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Globalization, International Transport and the Global Environment: four quantitative scenarios

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Content

Boxes, Tables and Figures

1. Introduction[1]

Globalization is an ongoing trend. Although the current economic crisis may raise some doubts on the benefits of globalization in some developing countries, globalization is still seen as a prerequisite for further development. Globalization can be interpreted as the growing economic interdependence of countries world-wide through the increasing volume and variety of cross -border transactions in goods and services and of international capital flows and also through the more rapid and widespread diffusion of technology. It affects trade patterns, capital flows and location choices of firms at a regional and global level. It could raise economic growth of developing regions substantially, leading to a drastic shift of production activities to these countries. Moreover, increasing linkages between regions could affect the dissemination of new technologies and consumer preferences.

The distance between production and (intermediary and final) demand determines the size of trade and correspondingly the demand for transport. Because globalization affects the volume of consumption, production and the place of production, it has a large impact on the volume of transport. Transport movements can have substantial effects on the environmental quality. If globalization puts through, its impact on environment will probably increase. The intensity of transport, the distances and the used modes of transport can have big environmental impacts. The project Globalization, International Transport and the Environment addresses this issue.[2]

This project aims to map out the implications of current globalization trends on transport and the effects of international transport on environmental quality.

The outcome of the process of globalization and its environmental effects is uncertain. Will the process of globalization accelerate, or will it be slowed down by political and social tensions. Will all regions benefit from globalization, or is it in favour of developed or just developing countries? Do countries take environmental quality seriously or is economic growth the overwhelming goal?

These issues are identified in four scenarios. These address in various ways the process of globalization, its effects on the various regions, political cooperation between regions, the pace of technological progress, changing consumption patterns, and developments in the transport sector. In the previous stage of this project, the qualitative scenarios are constructed. The method of construction is discussed in Van Veen-Groot and Nijkamp (1998). They also present the qualitative scenarios extensively. This paper

[1]The paper benefitted from comments and suggestions by Hans Timmer, Johannes Bollen, George Gelauff and Casper van Ewijk and the members of the GITAGE project, see footnote 2.

[2]This project is carried out in the framework of the Dutch National Research Programme on Global Air Pollution and Climate Change, registered under nr. 953242, titled 'Globalization, International Transport and the Global Environment (GITAGE)'.

presents the next stage of the project: the quantitative illustration of these scenarios. The qualitative scenarios are thus used as an input in this paper. They have to be quantified for the succeeding stages. The results for economic growth, consumption, and trade in the four scenarios are used to derive the volume of (international transport) between and in the various regions in the next stages. Given the volume of transport and scenario assumptions on spatial organization, the modal split, routes and distances, and environmental-friendly technological progress in the transport sector, the emittance of greenhouse gasses by the transport sector can be determined. These results will be used to evaluate policies aimed at restricting the emittance of greenhouse gasses by the transport sector.

This paper aims to present the quantification of the four scenarios. For that purpose we use WorldScan. This is an applied general equilibrium model for the world economy. It focusses on economic growth in the long run and trade patterns between twelve regions. For that reason WorldScan is a good tool to analyse scenarios in which trade and trade liberalization and differences in growth rates between regions are important. Moreover, it distinguishes several sectors among which are trade and transport and the energy sectors such as oil, gas and coal. Therefore the macroeconomic analyses can be combined with policies which affect transport and energy.

Emphasis will be laid on the economic outcomes of scenarios and growth in energy and emissions. In the construction of the qualitative scenarios, seven driving forces are distinguished, see Van Veen-Groot and Nijkamp (1998). These driving forces are economy, politics, technology, demographics, resource use, firm strategies and consumer preferences. Driving forces such as politics, technology, and demographics are directly or indirectly exogenous in the model. The microeconomic variable firm strategies is not present in WorldScan, because the model focusses on macroeconomic outcomes. Resource use is endogenous in the model, although the adoption of energy-saving production techniques is exogenous. Consumption patterns are endogenous, because the allocation of the consumer budget over the various categories of goods depends on income per capita. Section 2 gives a further overview of the model.

The quantitative results of the four scenarios are described in Section 3 to 6. Section 3 describes the Schumpeterian scenario. In the *Schumpeterian World*, the high and accelerating speed of technological progress is the most important force behind globalization. Strong competitiveness and internationalization of business are essential elements in this dynamic process, leading to high economic growth in nearly all regions in the world economy. Economic systems are increasingly market-oriented, induced by a strong liberalization of international trade and capital. International trade increases drastically.

Section 4 focusses on the *Malthusian Scenario.* In this scenario, the OECD economies flourish, but the non-OECD countries stay behind. This results in strong polarisation between these regions. The prosperous economic situation in the OECD countries is the consequence of high technological progress, and the liberalization of

trade and capital within the OECD. In the non-OECD countries, unstable political systems, overpopulation and low incomes countries stimulate large migration flows to the OECD countries.

In the *Developing World*, strong economic centres in the non-OECD countries arise, as a result of liberalization of goods, service and capital markets, and market-oriented and outward- looking government policies. High economic growth rates in these areas are accompanied with severe ecological problems. On the other hand, the OECD countries are confronted with staggering economic growth caused by a limited availability of resources, labour shortage, and slow technological process. This scenario is the subject of section 5.

Section 6 describes the *Ecological Scenario.* Un this scenario the non-material aspects of life are more important: the emphasis is on well-being, and environment rather than on an increase in income and the amount of physical goods. Norms and values change towards more awareness of environmental problems, and family values. Production and consumption are localized in stead of internationalized.

Section 3 to 6 describe first, the main qualitative characteristics, see Van Veen-Groot and Nijkamp (1998). Then the sections discuss the effects on economic growth in the various regions and the causes of growth between 1995 and 2020 by a growth accounting exercise. Moreover, we present the changes in consumer spending patterns and the growth in energy and emissions. Finally, we show the developments in trade at a regional and world-wide level. We discuss the major changes in specialization patterns. Sections 3 to 6 present the scenarios in a coherent and systematic way, because it is the purpose of this paper to present the quantitative outcomes of these scenarios. For this reason we do not present the translation of the driving forces into exogenous variables of WorldScan which is necessary to mimic the qualitative scenarios in the various sections. The presentation of the quantified exogenous variables for WorldScan is postponed to Section 7. There we compare the scenarios and highlights some main differences. This seems to be the natural place to evaluate the quantification of exogenous variables in WorldScan regarding the outcomes of the scenarios.

Sections 3 to 7 focus on the scenario results in 2020. The reason is that most long-term scenarios simulated by economic models with a sectoral structure are simulated 25 years ahead. This makes the outcomes comparable to other simulation results. However, the introduction of new energy-efficient transport policies and the analysis of stable emission paths need a longer time horizon. Therefore, Section 8 presents scenario outcomes until 2050. It emphasizes the global macro-economic outcomes and emission levels in 2050. Section 9 summarizes the main results and draws some conclusions.

2. WorldScan: a global applied general equilibrium model[3]

WorldScan has been developed to construct scenarios. To avoid extrapolation of current trends or mere reproduction of the current situation, WorldScan relies on the neoclassical theories of growth and international trade. Changes in economic growth and international specialization patterns evolve from changes in (relative) endowments. The emphasis on the long run also manifests itself in the broad definition of sectors. WorldScan distinguishes 11 sectors. This is a relatively small number compared to other AGE models. Over a long period of two decades or more the character of products and branches of industry change drastically. Current statistical definitions of products and branches of industry are likely to become irrelevant at the end of scenario period. For this reason, WorldScan uses broad aggregates.

The standard neoclassical theory of growth distinguishes three factors to explain changes in production: the accumulation of physical capital, labour, and a fixed technology trend. WorldScan augments the simple growth model in three ways. First, WorldScan allows overall technology to differ across countries. It also takes up the related idea that developing countries can catch up quickly by adopting foreign state-of-the-art technologies. Second, the model distinguishes two types of labour: high-skilled and low-skilled labour. Sectors differ according to the intensity with which they use high-skilled and low-skilled labour. Countries can raise per capita growth by schooling and training the labour force. Third, in developing countries part of the labour force works in low-productivity sectors. In these sectors workers do not have access to capital and technology. Reallocation of labour from the low-productivity sectors to the high-productivity sectors enables countries to raise per capita growth as well. In principle, all these three factors affect the performance of a region only temporarily. Catching-up, training of low-skilled workers and reallocating labour to the high-productivity sector do not raise the growth rate indefinitely. Nevertheless, they are important. Adjustments in the economies of developing regions take a great deal of time and will surely show up in the growth rates of these regions in the period under consideration.

Education and reallocation of workers not only explain the performance of developing countries, but also affect specialization patterns. Workers in the informal, low-productivity sector are predominantly low-skilled. When more workers find employment in the high-productivity sectors, the (relative) wage of low-skilled workers falls and mainly sectors that intensively employ low-skilled workers expand. These regions will specialize further in sectors which make a lot of use of the relative abundant factor: low-skilled labour. Obviously, education has an opposite effect. Low-skilled labour will become relatively more scarce and shifts production to sectors which intensively use high-skilled labour. Either effect can dominate. This is also reflected in

[3]The model is described extensively in CPB (1999).

the relative wages of high and low-skilled. In some developing countries wages of low-skilled workers lag behind the wage of high-skilled workers, whereas in other regions the skill premium decreases.

Sectors in WorldScan have different factor requirements. For a given sector these factor requirements are more or less similar across regions. This means that if a sector is relatively capital intensive in one region, it is also relatively capital intensive in other regions. Agriculture (including food processing) and Consumer Goods employ relatively few high-skilled workers, whereas Capital Goods, Electricity, Trade and Transport and Services (including the government) absorb many high-skilled workers. Sectoral restructuring can easily be linked to changes in relative endowments and changes in (region-specific) demand patterns. This also holds because in WorldScan substitution elasticities between domestic and foreign goods are believed to be high in the long run, at least much higher than in the short run. In principle, all goos are tradable, although trade in services is much lower than in manufacturing and raw materials.

Except for different factor inputs, sectors vary also is some other respects. The sectors Capital Goods and Services are the suppliers of investment goods and the sectors, Oil, Coal, Gas and other Raw Materials only produce intermediate outputs. Consumer demand for electricity also includes demand for other energy carriers. This assumption is made because nearly all demand for Raw materials is intermediate demand.

Data

WorldScan has been calibrated on the GTAP database, see Mc Dougall et all. (1998). The calibration year is 1995. From this data base we derive not only demand, production and trade patterns, but also labour and capital intensity of the various sectors. The sectoral classification according to skill intensity is broadly correct, but the precise differences could very well change, when better data become available.

The data and projections for population size and labour supply are from various sources. The United Nations (1995) provide demographic projections until 2050. The ILO (1996) provides projection rates on participation rates until 2010. We extrapolate the regional trends in participation rates between 1950 and 2010 to 2050. The data for the supply of low-skilled and high-skilled workers at a regional level have been taken from Ahuja and Filmer (1995). Workers are labelled high-skilled when they have completed secondary education or a higher level. Ahuja and Filmer provide projections for many developing countries. We lack projections for the OECD, Eastern Europe and the Former Soviet Union. Therefore we use the Barro and Lee (1996) data on education. We derive a trend between OECD and non-OECD regions between 1960 and 1990 and extrapolate this trend until 2050.

The data on the size of the informal sector are obtained from the WorldBank (1995) and the ILO (1998). The IEA (1997) provides data on energy volumes and emissions in the base year 1995.

Box 1 WorldScan, a global general equilibrium model

At the heart of WorldScan are the neoclassical theories of economic growth and international trade. The core of the model is extended to add realism to scenarios. In doing so, we aim at bridging the gap between academic and policy discussions. The extensions include:

- an Armington trade specification, explaining two-way trade and allowing market power to determine trade patterns in the medium run, while allowing Heckscher-Ohlin mechanisms in the long run;
- imperfect financial capital mobility;
- consumption patterns depending upon per capita income, and developing towards a universal pattern;
- a Lewis-type low-productivity sector in developing regions, from which the high-productivity sector can draw labour, enabling high growth for a long period.

The model distinguishes the following regions, sectors and productive factors (see appendix for a detailed, regional and sectoral classification):

Regions	*Sectors*	*Productive factors*
United States	Agriculture	*Primary inputs*
Western Europe	Services	Low-skilled labour
Japan	Trade and Transport	High-skilled labour
Rest of the OECD	Electricity	Capital
Eastern Europe	Intermediate goods	(fixed factor)
Former Soviet Union	Consumer goods	
Middle East and North Africa	Capital goods	*Intermediate inputs*
Sub-Saharan Africa	Oil	from all sectors
Latin America	Natural Gas	
China	Coal	
South-East Asia	Other Raw Materials	
South Asia & Rest		

Substitution elasticities

The results of the model depend also on the substitution possibilities in production and consumption. The production possibilities are described by a nested CES function. The upper level distinguishes between value added and intermediate goods. The elasticity between these two broad categories is 0.8. At the lower level value added is described by Cobb-Douglas function of the primary productive factors: capital, low-skilled labour and high-skilled labour. The intermediate goods are described by a nested CES function with a substitution elasticity of 0.8. The first nest is a CES function which includes energy and raw materials such as Oil, Petrol, Natural Gas, Electricity and other Raw Materials. The substitution elasticity between these inputs is 2.0. The second nest is also a CES function with again a substitution elasticity of 0.8. which includes the other intermediate inputs.[4] The utility function, from which demand for different consumption categories is derived, has been given a Cobb-Douglas specification. The substitution elasticity between any pair of consumption categories therefore is unity.

Traded, foreign goods are not perfect substitutes for domestic goods, and this also affects the outcome of simulations. The substitution between goods from different origin is not perfect. WorldScan employs an Armington-type assumption. However, the price elasticities of demand considerably increase over time. The model employs different assumptions for raw materials, Agriculture, Manufacturing and Services. The long-run substitution elasticities in the benchmark case are 17, 13, 7 and 5 respectively.

[4]In case of the sector Electricity, the input Electricity is a part of the nest with other Intermediate inputs instead of the nest consisting of Energy and Raw materials.

3. Schumpeterian scenario

The Schumpeterian scenario is an optimistic scenario on economic progress in developed and developing regions. It emphasizes globalization tendencies and market-oriented policies in the world economy. Therefore, this scenario is akin to the High Growth scenario, which CPB and OECD constructed for their collaborative study on globalization and the consequences for the OECD countries (OECD, 1997).The idea of this scenario is that when developing countries grow fast or start to grow rapidly, the linkages between the OECD and the non-OECD countries intensify. Fast development outside the OECD area and complete liberalization of goods and capital markets produce closer economic integration of rich and poor countries. More generally, the scenario extrapolates and probably exaggerates the current globalization tendencies.

Table 3.1. Characteristics Schumpeterian scenario

1. Economy	*high economic growth rates*
2. Politics	*stable in OECD and non-OECD* *increasing market-oriented policies*
3. Technology	*strong technological development* *catching up of the non-OECD*
4. Demographics	*overpopulation in non-OECD* *diminishing population in OECD*
5. Resource Use	*innovations improving material and energy efficiency* *volume growth exceeds efficiency gains*
6. Firm strategies	*internationalization of business* *strong competitive forces*
7. Consumer preferences	*convergence of consumer patterns*

This table presents the qualitative characteristics. The translation into the quantitative exogenous variables of the model necessary to mimic economic growth, resource use, and consumer preferences is presented in Table 7.1. In this table the quantification of all four scenarios are compared to each other.

To attain and sustain high growth rates, developing countries should pursue sound domestic policies. Countries that do not create favourable conditions for market-based development, are likely to fail. Governments must also promote or at least not discourage (private) savings, invest in public infrastructure and human capital and at the same time try to control or even curb fiscal deficits and public debt. Finally, developing economies must open up to allow foreign goods and foreign investment. Liberalising trade of goods, services and capital allows countries to specialise, exploit economies of

scale and create competition. Moreover, open markets stimulate the dissemination of modern technologies in the developing regions.

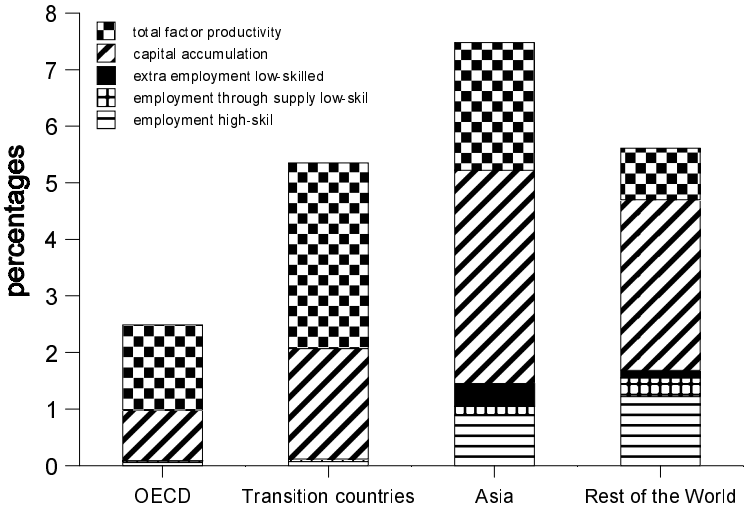
In the scenario, trade liberalization is not confined to trade blocs, but applies globally. The OECD countries open up their markets further. Whereas barriers to trade in manufacturing goods are already low, agriculture is still heavily protected. Mainly developing countries benefit from partial liberalization of agriculture. Moreover, the degrees of competition for Agricultural Goods, Manufacturing Goods and Services are larger than in other scenarios. The long-term substitution elasticities between goods of different origin are assumed to be about twice as high as in the other scenarios.

Fast economic growth in the developing regions together with a strong trend towards internationalization leads also to a convergence of consumer preferences towards the OECD. Moreover, rising incomes per capita in the OECD countries lead to a higher demand for Services and a relatively lower demand for industrial goods. In spite of the relative decline of manufacturing in the OECD, increasing demand in the developing regions, population growth and the development of transport and tourism will put a heavy strain on the use of energy and environment. Improvements in energy efficiency are necessary to compete with increasing demand. Energy prices will rise and environmental pollution will continue. From an environmental perspective the scenario is thus less optimistic, although it does not foresee an environmental disaster.

growth

In the Schumpeterian scenario many poor countries catch up, though not completely, with rich countries. Due to education, population growth, and labour reallocation from the low-productivity to the high-productivity sectors, labour is one of the engines for growth, see Figure 3.1. Moreover, capital accumulation is fairly important in the developing regions. The liberalization of capital markets and the high savings rates in Asia contribute substantially to the supply of capital in the non-OECD. Because of the lack of population growth and stable schooling levels in the OECD, technology is the most important contributor to economic growth. Technology is also important for the transition countries in order to reform the inefficient production processes inherited from the communist past.

Figure 3.1 Growth accounting in Schumpeterian scenario
annual contributions of the productive factors 1996-2020



Non-OECD countries grow at a per capita rate of 4.7%, while OECD countries grow on average with a rate of 2.2% per capita (Table 3.2). This a an optimistic scenario, because only a few countries have been able to maintain growth rates of about 4% per capita for two decennia or more. Sub-Saharan Africa is lagging behind. Although the macro growth rates are impressive given the developments during the last two decades in Sub-Saharan Africa, the large population increase will keep per capita growth rates at European levels.

The increase in labour productivity in the non-OECD is also apparent in Table 3.2. First, labour reallocates quite quickly from the low-productive sectors to the high-productivity sectors, see also Table 3.3. Second, education levels will increase. The supply of high-skilled labour is much higher than average population growth (2.8% compared to 1.4%, respectively). Technical progress contributes also to economic growth in the non-OECD. The opening of goods and capital markets facilitates the dissemination of western technologies to the non-OECD countries. Together with sound market-oriented policies and government investment, productivity rates will be pushed upwards in these countries. The high growth rate for total factor productivity in the non-OECD compared to the one in the OECD represents the technological catching up.

Table 3.2 Aggregated annual growth rates in Schumpeterian scenario

Annual average growth 1995 -2020	OECD	non OECD	World
GDP	2.6	6.2	3.7
Population	0.3	1.4	1.3
GDP per capita	2.2	4.7	2.4
TFP on average	1.5	2.0	1.7
TFP sector Trade and Transport	2.0	2.2	2.1
Employment	0.1	3.0	2.5
Supply of high-skilled labour	0.1	2.8	2.2
Real producer price for energy	1.5	0.2	0.8
Volume of emissions	0.8	3.6	2.5

High productivity growth rates match rapidly increasing demand from the non-OECD countries. The reduction and elimination of trade barriers contributes to this process. International specialization becomes more and more pronounced during the scenario period in response to the liberalization of goods markets and lower transport costs. International trade flourishes as is indicated by the substantial increase in the trade to GDP ratio. The OECD specializes relatively more in high-skilled labour-intensive goods such as Capital goods and Services. Non-OECD countries specialize in Consumer goods which are low-skilled labour intensive.

Table 3.3 Aggregated percentage shares in 1995 and 2020 in Schumpeterian scenario

	OECD		non-OECD	
Year	1995	2020	1995	2020
Informal sector (share labour supply)[1]	6.9	6.9	49.7	30.7
Savings ratio (ratio nat. income)	20.7	17.8	23.8	23.5
Ratio of value of trade to GDP[2]	11.0	22.9	24.8	43.6
Share of food in total consumption	9.6	6.5	26.0	12.6
Share of services in total consumption	74.3	77.9	54.0	70.6
Share in world GDP	77.1	58.1	22.9	41.6
Share in world population	14.4	11.3	85.6	88.7
Share in world emissions	48.9	32.7	51.1	67.3

[1] For the OECD countries, this is the unemployment rate.
[2] This includes intra-regional trade.

Changes in production structure are not only affected by specialization, but for the greater part by the general trend towards the production of high-skilled labour-intensive goods. In particular, consumers in the non-OECD countries change their consumption

patterns from Agriculture and Food towards Services. In the OECD this trend also continues, but to a moderate extent. This implies that in spite of specialization the non-OECD countries produce also much more Services now. The non-OECD share in world production increases from 22.9% to 41.6% in this scenario. This is amazing, but still far away from their share in total population.

energy and emissions

High and persistent economic growth also feeds energy demand. Some of the potential demand is substituted by energy-efficiency improvements in the production processes of 0.5% and 1% per annum in the OECD countries, and non-OECD countries respectively. By these energy-efficiency improvements and increasing prices in the OECD, emission and energy growth do not accelerate. Emissions grow fast in the non-OECD countries, but at a global level, emission growth is less than 2% per year. The total level of emissions is about 11.1 million kilotonnes of C(arbon). Due to the ono-to-one relation with emissions, the growth rate in emissions exactly replicates the volume growth rate in energy.

The shift in production activities from the OECD to the non-OECD implies also a shift in polluting activities. This can be seen in Table 3.3 by comparing the shares in world GDP and world emissions in 1995. Fortunately, by copying the technologies from the OECD and the energy-efficiency improvements in the non-OECD the energy to GDP ratio decreases significantly in this scenario. But still these techniques are not sufficient at all in turning the trend of increasing emissions in the OECD. Given high economic growth rates in the non-OECD countries, rapidly increasing emissions seem to be unavoidable. Only very strict environmental legislation could press the increasing emissions growth rates down.

specialization patterns

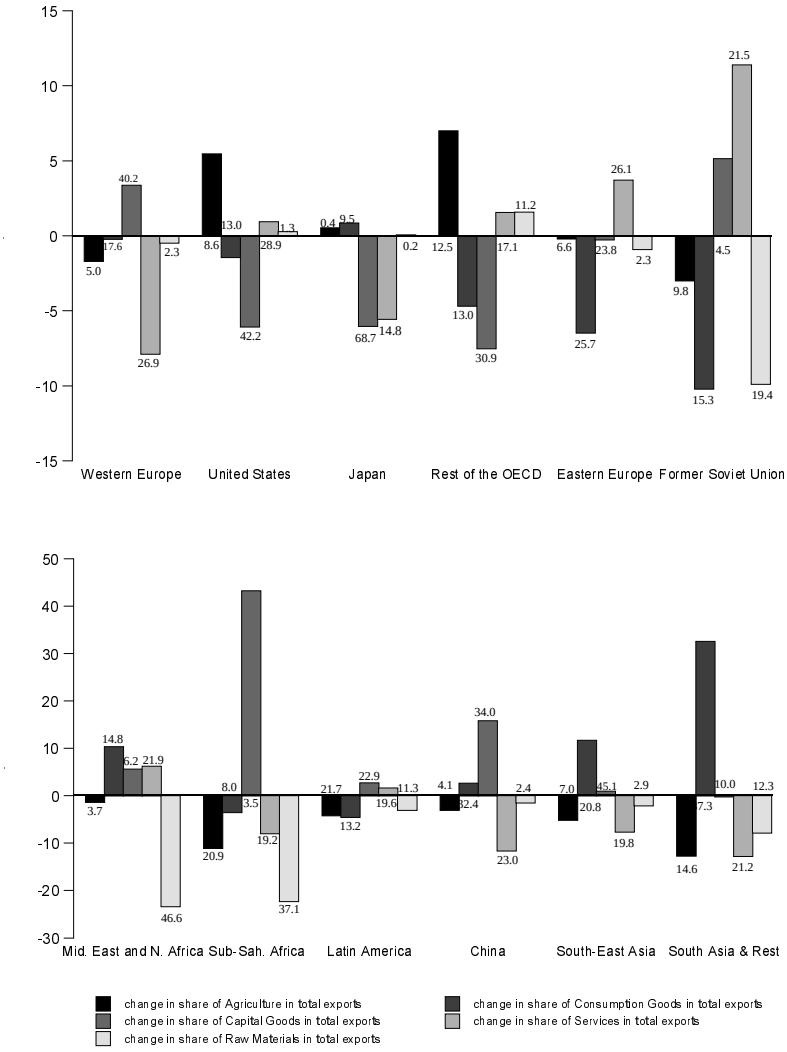
At a more detailed level (see Figure 3.2) the reduction of import tariffs and export subsidies in the sector Agriculture benefits the land abundant and efficient producing regions. Examples are the United States and the Rest of the OECD (Australia and Canada). Their exports towards Western Europe, and South Asia & Rest drives many farmers from the markets in these regions. The Middle East, Sub-Saharan Africa and the Former Soviet Union are the main suppliers of raw materials in particular energy. However, the decrease in the share in total exports reflects the fact that energy becomes less important in total production. For Sub-Saharan Africa the composition of its exports shifts drastically to capital goods. Their total export volume is however very modest.

The Asian regions specialize in the production of consumer goods. In particular, the rise of South Asia & Rest is astonishing. Eastern Europe and the Former Soviet Union lose their markets shares in this sector. They shift to (tradeable) Services at the expense of Western Europe and Japan. Western Europe compensates this loss by exporting more

Capital goods, The export of Capital goods is still very important in Japan. Moreover, both countries export relatively more Intermediate Goods (not depicted).

The size of the shifts in the export composition is much larger than in the other scenarios. This is the impact of the higher substitution elasticities in demand which enforces competition at the international goods and services markets.

Figure 3.2 Specialization patterns in Schumpeterian scenario
changes in share of total exports in 2020 compared to 1995 (% points).
numbers below or above columns refer to shares in 1995 (%)



4. Malthusian Scenario

The quite optimistic picture for the developing countries which is sketched in the Schumpeterian scenario is abandoned. The Malthusian scenario assumes that governments in developing regions are not able to pursue market-oriented and outward-oriented policies. The political situation in most of these countries is not stable and leads to an inward-looking attitude. This does not stimulate international cooperation on trade and environmental policies. The lack of trade liberalization and neglect of infrastructure and education harms economic growth substantially in these countries. The high technological progress in the OECD is not disseminated to the developing regions. This reduces economic growth even further, which in its turn attributes to the political tensions in those countries.

Table 4.1 Characteristics Malthusian scenario

1. Economy	*high economic growth rates in OECD* *non-OECD countries lagging behind* *increasing polarisation*
2. Politics	*stable in OECD, non-stable in non-OECD* *strained political relations due to large migration flows*
3. Technology	*strong technological development in OECD* *hampering diffusion technologies to non-OECD*
4. Demographics	*overpopulation in non-OECD* *diminishing population in OECD* *large international migration flows*
5. Resource Use	*improving energy efficiency in OECD* *modest increase of energy use in non-OECD*
6. Firm strategies	*internationalization of business* *relocation of polluting activities*
7. Consumer preferences	*no global convergence of consumer patterns*

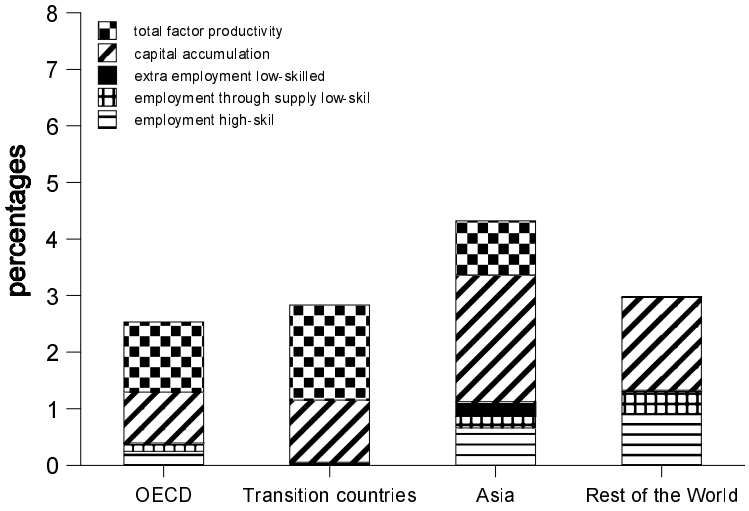
This table presents the qualitative characteristics. The translation into the quantitative exogenous variables of the model necessary to mimic economic growth, resource use, and consumer preferences is presented in Table 7.1. In this table the quantification of all four scenarios are compared to each other.

The lack of perspectives on progress does not facilitate structural changes in developing economies. Labour reallocation is modest, which contributes to the depriving conditions for a large part of the population. Because the OECD countries succeed in managing their economies well, people in the developing countries have a tendency to migrate in this scenario in spite of stricter controls at the OECD borders. The trend towards globalization seems to be reversed in this scenario, in particular for the developing countries. As a result, consumer preferences in the developing countries will not

converge to those in the OECD. The reduced growth perspectives are of course also important in this respect.

growth
Less economic growth is of course beneficial for the environment. The demand for energy is lower than in the Schumpeterian scenario. The energy efficiency is also lower but the reduced trade in raw materials induced by trade barriers from the non-OECD to the OECD stimulate efficiency and new energy sources in the OECD countries.

Figure 4.1 Growth accounting in Malthusian scenario
annual contributions of the productive factors 1996-2020.



The lack of a market-oriented environment in most non-OECD countries harms growth tremendously. First of all, less expenditure on education hampers the growth of high-skilled labour supply. Although the young generations are better educated than the old ones, on average the progress in schooling is modest. The skilled labour force grows at a rate of 2.1% exceeding population growth by only 0.7% (Table 4.2). In effect it will take more than a century to reach the OECD education levels. As a consequence, high-skilled labour also contributes less to economic growth than in the Schumpeterian scenario as can be seen by comparing Table 3.1 and 4.1. Second, restrictions on the reallocation of labour within the non-OECD regions, such as strict migration laws, slow down labour reallocation from low-productivity to high-productivity sectors, as can be seen from the size of the informal sector in 2020 (Table 4.3).

Table 4.2 Aggregated annual growth rates in Malthusian scenario

annual average growth 1995 -2020	OECD	non OECD	World
GDP	2.6	3.6	2.8
population	0.8	1.4	1.3
GDP per capita	1.7	2.2	1.5
TFP on average	1.2	0.7	1.1
TFP sector Trade and Transport	1.6	0.7	1.4
employment	0.6	2.2	1.9
supply of high-skilled labour	0.6	2.1	1.7
real producer price for energy	0.7	0.2	0.5
volume of emissions	1.1	2.8	2.1

Less technological progress does slow down the increasing productivity gap between high- and low-productivity sectors. This process also hampers labour reallocation. Furthermore, a substantial part of the population migrates to the OECD. In 2020, population in the OECD is increased by 10% due to migration. This also appears in Figure 4.1, where labour now contributes to growth in the OECD. Without migration this is not the case.

The restrictions on the markets for capital, goods and services harm the supply of capital and the dissemination of technology. Total factor productivity in the non-OECD regions grows at a lower pace than in the OECD, suggesting that the technology gap only widens. Due to the relative less abundant supply of production factors the productivity increases are less substantial than in the Schumpeterian scenario. Moreover, less economic growth leads to a smaller increase in savings which in its turn affects investment negatively, see Table 4.3.

Table 4.3 Aggregated percentage shares in 1995 and 2020 in Malthusian scenario

	OECD		non-OECD	
Year	1995	2020	1995	2020
Informal sector (share labour supply)[1]	6.9	6.9	49.7	41.8
Savings ratio (ratio nat. income)	20.7	17.9	23.8	16.6
Ratio of value of trade to GDP[2]	11.0	12.5	24.8	22.6
Share of food in total consumption	9.6	7.1	26.0	17.0
Share of services in total consumption	74.3	77.2	54.0	65.2
Share in world GDP	77.1	72.5	22.9	27.5
Share in world population	14.4	12.8	85.6	87.2
Share in world emissions	48.9	38.4	51.1	61.6

[1] For the OECD countries, this is the unemployment rate.
[2] This includes intra-regional trade.

In spite of the unfavourable market circumstances in the non-OECD countries, the macro growth rates are higher than in the OECD. This reflects the enormous potential of these countries which will develop to some extent even when the circumstances are not beneficial for economic development. Per capita growth is 2.2%, 0.5% above the average per capita growth in the OECD countries.

The increase in population in OECD and non-OECD is now nearly similar (0.8% and 1.4%). This is caused by the large migration flows from the non-OECD countries to the OECD countries. Europe has to cope with large inflows from Africa, the Middle East and Eastern Europe. Asian migrants try to find their luck in the United States, Japan, and the Rest of the OECD. These large flows - from the perspective of the OECD countries - have nearly no effect on the population in the non-OECD countries, but double population growth excluding migration in the OECD. Migration is stimulated by increasingly unequal income distributions between developed and developing countries and the unstable political situation in the latter countries.

Migration increases economic growth in the OECD. Figure 4.1 shows that labour contributes in this scenario to economic growth while this is not the case in the Schumpeterian scenario.

Less economic growth is also reflected in the consumption patterns. In the non-OECD countries, the shift away from food towards services is less pronounced than in the Schumpeterian scenario (compare Table 4.3 to 3.3). The trend to relatively more expenditures on services in the OECD continues, although its speed dies out. This also implies that changes in production structure from Agriculture to Services is more limited than in the Schumpeterian scenario.

Prosperous economic conditions in the OECD and less so in the non-OECD also implies that large shares of world-wide production are still located in the OECD. This does not imply that firms and / or capital are not mobile. Within the OECD all trade barriers are eliminated and barriers for the capital markets are reduced. The trend towards specialization within the OECD continues. Trade within the OECD is stimulated but not extensively. This is no surprise. The existing trade barriers are already fairly low, except for trade in agriculture and energy. As a consequence, the gains of liberalization are modest. The trade restrictions imposed by the non-OECD countries hamper trade significantly. The ratio of trade to GDP even lowers in the non-OECD countries during the simulation period en specialization in manufacturing becomes less pronounced.

energy and emissions

Less economic growth in the non-OECD does not reduce the growth in energy and emissions proportionally. The reason is that those countries take less measures to improve energy efficiency, and new technologies are not quickly disseminated. Due to the unstable political situation and unfavourable economic conditions, the reduction of

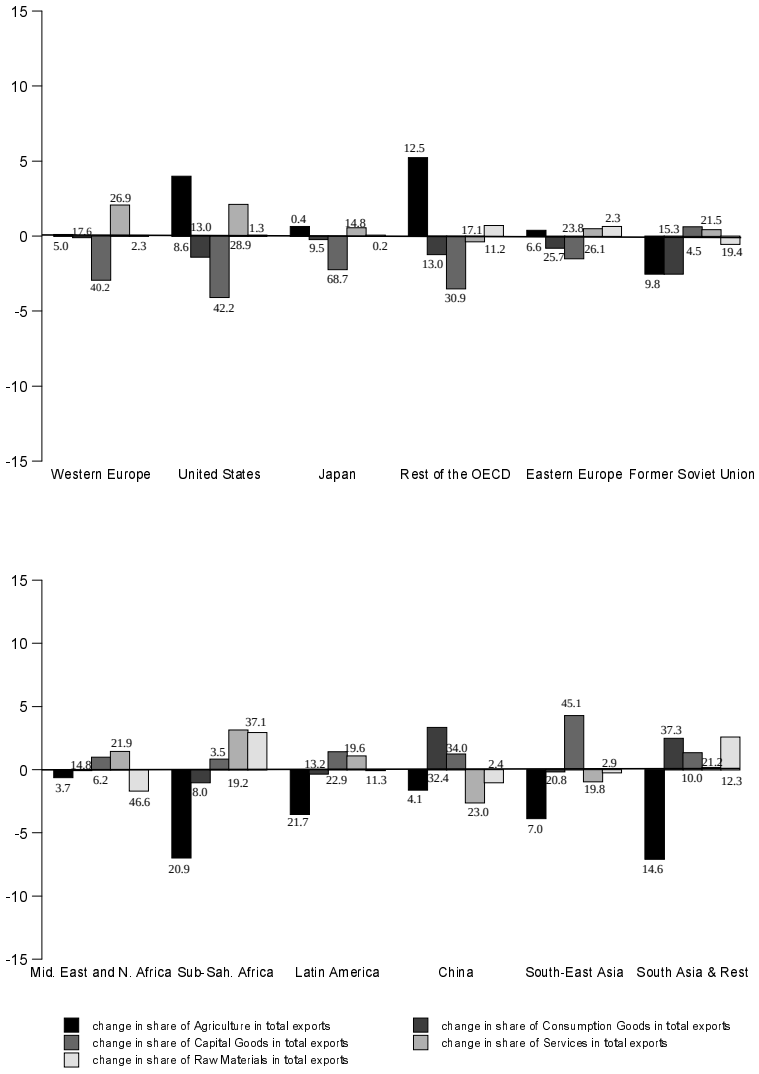
emissions has no priority in the non-OECD regions. There are no improvements in the energy efficiency. As a consequence, the differences in environmental policy between the OECD and non-OECD countries increase strikingly. The difference in emission growth of about 2% per year is much larger than the difference in GDP growth of about 1%. There are two reasons for this result. First, production processes in the OECD are already more energy-extensive. Second, firms in the OECD are able to innovate their technologies such that production processes become less polluting. The energy-efficiency improvement is 0.5% per year. Table 4.3 shows that OECD's share in emissions is reduced by about 10% points while the share in production decreased by 5% points.

specialization patterns

In spite of the moderate gains of trade liberalization, international specialization within the OECD will become more pronounced. The United States and the Rest of the OECD export more agricultural products. They face less competition from the non-OECD countries due to the trade barriers. Japan and also Western Europe strengthen their position in the production of Intermediate goods, while all OECD countries can maintain their position in the production of Consumer goods. Compared to the Schumpeterian scenario OECD regions export a bit more Services now at the expense of Capital Goods. The specialization pattern in the latter scenario was the result of intensified trade linkages between the OECD and non-OECD which is not the case now.

Most developing regions lose the opportunities to export agricultural goods to the OECD. South-East Asia and South Asia & Rest specialize hardly in Consumption Goods because of trade restrictions with the OECD. China faces the same problem for its Capital Goods. China shifts to the production of Consumer Goods, because it faces less competition from its Asian neighbours. Due to less competition caused by trade barriers the export composition shift a bit to Capital Goods (excluding China) and / or Services in the non-OECD regions.

Figure 4.2 Specialization patterns in Malthusian scenario
changes in share of total exports in 2020 compared to 1995 (% points).
numbers below or above columns refer to shares in 1995 (%)



5. Developing Scenario

The Schumpeterian and Malthusian scenario sketched a rosy picture of the OECD countries. The OECD countries benefited from high growth in the non-OECD regions or were able to generate high growth rates by themselves. At least in economic sense these countries flourish, while an environmental catastrophe seems to be prevented. However, this catastrophe can still occur after 2020, because the trend in emission growth is only tempered, but not altered.

Table 5.1 Characteristics Developing scenario

1. Economy	*high economic growth rates in non-OECD* *economic crisis in OECD*
2. Politics	*stable in non-OECD, unstable in OECD* *increasing market based systems in non-OECD*
3. Technology	*high rate of imitation and innovation non-OECD* *limited technological development in OECD*
4. Demographics	*overpopulation in non-OECD: smaller families* *diminishing population in OECD*
5. Resource Use	*severe ecological problems* *rapidly increase of resource use in non-OECD*
6. Firm strategies	*internationalization of non-OECD firms*
7. Consumer preferences	*convergence of consumer patterns* *strong youth culture in non-OECD*

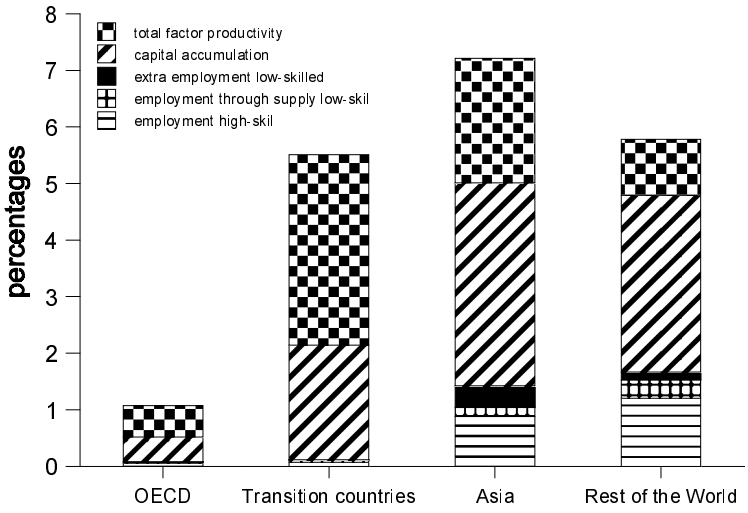
This table presents the qualitative characteristics. The translation into the quantitative exogenous variables of the model necessary to mimic economic growth, resource use, and consumer preferences is presented in Table 7.1. In this table the quantification of all four scenarios are compared to each other.

The Developing scenario does not fit in this framework. Growth perspectives for the OECD countries are meagre, while non-OECD grow fast at high environmental costs. The Developing scenario assumes that the OECD countries experience problems. Demand for social protection and other risk averting behaviour enforces rules and institutions which hamper structural growth. The lack of flexibility on the labour and product markets with in the OECD keep unemployment levels high. Moreover, established interests and inflexible institutions oppose effectively solutions to the financial burden of ageing. As a result, labour taxes increase and raise unemployment levels even further. Economic crises inside the OECD strengthen protectionist sentiments. Disagreement on free trade issues on agriculture and services between the United States, European Union and Japan withholds all globalization tendencies in the OECD. This relative autarky together with expanding welfare states, affects expectations of producers. They reduce investment and curb research and development. Technical

progress slows down. The social and economic tensions dominate environmental problems. As a consequence, energy efficiency and environmental legislation are unimportant issues now.

The developing countries do not face these problems. They go further in opening up and strengthening markets. Their policies are outward oriented. They invest in infrastructure and education and copy at a fast pace technologies from the OECD countries. In spite of protectionist measures from the OECD, the developing countries liberalise trade and capital in their own regions, thereby creating their own trade blocs. In their efforts to raise welfare at a quick pace, countries do not worry about the environment. Moreover, the lack of energy-extensive innovations in the OECD implies the imitation of energy-intensive technologies in the non-OECD countries. As a result, the demand for energy increases substantially, leading a sharp increase in emissions.

Figure 5.1 Growth accounting in the developing scenario
annual contributions of the productive factors 1996-2020.



growth

The lack of technical progress in the OECD has a large impact on the economy, because it is the main contributor to economic growth in this area. Economic growth is thus reduced substantially. Moreover, savings and investment are reduced due to a lack of confidence within the OECD. As a consequence, the growth rates hardly exceed 1% per year. As in the Schumpeterian scenario, the transition countries have to rely on technical progress, which pushes up economic growth substantially. The other regions also benefit from the increase in labour productivity by schooling and labour reallocation. Table 5.2

and 5.3 show that high-skilled labour supply grows 2.8% per year and about 20% of the labour force reallocates from low- to high-productivity sectors. These two factors raise economic growth with about 2% in Asia and the Rest of the World.

Developing countries really catch up with the developed ones. Table 5.2 shows that the difference in GDP per capita is 3.6% per annum. The deviations in the growth of total factor productivity are also striking. While, the rate of technological progress is nearly zero in the OECD countries, non-OECD countries are able to improve their technologies at a quick pace. The variation in labour supply growth of high-skilled workers was already apparent in the Schumpeterian scenario, and contributes here also significantly to the differences in growth rates.

These huge disparities in growth implicate a big shift in the location of production. The share in world production of the non-OECD doubles from about 25% to nearly 50% This is an enormous reallocation of activities in 25 years time. Trade as such does not increase substantially compared to GDP. This is caused by the trade barriers between the OECD and the non-OECD. Consequently the specialization pattern is not so pronounced as in the Schumpeterian scenario where the linkages were increased between regions with different comparative advantages.

Consumption patterns converge rapidly. High growth in the non-OECD countries increases consumption expenditures and a shift from agricultural goods (income elasticity less than one) to Services (income elasticity larger than one). In 2020, the average consumer will spend nearly 70% on service goods, while the share of agriculture in total consumption is lowered to about 10%. This number is affected positively by the low income per capita in Sub-Saharan Africa.

Table 5.2 Aggregated annual growth rates in Developing scenario

Annual average growth 1995 -2020	OECD	non OECD	World
GDP	1.2	5.9	2.8
Population	0.3	1.4	1.3
GDP per capita	0.8	4.4	1.5
TFP on average	0.6	2.0	1.3
TFP sector Trade and Transport	0.6	2.3	1.5
Employment	0.1	3.0	2.4
Supply of high-skilled labour	0.1	2.8	2.2
Real producer price for energy	1.6	-0.1	0.7
Volume of emissions	0.3	4.6	3.0

energy and emissions

The growth in energy and emission volumes follows closely the developments in the economy. Without energy-saving technologies or environmental legislation emission volumes accelerate in the non-OECD regions with nearly 5% per annum. The reduction

of tariffs in raw materials in the non-OECD countries and lagging demand in the OECD, exerts an downward pressure on the relative energy prices. Consequently 75% of the emissions is produced in the non-OECD countries. Due to meagre economic growth, emission growth in the OECD is lower than in the scenarios with high growth rates and energy-saving technologies. In itself this increase is sustainable. But, the already high level of emissions in the developed countries together with the huge increase in emissions in the developing countries poses a large burden on the environment. Although the world-wide growth of emissions is not much higher than in the Schumpeterian scenario, the environmental prospects are more worrisome. High economic growth in the Schumpeterian scenario was combined with energy savings technologies in the OECD. This is not the case now. A larger part of the emissions is produced by non-OECD countries without any environmental-friendly technologies. Section 7 will show that this situation will lead to large differences in 2050.

Table 5.3 Aggregated percentage shares in 1995 and 2020 in Developing scenario

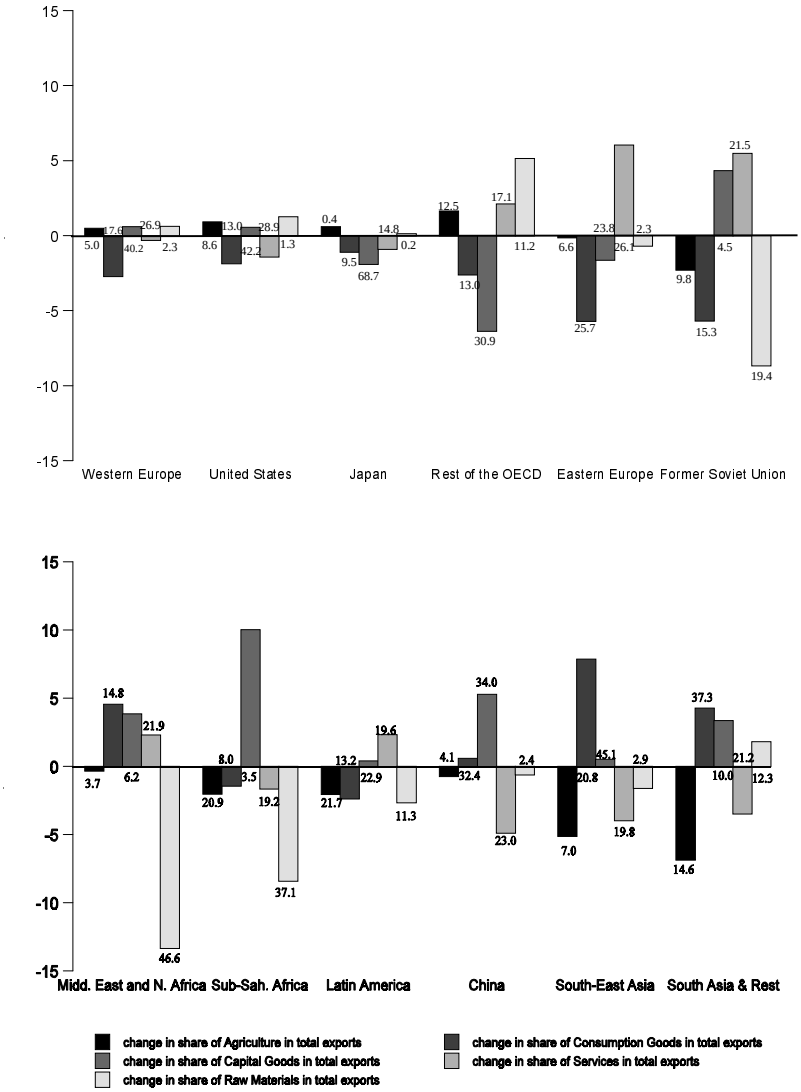
	OECD		non-OECD	
Year	1995	2020	1995	2020
Informal sector (share labour supply)[1]	6.9	6.9	49.7	31.6
Savings ratio (ratio nat. income)	20.7	14.7	23.8	24.4
Ratio of value of trade to GDP[2]	11.0	15.0	24.8	25.5
Share of food in total consumption	9.6	7.6	26.0	13.4
Share of services in total consumption	74.3	75.7	54.0	68.6
Share in world GDP	77.1	51.9	22.9	48.1
Share in world population	14.4	11.3	85.6	88.7
Share in world emissions	48.9	25.4	51.1	74.6

[1] For the OECD countries, this is the unemployment rate.
[2] This includes intra-regional trade.

specialization pattern

The maintenance of trade barriers within the OECD is not in favour of the farmers in the United states and the Rest of the OECD. Western Europe and Japan are able to maintain their market shares using these barriers. The lack of energy efficiency and limited possibilities to import raw materials from the developing countries shift some of the endowments towards the raw materials sectors in the OECD from which the Rest of the OECD benefits. The lack of trade in Raw Materials hurts the traditional exporters, such as the Middle East & North Africa, Sub-Saharan Africa and the Former Soviet Union. The existing trade barriers in manufacturing hurts the rest of the OECD, but they shift the resources to Services. However the shifts in the export composition are very modest in the OECD.

Figure 5.2 Specialization patterns in Developing scenario
changes in share of total exports in 2020 compared to 1995 (% points).
numbers below or above columns refer to shares in 1995 (%)



The change in the specialization pattern for the developing countries is more pronounced than in the Malthusian scenario, but less than in the Schumpeterian scenario. This reflects trade liberalization within the non-OECD regions and the lack of trade liberalization with the OECD regions. South-East Asia and South Asia & Rest can

not benefit from open markets in the OECD for their Consumer Goods and China can not sell their Capital Goods to the OECD. Consequently, Eastern Europe and the Former Soviet Union shift from the export of Consumption Goods to Services. All regions leave Agriculture because the export towards Western Europe and Japan are hampered by barriers. The developing regions export also less Services. Production is not heavily affected due to increasing demand in their own region.

6. Ecological Scenario

Environmental quality is not a specific goal in the Schumpeterian, Malthusian and Developing scenario. The Schumpeterian and Malthusian scenario assume that economic growth can continue without any limitations imposed by the environment Some energy improvements in production take place such that energy demand does not rise too much. However, environment as such is not an objective in these scenarios. The Developing scenario is the best example of a lacking objective: energy demand in the non-OECD regions rises dramatically.

Table 6.1 Characteristics Ecological scenario

1. Economy	*low economic growth rates*
2. Politics	*stable in non-OECD and OECD* *increasing market based systems*
3. Technology	*focus on environmental-friendly technology*
4. Demographics	*smaller increase population in non-OECD*
5. Resource Use	*sustainability* *strict environmental legislation*
6. Firm strategies	*localized production and consumption*
7. Consumer preferences	*preference for environmental-friendly products* *preference for local products*

This table presents the qualitative characteristics. The translation into the quantitative exogenous variables of the model necessary to mimic economic growth, resource use, and consumer preferences is presented in Table 7.1. In this table the quantification of all four scenarios are compared to each other.

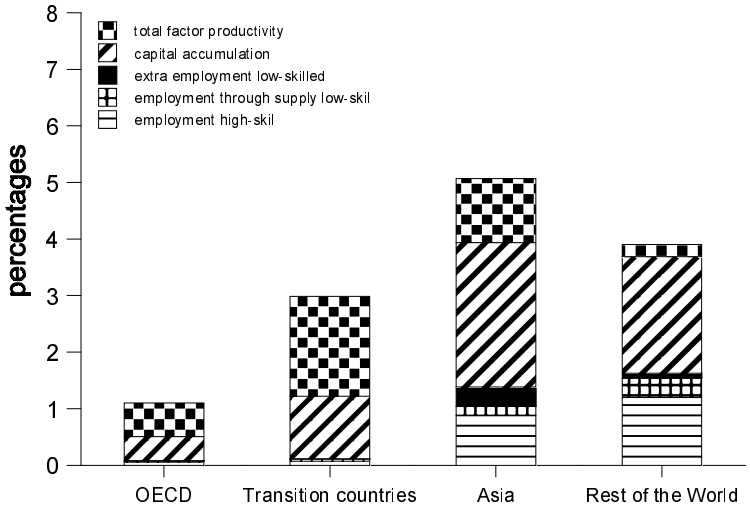
In the Ecological scenario consumers and producers value environmental quality. Economic growth as such is not so important. Well-being and the environment are the issues in this scenario. Technical progress as such is not so high, but it is directed to energy-efficiency improvements. New innovations are motivated by the positive environmental effects instead by higher productivity levels. Moreover, consumers prefer to save energy, and spend consequently less on electricity. Furthermore, governments introduce a strict environmental legislation by introducing energy taxes. The emission targets agreed upon in the Kyoto protocol will be reached in 2010 and the emissions will be lowered by 1% per year after 2010. Environmental legislation is only possible in a sphere of political and social harmony. Countries agree to cooperate on environmental legislation without free rider behaviour. The agreements in the Kyoto protocol are only binding for the industrial and transition countries. Developing countries are permitted to growth with energy saving technologies, but without strict environmental limits. The energy-efficiency savings are 2% per year. The reverse of the medal is low economic growth, and thereby a slow rise in the standards of living in the non-OECD countries.

In this scenario, people value the consumption of local products of their own culture. Globalization is thus not important in this respect. For that reason, there are not many incentives to eliminate trade barriers. Firms stay in their own region, and the need for transport is more limited than in the other scenarios. This also limits the incentives for technological development in the Trade and Transport sector.

growth

The relative insignificance of economic growth is illustrated by 0.9 and 2.5 GDP growth per capita in the OECD and non-OECD, respectively, see Table 6.2. The main reason for low economic growth is the lack of technical progress. Figure 6.1 shows that in Asia and the Rest of the World growth is mainly driven by the growth in labour supply and the accompanying capital accumulation. Labour reallocation of about 15% of total labour supply and higher education levels push up productivity further. Given modest economic growth the size of labour reallocation is high. This reflects the social objectives of the governments in non-OECD countries, to reduce poverty by stimulating people to work in the high-productivity sectors.

Figure 6.1 Growth accounting in the Ecological scenario
annual contributions of the productive factors 1996-2020.



The stable schooling levels in the OECD and transition countries imply that capital accumulation and technical progress are solely responsible for economic growth. However, less technical progress, lowers also the productivity and consequently accumulation of capital and thereby lowers economic growth substantially.

Table 6.2 Aggregated annual growth rates in Ecological scenario

Annual average growth 1995 -2020	OECD	non OECD	World
GDP	1.2	4.0	2.0
Population	0.3	1.4	1.3
GDP per capita	0.9	2.5	0.7
TFP on average	0.6	0.9	0.7
TFP sector Trade and Transport	0.6	0.8	0.7
Employment	0.1	2.7	2.2
Supply of high-skilled labour	0.1	2.8	2.2
Real producer price for energy	0.7	0.0	0.4
Volume of emissions	0.0	1.4	0.8

Less economic growth per capita reduces the changes in consumer spending. Even in the OECD, consumers spend relatively more on agriculture and less on services compared to the other scenarios. The fact that government policies do not stress globalization and increasing linkages is reflected in the trade to GDP ratio, see Table 6.3. In the non-OECD it is nearly not affected in the scenario period, while it increases in the OECD. The lack of fast technological progress in the Trade and Transport sector contributes also to the modest increase of trade.

Together with low economic growth, most of the production still takes place in the OECD. The shift to the non-OECD regions is modest.

Table 6.3 Aggregated percentage shares in 1995 and 2020 in Ecological scenario

	OECD		non-OECD	
Year	1995	2020	1995	2020
Informal sector (share labour supply)[1]	6.9	6.9	49.7	35.2
Savings ratio (ratio nat. income)	20.7	14.9	23.8	18.9
Ratio of value of trade to GDP[2]	11.0	14.6	24.8	24.7
Share of food in total consumption	9.6	7.7	26.0	16.7
Share of services in total Consumption	74.3	75.6	54.0	64.8
Share in world GDP	77.1	63.2	22.9	36.8
Share in world population	14.4	11.3	85.6	88.7
share in world emissions	48.9	40.0	51.1	60.0

[1] For the OECD countries, this is the unemployment rate.
[2] This includes intra-regional trade.

energy and emissions

The Ecological scenario distinguishes itself from the other ones by a very modest increase in the demand for energy and growth of CO_2 emissions of 0.8% per year. As a result, the total emissions are about 40% lower than in the Developing scenario. In the

OECD, emissions do not even increase. This is caused by three factors. First of all, the OECD and transition countries agree to reduce the emissions according to the Kyoto protocol. This scenario assumes that the countries reach these targets in 2010. The non-OECD countries do not participate with binding emission targets, because the OECD take the responsibility for its high abatement levels per capita. The non-OECD countries limit the growth of energy demand by energy-efficiency improvements in production and a reduction in consumer demand. This reflects their preferences for environmental quality. The non-OECD regions do not prefer strict emission limits as in the Kyoto protocol, because this restrict economic growth too drastically. After 2010, the emissions in the OECD and transition countries are reduced by 1% per year, reflecting the ongoing environmental concerns in this scenario. As a result, the taxes on coal in the OECD are about 25% of the consumer price in 2020, and the energy taxes on gas and oil are about 10% of the consumer price. This reduces the demand for energy substantially. The consumer price for energy rises yearly with 0.4% extra upon the annual growth in the producer price in the OECD.

Second, we assume improvements in energy-efficiency of production of 2% per year in the non-OECD countries. This reflects the idea that non-OECD countries copy the more environmental- friendly technologies from the industrial countries instead of the economically efficient ones. In the OECD countries there is no energy-efficiency improvement. It is also much harder to develop more environmental-friendly technologies because technical progress is also much lower. For that reason these improvements are only possible in high-growth scenarios such as the Schumpeterian and Malthusian scenario. Third, consumers reduce their demand for electricity. As a result, total energy demand by the OECD remains stable until 2020. The demand in the non-OECD regions rises because of the growth in GDP. Due to the energy-savings technologies the rise is energy demand is very modest compared to other scenarios.

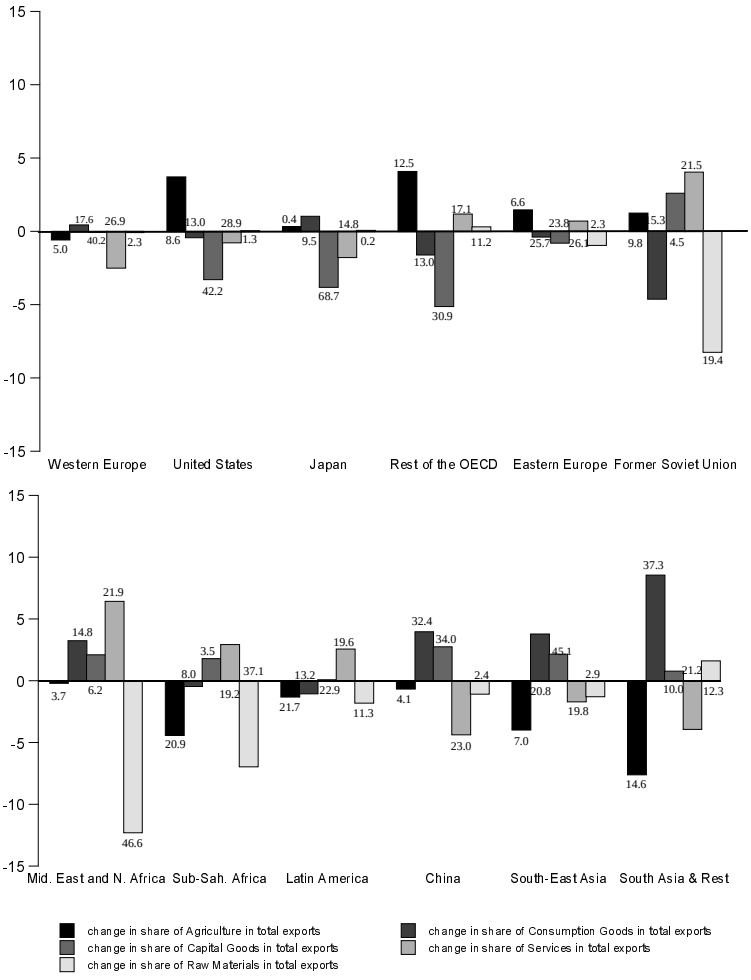
specialization

Curbed demand for energy hurts the energy-exporting regions. The share of energy in total exports by Middle-East and North Africa, Sub-Saharan Africa and the Former Soviet Union is significantly reduced. They diversify their exports to Capital Goods, Services, and Intermediate Goods. The traditional exporters of Agriculture, the United States and the Rest of the OECD improve their position in that sector in response to the partial trade liberalization. Sub-Saharan Africa and Asia export less Agricultural Goods. Western Europe and Japan export relatively more Intermediate goods (not depicted) instead of Consumer Goods and Capital Goods. However, Services and Capital Goods are still their most important export products. The market for Consumer Goods is now dominated by the Asian regions. They specialize in these goods, because of the relative abundant supply of low-skilled labour. In particular, the rise in South-East Asia is remarkable. This shift in the export mix is possible due to shift of low-skilled labour

from Agriculture to Consumer Goods. The Former Soviet Union is the biggest loser in this sector. Its export share vanishes.

In general, the shifts in the export composition are modest compared to the Schumpeterian scenario with full trade liberalization and higher substitution elasticities. On the other hand, the shifts are larger than in the Malthusian and developing scenario, because (partial) trade liberalization takes also place between the OECD and non-OECD regions. The variation between these regions is bigger than within the OECD or non-OECD. As a result, specialization patterns are more pronounced.

Figure 6.2 Specialization patterns in Ecological scenario
changes in share of total exports in 2020 compared to 1995 (% points).
numbers below or above columns refer to share in 1995 (%).



7. Comparison of the scenarios

Sections 3 to 6 described the Schumpeterian, Malthusian, Developing and Ecological scenario. In presenting these scenarios we did not compare the outcomes of the various scenarios systematically. This Chapter aims to compare the scenarios and to summarize the most important scenario results. The scenario outcomes vary because we make different assumptions on the driving forces of the scenarios. These assumptions are based on the qualitative description of the scenarios in Van Veen-Groot and Nijkamp (1998). We specify the driving forces of the four scenarios as input in the model to quantify economic growth, trade and CO_2 emissions. Table 7.1 compares these exogenous trends and variables for all scenarios. The key results are presented in Table 7.2.

Table 7.1 Exogenous trends in all scenarios until 2020 (in %)

Scenario	Schumpeter		Malthus		Developing		Ecology	
Region	O	N	O	N	O	N	O	N
Technical progress (annual)	1.5	2.0	1.2	0.7	0.6	2.0	0.6	0.9
Technical progress Trade & Transport sector (annual)	2.0	2.2	1.6	0.7	0.6	2.3	0.6	0.8
Population growth (annual)	medium scenario United Nations 0.3% in O and 1.4% in N							
Migration (from N to O)	no		yes		no		no	
Schooling (annual)	0.1	2.8	0.6	2.1	0.1	2.8	0.1	2.8
Trade liberalization in Manufacturing and Services	100%	100%	100%	0%	0%	100%	50%	50%
Trade liberalization in Raw Materials and Agriculture	50%	50%	50%	0%	0%	50%	25%	25%
Capital market integration	increasing		stable		stable		stable	
Consumer preferences convergence towards	services	O	services	bit to O	stable	to O	greening	bit to O
Degree of competition	high		standard		standard		standard	
Energy efficiency (annual)	0.5	1.0	0.5	0.0	0.0	0.0	0.0	2.0
Energy taxes	no	no	no	no	no	no	yes	no

O and N are abbreviations for the OECD and non-OECD.

One of the most important driving forces for economic growth is technical progress. If the speed of technical progress is high, economies grow fast, such as in the Schumpeterian scenario for all countries, in the Malthusian scenario for the OECD countries, and the developing scenario for the non-OECD countries. The rate of innovation in the Trade and Transport sector is higher than average technical progress

for those regions which globalize quickly. This reflects the idea that sharp falling costs in transportation and communication benefit trade substantially.

Schooling and labour reallocation from low- to high productivity sectors contributes also significantly to growth. The pace of schooling and reallocation is low in the Malthusian scenario, the most devastating scenario for the non-OECD. In this scenario people also migrate to the OECD at a pace of 0.5% of the OECD population per year. In terms of the non-OECD population this is fairly low, but larger inflows would probably lead to social tensions in the OECD.

In all scenarios we combined abundant growth with increased international linkages, and consequently trade liberalization. Tariff reductions in agriculture and raw materials are limited to 50%, because these levels are very high for some regions, and much less progress is thus far made in lowering these barriers. Even in the Ecological scenario some trade liberalization takes place, because regions are willing to cooperate as they do on environmental policy. However, they are less interested in globalization. For that reason trade liberalization is limited. The Schumpeterian scenario contains also increasing capital market integration. Moreover, we assume that the degrees of competition for Agricultural Goods, Manufacturing Goods and Services are larger than in the other scenarios. The long-term substitution elasticities between goods of different origin are twice as high.

Because per capita incomes rise in the non-OECD, the consumption patterns will change. Consumers will spend relative more money on Services and less on Agriculture, as is the case in the OECD countries. This convergence to the OECD consumption pattern is of course less pronounced in the Malthusian scenario, in which the per capita growth rate is low. OECD consumers in the Schumpeterian and Malthusian scenario will also spend more on Services because their per capita incomes rise. In the Ecology scenario, all consumers will save energy in correspondence to their environmental awareness.

In all scenarios with high economic growth sustainable production is only possible if energy-efficient technologies are introduced. For that reason the OECD countries save yearly 0.5% on energy per unit of production in the Schumpeterian and Malthusian scenario. In the former scenario, the non-OECD countries even save 1% on energy each year. Due to the quick dissemination of technology from the OECD to the non-OECD countries it is relatively easy for the latter countries to copy more environmental-friendly policies. In the Ecological scenario the environmental awareness of these countries is much higher. The energy saving in units of production is even 2% per year with a much lower dissemination of technology from the OECD. The efforts to reduce energy are thus much higher.

The OECD countries save less in the Ecological scenario, because technical progress is meagre. Less technological progress makes it more difficult to implement energy-saving technologies. The reduction in energy demand is reached by introducing energy taxes. The OECD countries levy these taxes according to the Kyoto protocol. They even

agree to reduce the emissions even further by 1% per year after 2010. In the Ecological scenario the industrial and transition countries have the possibility to trade in emission rights in order to reach the emission targets. The other non-OECD countries do not participate because the OECD and the transition countries are mainly responsible for the abatement.

The use of these different exogenous trends presented in the various scenarios implies a broad (and desired) variation in the outcomes. Speeding up technological progress raises economic growth as is the case in the Schumpeterian scenario for all regions, in the Malthusian scenario for the OECD regions and in the Developing scenario for the non-OECD regions. In high-growth scenarios GDP growth per capita is about 2% and 4.5 % in OECD and non-OECD regions, respectively, while it is 1% and 2.5%, respectively, in low-growth scenarios, see Table 7.2. Differences of about 2% of GDP growth per year are substantial. In 25 years time this implies a deviation of about 65% in GDP levels between the various scenarios.

Table 7.2 Summary of all scenarios results until 2020
Average growth rates between 1995 and 2020 and ratios in 2020 (%).

Scenario	Schumpeter		Malthus		Developing		Ecology	
Region	O	N	O	N	O	N	O	N
Average annual growth between 1995 and 2020								
GDP	2.6	6.2	2.6	3.6	1.2	5.9	1.2	4.0
GDP per capita	2.2	4.7	1.7	2.2	0.8	4.4	0.9	2.5
Real producer prices energy	1.5	0.3	0.7	0.2	1.6	-0.1	0.7	0.0
Emissions	0.8	3.6	1.1	2.8	0.3	4.6	0.0	1.4
Ratios in 2020								
Labour reallocation as % labour supply		19.1		7.9		18.1		14.5
Savings rate	17.8	23.5	17.9	16.6	14.7	24.4	14.9	18.9
Spending on Services	77.9	70.6	77.2	65.2	75.7	68.6	75.6	64.8
Spending on Agriculture	6.5	12.6	7.1	17.0	7.6	13.4	7.7	16.7
Trade to GDP	22.9	43.6	12.5	22.6	15.0	25.5	14.6	24.7

O and N are abbreviations for the OECD and non-OECD.

High economic growth leads to increasing wealth and capital accumulation. Savings rates are correspondingly higher if GDP growth is high. Savings rates in the OECD are in general lower than in the non-OECD. This is partly due to ageing in the OECD. Higher GDP growth changes also the consumption patterns. Consumers in the OECD countries spend relatively more on Services. Because the consumption share on Services is already high in 1995 and low for food (74% and 10% respectively), the differences within the OECD between the various scenarios are not so pronounced. For the non-OECD countries these differences are much larger. The consumption share in food decreases drastically from 26% to 17% or 13% depending on GDP growth per capita in the scenario. The consumption share on Services rises from 54% to 65% or 70%. From these numbers, we also conclude that the consumption shares on other goods, such as manufacturing goods are more or less constant in time.

Trade only flourishes if all countries reduce their trade barriers. Because OECD countries are endowed with high-skilled labour and capital and non-OECD countries are endowed with low-skilled labour, specialization will increase if trade barriers between these regions are reduced or even eliminated. This is the case in the Schumpeterian scenario. The various OECD countries have similar endowments of high-skilled labour and capital. The non-OECD countries look like each other with respect to low-skilled labour. In this sense specialization within the OECD or non-OECD will not be as pronounced as between the OECD and non-OECD countries - given the level of aggregation in the model. Therefore the trade to GDP ratios are fairly low in the Malthusian and Developing scenario. Except for trade liberalization, the high trade to GDP ratio in the Schumpeterian scenario depends also on a higher degree of international competition due to higher substitution elasticities in this scenario.

High economic growth does not benefit the environment. In the Schumpeterian and Malthusian scenario emissions grow substantially but do not accelerate, due to energy-saving technologies. Even in these scenarios the annual global emissions grow with about 70% between 1995 and 2020. In the Ecological scenario demand for energy and consequently CO_2 emissions are stable due to strict environmental legislation in the OECD between 1995 ands 2020. The global increase in emissions is about 20%, which seems very modest given economic development in the non-OECD countries. Moreover, at the end of the scenario period emissions do not increase at all. Emissions growth in the Development scenario does accelerate due to fast growing developing regions. These regions ignore environmental quality. As a result, emissions double in the scenario period. This scenario shows that high economic growth and a non-accelerating emission growth is possible with sufficient energy-saving technologies, such as energy improvement of about 2% per year. If energy growth is not allowed at all, economic growth has to be low, as in the Ecological scenario or a more strict environmental legislation is necessary.

The differences in emission growth in the non-ecological scenarios are not very pronounced. In these three scenarios emission growth is substantial. Whether these increases are sustainable or not is hard to tell. Except that the quantitative effects of pollution on the environment are unclear, simulation paths of 25 years time are relatively short to analyse emission paths. Therefore Section 8 presents some scenarios results for the year 2050.

8. Beyond 2020

So far we analysed the quantitative content of the four scenarios until 2020. The year 2020 was chosen because most long term economic scenarios look 25 years ahead. Examples are CPB (1992) and OECD (1997). In particular, this is valid for scenarios which do not only consider macroeconomic outcomes but also the development of various sectors and specialization patterns. The advantage of time paths of 25 years is that the outcomes can be compared to other studies. However, an analysis of the consequences of globalization, transport and environment until 2020 has also some drawbacks. The first one is that the incorporation of complete new transport technologies which are more environmental friendly takes decades.[5] Second, sustainable development policies aiming at environmental quality are long-term policies. Even if countries will reach targets agreed upon at the Kyoto protocol, world-wide emissions will rise steadily due to economic growth in developing regions. For both reasons it is necessary to look ahead beyond 2020.

This section deals with this issue. The time horizon of the scenarios presented in the previous sections is extended until 2050. We emphasize the macroeconomic outcomes and not a detailed sectoral analysis.

In principle the differences in exogenous trends between the various scenarios are equal in the periods 1995 - 2020 and 2020 - 2050. These trends are summarized in Table 7.1. However, some modifications are made after 2020.

First of all, the rate of technical progress in the fast growing scenarios is lowered by about 0.3% point. The reason is that the differences in GDP between the scenarios are already large in 2020. We do not want to extrapolate this increase in GDP differences to such large extent in 2050. However, we do not want change the nature of the scenarios drastically after 2020. Because of these considerations technical progress is a bit lower in the time period 2020 - 2050 for the fast-growing regions.

The progress in schooling is also lower after 2020. The reason is that our projections of the share of the population which completed secondary education assume a convergence trend between OECD and non-OECD regions. This trend is based on the analysis of Barro and Lee (1996) between 1960 and 1990. The higher the population share which completed secondary education, the more difficult it is to raise the education level further. Therefore the progress in schooling will slow down in time. For most scenarios the average rate lowers from 2.8% to 1.4%. In the Malthusian scenario the average rates are a quarter lower. Population growth also slows down according to the projections of the United Nations (1995). In the OECD regions the continuing low

[5] This issue is discussed in Nederveen et al. (1998). The possible incorporation of new transport technologies is important in the transport scenario at a later stage of this project. Therefore we take account of this issue although it is not very relevant for the macroeconomic scenarios presented here.

birth rates leads to a decrease in the population size after 2020. Lower birth rates in the non-OECD regions lead to a slowdown in population growth.

Table 8.1 Exogenous trends from 2020 until 2050 (in %)
so far these trends differ from those between 1995 and 2020 (see Table 7.1).

Scenario	Schumpeter		Malthus		Developing		Ecology	
Region	O	N	O	N	O	N	O	N
Technical progress (annual)	1.2	1.8	1.0	1.0	0.6	1.8	0.6	1.1
Technical progress Trade & Transport sector (annual)	1.5	2.1	1.3	0.9	0.6	2.1	0.6	1.0
Population growth (annual)	medium scenario United Nations: -0.1% in O and 0.8% in N							
Schooling (annual)	-0.4	1.4	0.1	1.0	-0.4	1.4	-0.4	1.4
Trade liberalization in Manufacturing and Services	100%	100%	100%	0%	0%	100%	50%	50%
Trade liberalization in Raw Materials and Agriculture	100%	100%	100%	0%	0%	100%	25%	25%

O and N are abbreviations for the OECD and non-OECD.

Trade liberalization was not completed for Agriculture and Raw materials in the globalizing scenarios. The reason was that barriers in these markets are quite high, and that regions are not very willing to eliminate these barriers completely. In the time span between 2020 and 2050 globalization will go on, such that also the barriers in these markets are completely eliminated.

A lower rate of technical progress reduces economic growth per capita. The average rate of growth per capita in the OECD is at least 0.3% point lower in all scenarios. For the non-OECD countries the differences are 0.5 to 1% point per year. The macro-economic growth rates are correspondingly lower which is magnified by the lower rate of population growth. Economic growth is not only lower because to less technical progress. The lower increase in education, and lower pace of labour reallocation limit the productivity increase of labour. Moreover, the decrease in savings reduces the speed of capital accumulation. These trends are more pronounced in high growth scenarios. For that reasons the differences in average growth rates between 2020 and 2050 are larger in these scenarios.

Table 8.2 Summary of all scenarios results
Average growth rates between 1995 and 2050 and ratios in 2050 (%).

Scenario	Schumpeter		Malthus		Developing		Ecology	
Region	O	N	O	N	O	N	O	N
Average annual growth between 1995 and 2020								
GDP	1.9	4.8	2.0	2.7	0.8	4.7	0.8	3.0
GDP per capita	1.8	3.7	1.4	1.7	0.6	3.5	0.6	1.9
Real producer prices energy	1.4	0.3	0.6	0.1	1.7	0.2	0.6	-0.1
Emissions	0.5	2.6	0.7	2.2	0.1	3.6	-0.5	0.8
Ratios in 2020								
Labour reallocation as % labour supply		29.7		11.0		29.0		23.1
Savings rate	15.9	20.5	17.0	16.1	13.4	21.4	15.2	18.1
Spending on Services	78.5	75.4	78.0	69.5	76.1	73.4	75.9	69.2
Spending on Agriculture	6.1	8.7	6.4	13.4	7.1	9.3	7.3	12.8
Trade to GDP	31.7	44.9	13.8	21.7	21.5	25.8	17.3	22.3

O and N are abbreviations for the OECD and non-OECD.

As non-OECD regions develop strongly in the Schumpeter and Developing scenario, labour quickly reallocates from the informal to the high-productivity sectors, although at a lower pace at the end of the scenario period. In 2050 the informal sector contains hardly 20% of the labour force. The difference with the Malthusian scenario, where only 10% of the labour force reallocates within 50 years, is large.

As ageing goes on after 2020, savings rates drop. Lower economic growth per capita and ageing exert a downward pressure on savings rates in the OECD and non-OECD. Due to high consumption shares in Services and low consumption shares in Agriculture, these shares hardly change in the OECD countries. The consumption patterns are nearly constant between 2020 and 2050. The changes in consumption patterns of the non-OECD regions are larger. In particular, if the regions grow fast these patterns are simular to those in the OECD. As a result, Agriculture is less important in the economy now and Services dominate the world economy.

High economic growth in the non-OECD regions has also an effect on trade. In particular, the increase in purchasing power leads a higher demand for products from the OECD, such as services. Moreover, the relative importance of the OECD economies is smaller in the Schumpeterian and Developing scenario. Therefore these regions import also more goods and services from the non-OECD regions. This is reflected by

the higher trade to GDP ratio for the OECD in 2050 compared to 2020 in these two scenarios. For the non-OECD regions these ratios do not change significantly. The progress in trade liberalization is limited after 2020 and substitution elasticities between goods from different origin do not change either.

Less economic growth and continuing energy-savings measures in production limit emission growth in all scenarios after 2020. On average the emissions in the OECD hardly increase. More strict environmental legislation in the Ecological scenario leads even to lower emissions. The emissions are even lowered by 25% compared to their 1995 level. The energy taxes implemented to achieve this aim vary from 25% of the consumer price for natural gas to 60% of the consumption price for coal. The real consumer price for energy grows about 1.2% per year in the OECD, compared to 0.6% for the real producer price. In the developing regions emissions grow. Due to the energy-efficiency measures in the Ecological scenario the increase in emissions is limited. Moreover, the increase in emissions occurred in the first half of the scenario period. From 2020, the emission levels are almost stable.

Table 8.3 Summary of all scenarios results at world level
Average growth rates between 1995 and 2050 and ratios in 2050 (%).

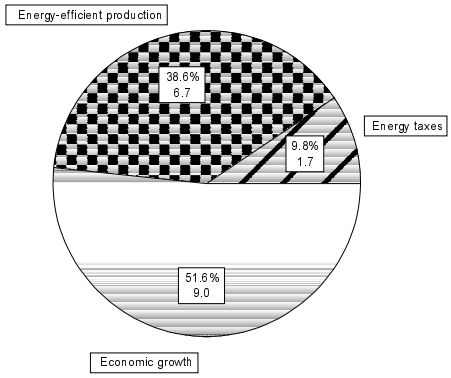
Scenario	Schumpeter	Malthus	Developing	Ecology
Average annual global growth rates between 1995 and 2050				
GDP	3.1	2.2	2.6	1.6
GDP per capita	2.0	1.2	1.6	0.6
Real producer price energy	0.7	0.4	0.7	0.2
Emissions	1.8	1.7	2.6	0.3
Global ratios in 2050				
Savings rate in 2050	18.5	16.7	19.1	16.7
Trade to GDP in 2050	39.4	16.3	24.6	19.8

Table 8.3 shows global emission growth in the four scenarios. The ecological scenario is thus indeed an environmental-friendly scenario. Global emissions only grow at a rate of 0.3% per year until 2050. The discrepancies with the other scenarios are large. In the Developing scenario emissions quadruple. Economic growth in the developing regions draws heavily on the environment in this scenario. Annual GDP growth is 1% higher in the Developing scenario, but the Schumpeterian scenario shows that high economic growth rates are also possible with less pollution. Energy-efficient measures in production are important to achieve this goal. 2% annual growth per capita is combined

with 1.8% annual increase in emissions in that case. Emissions are more than doubled in the scenario period.

A comparison between the Ecological and Developing scenario points out the main contributors to gap in emission levels in both scenarios. From Tables 7.1 and 8.1 it is clear that both scenarios differ from each other in numerous ways. Starting from the Developing scenario, we eliminate these differences one-by-one in order to analyse the main contributors to the difference in emissions levels in both scenarios. These differences depend above all on the assumptions made for the non-OECD regions, in particular on technological progress which drives economic growth and energy efficiency in production, see Figure 8.1. The different assumptions on trade liberalization, the pace of labour reallocation from the low-productivity sectors and the decreasing consumption share on electricity cancel each other out.

Figure 8.1 Contributions to emission gap in Developing and Ecological scenario in 2050.



The global emission level is about 16,5 million kilo tonnes C lower in the Ecological scenario compared to the Developing scenario. Notice that in 1995 the emission level is 6 million kilo tonnes C. 90% of the difference in emission levels can be attributed to differences in economic growth driven by technological progress and energy-saving production techniques. In particular, these different assumptions are made for the non-OECD regions. For the OECD the introduction of energy taxes in the ecological scenario is an important element. However, Figure 8.1 shows that on a global level, a very strict environmental legislation in the OECD and transition regions is far from sufficient for stable global emission levels in the scenario period. Only 10% of the difference is due to energy taxes in the OECD and transition countries.

9. Summary and Conclusions

This paper presents the quantitative effects of four scenarios which are designed for a research project which analyses the effects of globalization on (international) transport and consequently on the environment. We only present the outcomes of the scenarios. In the succeeding stages of the project, the results on production, consumption and trade are used to determine the volume of international transport between and within regions. We use our applied general equilibrium model WorldScan to illustrate these scenarios. In the *Schumpeterian* world, technological progress drives high economic growth in the whole world. Governments in the OECD and non-OECD regions pursue market-oriented and liberal policies, such that trade and business flourish. Governments introduce market-oriented policies and invest in human and physical capital. Globalization is the bottom-line in this scenario. In the *Malthusian* scenario the non-OECD countries cannot catch up with OECD. Social and political tensions in the former countries do not lead to open markets and prudent investment policies. Because of the increasing gap in wealth between the OECD and non-OECD many people migrate to the OECD. Meagre economic growth in the non-OECD countries prevents a strong rise in energy demand. The *Developing* scenario assumes that developing countries catch up with the developed ones. Market-oriented and investment policies in the non-OECD lead to high growth rates, but the lack of cooperation within the OECD reduces the economic performance of the latter ones. However, countries do not focus on the environment. In particular, the non-OECD economies boom at the expense of the environment. Environmental issues are, however, the primary concern in the *Ecological* scenario. People value the environment and well-being. For that reason, technological innovations are focussed on energy-efficiency, and less on economic growth. People value also their own culture and goods, so international economic linkages are more limited in this scenario.

An important driving force for economic growth is technical progress. Fast technical progress pushes economic growth as is the case for the OECD regions in the Schumpeterian and Malthusian scenarios, and for the non-OECD regions in the Schumpeterian and Developing scenarios. Schooling and labour reallocation from low- to high-productivity sectors contributes also significantly to growth in the latter regions. The pace of schooling and reallocation is low in the most unfavourable scenario for the non-OECD, the Malthusian one. In this scenario people also migrate to the OECD at a pace of 0.5% of the OECD population per year. In terms of the non-OECD population this is less than 0.1% per year.

High economic growth leads to increasing wealth and capital accumulation. Both savings ratios and investment ratios are positively correlated with GDP growth rates. Savings rates in the OECD are in general lower than in the non-OECD. This is partly due to slowing population growth in the OECD, and partly to technological catching-up in the non-OECD. As incomes per capita rise, consumption patterns change. Consumers

spend relative more money on services and less on agriculture. The shifts in consumption patterns are large for the developing regions where initially spending on Agriculture and Food is relatively high. These shifts are of course less pronounced in the Malthusian scenario, in which growth per capita is low. In the Schumpeterian and Malthusian scenario consumers from the OECD regions will also spend more on services because their incomes rise. In the Ecology scenario, all consumers will shift away from energy-intensive consumption.

In the Schumpeterian scenario we combine high growth with increased international linkages, and consequently trade liberalization. Specialization will increase if the barriers to trade between the OECD and non-OECD regions are reduced or even eliminated, because the OECD countries are endowed with high-skilled labour and capital, and the non-OECD countries are endowed with low-skilled labour. The differences in comparative advantage between the OECD and the non-OECD are much larger than within the OECD than or within the OECD. Therefore, trade liberalization within only the OECD as in the Malthusian scenario or within or only within the non-OECD as in the Developing scenario has much less effects on specialization than in the Schumpeterian scenario.

Therefore, the trade to GDP ratios are much lower in the Malthusian and Developing scenario than in the Schumpeterian scenario. Due to partial trade liberalization for all regions in the Ecological scenario this ratio is higher than in the Malthusian scenario. The demand for international transport follows these trade patterns. It is high in the Schumpeterian scenario and much lower in the other scenarios.

High economic growth stimulate the demand for energy and therefore the emissions of CO_2. Without environmental legislation or energy-savings production techniques emissions grow very fast as is the case in the Developing scenario. The emissions quadruple until 2050. In the other scenarios energy-saving techniques are introduced. In the Schumpeterian and Malthusian scenario global emissions still double in the scenario period. In the OECD energy intensity decreases at an annual rate of 0.5% in those scenarios. The non-OECD countries save even 2% on energy in the Ecological scenario per year, and 1% in the Schumpeterian scenario. The OECD countries do not change their energy intensity in the latter scenario. Because technical progress is modest, it is fairly difficult to implement energy-saving technologies. A reduction in energy demand can be reached by introducing energy taxes. The OECD countries and transition countries levy these taxes according to the targets in the Kyoto protocol for 2010 and reduce the emissions by 1% per year after 2010. In the Ecological scenario industrial and transition countries trade in emission rights in order to reach the emission targets.

From the comparison of the emission levels in the Developing and Ecological scenario it follows that mainly modest economic growth and energy-saving technologies contribute to lower emissions of about 16.5 million kilo tonnes C in the latter scenario. For the OECD the strict environmental legislation is also an important element. On a

global level, however, strict legislation in these regions is far from sufficient to reach stable emission levels in 2050.

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Appendix Regional and sectoral concordances for WorldScan

1	United States	1	Agriculture and food production
2	Japan		Paddy rice, Wheat, Grains, Cereal Grains, Non grain crops, Vegetables, Oil seeds, Sugar cane Plant-based fibres, Crops, Bovine cattle, Animal products, Raw milk,, Wool, Forestry, Fisheries, Processed rice, Meat products, Vegetable Oils, Dairy products, Sugar, Other food products, Beverages and tobacco
3	Western Europe United Kingdom, Germany, Denmark, Sweden, Finland, Rest of European Union, EFTA	2	Consumption goods Textiles, Wearing apparels, Leather etc, Wood products, Chemical, rubbers and plastics
4	Remaining OECD	3	Intermediate goods
5	Eastern Europe		Pulp paper, Petroleum and coal, Nonmetallic minerals, Ferrous metals, Nonferrous metals
6	Former Soviet Union	4	Capital goods
7	Middle East and North Africa		Fabricated metal products, Transport industries Machinery and equipment, Electronic equipment Motor vehicles and parts, Rest of manufacturing
	Turkey, Rest of Middle East, Morocco, Rest of North Africa	5	Services
8	Sub-Saharan Africa		Gas manufacture and distribution, Water, Construction, Financial, business and recreational services, Public administration, education and health, Dwellings
	South African Customs Union, Rest of Southern Africa, Rest of Sub-Saharan Africa	6	Trade and Transport
9	Latin America Central America and Carribean, Mexico, Argentina, Brazil, Chile, Uruguay, Venezuela, Colombia, Rest of South America	7 8	Electricity Oil
10	China China, Hong Kong	9 10	Natural gas Coal
11	South East Asia Republic of Korea, Indonesia, Malaysia, Philippines, Singapore, Thailand, Taiwan, Vietnam	11	Other Raw Materials minerals
12	South Asia & Rest India, Sri Lanka, Rest of South Asia, Rest of the World		

Abstract
This paper presents four quantitative scenarios simulated with the applied general equilibrium model WorldScan. The scenarios are constructed to study the effects of globalization on transport and the environment. They contain different assumptions on the degree of globalization, technical progress, migration and energy policies. WorldScan focusses on long-term economic growth, trade and specialization patterns. It quantifies the economic content of the scenarios and the volume growth of energy and emissions between 1995 and 2050. The scenario outcomes show that emission growth quadruples with high economic growth without any energy-efficient technologies and environmental legislation. However, in an ecological scenario which combines energy-efficient-technologies, environmental legislation and modest economic growth, global emissions hardly increase.