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Global Trade Analysis Project

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On the construction and first empirical application of the new European Model for the Assessment of Environmental, Economic and Social effects of Sustainability Policies (EDIP)

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Abstract

The present paper describes the construction and first empirical application of the new European Model for the Assessment of Environmental, Economic and Social effects of Sustainability Policies (EDIP). The model is constructed using the Computable General Equilibrium (CGE) framework, which takes as a basis the notion of the Walrasian equilibrium.

The EDIP model is a dynamic, recursive over time, model, involving dynamics of capital accumulation and technology progress, stock and flow relationships and backward looking expectations. It includes the representation of the micro-economic behavior of the following economic agents: several types of households differentiated by 5 income quintiles, 3 degrees of urbanization and 6 family types; production sectors differentiated by 59 NACE classification categories; investment agent; federal government and external trade sector.

EDIP includes detailed representation of the production technology of all major energy sectors as well as the complex substitution possibilities between different energy inputs. It also includes distinction between income classes, family types and education levels, which make the model applicable for assessment with social indicators in a quantitative way.

The first version of the model has been applied to the estimation of the temporal economic, environmental and social effects of the energy taxation as described in the EU Energy Taxation Directive. The paper describes the results of this exercise in the form of welfare effects and changes in sustainability indicators and discusses the ways the EDIP model can be developed further.

1 Introduction

With this research, we want to develop, test and validate a modelling tool that produces data on a set of identified indicators and that enables *ex-ante* evaluation of transport and energy policy considering the economic, environmental and, which is new in economic modelling, social dimensions of sustainability. Up until now, modelling tools covered very well the economic and environmental dimension, with this model we want to include the social dimension of sustainability in policy assessment.

In almost every recent paper on sustainable transport there is a statement about the underdeveloped "poor-relation", social dimension and lacking knowledge about the social aspects of sustainability. This is partly due to the fact that a lot of social indicators overlap with economical and environmental indicators. We will make a step forward in addressing the impacts of transport policy on *equity & income distribution*. This aspect considers the allocation of costs between different income classes. This indicator is used to justify efforts to keep transport costs "affordable" to disadvantaged lower-income transport system users.

The primary aim of the socio-economic model called European Model for the Assessment of Environmental, Economic and Social effects of Sustainability Policies (EDIP) is to assess the inequality and income distribution effects of the energy and transport related policies. The model focuses on the socio-economic aspects of the policy effects. It includes detailed representation of the household types as well as the detailed representation of the types of individuals. Given such detailed representation of the population structure, the EDIP model is able to incorporate a thorough modeling of the labor market and unemployment. It also includes the national-level wage bargaining for each of the NACE95 sectors.

1.1 State-of-the-art

The detailed structure of the labor market and representation of the different socio-economic groups is the feature that differentiates the EDIP model from all other existing state-of-the-art modeling tools. This feature makes it better suited for the assessment of socio-economic effects of various policies than other existing models.

EDIP is the first European-wide model to include detailed search and matching formulation of labor market, a realistic representation of wage formation via bargaining mechanism and unemployment per education level and occupation type. This distinctive feature of the model makes it well-suited for the assessment of detailed unemployment effects of governmental policies. It can also assess the policy impacts on the wage levels of various labor types.

Given that EDIP is a general equilibrium model, it incorporates the full representation of production and consumption activities in the economy. The model has rather refined

representation of production technologies of the sectors and detailed sector/commodity disaggregation, which is consistent with EuroStat NACE95 classification. EDIP treats energy substitution possibilities of the sectors and households in a realistic way. In its energy part the model borrows from the best international state-of-the-art practices in modeling.

Households' welfare in the EDIP model is negatively influenced by the amount of emissions associated with production and consumption activities in the country, where a certain share of emissions is allocated to different household types. EDIP is the first European model, which allocates emissions differently between the income groups. The allocation rule depends upon the type of the pollutant. In case of the regional pollutants, a larger share is allocated to the poor household groups.

The core of the own-production part of the model is the modeling of the joint demand for durable and non-durable goods. Modeling of the durables and non-durables link in EDIP is similar to the one used in GEM-E3.

1.2 Model overview

The EDIP model is constructed using the Computable General Equilibrium (CGE) framework, which takes as a basis the notion of the Walrasian equilibrium.

CGE models are a class of economic models that use actual economic data to estimate how an economy might react to changes in policy, technology or other external factors. A model consists of (a) equations describing model variables and (b) a database (usually very detailed) consistent with the model equations. The EDIP model is based on the social, economic, environmental transport and energy data for the year 2005. The EDIP database covers EU27 countries, Norway, Switzerland, Croatia and Turkey.

The model equations tend to be neo-classical in spirit, assuming cost-minimizing behavior by producers, average-cost pricing, and household demands based on optimizing behavior. A CGE model database consists of tables of transaction values and elasticities: dimensionless parameters that capture behavioral response. The database is presented as a social accounting matrix (SAM). It covers the whole economy of a country, and distinguishes a number of sectors, commodities, primary factors and types of households.

Behavior of the households is based on the utility-maximization principle. Household's utility is associated with the level and structure of its consumption. Each household spends its consumption budget on services and goods in order to maximize its satisfaction from the chosen consumption bundle. Utility of the household is maximized under the budget constraint. Households in the EDIP model receive their income in the form of wages, capital rent, unemployment benefits and other transfers from the federal government.

Behavior of the sectors is based on the minimization of the production costs for a given output level under the sector's technological constraint. Production costs of each sector in the EDIP model include labor costs by type of labor, capital costs and the costs of intermediate inputs. The sector's technological constraint describes the production technology of each sector. In accordance with their production technology, sectors have substitution possibilities between different intermediate inputs and production factors. They can substitute between the use of different education types and between different occupations within each education type. They are also able to substitute between their consumption of electricity and other energy types such as gas, coal and refined oil.

An Armington assumption on international trade is adopted in the model. According to this assumption the commodities produced by the domestic sectors for the consumption inside the country and for the consumption outside of it have different specifications. Domestic sales of each of the 59 types of commodities composed of the commodities produced by the domestic sectors, those imported from the EU25 and those imported from the rest of the world. According to the Armington assumption, the same type of commodity produced by the domestic sectors, imported from the EU25 or imported from the rest of the world has different specifications and, hence, cannot be treated as a homogenous good.

The model incorporates the representation of investment and savings decisions of the economic agents. Savings in the economy are made by households, government and the rest of the world. The total savings accumulated at each period of time are invested into accumulation of the sector-specific physical capital, which is not mobile between the sectors. The stock of this capital at each period of time is equal to the last period stock minus depreciation plus the new capital accumulated during the previous period of time.

The EDIP model incorporates the representation of the federal government. The governmental sector collects taxes, pays subsidies and makes transfers to households, production sectors and to the rest of the world. The federal government consumes a number of commodities, where the optimal governmental demand is determined according to the maximization of the governmental consumption utility function. The model incorporates the governmental budget constraint. According to this constraint the total governmental tax revenues are spend on subsidies, transfers, governmental savings and consumption.

Finally, the model includes the trade balance constraint, according to which the value of the country's exports plus the governmental transfers to the rest of the world are equal to the value of the country's imports.

1.3 Applicability

Thorough sectoral disaggregation of the EDIP model allows one to assess sector-specific impacts of the transport and energy policies in great detail and provides its users with useful insights into the channels, through which policy measures influence the economies of the European countries.

Besides the representation of the transport-related taxes, the EDIP model also includes all other major taxes and subsidies in the economy. It represents both the governmental spending and governmental budget in detail. Governmental spending includes its transfers to different income quintiles besides other things. This particular model feature makes it possible for the user to assess the combined effect of measures, related to different policy areas. For example, it allows one to combine an increase in the fuel tax with higher governmental transfers to poor income groups. The model user can analyze not only in which way it is the best to collect transport and energy-related revenues but also in which way it is the best to spend them.

The EDIP model is well suited for the assessment of a wide range of energy, transport, economic and social policies. The model allows for the calculation of broad welfare and macro-economic effects of the policies as well as their sector-specific and labor market effects.

The model can help with an evaluation of both separate measures and packages of policies. Despite its broad nature, the main focus of the EDIP model is an assessment of impact of transport-related policies on inequality and income distribution in the economies of European countries.

For this paper we tested one policy option as an example. First we elaborate more in detail about the model structure, after which we present the results of the first simulations.

2 The EDIP Model structure

The EDIP model has a single mathematical formulation for all European countries. It is one model with 31 different versions, which are estimated using the country-specific dataset. The main element of the country-specific dataset of the EDIP model is the Social Accounting Matrix (SAM), which represents the annual monetary flows between different economic agents for the year 2005. Structure of the SAMs does not differ between the countries and corresponds to the overall structure of the EDIP model. Other country-specific data includes the socio-economic data related to different household types, labor market data, transport data, energy and emissions data. The EDIP model uses the latest available data from different statistical sources including EuroStat, national statistical offices, International Labor Organization, OECD, IEA etc.

CGE models utilize the notion of the aggregate economic agent. They represent the behavior of the whole population group or of the whole industrial sector as the behavior of one single aggregate agent. It is further assumed that the behavior of each such aggregate agent is driven by certain optimization criteria such as maximization of utility or minimization of costs.

The EDIP model includes the representation of the micro-economic behavior of the following economic agents: several types of households differentiated by 5 income quintiles, production sectors differentiated by 59 NACE classification categories; investment agent; federal government and external trade sector. Each household group in the EDIP model consists of the individuals differentiated by three types of education levels and ten types of professions. The composition of households is based on the extensive socio-economic dataset for the year 2005.

The EDIP model is a dynamic, recursive over time, model, involving dynamics of capital accumulation and technology progress, stock and flow relationships and backward looking expectations. A recursive dynamic structure composed of a sequence of several temporary equilibriums. The first equilibrium in the sequence is given by the benchmark year. In each time period, the model is solved for an equilibrium given the exogenous conditions assumed for that particular period. The equilibriums are connected to each other through capital accumulation. Thus, the endogenous determination of investment behavior is essential for the dynamic part of the model. Investment and capital accumulation in year t depend on expected rates of return for year $t+1$, which are determined by actual returns on capital in year t .

Apart from the model description in this paper, a full mathematical formulation of the model can be found in online reports on <http://www.refitweb.eu/>

2.1 Production

Behavior of the sectors is based on the minimization of the production costs for a given output level under the sector's technological constraint. Production costs of each sector in the EDIP model include labor costs by type of labor, capital costs and the costs of intermediate inputs. The sector's technological constraint describes the production technology of each sector. It provides information on how many of different units of labor, capital and of the 59 commodities, traded in the economy, are necessary for the production of one unit of the composite sectoral output.

Production technology of the sectors in EDIP is represented using a Constant Elasticity of Substitution (CES) function. Substitution possibilities at each of the nests are captured by the corresponding elasticity of substitution parameter. The higher the values of this parameter the easier it is to substitute between the inputs. The intermediate demands of the firms are determined by the relative prices of commodities and the substitution possibilities between them, which are summarized in the form of the CES tree (Figure 1).

At the top level of the production function, the firms use the capital-labor-energy bundle, the composite transport bundle and other intermediate inputs in fixed proportion to the total composite output. At the level of the capital-labor-energy bundle, the firms can substitute between the use of the composite energy bundle and the capital-labor bundle. In case of the energy inputs, the sector can further substitute between electricity and other energy, where other energy bundle includes coal, gas, oil and refined oil. The firms have possibility to substitute between the non-electric energy inputs.

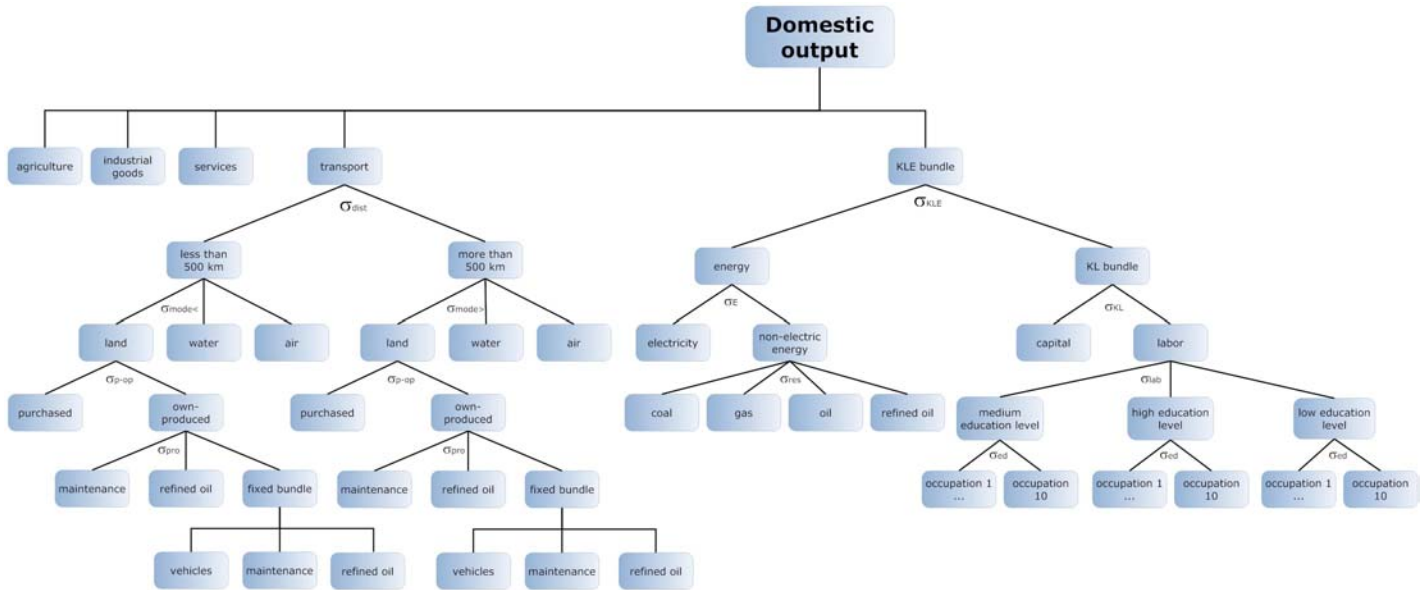
At the level of the capital-labor bundle, the firms substitute between physical capital (such as machinery and buildings) and the composite labor input. For most of the sectors this substitution possibilities are rather limited. The composite labor is further split between the three education levels, which are further subdivided into ten occupation types. The firms have the possibility to substitute between the education levels as well as between the occupation types. However, this possibility is limited.

At the level of the composite transport inputs, the firms can substitute between the two distance classes of their trips: below 500 km and above 500 km. The length of the trip strongly influences the choice of the transportation mode used to perform the trip. The two distance classes of transportation are further split between the transportation by different modes including land, air and water. Transportation by air and water are produced by the respective production sectors and are bought by the firms.

Transportation by land is treated differently. It can be either purchased from the land transport sector or produced by the firms themselves. Own-production of land transportation by the firms involves consumption of durables and non-durables bundle that is vehicles and maintenance and refined oil. In order to model the joint consumption of durables and non-durables we have split the total inputs of maintenance and refined oil into the minimum/fixed amount necessary for the use of a vehicle and the rest. The minimum/fixed amount of the inputs of refined oil and maintenance is associated with the

fact of having a vehicle. The rest part of the inputs of refined oil and maintenance is associated with driving more with the same vehicle.

Figure 1 Production technologies of the EDIP sectors



2.2 Consumption

Behavior of the households is based on the utility-maximization principle. Household's utility is associated with the level and structure of its consumption. Each household spends its consumption budget on services and goods in order to maximize its satisfaction from the chosen consumption bundle.

Utility function of the households in EDIP is represented using a Constant Elasticity of Substitution (CES) function. Substitution possibilities at each of the nests are represented by the corresponding elasticity of substitution parameter. The higher is the value of this parameter the easier it is to substitute between the consumption commodities. The final demands of the households are determined by the relative prices of commodities and the substitution possibilities between them, which are summarized in the form of the CES tree (see Figure 2).

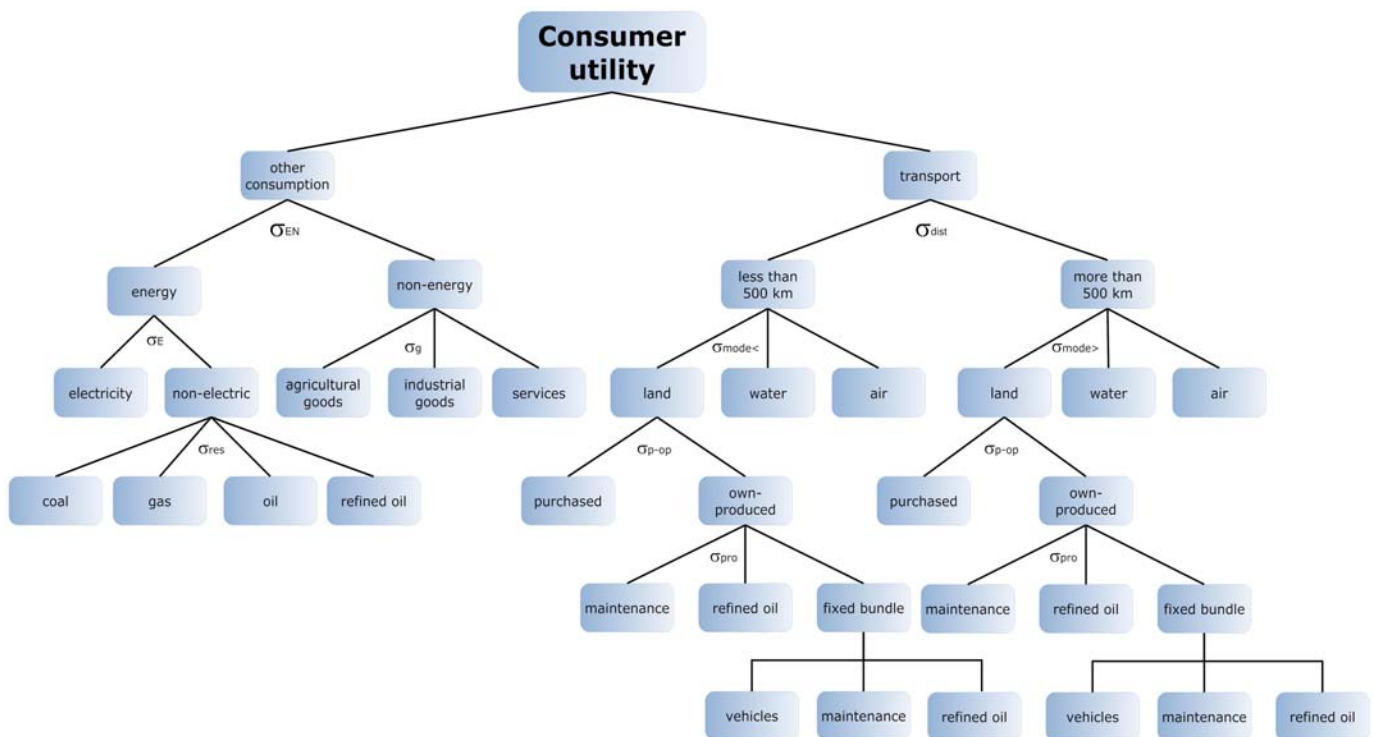
At the top level of the utility function, the households substitute between consumption of transportation and all other goods and services. Other consumption of the households is further split into the consumption of composite energy bundle and the consumption of non-energy goods and services.

In case of the energy goods, the households can further substitute between electricity and other energy, where other energy bundle includes coal, gas, oil and refined oil. The households have the possibility to substitute between the non-electric energy inputs.

At the level of the composite transport bundle, the households can substitute between the two distance classes of their trips: below 500 km and above 500 km. The length of the trip strongly influences the choice of the transportation mode used to perform the trip. The two distance classes of transportation are further split between the transportation by different modes including land, air and water. Transportation by air and water are produced by the respective production sectors and are bought by the firms.

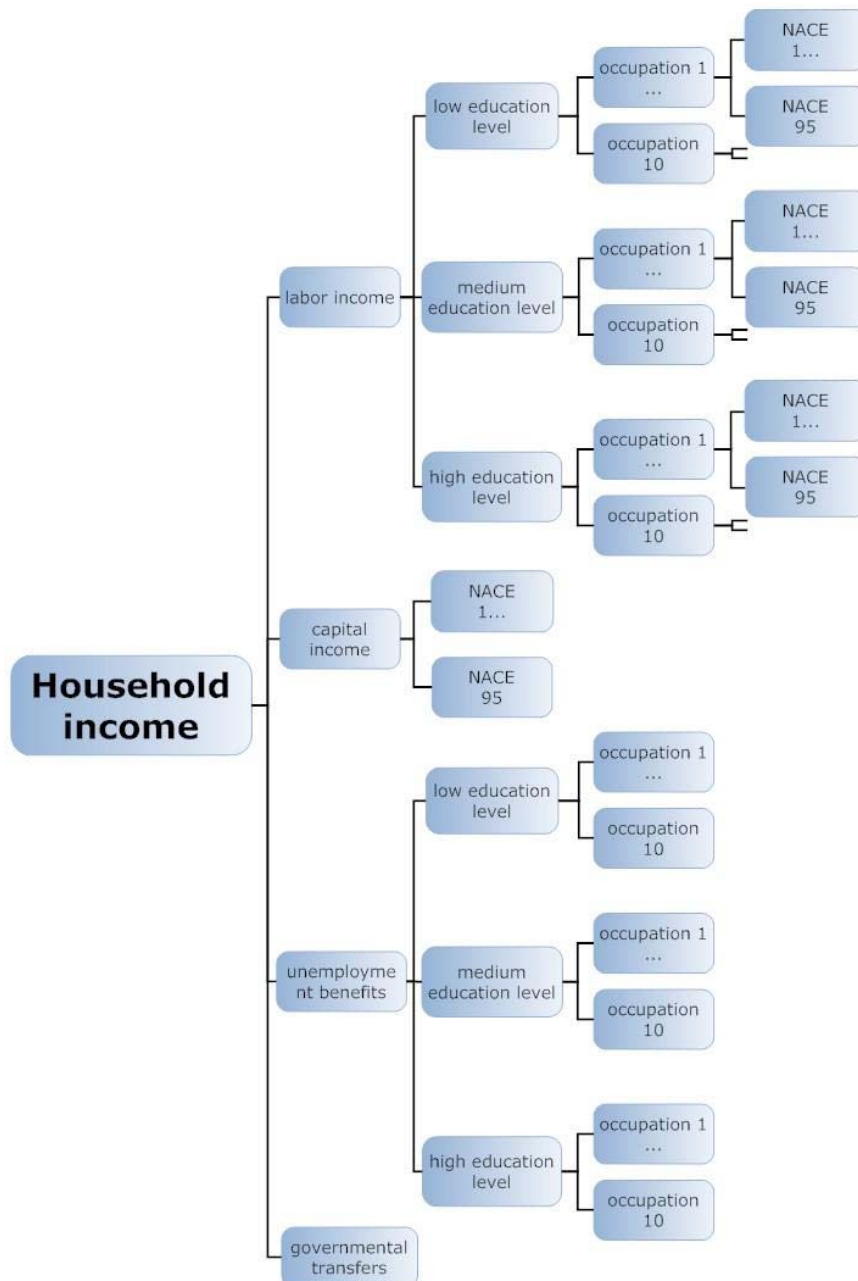
Transportation by land is treated differently. It can be either purchased from the land transport sector or produced by the households themselves. Own-production of land transportation by the households involves consumption of durables and non-durables bundle that is vehicles and maintenance and refined oil. In order to model the joint consumption of durables and non-durables we have split the total inputs of maintenance and refined oil into the minimum/fixed amount necessary for the use of a vehicle and the rest. The minimum/fixed amount of the inputs of refined oil and maintenance is associated with the fact of having a vehicle. The rest part of the inputs of refined oil and maintenance is associated with driving more with the same vehicle.

Figure 2 Structure of the households' utility



Utility of the household is maximized under the budget constraint, where the household's consumption spending is equal to its income minus income tax and the household's savings. Households in the EDIP model receive their income in the form of labor income, capital rent, unemployment benefits and other transfers from the federal government. Labor income of the households consists of wages received from different production sectors. The labor compensation differs between the three education levels and ten occupation types. The structure of the households' income is represented in Figure 3.

Figure 3 Structure and sources of the households' income



The level of the unemployment benefits, received by the household, depends upon the level of unemployment associated with the particular education level and occupation type of the individuals within the household. The level of the unemployment for each education-occupation bundle is defined according to the search and matching model by Pissaridi and depends upon the mismatch upon the available labor and available vacancies.

2.3 *Transport sector*

Households and domestic sectors use transport services in their consumption and production activities. The transport services represented in the EDIP model are differentiated by the two distance classes (below 500km and above 500km) and all main types of transport modes (land, water and air). Each type of transport service is associated with the particular after tax price, which includes VAT taxes and other taxes.

Public transport and freight transport services are produced by several national transport sectors. These sectors use labor, capital and commodities, for example fuels and vehicles, as inputs to their production. The price of transportation services are determined endogenously in the EDIP model according to the equilibrium condition of the transportation markets.

Passenger transportation by car is produced by the households and firms themselves using fuel and car vehicles. In order to have a passenger car vehicle a household has to pay the car ownership costs, which include different types of taxes, such as registration taxes, for example.

The EDIP model employs the concept of a variable expenditure function with quasi-fixed durable goods (car vehicles) as arguments in order to derive a demand system for nondurable goods (fuels) in prices of the nondurables, in the stocks of durables and in variables expenditure. Investment demand for durables and their desired stocks (car stocks) are determined inside the model. The desired stock of cars in the EDIP model depends upon the development of the demand for transportation and the car ownership costs.

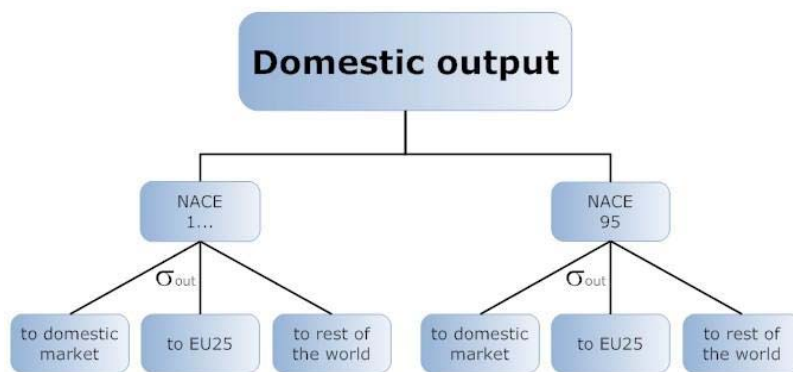
2.4 *International trade*

Each sector in the economy may produce more than one type of commodity and the combination of these different commodities corresponds to the sectoral composite output. Production output of each sector can be either delivered to the domestic market or exported to EU25 trade zone or to the rest of the world. Each sector determines the shares of its outputs sold domestically and exported based on the profit maximization principle. It takes into account the relative prices of the same type of commodities in its own country and abroad.

An Armington assumption on international trade is adopted in the model. According to this assumption the commodities produced by the domestic sectors for the consumption inside the country and for the consumption outside of it have different specifications. In order for the sector to be able to switch its technological process between producing these two different specifications of commodities, it has to overcome some adjustments.

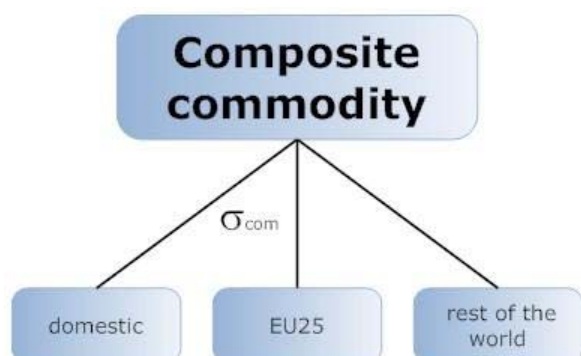
The degree of difficulty and feasibility of such adjustment is represented by the constant elasticity of transformation (CET) elasticity of substitution between producing commodity for the domestic use, for export to the EU25 and for the export to the rest of the world. The higher is this elasticity of substitution the more feasibly and easy the adjustment technological process described above. Than the proportions, in which the total output of each sector is split between the three possibilities, depend not only upon the relative prices of the commodities inside the country and on the world market but also upon the CET elasticity of substitution (see Figure 4).

Figure 4 CET function for the representation of export decisions of domestic sectors



Domestic sales of each of the 59 types of commodities composed of the commodities produced by the domestic sectors, those imported from the EU25 and those imported from the rest of the world. According to the Armington assumption, the same type of commodity produced by the domestic sectors, imported from the EU25 or imported from the rest of the world has different specifications and, hence, cannot be treated as a homogenous good. Domestic consumers have different preferences for these three specifications and can substitute between them in case the relative prices of the specifications change. The substitution possibilities between these three commodity specifications are represented by the Armington elasticity of substitution and vary between the types of commodities. The shares in which commodity is bought from the domestic producers, from the EU25 and from the rest of the world are determine by the relative producer prices of the commodity inside the country, in EU25 and in the rest of the world as well as by the Armington elasticity of substitution (see Figure 5).

Figure 5 CES function for the representation of international trade



Finally, the model includes the trade balance constraint, according to which the value of the country's exports plus the governmental transfers to the rest of the world are equal to the value of the country's imports.

2.5 Labor market

The unemployment in the EDIP is modeled according to the search-and-matching approach, which explains the existence of frictional unemployment in the country. The main idea behind this approach is that there exists a mismatch between the available vacancies and the unemployed labor. It takes firms and individuals some time to find the right vacancy/employee, which results in the frictional unemployment. The level of this type of unemployment varies between the education types and occupations (see Table 1).

N ⁰ in EDIP	Isced-97 classification	Full name of education type
1	isced0_2	Pre-primary, primary and lower secondary education - levels 0-2 (ISCED 1997)
2	isced3_4	Upper secondary and post-secondary non-tertiary education - levels 3-4 (ISCED 1997)
3	isced5_6	Tertiary education - levels 5-6 (ISCED 1997)

N0 in EDIP	ISCO-88 classification	Full name of occupations
1	isco1	Legislators, senior officials and managers
2	isco2	Professionals
3	isco3	Technicians and associate professionals
4	isco4	Clerks
5	isco5	Service workers and shop and market sales workers
6	isco6	Skilled agricultural and fishery workers
7	isco7	Craft and related trades workers
8	isco8	Plant and machine operators and assemblers
9	isco9	Elementary occupations
10	isco0	Armed forces

Table 1 Education levels and occupations used in EDIP

The levels of the wages earned in different sectors of the economy by individuals with different education levels and occupation types are determined by the national-level bargaining process between the sector-specific trade union and the firms. Firms share partially their profits with their employees by paying them wages, which are higher than their marginal product of labor.

2.6 General equilibrium structure

The EDIP model is formulated and solved as a mixed complementarity problem (MCP), where three inequalities should be satisfied: the zero profit, market clearance, and income balance conditions. Using the MCP approach, a set of three non-negative variables is involved: prices, quantities, and income levels.

The zero profit condition requires that any activity operated at a positive intensity must earn zero profit (i.e., value of inputs must be equal or greater than value of outputs). Activity levels y for constant returns to scale production sectors are the associated variables with this condition. It means that either $y > 0$ (a positive amount of y is produced) and profit is zero, or profit is negative and $y = 0$ (no production activity takes place).

The market clearance condition requires that any good with a positive price must have a balance between supply and demand and any good in excess supply must have a zero price. Price vector p (which includes prices of final goods, intermediate goods and factors of production) is the associated variable.

The income balance condition requires that for each agent (including any government entities) the value of income must equal the value of factor endowments and tax revenue.

A characteristic of the CES production and consumption structures that are used throughout the model is that all inputs (consumption goods) are necessary inputs. Thus, for most markets the above conditions are satisfied with prices, output, income, and consumption of all goods strictly greater than zero, and with supply strictly equal to demand. Falling demand for an input or consumption good will simply mean that the price will fall very low.

Due to the existence of unemployment and wage bargaining on the labor market, it is in disequilibrium. The level of the wages is determined by the bargaining process between the trade unions and firms. It depends positively upon the probability to find a new job and the firms' profits.

2.7 Government and its policy instruments

The EDIP model incorporates the representation of the federal government. The governmental sector collects taxes, pays subsidies and makes transfers to households, production sectors and to the rest of the world. The federal government consumes a number of commodities, where the optimal governmental demand is determined according to the maximization of the governmental consumption utility function. The model incorporates the governmental budget constraint. According to this constraint the total governmental tax revenues are spend on subsidies, transfers, governmental savings and consumption.

Figure 6 Schematic representation of government's incomes and expenditures

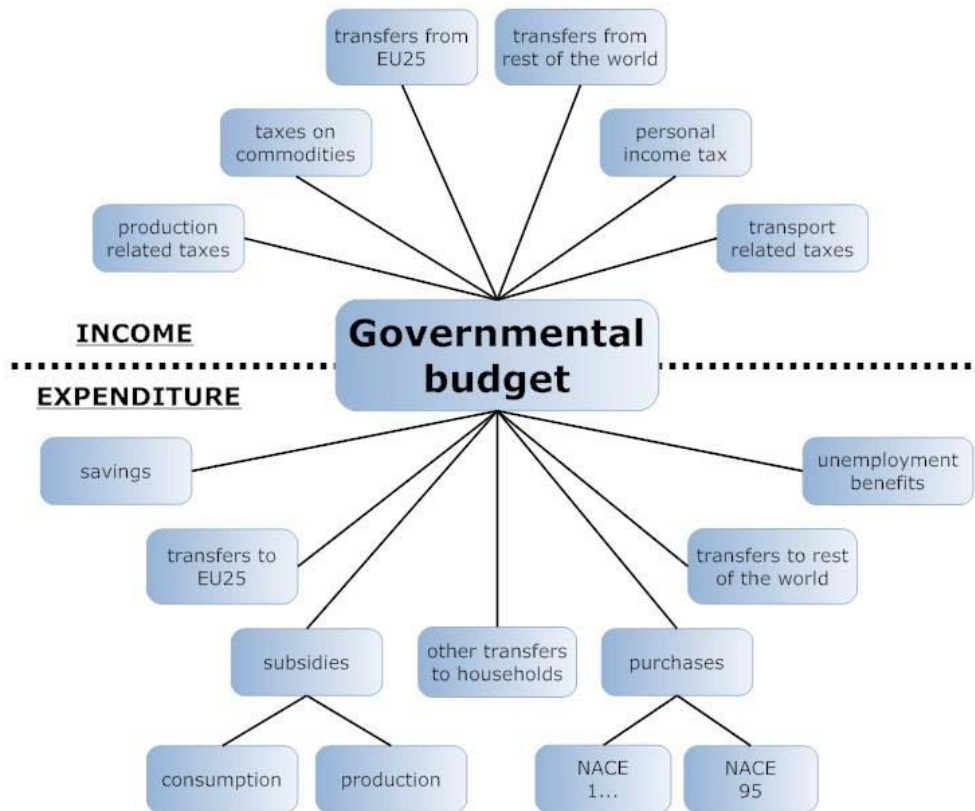


Figure 6 summarizes the sources of income and nature of expenditures of the federal government. On the income side, the government receives taxes on production, consumption and incomes paid by firms and households. It also received all transport-related taxes. Besides the tax revenues, the federal government also acquires the monetary transfers from EU25 countries and from the rest of the world.

The total budget of the federal government is spent on subsidies to production and consumption, savings, transfers to the domestic households and to abroad. A part of the

federal government's budget is also spent on buying different commodities. These purchases are used by the government in order to provide certain services to the population of the country. Demands for these commodities are set such as to maximize the government's consumption utility function. This utility function has a Cobb-Douglas functional form.

2.8 Emissions

All production and consumption activities in the EDIP model are associated with emissions and environmental damage. This is in particular true for the transportation. The model incorporates the representation of all major greenhouse gas and non-greenhouse gas emissions. Emissions in the EDIP model are associated either with the use of different energy types by firms and households or with the overall level of the firms' outputs.

The EDIP model incorporates all major types of greenhouse and non-greenhouse gas emissions. In particular it models the following types of emissions: CH₄, CO, CO₂, HCF, N₂O, NMVOC, Nox, PFC, PM₂₅, SF₆ and SO₂.

Emissions in EDIP are modeled as the fixed shares of either production inputs, production outputs of households' consumption. The overall amount of emissions in the economy is equal to emissions of the households and emissions of the firms.

Each emission type represented in the model is associated with the monetary value. The monetary values of emissions are used to calculate the welfare changes for different households types, where the environmental quality is incorporate into the households' welfare in a separable way.

2.9 Recursive dynamics

The model incorporates the representation of investment and savings decisions of the economic agents. Savings in the economy are made by households, government and the rest of the world. The total savings accumulated at each period of time are invested into accumulation of the sector-specific physical capital, which is not mobile between the sectors. The stock of this capital at each period of time is equal to the last period stock minus depreciation plus the new capital accumulated during the previous period of time.

The total investment into the sector-specific capital stock is spent on buying different types of capital goods such as machinery, equipment and buildings. The concrete mixture of different capital goods used for physical investments is determined by the maximization of the utility of the investment agent. This is an artificial national economic agent responsible for buying capital goods for physical investments in all the domestic sectors.

The EDIP model has a recursive dynamic structure composed of a sequence of several temporary equilibriums. The first equilibrium in the sequence is given by the benchmark year 2000. In each time period, the model is solved for an equilibrium given the exogenous conditions assumed for that particular period. The equilibriums are connected to each other through capital accumulation. In the benchmark case, we assume that the economy is on a steady-state growth path, where all the quantity variables grow at the same rate and all relative prices remain unchanged. When a policy measure is implemented the economy enters on a transition path, until, after some time it has reached a new steady-state growth path (Ballard, Fullerton, Shoven and Walley, 1985). We are of course interested in the transition path induced by the policy measure and the characteristics of the new growth path.

The endogenous determination of investment behavior is essential for the dynamic part of the model. Investment and capital accumulation in year t depend on expected rates of return for year $t+1$, which are determined by actual returns on capital in year t . This approach involves adaptive expectations. Thus, investment is not only a demand category in the model. In the dynamic economic processes a homogenous composite investment commodity is allocated between sectors according to the actual (year t) returns on capital in sector sec .

3 Results of first simulations

In order to verify the operation ability of the EDIP model we have implemented the following simulation scenario for EU27, Norway, Switzerland, Turkey and Croatia for the time period 2006-2020:

- Starting from the year 2008, there is introduced an additional 10% tax on the purchase of transport vehicles
- Starting from the year 2008, governmental transfers to the two poorest quintiles are increased with 2%

	GDP	Exports	Imports	Savings	Taxes	Subsidies
AT	0.23	-0.69	-0.55	0.17	0.91	-0.17
BE	0.36	-1.22	-0.82	0.18	1.26	-0.28
BG	0.28	-0.08	-0.01	0.35	0.77	0.03
CH	0.19	-0.34	-0.36	0.17	0.61	0.01
CY	0.57	-0.29	-0.14	0.02	3.80	-0.02
CZ	0.13	-2.27	-2.16	-0.09	1.42	-0.17
DE	0.28	-1.85	-2.07	-0.34	1.35	-0.19
DK	0.16	-0.15	-0.16	0.17	0.35	-0.03
EE	0.44	-0.57	-0.46	0.29	1.68	0.07
ES	0.28	-3.49	-2.73	-0.29	1.58	-0.25
FI	0.14	-0.22	-0.26	0.40	0.04	-0.08
FR	0.24	-1.34	-1.29	0.20	0.91	0.04
GR	0.14	-0.35	-0.25	0.12	0.32	0.14
HR	0.17	-0.98	-0.55	1.68	0.17	-0.14
HU	0.15	-2.07	-1.87	-0.02	1.28	-0.17
IE	0.39	-0.29	-0.27	0.41	1.34	-0.12
IT	0.39	-0.64	-0.62	0.11	0.93	-0.20
LT	0.31	-0.54	-0.35	0.18	1.74	-0.05
LU	0.39	-0.25	-0.23	0.31	1.02	0.02
LV	0.40	-0.72	-0.55	0.05	1.39	0.66
MT	0.25	-0.14	-0.10	0.09	0.81	-0.01
NL	1.00	-0.79	-0.53	1.44	0.74	1.37
NO	0.09	-0.10	-0.17	0.08	0.33	-0.01
PL	0.41	-0.51	-0.38	0.26	1.52	-0.02
PT	0.09	-3.24	-2.21	-0.13	0.80	-0.01
RO	0.29	-0.10	-0.05	0.61	0.81	-0.03
SE	0.09	-1.11	-1.31	-0.04	0.70	-0.01
SI	0.16	-3.33	-3.14	-0.05	0.93	-0.17
SK	0.01	-1.25	-0.98	0.03	0.29	-0.74
TR	0.35	-0.10	-0.09	0.13	1.63	0.14
UK	0.30	-1.21	-1.00	0.02	1.36	-0.10

Table 2 Relative percentage changes of the main economic variables for the year 2020

Table 2 represents the main macro-economic results of the simulations with EDIP. Model results are calculated as a percentage changes relative to the base case scenario. As a base case scenario we have used an assumption that the countries continue their steady-state growth path until the year 2020. This means that they grow with the same rate each year as they did in 2006.

The introduced changes in the governmental policy result in positive growth of the GDP for all the countries. Positive influence upon the GDP is explained by increase in the consumption of the lower income quintiles. Influence on the amount of international trade is negative due to increase in the transportation costs. Increase in the vehicle purchase taxes results in an increase in the tax revenues for all the countries. Influence of the policy change upon the total savings and total subsidies paid by the government varies between the countries and depends upon the initial structure of their economies. In case of most of the countries, total savings increase whereas total subsidies decrease. Increase in the total savings is due to an increase in the available budget of the lower income quintiles. Decrease in the total subsidies to production and consumption paid by the government is explained by the changes in the consumption patterns of the households.

	Initial Gini coefficient	Simulation Gini coefficient	Initial amount of people that fall below the poverty line	Simulation amount of people that fall below the poverty line
AT	0.4315	0.4314	0.3819	0.3818
BE	0.4564	0.4572	0.4423	0.4421
BG	0.4620	0.4619	0.4370	0.4370
CH	0.4244	0.4247	0.3169	0.3169
CY	0.5453	0.5459	0.5508	0.5507
CZ	0.3990	0.3993	0.3732	0.3732
DE	0.4675	0.4698	0.3965	0.3963
DK	0.4147	0.4148	0.3511	0.3510
EE	0.3928	0.3933	0.3395	0.3393
ES	0.4936	0.4964	0.4555	0.4553
FI	0.4236	0.4229	0.3473	0.3472
FR	0.4510	0.4517	0.4014	0.4015
GR	0.4436	0.4437	0.3834	0.3833
HR	0.4219	0.4208	0.2725	0.3204
HU	0.3727	0.3735	0.4155	0.4155
IE	0.5242	0.5246	0.4684	0.4683
IT	0.4481	0.4465	0.4681	0.4683
LT	0.5080	0.5082	0.4674	0.4674
LU	0.3998	0.3995	0.3408	0.3408
LV	0.4263	0.4267	0.4066	0.4064
MT	0.4326	0.4328	0.3810	0.3809
NL	0.5310	0.5306	0.5690	0.5690
NO	0.3686	0.3687	0.3414	0.3642
PL	0.4353	0.4359	0.3979	0.3980
PT	0.4125	0.4129	0.4414	0.4415
RO	0.3535	0.3527	0.2987	0.3515
SE	0.4439	0.4451	0.3502	0.3501
SI	0.4666	0.4686	0.4339	0.4337
SK	0.3384	0.3386	0.3484	0.3305
TR	0.3702	0.3704	0.3573	0.3572
UK	0.4740	0.4749	0.4503	0.4503

Table 3 Inequality and poverty indexes for the base case and for the simulation for the year 2020

Table 3 presents the changes in the two main inequality and poverty indexes associated with the investigated policy change. Both inequality and poverty indexes in EDIP are calculated on the basis of the after-tax inclusive of governmental transfers income of individuals with different education levels and occupations types.

According to the model results both inequality measure (Gini coefficient) and poverty decrease as a result of the changes in the governmental policy for all countries except for BG, HR, IT, LU, NL and RO. Negative changes in these countries are explained by the complex changes at the labor market, which result in decrease of the wages for education-occupation bundles with low initial wages and belonging to the lower income quintiles. This labor market effects follows the structural changes in the economy associated with the policy change.

	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
AT	0.37	0.09	-0.30	-0.28	-0.37
BE	-0.03	0.49	0.87	-2.86	0.56
BG	1.12	0.01	-0.13	-0.16	-0.08
CH	0.19	-0.08	-0.30	-0.17	-0.26
CY	0.06	-0.08	-0.38	-0.48	-0.43
CZ	-2.60	-1.54	0.13	2.16	-3.04
DE	0.60	-0.58	-0.61	-0.32	-1.01
DK	0.32	-0.12	-0.22	-0.25	-0.20
EE	0.23	-0.18	-0.26	-0.27	-0.06
ES	0.29	-0.60	-1.05	-0.69	-0.31
FI	0.30	0.21	-0.10	-0.19	-0.22
FR	0.84	-0.43	-0.77	-0.93	-1.05
GR	2.28	0.33	0.61	-1.29	-0.89
HR	6.14	-0.74	-0.80	-1.17	-2.21
HU	0.41	-0.61	-1.39	-0.97	-0.28
IE	0.21	-0.12	-0.30	-0.46	-0.37
IT	0.45	-0.39	-0.20	-1.03	0.18
LT	0.33	-0.93	-1.14	0.57	0.22
LU	-0.12	0.16	-0.38	-0.36	-0.63
LV	1.43	-0.14	-0.17	-0.44	-0.02
MT	-0.11	-0.10	-0.30	-0.31	-0.40
NL	3.86	-1.58	0.00	2.70	-3.16
NO	0.08	-0.08	-0.21	-0.25	-0.36
PL	8.21	-1.12	-0.20	0.27	-0.75
PT	4.55	0.43	0.02	-0.76	-2.29
RO	2.63	0.66	-0.35	-0.35	-0.33
SE	-0.26	-0.17	-0.69	-0.50	-0.59
SI	-0.13	-0.94	-0.75	-0.48	-0.47
SK	7.00	-0.43	-1.13	-0.79	-0.30
TR	7.84	1.88	0.22	-1.25	0.29
UK	-0.26	-0.31	-0.61	-0.45	-0.83

Table 4 Welfare measured in percent of the households' income per income quintile associated with the simulation for the year 2020

Tables 4 represents the changes in the overall welfare of the five income quintiles associated with both their consumption and with the changes in emission levels. In case of the test policy simulation, described in this section, the welfare of the households is

negatively influenced by an increase in the purchase tax for vehicles. An additional purchase vehicles tax decreases the households' consumption budget available for other commodities and services, reduces their overall consumption of transportation and shifts households' consumption from land to other transport modes and from own-produced land transport to purchased one.

The overall decrease in the use of transportation by households results in lower emissions and hence higher welfare of the households. Changes in the consumption patterns of the households further influence the markets for goods and services and the employment levels of different sectors in the economy. Changes in the employment by education level and occupation type are further translated into changes in the wages for the respective education-occupation bundles and influence the incomes of all household quintiles.

According to the set-up of the simulation, the two poorest income quintiles receive higher transfers from the government as a result of the introduced policy changes. This leads to an increase in their consumption budget and the respective increase in their demands for commodities and services, including transportation. Increase in their incomes compensates partially for the higher vehicle purchase taxes.

According to the model results presented at Table 4 the overall welfare of the two poorest income quintiles increases for most of the countries, whereas the welfare of the rest of income quintiles decreases. This is explained by an additional compensation received by the two lowest income quintiles. This compensation allows them to increase their welfare from consumption despite the negative influence of an additional vehicle purchase tax. Decrease in the emissions also has more positive effect upon the poorer income quintile than upon the rich ones. This contributes to the positive effect of the introduced policy upon the two lowest income quintiles.

The welfare of the three highest income quintiles is negatively influenced by the policy measure. They have to pay higher vehicle purchase tax and this increase is not compensated by any additional income. These quintiles also benefit the least from the improvement of the environmental quality, resulting from decrease in the amount of transportation.

In case of some countries like NL and CZ, higher income quintiles also benefit from the new policy measures. This can be explained by both the changes in the labor market, which are beneficial for the education-occupation labor bundles owned by these quintiles, and by the positive changes in the environmental quality.

4 Conclusions

Social distributional effects of policies have been neglected in many policy assessment tools, but can contribute significantly to the outcome of the assessment, e.g. related to equity. Several factors play a role in assessing the distributional effects of policies. E.g. an increased purchase price for cars, due to the introduction of emission standards, is likely to reduce car ownership in poorer households due to increased purchase cost.

Although these policies examples are rather general (in fact focused on environmental policy), it is shown that depending on the type of policy measure, different distribution effects can be expected. This is likely to be also the case for transport policy.

The first use of the EDIP model shows that complex social distributional effects due to policy are captured in the model structure. It allows for the use of new quantitative indicators such as Gini and poverty index, along with welfare. Moreover, the EDIP model allows for complex policy measures (e.g. different tax level per income quintile), which cannot be modelled by any existing model, to be assessed. First simulations show complex and ambiguous results where welfare may increase, but poverty may increase as well. This proves the importance of distributional effects in policy, which has in general been neglected in previous policy assessments.

The new European Model for the Assessment of Environmental, Economic and Social effects of Sustainability Policies, or EDIP, has proven to go one step further in policy assessment compared to existing models. Apart from the economic and the environmental dimension, EDIP can also cover the social dimension of energy and transport related policies, thus covering the 3 pillars of sustainable development.

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6 ANNEX

6.1 EDIP production sectors

EDIP Sectors	NACE code	Description Sector
1)	1	Products of agriculture, hunting and related services
2)	2	Products of forestry, logging and related services
3)	5	Fish and other fishing products; services incidental of fishing
4)	10	Coal and lignite; peat
5)	11	Crude petroleum and natural gas; services incidental to oil and gas extraction excluding surveying
6)	12	Uranium and thorium ores
7)	13	Metal ores
8)	14	Other mining and quarrying products
9)	15	Food products and beverages
10)	16	Tobacco products
11)	17	Textiles
12)	18	Wearing apparel; furs
13)	19	Leather and leather products
14)	20	Wood and products of wood and cork (except furniture); articles of straw and plaiting materials
15)	21	Pulp, paper and paper products
16)	22	Printed matter and recorded media
17)	23	Coke, refined petroleum products and nuclear fuels
18)	24	Chemicals, chemical products and man-made fibres
19)	25	Rubber and plastic products
20)	26	Other non-metallic mineral products
21)	27	Basic metals
22)	28	Fabricated metal products, except machinery and equipment
23)	29	Machinery and equipment n.e.c.
24)	30	Office machinery and computers
25)	31	Electrical machinery and apparatus n.e.c.
26)	32	Radio, television and communication equipment and apparatus
27)	33	Medical, precision and optical instruments, watches and clocks
28)	34	Motor vehicles, trailers and semi-trailers
29)	35	Other transport equipment
30)	36	Furniture; other manufactured goods n.e.c.
31)	37	Secondary raw materials
32)	40	Electrical energy, gas, steam and hot water
33)	41	Collected and purified water, distribution services of water
34)	45	Construction work
35)	50	Trade, maintenance and repair services of motor vehicles and motorcycles; retail sale of automotive fuel
36)	51	Wholesale trade and commission trade services, except of motor vehicles and motorcycles

37)	52	Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods
38)	55	Hotel and restaurant services
39)	60	Land transport; transport via pipeline services
40)	61	Water transport services
41)	62	Air transport services
42)	63	Supporting and auxiliary transport services; travel agency services
43)	64	Post and telecommunication services
44)	65	Financial intermediation services, except insurance and pension funding services
45)	66	Insurance and pension funding services, except compulsory social security services
46)	67	Services auxiliary to financial intermediation
47)	70	Real estate services
48)	71	Renting services of machinery and equipment without operator and of personal and household goods
49)	72	Computer and related services
50)	73	Research and development services
51)	74	Other business services
52)	75	Public administration and defence services; compulsory social security services
53)	80	Education services
54)	85	Health and social work services
55)	90	Sewage and refuse disposal services, sanitation and similar services
56)	91	Membership organization services n.e.c.
57)	92	Recreational, cultural and sporting services
58)	93	Other services
59)	95	Private households with employed persons

6.2 EDIP Occupations

ISCO-88	Occupation
isco1	Legislators, senior officials and managers
isco2	Professionals
isco3	Technicians and associate professionals
isco4	Clerks
isco5	Service workers and shop and market sales workers
isco6	Skilled agricultural and fishery workers
isco7	Craft and related trades workers
isco8	Plant and machine operators and assemblers
isco9	Elementary occupations
isco0	Armed forces

6.3 *EDIP Educations*

Isced-97	Education
isced0_2	Pre-primary, primary and lower secondary education - levels 0-2 (ISCED 1997)
isced3_4	Upper secondary and post-secondary non-tertiary education - levels 3-4 (ISCED 1997)
isced5_6	Tertiary education - levels 5-6 (ISCED 1997)