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Factsheet

SWD/2021/641 final

IMPACT ASSESSMENT REPORT Accompanying the document
Proposal for a Council Directive restructuring the Union
framework for the taxation of energy products and electricity
(recast)

Supporting model(s)

GEM-E3, Euromod, QUEST, AERO MS, GINFORS-E

Impact assessment SWD/2021/641 final

Fact sheet on model contributions

Source: Commission modelling inventory and knowledge management system (MIDAS)

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Overview

Title

IMPACT ASSESSMENT REPORT Accompanying the document Proposal for a Council Directive restructuring the Union framework for the taxation of energy products and electricity (recast)

Document ID

SWD/2021/641 final

Year of publication

2021

Led by

TAXUD

Model(s) used

GEM-E3, Euromod, QUEST, AERO MS, GINFORS-E

Additional information on model use for this Impact assessment

For the assessment of policy options, the models GEM-E3, EUROMOD, E-QUEST, AERO-MS and GINFORS-E are used.

The baseline scenario builds on the [EU reference scenario](#)[1] updated with effective tax rates for energy taxation of EU Member States. For details, please check the text of the impact assessment report.

The evaluation of policy options for the taxation of the aviation sector was supported by the “Study on the taxation of the air transport sector” [for details, see the impact assessment report].

[1] European Commission, EU Reference Scenario 2020: Energy, Transport and GHG Emissions: Trends to 2050, Publications Office, Luxembourg, 2021, <https://doi.org/10.2833/35750>.

GEM-E3

Full title

General Equilibrium Model - Economy, Energy, Environment

Run for this impact assessment by

European Commission

Contributed to

Baseline and assessment of policy options

Helped to assess the following impacts

<i>Impact area</i>	<i>Impact category</i>	<i>Impact subcategory</i>
Economic impacts	Operating costs and conduct of business	Equal treatment of products and businesses
Economic impacts	Operating costs and conduct of business	Affects on individual Member States
Economic impacts	Trade and investment flows	EU Exports & imports
Economic impacts	Trade and investment flows	Investment flows & trade in services
Economic impacts	Competitiveness (sectoral) of business	Cost of doing business
Economic impacts	Competitiveness (sectoral) of business	Business' capacity to innovate
Economic impacts	Competitiveness (sectoral) of business	Market share & advantages in international context
Economic impacts	Functioning of the internal market and competition	Free movement of goods, services, capital and workers
Economic impacts	Functioning of the internal market and competition	Competition
Economic impacts	Innovation and research	Innovation for productivity/resource efficiency
Economic impacts	Public authorities	Budgetary consequences for public authorities
Economic impacts	Consumers and households	Consumer's ability to benefit from the internal market or to access goods and services from outside the EU
Economic impacts	Consumers and households	Prices, quality, availability or choice of consumer goods and services
Economic impacts	Specific regions or sectors	Significant effects on sectors
Economic impacts	Specific regions or sectors	Disproportionately affected region or sector
Economic impacts	Third countries and international relations	Goods traded with developing countries
Economic impacts	Macroeconomic environment	Economic growth and employment
Economic impacts	Macroeconomic environment	Investments and functioning of markets
Economic impacts	Macroeconomic environment	Macro-economic stabilisation
Social	Employment	Impact on jobs
Social	Employment	Impact on jobs in specific sectors, professions, regions or countries
Social	Employment	Indirect effects on employment levels
Social	Working Conditions	Wages, labour costs or wage setting mechanisms
Social	Social impacts in third countries	Employment, social protection and poverty impacts in non-Member States (including developing countries)
Environmental	Climate	Emission of greenhouse gases
Environmental	Climate	Economic incentives set up by market based mechanisms
Environmental	Air quality	Emissions of acidifying, eutrophying, photochemical or harmful air pollutants
Environmental	Sustainable consumption and production	Sustainable production and consumption
Environmental	Sustainable consumption and production	Relative prices of environmental friendly and unfriendly products

Environmental	Sustainable consumption and production	Pollution by businesses
Environmental	International environmental impacts	Environment in third countries
Environmental	Transport and the use of energy	Energy intensity of the economy
Environmental	Transport and the use of energy	Fuel mix used in energy production
Environmental	Transport and the use of energy	Demand for transport
Environmental	Transport and the use of energy	Vehicle emissions
Environmental	Transport and the use of energy	Energy and fuel consumption

EUROMOD

Full title

EUROMOD Microsimulation

Run for this impact assessment by

European Commission

Contributed to

Baseline and assessment of policy options

Helped to assess the following impacts

<i>Impact area</i>	<i>Impact category</i>	<i>Impact subcategory</i>
Economic impacts	Consumers and households	Consumer's ability to benefit from the internal market or to access goods and services from outside the EU
Economic impacts	Consumers and households	Prices, quality, availability or choice of consumer goods and services
Economic impacts	Consumers and households	Impact on vulnerable consumers
Social	Employment	Impact on jobs
Social	Employment	Impact on jobs in specific sectors, professions, regions or countries
Social	Working Conditions	Wages, labour costs or wage setting mechanisms
Social	Effects on income, distribution and social inclusion	Households income and at risk of poverty rates
Social	Effects on income, distribution and social inclusion	Inequalities and the distribution of incomes and wealth
Social	Effects on income, distribution and social inclusion	Financing and organisation of social protection systems
Social	Effects on income, distribution and social inclusion	Cross-border provision of services, referrals across borders and cooperation in border regions

QUEST

Full title

Macroeconomic model QUEST

Run for this impact assessment by

European Commission

Contributed to

Baseline and assessment of policy options

Helped to assess the following impacts

<i>Impact area</i>	<i>Impact category</i>	<i>Impact subcategory</i>
Economic impacts	Trade and investment flows	EU Exports & imports
Economic impacts	Trade and investment flows	Investment flows & trade in services
Economic impacts	Functioning of the internal market and competition	Free movement of goods, services, capital and workers
Economic impacts	Functioning of the internal market and competition	Competition
Economic impacts	Innovation and research	Innovation for productivity/resource efficiency
Economic impacts	Public authorities	Budgetary consequences for public authorities
Economic impacts	Consumers and households	Consumer's ability to benefit from the internal market or to access goods and services from outside the EU
Economic impacts	Macroeconomic environment	Economic growth and employment
Economic impacts	Macroeconomic environment	Investments and functioning of markets
Economic impacts	Macroeconomic environment	Macro-economic stabilisation
Social	Employment	Impact on jobs
Social	Employment	Impact on jobs in specific sectors, professions, regions or countries
Social	Employment	Indirect effects on employment levels
Environmental	Climate	Emission of greenhouse gases

AERO-MS

Full title

Aviation Emissions and evaluation of Reduction Options Modelling System

Run for this impact assessment by

Ricardo

Contributed to

Baseline and assessment of policy options

Helped to assess the following impacts

<i>Impact area</i>	<i>Impact category</i>	<i>Impact subcategory</i>
Economic impacts	Operating costs and conduct of business	Equal treatment of products and businesses
Economic impacts	Operating costs and conduct of business	Affects on individual Member States
Economic impacts	Trade and investment flows	EU Exports & imports
Economic impacts	Competitiveness (sectoral) of business	Cost of doing business
Economic impacts	Competitiveness (sectoral) of business	Business' capacity to innovate
Economic impacts	Competitiveness (sectoral) of business	Market share & advantages in international context
Economic impacts	Functioning of the internal market and competition	Free movement of goods, services, capital and workers
Economic impacts	Functioning of the internal market and competition	Competition
Economic impacts	Innovation and research	Innovation for productivity/resource efficiency
Economic impacts	Public authorities	Budgetary consequences for public authorities
Economic impacts	Consumers and households	Consumer's ability to benefit from the internal market or to access goods and services from outside the EU
Economic impacts	Consumers and households	Prices, quality, availability or choice of consumer goods and services
Economic impacts	Specific regions or sectors	Significant effects on sectors
Economic impacts	Specific regions or sectors	Impact on regions
Economic impacts	Specific regions or sectors	Disproportionately affected region or sector
Economic impacts	Third countries and international relations	Goods traded with developing countries
Economic impacts	Macroeconomic environment	Investments and functioning of markets
Environmental	Climate	Emission of greenhouse gases
Environmental	Climate	Economic incentives set up by market based mechanisms
Environmental	Air quality	Emissions of acidifying, eutrophying, photochemical or harmful air pollutants
Environmental	Sustainable consumption and production	Sustainable production and consumption
Environmental	Sustainable consumption and production	Relative prices of environmental friendly and unfriendly products
Environmental	Sustainable consumption and production	Pollution by businesses
Environmental	International environmental impacts	Environment in third countries
Environmental	Transport and the use of energy	Energy intensity of the economy
Environmental	Transport and the use of energy	Fuel mix used in energy production
Environmental	Transport and the use of energy	Demand for transport
Environmental	Transport and the use of energy	Vehicle emissions
Environmental	Transport and the use of energy	Energy and fuel consumption

GINFORS-E

Full title

Global Interindustry FORecasting System - Energy

Run for this impact assessment by

Ricardo

Contributed to

Baseline and assessment of policy options

Helped to assess the following impacts

<i>Impact area</i>	<i>Impact category</i>	<i>Impact subcategory</i>
Economic impacts	Operating costs and conduct of business	Affects on individual Member States
Economic impacts	Trade and investment flows	EU Exports & imports
Economic impacts	Competitiveness (sectoral) of business	Cost of doing business
Economic impacts	Competitiveness (sectoral) of business	Business' capacity to innovate
Economic impacts	Competitiveness (sectoral) of business	Market share & advantages in international context
Economic impacts	Functioning of the internal market and competition	Free movement of goods, services, capital and workers
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Economic impacts	Innovation and research	Innovation for productivity/resource efficiency
Economic impacts	Public authorities	Budgetary consequences for public authorities
Economic impacts	Consumers and households	Consumer's ability to benefit from the internal market or to access goods and services from outside the EU
Economic impacts	Consumers and households	Prices, quality, availability or choice of consumer goods and services
Economic impacts	Specific regions or sectors	Significant effects on sectors
Economic impacts	Specific regions or sectors	Impact on regions
Economic impacts	Specific regions or sectors	Disproportionately affected region or sector
Economic impacts	Third countries and international relations	Goods traded with developing countries
Economic impacts	Macroeconomic environment	Economic growth and employment
Economic impacts	Macroeconomic environment	Investments and functioning of markets
Economic impacts	Macroeconomic environment	Macro-economic stabilisation
Social	Employment	Impact on jobs
Social	Employment	Impact on jobs in specific sectors, professions, regions or countries
Social	Employment	Indirect effects on employment levels
Social	Working Conditions	Wages, labour costs or wage setting mechanisms
Environmental	Climate	Emission of greenhouse gases
Environmental	Air quality	Emissions of acidifying, eutrophying, photochemical or harmful air pollutants
Environmental	Sustainable consumption and production	Sustainable production and consumption
Environmental	Sustainable consumption and production	Relative prices of environmental friendly and unfriendly products
Environmental	Sustainable consumption and production	Polution by businesses
Environmental	International environmental impacts	Environment in third countries
Environmental	Transport and the use of energy	Energy intensity of the economy
Environmental	Transport and the use of energy	Fuel mix used in energy production

Environmental	Transport and the use of energy	Demand for transport
Environmental	Transport and the use of energy	Vehicle emissions
Environmental	Transport and the use of energy	Energy and fuel consumption

GEM-E3

General Equilibrium Model - Economy, Energy, Environment

Fact sheet

Source: Commission modelling inventory and knowledge management system (MIDAS)

Date of Report Generation: 02/09/2021

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Overview

Acronym GEM-E3

Full title General Equilibrium Model - Economy, Energy, Environment

Main purpose

A macro-economic model used to assess energy, climate and air quality policies.

Summary

The GEM-E3 model is a global multi-sectoral general equilibrium model. GEM-E3 covers the interactions between the economy, the energy system and the environment. The model is used to calculate macro-economic impacts such as GDP, welfare, consumption, trade, employment, sectoral output, and carbon price.

It covers all EU Member States and the rest of the world, which is divided into 19 major economies. Countries are linked through endogenous bilateral trade. The calibration of the model is based on the [GTAP database](#) and uses techno-economic inputs from sectoral models such as POTEnCIA, PRIMES, POLES, GAINS, and GLOBIOM. The model simultaneously computes the equilibrium prices of goods, services, labour, capital and tradable emission rights such that all markets are in equilibrium. It integrates micro-economic behaviour into a macro-economic framework and allows assessing the medium to long-term implications of policies. The model evaluates the emissions of carbon dioxide (CO₂) and other GHG (e.g. CH₄). There are three mechanisms of emission reduction: (i) substitution between fuels, and between energetic and non-energetic inputs, (ii) emission reduction due to less production and consumption, and (iii) purchasing abatement equipment.

The model can be used for policy anticipation, formulation and implementation to assess macro-economic impacts of energy, climate and air quality policies. The model has been used, among others, for the Impact Assessments of the 2030 Framework of Energy and Climate Policies, its implementation in the context of the Energy Union, the Paris Agreement, and the Clean Air Package.

Keywords

Energy , Environment , Climate , General equilibrium , Climate policy , Air Pollution

Model category (thematic)

Economy

Model home page

<https://ec.europa.eu/jrc/gem-e3>

Ownership & license

Ownership

Joint copyright

Ownership details

The ownership is shared with the institutions that developed the model and the JRC, European Commission: a) Institute of Communication and Computer Systems - National Technical University of Athens (ICCS/NTUA); b) CES, Centre for Economic Studies, Katholieke Universiteit Leuven c) DG JRC, European Commission (C6) which has developed various modules for GEM-E3, as well as extended and updated the supporting databases (incl. GTAP).

Licence type

Non-Free Software licence. The license has one or more of the following restrictions: it prohibits creation of derivative works; it prohibits commercial use; it obliges to share the licensed or derivative works on the same conditions.

Details

GEM-E3 structure and approach

GEM-E3 can be used for policy anticipation, formulation and implementation.

In terms of anticipation and formulation, as applied general equilibrium model covering the interactions between the Economy, the Energy system and the Environment with high level of details, the GEM-E3 Model is well suited to assess the impact of climate, energy, and transport regulations, as well as fiscal, air quality, and labour market policies. It can simulate the welfare effects of alternative regulation regimes as well as the consequences of emission targets.

The Clean Air Programme for Europe envisages a regular update of the impact assessment analysis, to track progress towards the objectives of the Directive and to serve as input into the regular [Clean Air Forum](#). In 2018 GEM-E3 was used to update the Impact Assessment during the implementation phase. For more information see http://ec.europa.eu/environment/air/clean_air/outlook.htm. Results featured in the First Clean Air Outlook.

One of the applications of the model includes an economic and employment impact assessment of different EU decarbonisation scenarios for 2050. This is included in the in-depth analysis accompanying the European Commission's *Clean Planet for All* communication of 2018. See https://ec.europa.eu/clima/policies/strategies/2050_en#tab-0-1

See <https://ec.europa.eu/jrc/en/gem-e3> for latest updates.

Input and parametrization

- Input/Output tables and SAM (GTAP, Eurostat)
- Energy balances (International Energy Agency, IEA)
- Elasticity of Substitution and Armington elasticity (economic literature)
- Costs of Abatement Technology (Research Projects)
- Emission coefficients (Research Projects)
- Techno-economic inputs from sectoral models such as POTEnCIA, PRIMES, POLES, GAINS, and GLOBIOM

Main output

GEM-E3 analyzes the economic and distributional effects of environmental and economic policies for sectors, agents and regions. The output of GEM-E3 includes projections of

- input-output tables
- employment

- trade
- capital flows
- government revenues
- household consumption
- energy use
- atmospheric emissions.

The model allows the evaluation of the welfare and distributional effects of various environmental policy scenarios, including different burden sharing scenarios, environmental instruments (i.e. taxes, pollution permits or command-and-control policy) and revenue recycling scenarios.

Spatial - temporal extent

The output has the following spatial-temporal resolution and extent:

Parameter	Description
Spatial Extent / Country Coverage (Spatial) resolution	Global coverage; EU 27 Member States + UK and 18 World Regions Country level for each of the 27 EU Member States and for 8 non-EU countries; regional resolution for the rest of the world
Temporal extent	Currently, typical runs go up to 2050 (but can be extended beyond if there is a need to)
Temporal resolution	The model is solved in 5-year steps

Quality & transparency

Quality

Question	Answer	Details
Models are by definition affected by uncertainties (in input data, input parameters, scenario definitions, etc.). Have the model uncertainties been quantified? Are uncertainties accounted for in your simulations?	yes	Policy uncertainty is covered by running several scenarios in a what-if fashion
Sensitivity analysis helps identifying the uncertain inputs mostly responsible for the uncertainty in the model responses. Has the model undergone sensitivity analysis?	yes	Sensitivity of output results is done on ad-hoc basis
Has the model undergone external peer review by a panel of experts, or have results been published in peer-reviewed journals?	yes	The output published in academic papers and presented on academic conferences have been reviewed by peers. In addition, separate versions of the model are run independently by JRC and NTUA / E3M-Lab in Athens, enabling comparison of findings and investigation of differences.
Has model validation been done? Have model predictions been confronted with observed data (ex-post)?	yes	As the model does not aim to predict the future, we mainly validate the model through results with our peer group. In addition, elasticity parameters are based on historical data to validate partial model responses, such as reactions to changes in energy prices

References related to external peer-review and publication in scientific journals:

- Vandyck T; Keramidas K; Saveyn B; Kitous A; Vrontisi Z. A global stocktake of the Paris pledges: Implications for energy systems and economy. GLOBAL ENVIRONMENTAL CHANGE-HUMAN AND POLICY DIMENSIONS 41; 2016. p. 46-63. JRC101134
- Vandyck, T., Keramidas, K., Kitous, A., Spadaro, J., Van Dingenen, R., Holland, M. and Saveyn, B., Air quality co-benefits for human health and agriculture counterbalance costs to meet Paris Agreement pledges, NATURE COMMUNICATIONS, ISSN 2041-1723 (online), 9, 2018, p. 4939, JRC111245.

Transparency

Question	Answer	Details
Is the model underlying database (i.e. the database the model runs are based on) publicly available?	yes	The core data, GTAP, are publicly available (if purchased) Other major inputs like IEA energy balances etc. are as well. The input-output tables for future years are published and freely available for the GECO report (from 2018 onwards).
Can model outputs be made publicly available?	yes	Output usually is published in Report and academic papers. Most of them can be downloaded from https://ec.europa.eu/jrc/en/gem-e3/publications

Is the model transparently documented (including underlying data, assumptions and equations, architecture, results) and are these documents available to the general public?	yes	More detailed output can be published upon request See model documentation. JRC C.6 published a complete manual as an open-access Technical Report in 2013 with a detailed description of the model. Documentation of the NTUA/E3M-Lab version is also available online under http://www.e3mlab.eu/e3mlab/index.php?option=com_content&view=article&id=56%3Amanual-of-gem-e3-model&catid=36%3Agem-e3&Itemid=71&lang=en
Is the model source code publicly accessible or open for inspection?	no	The GAMS model code is not published as such, but can be replicated from the published set of equations.

References related to documentation:

- Capros P, Van Regemorter D, Paroussos L, Karkatsoulis P, Fragkiadakis C, Tsani S, Charalampidis I, Revesz T, authors Perry M, Abrell J, Ciscar Martinez J, Pycroft J, Saveyn B, editors. GEM-E3 Model Documentation. EUR 26034. Luxembourg (Luxembourg): Publications Office of the European Union; 2013. JRC83177

The model's policy relevance and intended role in the policy cycle

The model is designed to contribute to the following policy areas

- Climate action
- Taxation
- Employment and social affairs
- Energy
- Environment
- Transport

The model is designed to contribute to the following phases of the policy cycle

- Anticipation
- Formulation
- Implementation

The model's potential

GEM-E3 can be used for policy anticipation, formulation and implementation.

In terms of anticipation and formulation, as applied general equilibrium model covering the interactions between the Economy, the Energy system and the Environment with high level of details, the GEM-E3 Model is well suited to assess the impact of climate, energy, and transport regulations, as well as fiscal, air quality, and labour market policies. It can simulate the welfare effects of alternative regulation regimes as well as the consequences of emission targets.

The Clean Air Programme for Europe envisages a regular update of the impact assessment analysis, to track progress towards the objectives of the Directive and to serve as input into the regular Clean Air Forum. In 2018 GEM-E3 is used to update the Impact Assessment during the implementation phase. For more information see http://ec.europa.eu/environment/air/clean_air/outlook.htm. Results featured in the First Clean Air Outlook.

One of the applications of the model includes an economic and employment impact assessment of the European Commission's strategic long-term vision for greenhouse gas reductions, a document that sets the stage for the debate on the long-term climate policy in the EU.

Concerning contributions to Impact Assessments see www.gem-e3.net for latest updates.

Previous use of the model in ex-ante impact assessments of the European Commission

Use of the model in ex-ante impact assessments since July 2017.

In the Year	GEM-E3 contributed to the Impact assessment called	Led by	By providing input to the	The model was run by	Details of the contribution
2021	Impact assessment accompanying the document Proposal for a Council Directive: restructuring the Union framework for the taxation of energy products and electricity (recast) SWD/2021/641 final	TAXUD	Baseline and assessment of policy options	European Commission	The model helped to assess the following impacts: <ul style="list-style-type: none"> - Equal treatment of products and businesses - Affects on individual Member States - EU Exports & imports - Investment flows & trade in services - Cost of doing business - Business' capacity to innovate - Market share & advantages in international context - Free movement of goods, services, capital and workers - Competition - Innovation for productivity/resource efficiency - Budgetary consequences for public authorities - Consumer's ability to benefit from the internal market or to access goods and services from outside the EU - Prices, quality, availability or choice of consumer goods and services - Significant effects on sectors - Disproportionately affected region or sector - Goods traded with developing countries - Economic growth and employment - Investments and functioning of markets - Macro-economic stabilisation - Impact on jobs - Impact on jobs in specific sectors, professions, regions or countries - Indirect effects on employment levels - Wages, labour costs or wage setting mechanisms - Employment, social protection and poverty impacts in non-Member States (including developing countries) - Emission of greenhouse gases

					<ul style="list-style-type: none"> - Economic incentives set up by market based mechanisms - Emissions of acidifying, eutrophying, photochemical or harmful air pollutants - Sustainable production and consumption - Relative prices of environmental friendly and unfriendly products - Pollution by businesses - Environment in third countries - Energy intensity of the economy - Fuel mix used in energy production - Demand for transport - Vehicle emissions - Energy and fuel consumption
2021	<p>Impact assessment accompanying the Proposal for a Directive of the European Parliament and the Council: amending Directive (EU) 2018/2001 of the European Parliament and of the Council, Regulation (EU) 2018/1999 of the European Parliament and of the Council and Directive 98/70/EC of the European Parliament and of the Council as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652</p> <p>SWD/2021/621 final</p>	ENER	Baseline and assessment of policy options	<p><i>Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens</i></p>	<p>The model helped to assess the following impacts:</p> <ul style="list-style-type: none"> - Significant effects on sectors - Economic growth and employment - Investments and functioning of markets - Macro-economic stabilisation - Impact on jobs - Impact on jobs in specific sectors, professions, regions or countries - Indirect effects on employment levels - Households income and at risk of poverty rates - Inequalities and the distribution of incomes and wealth - Access to and quality of social protection benefits
2021	<p>Impact assessment accompanying the Proposal for a Directive of the European Parliament and of the Council: on energy efficiency (recast)</p> <p>SWD/2021/623 final</p>	ENER	Baseline and assessment of policy options	<p><i>Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens</i></p>	<p>The model helped to assess the following impacts:</p> <ul style="list-style-type: none"> - EU Exports & imports - Cost of doing business - Economic growth and employment - Impact on jobs - Impact on jobs in specific sectors, professions, regions or countries - Wages, labour costs or wage setting mechanisms
2021	<p>Impact assessment accompanying the document Proposal for a regulation of the European Parliament and of the Council: establishing a carbon border</p>	TAXUD	Baseline and assessment of policy options	<p><i>European Commission</i></p>	<p>The model helped to assess the following impacts:</p> <ul style="list-style-type: none"> - Equal treatment of products and businesses - Affects on individual Member

adjustment mechanism

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States

- EU Exports & imports
- Investment flows & trade in services
- Non-trade barriers
- Cost of doing business
- Business' capacity to innovate
- Market share & advantages in international context
- Free movement of goods, services, capital and workers
- Competition
- Innovation for productivity/resource efficiency
- Budgetary consequences for public authorities
- Consumer's ability to benefit from the internal market or to access goods and services from outside the EU
- Prices, quality, availability or choice of consumer goods and services
- Significant effects on sectors
- Disproportionately affected region or sector
- Adjustment costs in developing countries
- Goods traded with developing countries
- Economic growth and employment
- Investments and functioning of markets
- Macro-economic stabilisation
- Impact on jobs
- Impact on jobs in specific sectors, professions, regions or countries
- Indirect effects on employment levels
- Wages, labour costs or wage setting mechanisms
- Employment, social protection and poverty impacts in non-Member States (including developing countries)
- Emission of greenhouse gases
- Economic incentives set up by market based mechanisms
- Sustainable production and consumption
- Relative prices of environmental friendly and unfriendly products
- Pollution by businesses
- Environment in third countries
- Energy and fuel consumption

2021

Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council:

CLIMA

Baseline and assessment of policy options

Energy - Economy - Environment Modelling Laboratory,

GEM-E3 is used for macroeconomic assessment of different CO2 emission standards for vehicles levels.

	amending Regulation (EU) 2019/631 as regards strengthening the CO2 emission performance standards for new passenger cars and new light commercial vehicles in line with the Union's increased climate ambition			<i>National Technical University of Athens</i>	
	SWD/2021/613 final				
2020	Impact Assessment accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Stepping up Europe's 2030 climate ambition	CLIMA	Baseline only	<i>Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens</i>	GEM-E3 is used for sectoral economic assumptions used as inputs for the PRIMES energy system model.
	SWD/2020/176 final				
2020	Impact Assessment accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Stepping up Europe's 2030 climate ambition	CLIMA	Baseline and assessment of policy options	<i>European Commission</i>	GEM-E3 is used for the assessment of the impacts of policy options on key economic variables, including GDP, sectoral output and aggregate and sectoral employment.
	SWD/2020/176 final				
2017	Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council: setting emission performance standards for new passenger cars and for new light commercial vehicles as part of the Union's integrated approach to reduce CO2 emissions from light-duty vehicles and amending Regulation (EC) No 715/2007 (recast)	CLIMA	Baseline and assessment of policy options	<i>European Commission</i>	GEM-E3 was used to assess macroeconomic impacts of target setting based on GDP per capita.
	SWD/2017/0650 final				
2017	Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council: setting emission performance standards for new passenger cars and for new light commercial vehicles as part of the Union's integrated approach to reduce CO2 emissions from light-duty vehicles and amending Regulation (EC) No 715/2007 (recast)	CLIMA	Baseline and assessment of policy options	<i>Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens</i>	The model has been used by E3MLab/ICCS to provide the macro assumptions for the Reference scenario and for the policy scenarios.
	SWD/2017/0650 final				

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EUROMOD

EUROMOD Microsimulation

Fact sheet

Source: Commission modelling inventory and knowledge management system (MIDAS)

Date of Report Generation: 02/09/2021

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Overview

Acronym EUROMOD

Full title EUROMOD Microsimulation

Main purpose

A static tax benefit microsimulation model, covering the EU Member States and the UK (up to 2020), used to assess the budgetary and distributional consequences of consolidated and prospective policy reforms.

Summary

EUROMOD is a static tax-benefit microsimulation model. Originally maintained, developed and managed by the Institute for Social and Economic Research (ISER), since 2021 EUROMOD is maintained, developed and managed by the Joint Research Centre (JRC) of the European Commission, in collaboration with EUROSTAT and national teams from the EU countries. The project is financially supported by DG EMPL, DG ECFIN, DG TAXUD and DG REFORM.

EUROMOD covers all European countries in a consistent manner, allowing for flexibility of the analyses and comparability of the results. EUROMOD combines information on policy rules with detailed and representative micro-data on individual and household circumstances drawn from the EU Statistics on Income and Living Conditions (EU-SILC). The simulations cover a large part of the tax and benefit components of household disposable income, in particular direct taxes and non-contributory cash benefits. The components of disposable income which are not simulated are taken directly from the data. Additionally, a specific EUROMOD module allows performing simulations based on hypothetical household data, a synthetic set of microdata where family and labour market characteristics are defined by the user.

EUROMOD can be used for policy formulation or evaluation, to analyse the effects of actual and prospective changes in tax-benefit policies over time, studying for example their budgetary implications, the effects on poverty and inequality and the impact on work incentives.

A EUROMOD extension (Indirect Tax Tool) allowing the simulation of indirect taxes in 18 EU countries is currently under development. The JRC intends to further extend the number of countries included by end 2021.

Keywords

tax-benefit , microsimulation

Model category (thematic)

Economy

Model home page

<https://euromod-web.jrc.ec.europa.eu/>

Ownership & license

Ownership

Joint ownership [Original code owned by 3rd party]

Ownership details

European Union, Institute for Social and Economic Research, University of Essex. Between 2004 and 2018, EUROMOD was developed, managed, maintained and updated by the Microsimulation Unit of the Institute for Social and Economic Research, based at the University of Essex, with support and funding of the European Union. Since 2018, EUROMOD has been co-developed by the University of Essex and by the Joint Research Centre of the European Commission. The intellectual property rights, including copyright, on EUROMOD are jointly owned by the University of Essex and the European Union. The Joint Research Centre of the European Commission has taken over the sole responsibility for the further development, management, maintenance and update of EUROMOD as of January 2021. The transfer of EUROMOD has been a joint effort by DG EMPL together with DG ECFIN, DG TAXUD, DG REFORM, DG ESTAT and DG JRC.

Licence type

Free software licence. The license grants freedom to run the programme for any purpose; freedom to run the program for any purpose; freedom to study (by accessing the source code) how the program works, and change it so it does enable computing; freedom to redistribute copies; and freedom to distribute copies of modified versions to others.

Details

EUROMOD structure and approach

For a complete overview of EUROMOD readers are invited to consult Sutherland and Figari (2013), "EUROMOD: The European Union Tax-Benefit Microsimulation Model", International journal of microsimulation, 6(1) 4-26". The paper is the main source of information for the following sections (Detail on EUROMOD structure and approach; Input and parameters).

EUROMOD is a static tax-benefit calculator that allows the simulation of tax liabilities and benefit entitlements for a representative sample of households and individuals in each EU Member State and the UK (up to 2020). The model is static and non-behavioural, in the sense that it does not take into account socio-demographic changes and behavioural responses of individuals. The scope of EUROMOD simulations includes Personal Income Tax, Social Insurance Contributions paid by employees, self-employed and employers and most non-contributory benefits. Contributory benefits (e.g. pensions) are usually not simulated because of lack of relevant information (e.g. contribution history) in the underlying data. Nevertheless, some contributory benefits such as unemployment benefits are simulated making use of assumptions where needed. For those not simulated, the values collected in the underlying data are used and included in the concept of disposable income.

Depending on when a country module was first introduced in EUROMOD, the first policy system included in the model varies from 2005 to 2007 (2011 for Croatia). All the following policy systems are included up to the current year (2021) with the exception of the UK, which is updated until 2020.

EUROMOD baseline simulations are validated and tested both at a micro level (i.e. case-by-case validation) and at macro level (comparing aggregate amounts and recipients/payers with official statistics). A similar process is applied to income distribution and poverty statistics. The results of the validation exercises are reported in the Country Reports (available on the EUROMOD web pages).

Although EUROMOD simulations usually assume full benefit take up and full tax-compliance, adjustments for benefit non take-up and/or tax evasion are simulated in a number of country modules. Such adjustments are modelled in a transparent way that can be activated or deactivated by users.

EUROMOD code is written in C# and compiled. Users use the model through a standalone user interface, programmed using Microsoft .net Framework.

See Sutherland and Figari (2013) for a complete overview of EUROMOD.

Input and parametrization

EUROMOD input datasets are usually derived from the European Union Statistics on Income and Living Conditions (EU-SILC), as harmonised by EUROSTAT. In some cases the EU-SILC is enriched using variables contained in the national SILC surveys, which are the basis for the harmonised version. In some other

cases the national SILC surveys are used directly. The EUROMOD input datasets include the following key inputs:

- demographics at household and individual level
- labour market characteristics
- gross incomes from market and other income sources (i.e. pensions, public transfers and private incomes)

A network of teams of national experts also collects information on the policy rules in place in each country each year.

The original survey data undergo a process of transformation and imputation before being used as EUROMOD input dataset. In particular, a process of imputation aimed at “splitting” the aggregated benefit variables provided in EU-SILC is applied. The process is described in the EUROMOD country reports. In addition, variables are renamed to follow the EUROMOD naming conventions (aimed at improving cross-country comparability).

The income variables contained in a EUROMOD input dataset are uprated using specific uprating factors when the year to which the income variables refers to differs from the tax-benefit systems to be simulated.

Starting from 2021, EUROSTAT and JRC, with the agreement of the National Statistical Institutes, are gradually implementing a new data production workflow. It consists in EUROSTAT producing and distributing to National teams a new dataset called EUROMOD SILC Database (EMSD) containing the harmonised EU-SILC already enriched with selected variables from national SILC and information derived from the SILC production database (PDB). The new data workflow simplifies the process of accessing National SILC variables and the dissemination of the EUROMOD input data among users.

See Sutherland and Figari (2013) for a complete overview of EUROMOD.

Main output

The output microdata contains information on the:

- demographic characteristics of individuals and households, as well as their financial circumstances
- simulated and non-simulated tax-benefit instruments
- disposable income.

The information contained in the output microdata can be analysed using built-in plugins (Statistics Presenter and In-depth analysis) or other statistical software (such as R or STATA).

Spatial - temporal extent

The output has the following spatial-temporal resolution and extent:

Parameter	Description
Spatial Extent / Country Coverage	EU Member states 27 and UK
(Spatial) resolution	Individual and household level
Temporal extent	2005 – current year (8 countries); 2006 – current year (17 countries); 2007-current year (26 countries); 2011-current year (27 countries); 2005-2020 (UK)
Temporal resolution	Yearly

Quality & transparency

Quality

Question	Answer	Details
Models are by definition affected by uncertainties (in input data, input parameters, scenario definitions, etc.). Have the model uncertainties been quantified? Are uncertainties accounted for in your simulations?	no	Deterministic model. Users can design uncertainty through simulating various scenarios.
Sensitivity analysis helps identifying the uncertain inputs mostly responsible for the uncertainty in the model responses. Has the model undergone sensitivity analysis?	not_applicable	Due to the nature of the model this does not apply.
Has the model undergone external peer review by a panel of experts, or have results been published in peer-reviewed journals?	yes	Model review is assured by its academic and policy uses and annual validation. EUROMOD coding language allow users to check what is modelled and how. Papers using EUROMOD are published in peer-reviewed journals.
Has model validation been done? Have model predictions been confronted with observed data (ex-post)?	yes	Simulation results are validated against official statistics. The validation process is documented in a series of country reports.

References related to external peer-review and publication in scientific journals:

- No references provided in MIDAS

Transparency

Question	Answer	Details
Is the model underlying database (i.e. the no database the model runs are based on) publicly available?	no	Underlying input data are made available by the European Commission (for EU member states) and the University of Essex (for the UK) to researchers who have a EUROMOD-related Research Project Proposal (RPP) approved by EUROSTAT. See EUROMOD website for more information. However, the model also runs with hypothetical data created by the user, for which no authorization is needed. Additionally, users can create their own input microdata based on other sources, e.g. administrative registers.
Can model outputs be made publicly available?	yes	Output microdata can be only made shared among approved researchers. However, aggregate indicators derived from the output microdata can be made publicly available, as long as they respect the confidentiality rules set by the data providers. Selected indicators are made available in the EUROMOD website.
Is the model transparently documented (including underlying data, assumptions and equations, architecture, results) and are these documents available to the general public?	yes	The coding of all tax-benefit policies is visible for the users. The model structure is documented in built-in help and user documentation included in the model. Model simulations and content are described in country reports publicly available on the EUROMOD website. The process

	of data manipulation for the creation of the EUROMOD input dataset is described in the Data Requirement Documents (DRDs), provided together with the EUROMOD input datasets.
Is the model source code publicly accessible or open for inspection?	yes EUROMOD is released as open source. The model can be downloaded from the EUROMOD website: https://euromod-web.jrc.ec.europa.eu/access-euromod . The source code of the software can be downloaded from GitHub: https://github.com/ec-jrc/JRC-EUROMOD-software-source-code

References related to documentation:

- No references provided in MIDAS

The model's policy relevance and intended role in the policy cycle

The model is designed to contribute to the following policy areas

- Economy, finance and the euro

The model is designed to contribute to the following phases of the policy cycle

- Formulation
- Evaluation

The model's potential

EUROMOD is unique in being a research tool that is relevant not only at national level and as an integrated tool for European comparative social science research, but also as a model of the EU as a whole. EUROMOD brings a distinctive economic research on the redistributive effects of tax-benefit policies across Europe.

The JRC has developed an interaction of EUROMOD with the DG ECFIN model QUEST in close collaboration with DG ECFIN and ZEW-Mannheim (see Barrios et al., 2016). Published JRC research includes analyses of in-work tax expenditures for low income workers (see Barrios et al., 2015) and contributions to the Commission Tax reforms in the EU Member States report (see European Commission 2014, 2015). EUROMOD is also used in combination with the GEM-E3 model to analyse the distributional impact of green taxes. EUROMOD provides also the micro-parameters needed to run the EDGE-M3 model.

The model has increasingly been used by the Commission services over the past few years. DG EMPL uses results from the model for its Quarterly and Annual reports on Employment and Social Developments in Europe (European Commission 2018) and different research notes delivered in the context of the Social Situation Monitor are based on EUROMOD. EUROMOD based simulations are also used by DG ECFIN in the Report on Public Finances in EMU (European Commission 2017). EUROMOD is also used by ESTAT for the production of the flash estimates on income and poverty: <https://ec.europa.eu/eurostat/web/experimental-statistics/income-inequality-and-poverty-indicators>. Improved timeliness in the data production and the flash estimates using EUROMOD are part of a two-pillar strategy in order to ensure more recent data for income indicators for policy making. The use of the EUROMOD model for the provision of near-real time information on income indicators is therefore critical in the context of the European Semester. The JRC uses the model in cooperation with policy DGs, in particular DG ECFIN, DG TAXUD, DG EMPL and the SRSS. Since 2015 the JRC contributes to the preparation of the Country reports for the European Semester and produces regular notes also circulated in other policy DGs (the so-called "In-depth analyses of tax reforms using the EUROMOD model"). These notes were extensively used in the Country reports of the European Semester. EUROMOD has also been used for the Social Impact Assessment of the third Greek Stabilisation programme in cooperation with DG EMPL and DG REFORM for the assessment of the reform of the

personal income system in Greece in 2015 and 2016. EUROMOD has also been used to provide technical assistance to the Greek Ministry of Finance (2018-2021) and it is currently being used for technical support to Romania, Lithuania and Slovakia (since 2020).

Work with DG TAXUD extended the model to improve the coverage of wealth taxation and for future analyses of tax shifting between corporate income taxes and personal income taxes. The model has been extended to account for labour supply adjustment combining EUROMOD and an econometrically estimated labour supply model. This extension covers all the EU Member States. The JRC is also currently extending the model to cover consumption taxation (VAT and excises). The model provided also input to a study on the fiscal impact of migration (2020) in cooperation with IIASA.

The JRC has developed a "simplified" version of EUROMOD, based on a web interface, which can be accessed upon request by researchers and policy analysts.

EUROMOD has been used extensively to assess, among others, the extent to which policy responses to the COVID-19 crisis in Member States have cushioned household incomes losses during the pandemic. The Commission Staff Working Documents analysing the recovery and resilience plans of several Member States (June 2021) cite this work.

Previous use of the model in ex-ante impact assessments of the European Commission

Use of the model in ex-ante impact assessments since July 2017.

In the Year	EUROMOD contributed to the Impact assessment called	Led by	By providing input to the	The model was run by	Details of the contribution
2021	Impact assessment accompanying the document Proposal for a Directive of the European Parliament and of the Council: to strengthen the application of the principle of equal pay for equal work or work of equal value between men and women through pay transparency and enforcement mechanisms SWD/2021/41 final	JUST	Baseline and assessment of policy options	European Commission	The model helped to assess the following impacts: - Budgetary consequences for public authorities - Households income and at risk of poverty rates - Inequalities and the distribution of incomes and wealth - Specific effects on particular risk groups - Different impact on women and men
2021	Impact assessment accompanying the document Proposal for a Council Directive: restructuring the Union framework for the taxation of energy products and electricity (recast) SWD/2021/641 final	TAXUD	Baseline and assessment of policy options	European Commission	The model helped to assess the following impacts: - Consumer's ability to benefit from the internal market or to access goods and services from outside the EU - Prices, quality, availability or choice of consumer goods and services - Impact on vulnerable consumers - Impact on jobs - Impact on jobs in specific sectors, professions, regions or countries - Wages, labour costs or wage setting mechanisms - Households income and at risk of poverty rates - Inequalities and the distribution of incomes and wealth - Financing and organisation of social protection systems - Cross-border provision of services, referrals across borders and cooperation in border regions
2021	Impact assessment accompanying the document Proposal for a regulation of the European	TAXUD	Baseline and assessment of policy options	European Commission	The model helped to assess the following impacts: - Consumer's ability to benefit

	Parliament and of the Council: establishing a carbon border adjustment mechanism				from the internal market or to access goods and services from outside the EU - Prices, quality, availability or choice of consumer goods and services - Impact on vulnerable consumers - Impact on jobs - Impact on jobs in specific sectors, professions, regions or countries - Wages, labour costs or wage setting mechanisms - Households income and at risk of poverty rates - Inequalities and the distribution of incomes and wealth - Financing and organisation of social protection systems - Cross-border provision of services, referrals across borders and cooperation in border regions
	SWD/2021/643 final				
2020	Impact assessment accompanying the document Proposal for a Directive of the European Parliament and of the Council: on adequate minimum wages in the European Union	EMPL	Baseline and assessment of policy options	European Commission	The model helped to assess the following impacts: - Budgetary consequences for public authorities - Economic growth and employment - Impact on jobs - Impact on jobs in specific sectors, professions, regions or countries - Wages, labour costs or wage setting mechanisms - Households income and at risk of poverty rates - Inequalities and the distribution of incomes and wealth
	SWD/2020/245 final				
2018	Impact assessment accompanying the document Proposal for a Council recommendation on: access to social protection for workers and the self-employed	EMPL	Baseline and assessment of policy options	European Commission	The model helped to assess the following impacts: - Employment protection - Households income and at risk of poverty rates - Inequalities and the distribution of incomes and wealth - Financing and organisation of social protection systems
	SWD/2018/070 final				
2018	Impact assessment accompanying the document Proposal for a Council recommendation on: access to social protection for workers and the self-employed	EMPL	Baseline and assessment of policy options	Fondazione Giacomo Brodolini	The model helped to assess the following impacts: - Employment protection - Households income and at risk of poverty rates

SWD/2018/070 final

- Inequalities and the
distribution of incomes and
wealth
- Financing and organisation of
social protection systems

Documented in:
- DOI 10.2767/65810

Bibliographic references

- *Employment and social developments in Europe 2018.* - 10.2767/875456
- *Report on public finances in EMU 2017.* - 10.2765/256263
- *The fiscal effects of work-related tax expenditures in Europe.* - 10.2765/6099
- *Tax reforms in EU Member States 2015 : tax policy challenges for economic growth and fiscal sustainability.* - 10.2765/274179
- *Tax reforms in EU Member States : tax policy challenges for economic growth and fiscal sustainability : 2014 report.* - 10.2778/68699

QUEST

Macroeconomic model QUEST

Fact sheet

Source: Commission modelling inventory and knowledge management system (MIDAS)

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Overview

Acronym QUEST

Full title Macroeconomic model QUEST

Main purpose

A macro-economic model used to analyse and understand the state of the EU economy.

Summary

QUEST is a macro-economic model (Dynamic Stochastic General Equilibrium) used to analyse and understand the state of the EU economy. It is developed by DG ECFIN, and estimated model variants have been developed jointly with support from the JRC. The first version of QUEST was applied in 2007, and many extensions have been developed since.

QUEST belongs to the class of New-Keynesian Dynamic Stochastic General Equilibrium (DSGE) models that are now widely used by international institutions and central banks. These models have rigorous microeconomic foundations derived from utility and profit optimisation and include frictions in goods, labour and financial markets. With empirically plausible estimation and calibration they are able to fit the main features of the macroeconomic time series. The QUEST model has been estimated on euro area and US data using Bayesian estimation methods. Calibrated model versions are used in wider applications.

QUEST supports questions related to policy formulation, implementation and evaluation. Many of the main applications deal with fiscal and monetary policy interactions. In order to deal with the wide range of policy issues in DG ECFIN, different model versions of the QUEST model have been constructed, each with a specific focus and regional and sectoral disaggregation.

Keywords

macroeconomic model , DSGE model

Model category (thematic)

Economy

Model home page

https://ec.europa.eu/info/business-economy-euro/economic-and-fiscal-policy-coordination/economic-research/macro-economic-models_en

Ownership & license

Ownership

Sole ownership [European Union]

Ownership details

The model is owned by DG ECFIN.DDG2.B.3

Licence type

Non-Free Software licence. The license has one or more of the following restrictions: it prohibits creation of derivative works; it prohibits commercial use; it obliges to share the licensed or derivative works on the same conditions.

Details

QUEST structure and approach

QUEST III belongs to the class of New-Keynesian Dynamic Stochastic General Equilibrium (DSGE) models that are now widely used by international institutions and central banks. These models have rigorous microeconomic foundations derived from utility and profit optimisation and include frictions in goods, labour and financial markets. With empirically plausible estimation and calibration they are able to fit the main features of the macroeconomic time series. Calibrated model versions are used for most policy applications, but the QUEST III model has also been estimated on Euro Area, US and specific Euro Area countries (ES, DE) data using Bayesian estimation methods.

In order to deal with the wide range of policy issues in DG ECFIN, different model versions of the QUEST III model have been constructed, each with a specific focus and regional and sectoral disaggregation. Many of the main applications deal with fiscal and monetary policy interactions and either use a one-sector model or models that explicitly distinguish tradable and nontradable sectors, and include trade in intermediates. Other model variants also include housing and collateral constraints.

QUEST III has also been used for the analysis of structural reforms and another version has been employed for the analysis of energy and climate change policies. All these models are employed using different country disaggregations, focusing on the euro area or EU as a whole, and other global regions, or on individual member states.

The models are developed by the modelling unit in DG ECFIN. The Joint Research Centre of the European Commission supports QUEST development providing econometric, computational and methodological expertise in estimation and calibration, maintaining dedicated IT resources.

An update of some new developments of the QUEST III models was described in ECFIN Research Letter Vol.3.Issue 1/2009 (pp 10-13). For further references on the QUEST model, see the model homepage.

Input and parametrization

Key inputs for the estimated model versions are coming from national accounts and other macroeconomic data source. The main ones are:

- National account data (GDP and its components, current and constant prices)
- Labour market data (wages, employment)
- Financial variables (interest rates)
- Trade data
- Monetary data (interest rates)

Main output

Key outputs produced by the model:

- Model parameter estimates to be used for simulation (time evolution of all macro-variables of interest in response to a shock in the economy or changes in policy) and model-based policy analysis;
- Among the macroeconomic variables of interest, the model allows to study dynamics and economic drivers of:
 - GDP and its components
 - Price deflators
 - Fiscal variables
 - Employment, wages
 - Interest rates
 - Trade

Spatial - temporal extent

The output has the following spatial-temporal resolution and extent:

Parameter	Description
Spatial Extent / Country Coverage	Global, incl. individual EU countries, various EU aggregates (EU, Euro area, OMS, NMS, etc).
(Spatial) resolution	Up to country aggregation
Temporal extent	Estimation data range: 1985-2013 for Euro area aggregate; 1995-2013 for individual countries. Simulation horizon: the model is simulated for several periods ahead to allow convergence.
Temporal resolution	Quarterly

Quality & transparency

Quality

Question	Answer	Details
Models are by definition affected by uncertainties (in input data, input parameters, scenario definitions, etc.). Have the model uncertainties been quantified? Are uncertainties accounted for in your simulations?	yes	Possible
Sensitivity analysis helps identifying the uncertain inputs mostly responsible for the uncertainty in the model responses. Has the model undergone sensitivity analysis?	yes	Very often model versions are subject to sensitivity analysis.
Has the model undergone external peer review by a panel of experts, or have results been published in peer-reviewed journals?	yes	The model has many publications in peer-reviewed journals.
Has model validation been done? Have model predictions been confronted with observed data (ex-post)?	yes	k-periods ahead behavior of the model variables is compared with historical observations.

References related to external peer-review and publication in scientific journals:

- Ratto M, Roeger W, Int Veld J. QUEST III: An Estimated Open-Economy DSGE Model of the Euro Area with Fiscal and Monetary Policy. ECONOMIC MODELLING 26; 2009. p. 222-233. JRC46465

Transparency

Question	Answer	Details
Is the model underlying database (i.e. the database the model runs are based on) publicly available?	yes	Taken from public sources.
Can model outputs be made publicly available?	yes	In publications.
Is the model transparently documented (including underlying data, assumptions and equations, architecture, results) and are these documents available to the general public?	yes	Model structure is typically documented in scientific publications (e.g. Ratto et.al 2009). Technical algorithms and codes are available upon request.
Is the model source code publicly accessible or open for inspection?	no	Technical algorithms and codes of estimated model versions published in academic journals are made available upon request.

References related to documentation:

- Fiscal stimulus and exit strategies in the EU : a model-based analysis. - 10.2765/44208

The model's policy relevance and intended role in the policy cycle

The model is designed to contribute to the following policy areas

- Economy, finance and the euro
- Taxation
- Employment and social affairs
- Trade

The model is designed to contribute to the following phases of the policy cycle

- Anticipation
- Formulation
- Implementation
- Evaluation

The model's potential

QUEST III is a tool suitable for policy preparation and implementation. It is designed to analyze economic issues like the occurrence boom-bust cycles, the study of structural reforms (Lisbon process), fiscal policy, country debt stabilization and sustainability. Main policy areas requiring QUEST based analysis concern MIP (Macroeconomic Imbalance Procedure) assessments, EDP (Excess Deficit) procedures and debt sustainability analysis.

DG ECFIN uses QUEST III for macroeconomic policy analysis and research. Results of the studies feed into ECFIN policy reports. JRC supports DG ECFIN for the development of QUEST III, focusing on the estimation. JRC provides estimated versions of QUEST models for individual member states, used to support policy studies for macro-economic surveillance by DG ECFIN

Previous use of the model in ex-ante impact assessments of the European Commission

Use of the model in ex-ante impact assessments since July 2017.

In the Year	QUEST contributed to the Impact assessment called	Led by	By providing input to the	The model was run by	Details of the contribution
2021	Impact assessment accompanying the document Proposal for a Council Directive: restructuring the Union framework for the taxation of energy products and electricity (recast) SWD/2021/641 final	TAXUD	Baseline and assessment of policy options	European Commission	The model helped to assess the following impacts: - EU Exports & imports - Investment flows & trade in services - Free movement of goods, services, capital and workers - Competition - Innovation for productivity/resource efficiency - Budgetary consequences for public authorities - Consumer's ability to benefit from the internal market or to access goods and services from outside the EU - Economic growth and employment - Investments and functioning of markets - Macro-economic stabilisation - Impact on jobs - Impact on jobs in specific sectors, professions, regions or countries - Indirect effects on employment levels - Emission of greenhouse gases
2020	Impact Assessment accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Stepping up Europe's 2030 climate ambition SWD/2020/176 final	CLIMA	Baseline and assessment of policy options	European Commission	QUEST is used for macroeconomic assessment.
2020	Impact assessment accompanying the document Proposal for a Directive of the European Parliament and of the Council: on adequate minimum wages in the European Union SWD/2020/245 final	EMPL	Baseline and assessment of policy options	European Commission	The model helped to assess the following impacts: - Economic growth and employment - Impact on jobs - Wages, labour costs or wage setting mechanisms - Inequalities and the

					distribution of incomes and wealth
2018	Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council on: the establishment of a European Investment Stabilisation Function SWD/2018/297 final	ECFIN	Baseline and assessment of policy options	European Commission	The model helped to assess the following impacts: - Budgetary consequences for public authorities - Economic growth and employment - Macro-economic stabilisation
2018	Impact assessment accompanying the document Proposals for a Regulation of the European Parliament and of the Council on: the European Regional Development Fund and on the Cohesion Fund and; Proposal for a Regulation of the European Parliament and the Council on: a mechanism to resolve legal and administrative obstacles in a cross-border context and; Proposal for a Regulation of the European Parliament and the Council on: specific provisions for the European territorial cooperation goal (Interreg) supported by the European Regional Development Fund and external financing instruments SWD/2018/282 final	REGIO	Baseline and assessment of policy options	European Commission	The model helped to assess the following impacts: - Economic growth and employment - Investment cycle - Affects on individual Member States - Stimulation of research and development - Innovation for productivity/resource efficiency
2018	Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and the Council on: establishing Horizon Europe - the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination and; Proposal for a Decision of the European Parliament and the Council on: establishing the specific programme implementing Horizon Europe - the Framework Programme for Research and Innovation and; Proposal for a Regulation of the European Parliament and the Council on: establishing the Research and Training Programme of the European Atomic Energy Community for the period 2021-2025 complementing Horizon Europe - the Framework Programme for Research and Innovation SWD/2018/307 final	RTD	Baseline and assessment of policy options	European Commission	The model helped to assess the following impacts: - Investment cycle - Affects on individual Member States - Stimulation of research and development - Innovation for productivity/resource efficiency - Economic growth and employment

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AERO-MS

Aviation Emissions and evaluation of Reduction Options Modelling System

Fact sheet

Source: Commission modelling inventory and knowledge management system (MIDAS)

Date of Report Generation: 02/09/2021

Dissemination: Public

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Overview

Acronym AERO-MS

Full title Aviation Emissions and evaluation of Reduction Options Modelling System

Main purpose

Aviation model designed to quantify economic and environmental impacts of policy measures related to the emission reduction in the air transport system.

Summary

The development of the AERO Modelling System started in 1994 by the Dutch Civil Aviation Authority. The model is suited for long term projections covers all EU Member States plus the rest of the world.

AERO-MS assesses the effects of policies on supply-side costs which are then passed through on demand for air travel. As a result, it generates a balanced view of the potential policy impacts on the economy and environment.

AERO-MS can be used for the policy formulation. It is aimed at the assessment of global aircraft engine emissions under alternative emission mitigation scenarios by taking into account the responses of and effects on all relevant actors (airlines, consumers, governments and manufacturers). AERO-MS has been used in the SAVE (Study on AViation and Economic modelling) project, as well as in the impact assessment concerning the integration of aviation into the EU ETS, and for the analysis of policies at the International Civil Aviation Organization (ICAO).

Keywords

aviation

Model category (thematic)

Transport

Model home page

<https://www.easa.europa.eu/document-library/research-projects/easa2009op15>

Ownership & license

Ownership

Sole ownership [European Union]

Ownership details

The AERO-MS is owned by the European Union Aviation Safety Agency (EASA)

Licence type

Non-Free Software licence. The license has one or more of the following restrictions: it prohibits creation of derivative works; it prohibits commercial use; it obliges to share the licensed or derivative works on the same conditions.

Details

AERO-MS structure and approach

The AERO-MS is a tool owned by the European Union Aviation Safety Agency and has been developed specifically to support impact assessments for regulations to reduce greenhouse gas (GHG) emissions from aviation. The AERO-MS assesses the economic and environmental impacts of a wide range of policy options to reduce international and domestic aviation GHG emissions. Policy options that can be examined include the different taxation (including fuel and ticket taxation), emission trading schemes (such as the EU ETS) and offset schemes like CORSIA, the introduction of sustainable aviation fuels and air traffic management (ATM) improvements. Such policy options, the model shows, can affect both the supply side and demand side of the air transport sector. The AERO-MS forecasts the impact on emission reductions of measures and policies but also the extent by which demand for air travel is reduced due to these higher prices.

AERO-MS has formed a key part of about 40 international studies where the model results have provided a quantified basis for policy judgement. Recently AERO-MS was applied for the European Aviation Environmental Report. Also, AERO-MS has been applied in various impact assessment studies for the European Commissions, also with respect to the inclusion of aviation in the EU ETS. In 2019 the model was used for the evaluation of the air service regulation . Further studies, in which the AERO-MS was applied, were executed for a range of other clients like EASA, IATA, ICAO, Airbus, and national governments (Germany, UK, the Netherlands).

The AERO-MS has a global scope; the analysis is built on a Unified Database containing a detailed record of global aviation movements in the Base Year. The Unified Database records 123,025 airport-pairs, covering a full network of all key airports, derived from the EUROCONTROL WISDOM Operations Database. Airline cost and fare data are based on relevant data from the International Air Transport Association (IATA) and the International Civil Aviation Organisation (ICAO). Aircraft type input data is based on fleet inventory properties from the EUROCONTROL PRISME Fleet, OAG Fleet Databases, ICAO emissions databank as well as retirement curves derived by the ICAO Committee on Aviation Environmental Protection (CAEP) Forecasting and Economic Analysis Support Group (FESG). For the specification of aircraft operational characteristics use is made of the EUROCONTROL BADA data. Hence, all AERO-MS data are based on data sources from internationally well-reputed organisations.

AERO-MS has a global coverage, including data for both Intra-European routes and routes to and from Europe. The data include:

- Connectivity in terms of the number of direct routes, plus the frequency of these routes;
- Total flight km and flight capacity;
- Demand in term of passengers, passenger km, freight km;
- Airline costs and ticket prices;

- Airline employment;
- Fuel use and fuel efficiency;
- CO2 emissions.

The Unified Database and the five modules of the AERO-MS model are briefly described below.

- **Unified Database:** The starting point for the modelling of air transport demand and aircraft flights is provided by the Unified Database of the AERO-MS, which is a computerised description of the volume and pattern of global air transport activity in the base year.
- **Aircraft technology model (ATEC):** The ATEC model is used to calculate the technical characteristics by aircraft type and technology level based on a modelling of fleet development over time. Aircraft technology are particularly relevant to the fuel use and emission characteristics of different aircraft types. The technology characteristics are expressed as a function of aircraft 'technology age' which is defined by the year in which the aircraft (type) is certified. The technology age distribution is determined by the fleet build-up which depends on the development in time of aircraft sales (following air transport demand) and aircraft retirement.
- **Air transport demand model (ADEM):** The ADEM model matches the demand and supply side of air transport, i.e. air transport demand in terms of passengers and freight as well as the frequency and capacity of air transport services offered. Volumes of passengers and cargo transported, passenger fares and freight rates are determined in the process of balancing supply and demand. Aircraft flights are determined by origin-destination (airport pairs) and expressed in terms of aircraft types and technology levels, in accordance with available fleets.
- **Aviation cost model (ACOS):** The ACOS model computes the relevant variable aircraft operating cost components and total operating costs. Variable operating costs are associated with flights by aircraft type and technology level and include: fuel costs; route and landing (airport) charges; flight and cabin crew costs; maintenance costs; capital costs (depreciation) and finance costs. In addition, total operating costs include a number of other, volume-related, costs such as the costs of ground-handling, sales, ground facilities (buildings) and general and administration costs. Based on the total operating costs, ACOS determines the unit costs (per passenger and kg of cargo transported) of air transport by aircraft type, technology level and IATA region-pair. In particular, the model ACOS converts the costs of possible measures in the air transport sector to changes in unit operating costs.
- **Flights and emissions model (FLEM):** The FLEM model provides a detailed description of the actual flight profiles of individual aircraft flights. Fuel-burn and emissions for each flight are computed in three-dimensional space, taking into account the geographical flight specification and the technical characteristics by aircraft type and technology level. There is a direct connection between ATEC and FLEM allowing FLEM to take into account developments in

aircraft technical and environmental performance as projected from a baseline scenario and policies. Finally, FLEM provides information on fuel-burn as a basis for the cost computations in ACOS.

- **Direct economic impacts model (DECI):** The DECI model is essentially a post-processing model. One of its main functions is to provide a comprehensive overview of the results of the other modules in the AERO-MS, in particular the information related to air transport volumes; airline revenues; fleet size and flight operation. Another main function of DECI is to compute a number of direct impacts on the relevant actors (airlines, government, consumers).

Baseline scenario

The AERO-MS baseline scenario provides a projection, starting from a Base Year of 2016, of European aviation demand under current trends and policies up to the year 2050. Although the user can develop their own specification, the model is currently set up with an update of the EU Reference Scenario, using the projected annual growth rates of transport activity from the PRIMES-TREMOVE model from 2018 onwards. In 2021, the analysis of the impacts of different tax options for the aviation sector has included a further update to the baseline using the Commission's 2020 update to the Reference Scenario to reflect the impacts of the COVID-19 pandemic.

Assessment of direct impacts from policy options

AERO-MS has specific variables for the modelling of a fuel taxation and the modelling of a ticket taxation, whereby taxation levels are specified through user inputs. This means that any fuel taxation or ticket taxation can be modelled separately, but a fuel taxation and a ticket taxation can also be combined in a single model run. Furthermore, the geographical scope to which the policies will apply can be set fully flexible. This implies that we can model a taxation for the EU plus any set of third countries (e.g. UK, Norway, Iceland, Switzerland, Turkey). Also, taxations can be applied to only flights between a set of countries (e.g. Intra EU) or to all flights departing from a set of countries (e.g. all flights departing from the EU). Furthermore, for an intra-EU only policy option, an issue could for example be if flights between the EU and outermost regions and overseas territories should also be covered. Moreover, in the AERO-MS ticket taxation levels can be varied depending on the flight distance. Because of the global coverage of the AERO-MS and the great level of detail in the model (i.e. over 123,000 airport pairs included in the model), the application of the AERO-MS allows to assess the impact in case of such detailed specification of policy options.

The AERO-MS takes into account various responses to taxations including:

- A demand side response whereby policy-induced cost increases are passed on into higher ticket prices which will imply a reduction in passenger and cargo demand;
- A supply side response whereby airlines shift towards the use of more fuel-efficient aircraft.

In relation to the first response the default assumption in the AERO-MS is that all policy-induced costs increases are passed on into higher ticket prices. The impact on demand which follows from these

higher ticket prices is related to the price elasticities of demand in the model. Currently the price elasticities of demand values in the AERO-MS are based on an IATA study (<https://www.iata.org/en/iata-repository/publications/economic-reports/estimating-air-travel-demand-elasticities---by-intervistas/>), but these can be easily changed if alignment with assumptions adopted in other EC studies is required.

In relation to the supply side response, the AERO-MS takes into account responses will be different for a fuel or ticket taxation. In case of a fuel taxation there is a price incentive for the use of more fuel-efficient aircraft whereas this is not the case for a ticket taxation. This is a key difference between the two taxation alternatives and should be captured in the quantification of impacts. The AERO-MS takes into account the following supply side responses:

- New aircraft technology shift: change in purchase behaviour of airlines towards (available) environmentally more efficient new aircraft and accelerated development of new aircraft technology.
- Accelerated fleet renewal: replacing the older part of the fleet earlier than in the situation without a fuel taxation, based on financial considerations of airlines.
- New aircraft capacity shift: adjustment of mission capabilities to allow for more efficient aircraft operation in view of anticipated fuel taxation impacts on transport flows.

Since the supply response is endogenized into the model, the AERO-MS also allows for the assessment of impacts in case taxation revenues are rechannelled into the air transport sector, whereby taxation revenues can be used for the financing of:

- Development of additional technology improvement of new aircraft;
- Subsidizing the purchase of aircraft of the latest technology;
- Improvement in air traffic control.

AERO-MS can assess a wide range of impacts of policy options, including direct impacts on:

- Fleet composition;
- Ticket prices;
- Demand (passengers, passenger km, cargo);
- Number of flights and aircraft-km;
- Fuel use and CO2 emissions;
- Airlines costs, revenues and profitability;
- Taxation revenues;

- Consumer surplus.

Results can be presented by Member States, whereby for each Member State a further distinction can be made between: i) domestic flights; ii) international intra-EU flights; and iii) extra-EU flights.

Moreover, AERO-MS distinguishes between traditional scheduled carriers and low-cost carriers (LCC).

Hence impacts can also be presented separately for these two types of carriers, whereby impacts can be different because:

- Average ticket prices are generally lower for LCC and therefore a policy-induced cost increase can have a higher percentage impact on ticket prices;
- Average price elasticities differ between passenger purpose (business, leisure) and the percentage of leisure passengers on LCC flights is generally lower.

Input and parametrization

Key inputs (embedded in the model)

- Base year demand on the global route network
- Base year aircraft fleet
- Base year aviation sector cost data

Baseline definition

- Future year demand growth (by route)
- Future year oil price
- Future year carbon price
- Future year passenger ticket price developments
- Future year cargo rates developments
- Elasticities (demand vs. price)

Policy inputs

- Tax rates
- Technological inputs (e.g. aircraft fleet changes)
- Emissions regulations
- Economics regulations/incentives (e.g. for accelerated fleet replacement)

Main output

The AERO-MS can export a wide range of results parameters, including:

- Numbers of flights
- Numbers of passengers
- Demand (passenger-km and cargo tonne-km)
- Ticket price
- Fuel consumption
- Air carrier revenues
- Taxation revenues
- Aviation sector employment
- CO2 and NOx emissions
- Aircraft fuel efficiency

All the above can be exported by route, and hence amalgamated by departure and/or destination country.

The differences between the results for the baseline scenario and the policy cases represents the impacts of the policy option being analysed.

Spatial - temporal extent

The output has the following spatial-temporal resolution and extent:

Parameter	Description
Spatial Extent / Country Coverage	Global coverage (Europe, including EU Member States 27 and UK; America; Africa; Asia; Oceania).
(Spatial) resolution	Airports
Temporal extent	The AERO-MS calculates the impacts of policies on aviation activities, economics and environmental impacts for any future year for which the relevant inputs (aviation demand growth, fuel prices, etc.) are given.
Temporal resolution	Years

Quality & transparency

Quality

Question	Answer	Details
Models are by definition affected by	yes	Uncertainties in the input assumptions were considered

uncertainties (in input data, input parameters, scenario definitions, etc.). Have the model uncertainties been quantified? Are uncertainties accounted for in your simulations?		during the project 'Study on Aviation and Economic modelling (SAVE) (https://www.easa.europa.eu/sites/default/files/dfu/2010-SAVE-Study%20on%20Aviation%20and%20Economic%20Modelling-Final%20Report.pdf) Uncertainties/sensitivities can be considered by relevant changes to the input parameters. It is common to model multiple demand forecasts as baselines (e.g. low, central, high) to recognize the uncertainty in the background forecast, but changes in other parameters are also feasible.
Sensitivity analysis helps identifying the uncertain inputs mostly responsible for the uncertainty in the model responses. Has the model undergone sensitivity analysis?	yes	Some results were described in the SAVE Final report.
Has the model undergone external peer review by a panel of experts, or have results been published in peer-reviewed journals?	yes	Model was reviewed by the International Civil Aviation Organisation (ICAO) Committee on Aviation Environmental Protection (CAEP) and approved for use on CAEP policy analyses.
Has model validation been done? Have model predictions been confronted with observed data (ex-post)?	yes	In addition to the basic validation performed during the development of the model, ex-post comparisons are also made when the model is applied to ex-post evaluation studies.

References related to external peer-review and publication in scientific journals:

- No references provided in MIDAS

Transparency

Question	Answer	Details
Is the model underlying database (i.e. the database the model runs are based on) publicly available?	no	The base year movements database uses confidential data.
Can model outputs be made publicly available?	yes	The licence for use allows for the publication of, appropriately acknowledged, results from the model.
Is the model transparently documented (including underlying data, assumptions and equations, architecture, results) and are these documents available to the general public?	yes	A detailed description of the model is provided in the SAVE Final Report.
Is the model source code publicly accessible or open for inspection?	no	The source code is considered confidential.

References related to documentation:

- No references provided in MIDAS

The model's policy relevance and intended role in the policy cycle

The model is designed to contribute to the following policy areas

- Transport

The model is designed to contribute to the following phases of the policy cycle

- Formulation

The model's potential

The AERO-MS is a tool owned by the European Union Aviation Safety Agency and has been developed specifically to support impact assessments for regulations to reduce greenhouse gas (GHG) emissions from aviation. The AERO-MS assesses the economic and environmental impacts of a wide range of policy options to reduce international and domestic aviation GHG emissions. Policy options that can be examined include the different taxation (including fuel and ticket taxation), emission trading schemes (such as the EU ETS) and offset schemes like CORSIA, the introduction of sustainable aviation fuels and air traffic management (ATM) improvements. Such policy options, the model shows, can affect both the supply side and demand side of the air transport sector. The AERO-MS forecasts the impact on emission reductions of measures and policies but also the extent by which demand for air travel is reduced due to these higher prices.

AERO-MS has formed a key part of about 40 international studies where the model results have provided a quantified basis for policy judgement. Recently AERO-MS was applied for the European Aviation Environmental Report. Also, AERO-MS has been applied in various impact assessment studies for the European Commissions, also with respect to the inclusion of aviation in the EU ETS. In 2019 the model was used for the evaluation of the air service regulation . Further studies, in which the AERO-MS was applied, were executed for a range of other clients like EASA, IATA, ICAO, Airbus, and national governments (Germany, UK, the Netherlands).

Previous use of the model in ex-ante impact assessments of the European Commission

Use of the model in ex-ante impact assessments since July 2017.

In the Year	AERO-MS contributed to the Impact assessment called	Led by	By providing input to the	The model was run by	Details of the contribution
2021	Impact assessment accompanying the document Proposal for a Council Directive: restructuring the Union framework for the taxation of energy products and electricity (recast) SWD/2021/641 final	TAXUD	Baseline and assessment of policy options	RICARDO	The model helped to assess the following impacts: <ul style="list-style-type: none"> - Equal treatment of products and businesses - Affects on individual Member States - EU Exports & imports - Cost of doing business - Business' capacity to innovate - Market share & advantages in international context - Free movement of goods, services, capital and workers - Competition - Innovation for productivity/resource efficiency - Budgetary consequences for public authorities - Consumer's ability to benefit from the internal market or to access goods and services from outside the EU - Prices, quality, availability or choice of consumer goods and services - Significant effects on sectors - Impact on regions - Disproportionately affected region or sector - Goods traded with developing countries - Investments and functioning of markets - Emission of greenhouse gases - Economic incentives set up by market based mechanisms - Emissions of acidifying, eutrophying, photochemical or harmful air pollutants - Sustainable production and consumption - Relative prices of environmental friendly and unfriendly products - Pollution by businesses - Environment in third countries - Energy intensity of the economy - Fuel mix used in energy production

- Demand for transport
- Vehicle emissions
- Energy and fuel consumption

Bibliographic references

- *No references provided in MIDAS*

GINFORS-E

Global Interindustry FORecasting System - Energy

Fact sheet

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Overview

Acronym GINFORS-E

Full title Global Interindustry FORecasting System - Energy

Main purpose

GINFORS-E is a global model with country and sector detail for 64 countries and one rest of world region mainly based on OECD and IEA data. It is designed for assessments of economic, energy, climate and environmental policies up to the year 2050.

Summary

GINFORS-E can be used to analyse the macroeconomic effects of a variety of price changes and policies in individual countries in the global context. It is designed for assessments of economic, energy, climate and environmental policies up to the year 2050.

Bilateral trade data are consistently linked to OECD input-output tables. For every country, important macroeconomic variables are determined in a macro model. In addition, energy, and emissions data as well as energy prices are linked to the economic driver variables. It flexibly models trade structures, labour markets, energy intensities and energy source structures, considering price dependencies and the situation in specific countries. Explicitly included are all EU countries, all OECD countries and their major trading partners. GINFORS_E is a macroeconometric model, which builds on Post-Keynesian theory. The parameters used in the model equations are econometrically estimated based on time-series data. Agents have myopic expectations and follow behavioural routines of the past. Markets are not assumed to be cleared. The model solves annually.

The model can be applied for formulation, implementation, and evaluation. It is mainly used for ex ante simulations. This can include the effect of changed framework data (international oil prices), policy measures (carbon prices), technological changes (renewable energy deployment) or structural change (e-mobility). It is enlarged towards energy technology goods and bioeconomy. However, the database can also be used to determine past and current parameters (consumption-based emissions).

Keywords

Energy , Environment , climate change , bioeconomy , economy , global coverage

Model category (thematic)

Agriculture, Climate, Economy, Environment, Energy

Model home page

<https://www.gws-os.com/de/index.php/energy-and-climate/models/model-details/ginfors-e.html>

Ownership & license

Ownership

Sole ownership [3rd party]

Ownership details

Gesellschaft für Wirtschaftliche Strukturforschung (GWS) mbH

Licence type

Non-Free Software licence. The license has one or more of the following restrictions: it prohibits creation of derivative works; it prohibits commercial use; it obliges to share the licensed or derivative works on the same conditions.

Details

GINFORS-E structure and approach

The GINFORS-E (global inter-industry forecasting system – energy) model is a bilateral world trade model based on OECD data, which consistently and coherently models exports and imports of 25 goods groups for 64 countries and one 'rest of the world' region. It incorporates a macro-model, consisting of exports and imports, other core components of final demand (private and public sector consumption and investment), markets for goods and the labour market, for each country. The models are also divided into 36 goods categories in accordance with the latest OECD internationally harmonised input-output (IO) tables. For every country OECD bilateral trade data on industry level is linked to the IO tables. For EU countries, UK and Norway transport is further distinguished in land, water, air plus warehousing and support activities based on the WIOD World Input-Output Database. These variables are reported for 40 industries.

GINFORS-E can be used to analyse the macroeconomic effects of a variety of price changes and policies in individual countries. It flexibly models trade structures, labour markets, energy intensities and energy source structures, taking into account price dependencies and the situation in specific countries. The use of intermediate inputs, domestic and imported, labour demand and foreign trade are modelled price dependent. Changes in prices due to tax adjustments will be accounted for. The parameters used in the model equations are econometrically estimated (OLS) on the basis of time-series data.

Production prices of industries are driven by unit costs. If prices of electricity in the steel industry increase, producer prices will increase according to their electricity price share. Higher producer prices will influence global competitiveness of the respective industry and other downstream production (e.g. in the automotive industry).

Important behavioural parameters of the model are estimated econometrically, and different specifications of the functions are tested against each other, which gives the model an empirical validation. An additional confirmation of the model structure as a whole is given by the convergence property of the solution which has to be fulfilled on a yearly basis. The econometric estimations build on times series from OECD, UN, IMF and IEA from 1990 to 2000 onwards.

Each national model is linked to an energy model, which determines energy conversion, energy generation and final demand for energy for 19 energy sources disaggregated by economic sector. The model considers technological trends and price dependencies.

Input and parametrization

The model is solved simultaneously year after year. Almost all model variables are endogenously determined via identity or behavioural equations. Behavioural variables are econometrically estimated as far as possible. Only a few variables, such as population development and international energy prices, are exogenously specified based on international projections or kept constant such as tax rates.

Data for 64 countries plus one region for rest of world include:

- Macroeconomic data as GDP and components (consumption, investment, exports, imports), in constant and current prices plus deflators
- Bilateral trade by 33 product groups
- Population, employment, unemployment, wages
- Input-Output tables (<https://www.oecd.org/sti/ind/input-outputtables.htm>)
- Sector data for 36 industries: output in constant and current prices, value added, employment, and final demand
- Energy balances
- CO2 emissions by sector and fuel, other GHG emissions
- Energy prices by user and fuel, including tax rates (VAT, energy)
- Carbon prices

Main output

Due to the modelling approach, all input variables determined ex-ante by the model can also be output variables. The most important of these are macroeconomic indicators on national level, as well as corresponding sector variables, which are calculated for all countries considered for all years up to 2050. The most important among them are:

- GDP and its components (household consumption, government consumption, investment, exports, imports)
- Employment, production, value added and prices on sector level
- International trade flows by product group, origin and destination
- Energy demand by sector and fuel, energy prices
- CO2 emissions by sector and fuel

The model is flexible to reflect, for example, different uses of CO2 price revenues to reduce labour costs, increase (specific) government spending, or reduce government debt. Various other policy measures can also be mapped quite easily.

Spatial - temporal extent

The output has the following spatial-temporal resolution and extent:

Parameter	Description
Spatial Extent / Country Coverage	World trade model representing 64 countries, and one 'rest of the world' region. Explicitly included are all EU countries, all OECD countries and their

(Spatial) resolution	major trading partners.
Temporal extent	National Sub-national (NUTS2)
Temporal resolution	Short-term (period of 5 years or less), Medium-term (5 to 15 years), Long-term (more than 15 years)
	Years

Quality & transparency

Quality

Question	Answer	Details
Models are by definition affected by uncertainties (in input data, input parameters, scenario definitions, etc.). Have the model uncertainties been quantified? Are uncertainties accounted for in your simulations?	yes	The model can be run multiple times to test sensitivity of model properties including key assumptions.
Sensitivity analysis helps identifying the uncertain inputs mostly responsible for the uncertainty in the model responses. Has the model undergone sensitivity analysis?	yes	Due to the large number of variables per country and sector and the size of the result data set, this is not systematically possible. However, short model runtimes of about one minute allow extensive testing of individual important specifications and new model parts.
Has the model undergone external peer review by a panel of experts, or have results been published in peer-reviewed journals?	yes	Several peer-reviewed publications have been made by the developers of the model. References on www.gws-os.com and in the reference section at the end of this document. A comprehensive model description can be found most recently in Lutz et al. (2010). An updated model description publication is planned by 2022. Applications are published in Lutz et al. (2012), Lutz, Meyer 2009a and b), Wiebe, Lutz (2016), and Wiebe et al. (2016).
Has model validation been done? Have model predictions been confronted with observed data (ex-post)?	yes	Simulation properties of the model are compared with results of other similar models such as E3ME, GTAP-E and GEM-E3.

References related to external peer-review and publication in scientific journals:

- No references provided in MIDAS

Transparency

Question	Answer	Details
Is the model underlying database (i.e. the database the model runs are based on) publicly available?	yes	Data are publicly available sources such as OECD (input-output tables, bilateral trade data), IEA (energy balances, energy prices, CO2 emissions), and other sources such as IMF, UN, World Bank, Eurostat.
Can model outputs be made publicly available?	yes	Depending on contract.
Is the model transparently documented (including underlying data, assumptions and equations, architecture, results) and are these documents available to the general public?	no	Not yet. It will be made available to the general public by 2022.
Is the model source code publicly accessible or open for inspection?	no	

References related to documentation:

- No references provided in MIDAS

The model's policy relevance and intended role in the policy cycle

The model is designed to contribute to the following policy areas

- Agriculture and rural development
- Climate action
- Economy, finance and the euro
- Employment and social affairs
- Energy
- EU enlargement
- Environment
- Transport
- Competition
- International cooperation and development
- Business and industry
- Trade

The model is designed to contribute to the following phases of the policy cycle

- Formulation
- Implementation
- Evaluation

The model's potential

Although GINFORS-E can be used for forecasting, the model is mainly used for evaluating the impacts of policy scenarios, changes in assumptions such as international energy prices or another change to model variables. The model can be enlarged to include more detail on interesting datasets, currently e.g. on the bioeconomy and energy technology goods.

The analysis is mainly forward looking (ex-ante), but can also inform implementation or evaluate previous developments ex-post.

Previous use of the model in ex-ante impact assessments of the European Commission

Use of the model in ex-ante impact assessments since July 2017.

In the Year	GINFORS-E contributed to the Impact assessment called	Led by	By providing input to the	The model was run by	Details of the contribution
2021	Impact assessment accompanying the document Communication from the Commission to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions: Forging a climate-resilient Europe - The new EU Strategy on Adaptation to Climate Change SWD/2021/25 final	CLIMA	Baseline and assessment of policy options	<i>Gesellschaft für Wirtschaftliche Strukturforschung</i>	The model helped to assess the following impacts: <ul style="list-style-type: none"> - EU Exports & imports - Investment flows & trade in services - Competition - Economic growth and employment - Impact on jobs - Impact on jobs in specific sectors, professions, regions or countries
2021	Impact assessment accompanying the document Proposal for a Council Directive: restructuring the Union framework for the taxation of energy products and electricity (recast) SWD/2021/641 final	TAXUD	Baseline and assessment of policy options	<i>RICARDO</i>	The model helped to assess the following impacts: <ul style="list-style-type: none"> - Affects on individual Member States - EU Exports & imports - Cost of doing business - Business' capacity to innovate - Market share & advantages in international context - Free movement of goods, services, capital and workers - Competition - Innovation for productivity/resource efficiency - Budgetary consequences for public authorities - Consumer's ability to benefit from the internal market or to access goods and services from outside the EU - Prices, quality, availability or choice of consumer goods and services - Significant effects on sectors - Impact on regions - Disproportionately affected region or sector - Goods traded with developing countries - Economic growth and employment - Investments and functioning of markets - Macro-economic stabilisation - Impact on jobs

- Impact on jobs in specific sectors, professions, regions or countries
- Indirect effects on employment levels
- Wages, labour costs or wage setting mechanisms
- Emission of greenhouse gases
- Emissions of acidifying, eutrophying, photochemical or harmful air pollutants
- Sustainable production and consumption
- Relative prices of environmental friendly and unfriendly products
- Pollution by businesses
- Environment in third countries
- Energy intensity of the economy
- Fuel mix used in energy production
- Demand for transport
- Vehicle emissions
- Energy and fuel consumption

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