Cobb-Douglas specification.



The model accounts for main GHG emissions CO2, CH4 and N2O. Following Burniaux and Truong (2002) emissions are calculated proportionally to energy combustion. Data relative to energy volumes are included in the GTAP 6 Data Base.
Emissions of other greenhouse gases, namely methane and nitrous oxide, are also included in ICES. Data relative with emissions of these gases have been calculated starting from the GTAP non-CO2 emissions database (Lee, 2003). However, this database supplies data on emissions of these gases but for an aggregation to 66 countries and 57 GTAP sectors. Additionally the database includes emissions related to household's activities that are also included in the database by creating a new sector (HH).
Dynamics inside the ICES model are driven essentially by two different sources: one endogenous and one exogenous to the model. The first involves two components: one, the most important, is the capital and foreign debt evolution processes governed by endogenous investment decisions. The other concerns a peculiar treatment of the evolution of natural resources stock. The second is defined by a set of assumptions concerning the changes in some key economic - mainly supply-side - parameters and exogenous variables which are imposed to the model in order to reflect their possible evolution. These assumptions are made consistently with existing statistical sources, other modelling exercises and economic scenarios.

Annex 3 - ICES SI aggregation

Table A3.1: ICES-SI sectoral aggregation

No.	Code	Sector Description	Comprising GTAP Database V6 Sectors
1	Food	Food-related commodities	Paddy Rice, Wheat, Other Grains, Other Crops, Vegetables and Fruits, Plant Fibres, Cattle, Other Animal Products, Raw Milk, Wool, Cattle Meat, Other Meat
2	Forestry	Forestry	Forestry
3	Fishing	Fishing	Fishing
4	Oth_Ind	Other Industries	Beverages and Tobacco, Textiles, Wearing Appeal, Leather, Lumber, Paper and Paper Products, Fabricated Metal Products, Motor Vehicles, Other Transport Equipment
5	Coal	Coal	Coal
6	Oil	Oil	Oil
7	Gas	Gas, gas manufacture and distribution	Gas, Gas Distribution
8	Oil_Pcts	Petroleum, Coal Products	Water
9	Electricity	Electricity	Electricity
10	MServ	Market Services	Construction, Trade, Other Financial Intermediation, Insurance, Other Business Services, Dwellings, Transport
11	Ins	Insurance Services	Insurance and Pension Funding
12	En_Int_Ind	Energy Intensive Industries	Chemical Rubber Products, Non-Metallic Minerals, Iron and Steel, Non-Ferrous Metals
13	Water	Water	Water
14	RD*	Research & Development	Research & Development
15	Edu*	Education	Education
16	Hea*	Health	Health
17	NMServ	Non- Market Services	Trade, Retail, Financial Intermediation, Renting

* Additional sectors included to construct the FEEM SI

Table A3.2: ICES SI Regional aggregation

No.	Code	GTAP 6 Countries	No.	Code	GTAP 6 Countries
1	ARG	Argentina	**21**	MEX	Mexico
2	AUS	Australia	**22**	MEast	Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Palestinian Territory Occupied, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates, Yemen
3	AUT	Austria	**23**	NorthAfrica	Algeria, Morocco, Tunisia, Lybia, Egypt
4	Baltic	Estonia, Latvia, Lithuania	**24**	NZL	New Zealand
5	BNLX	Belgium, Netherlands, Luxembourg	**25**	POL	Poland
6	BRA	Brazil	**26**	PRT	Portugal
7	BUL	Bulgaria	**27**	RUS	Russia
8	CAN	Canada	**28**	ZAF	South Africa
9	CHN	China and Hong Kong	**29**	SEA	South-East Asia – Burma, Brunei Darussalam, (East) Timor Leste, Malaysia, Philippines, Singapore, Cambodia, Lao People's Democratic Republic, Vietnam
10	DNK	Denmark	**30**	ESP	Spain
11	FIN	Finland	**31**	SWE	Sweden
12	FRA	France	**32**	CHE	Switzerland
13	RoFSU	Rest of Former Soviet Union: Armenia, Azerbaijan, Belarus, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Moldova, Republic of Tajikistan, Turkmenistan, Ukraine, Uzbekistan	**33**	TUR	Turkey
14	GER	Germany	**34**	USA	USA
15	UKI	UK and Ireland	**35**	AFR	Africa excluding North and South Africa - Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo (Brazzaville), Cote d'Ivoire, Democratic Republic of Congo (Zaire), Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mayotte, Mozambique, Namibia, Niger, Nigeria, Reunion, Rwanda, Saint Helena, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe
16	GCM	Greece, Cyprus, Malta	**36**	RoAsia	Rest of Asia - Afghanistan, Bangladesh, Bhutan, Korea, Korea, Democratic People's Republic of, Macau, Maldives, Mongolia, Nepal, Pakistan, Sri Lanka, Taiwan
17	IND	India	**37**	RoE	Rest of Europe – Albania, Andorra, Bosnia and Herzegovina, Croatia, Faroe Islands, Gibraltar, Macedonia, Monaco, San Marino, Serbia and Montenegro(Yugoslavia)
18	IDN	Indonesia	**38**	RoEU	Rest of the European Union – Czech Republic, Hungary, Romania, Slovakia, Slovenia
19	ITA	Italy	**39**	RoLA	Rest of Latin America - Anguilla, Antigua & Barbuda, Aruba, Bahamas, Barbados, Belize, Bolivia, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador , El Salvador, Falkland Islands (Malvinas), French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Montserrat, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos, Uruguay, Venezuela, Virgin Islands, British, Virgin Islands, U.S.
20	JPN	Japan	**40**	NIR	Noway, Iceland, and Rest of the World – Bermuda, Greenland, Iceland, Liechtenstein, Norway, Saint Pierre and Miquelon, American Samoa, Papua New Guinea, (Western) Samoa, Cook Islands, Fiji, French Polynesia, Guam, KiribatiMarshall Islands, Micronesia, Federated States of, Nauru, New Caledonia, Norfolk Island, Northern Mariana Islands, Niue, Palau, , Solomon Islands, Thailand, Tokelau, Tonga, Tuvalu, Vanuatu, , Wallis and Futuna