FIDELIO: four modules linking input-output and general equilibrium modelling

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Abstract

Input-output models and general equilibrium models are largely recognized as useful tools for economic and environmental impact assessments. However, there are concerns raising from both approaches. One of the main criticisms that input-output models receive is that the results could be biased by the rigidities of the approach. On the other hand, general equilibrium models are often regarded as not transparent given their complexity, and highly dependent on the many assumptions that the model requires. The FIDELIO modelling approach tries to cope with these limitations, combining input-output and general equilibrium approach into a single model. Based on the previous versions of the model, FIDELIO 4 is re-built in a modular way that enables a decomposition of the model structure and results, improving its transparency and robustness. A comparison of the modelling results between four different modules allows for disentangling direct, indirect, investment, distributional and substitution/price effects. The four modules are as follows. (1) The input-output module estimates the direct and indirect effect by applying an input-output analysis. (2) The input-output investment module endogenizes the investment agent and activates capital accumulation. This module adds the investment effect to the direct and indirect effect. (3) The national accounts matrix module (also known as the social accounting matrix model) endogenizes households and the government, accounting for income and distributional effects. (4) The full econometric module activates prices adding a final layer and capturing substitution and price effects. Albeit requiring assumptions like any model, this approach attempts to improve the transparency of complex models by making effects more traceable and their robustness by allowing for a comparison of results using different modelling approaches. After a description of the model, for illustrative purposes this paper shows the model's functioning simulating the impact of the Horizon 2020 funding.

1. Introduction

The fourth version of the FIDELIO model[1] is an attempt to answer the recent need for more transparent general equilibrium models. Typically, this approach aims at answering different research questions using larger models that look at many impact channels simultaneously. The counter side is that these models are becoming more and more complex (Bulavskaya et al., 2014). This adds to the already existing complexity and uncertainty of such models due to their assumptions regarding elasticities, the lack of consensus regarding the economic foundations, and the data calibration process (Rivera et al., 2018).

A widely accepted but not widely used method to test the robustness of a general equilibrium model is sensitivity analyses (Harrison et al., 1987; Thissen, 1998). Sensitivity analyses test the robustness of the model with regards to elasticities. Systemic sensitivity analyses can manage the large number of required simulations but are not free from criticism. Approximation errors can be large with a Monte Carlo analysis due to its dimensionality. Gaussian quadrature addresses this issue but can in certain cases be too difficult to apply (Mary et al., 2019; Villoria and Preckel, 2017).

In this paper, robustness refers to the validation of model outcomes with a comparison of outcomes from different modelling approaches while transparency means that outcomes from policy simulations should be traceable inside the model (Devarajan, 2022). To improve the robustness and transparency of a general equilibrium model, this paper proposes to build a general equilibrium model using a modular approach, as in Bulavskaya and Reynès (2017). This method is applied to the FIDELIO model, which is developed in modules. In FIDELIO, modules can be switched on or off in order to go from a standard input-output (IO) model to a full econometric model. By doing so, we show that two of the most common economic impact assessment tools, IO and general equilibrium models (Koks et al., 2016), do not need to be viewed as substitutes (Rose, 1995; West, 1995), but are an integral part of a continuum of different economic models that have in common the IO data.

More specifically, the FIDELIO model is developed in four modules. The first module, the IO module, estimates the *direct* and *indirect effects* by applying an IO analysis. The indirect effect results from the link between sectors due to intermediary consumption. The advantage of IO analysis is that it is a widely accepted transparent impact assessment tool. The second module, the investment multiplier module, expands from the first module and endogenizes the investment agent and activates capital accumulation. This module estimates the *investment effect* in addition to the direct and indirect effect of the first module. It isolates the capital (accumulation) effect from other effects. The third module is the national accounts matrix (NAM) module (also known as the social accounting matrix model). It endogenizes, in addition, households and the government. It closes the system with the (re)distribution of incomes and thus this module simulates in addition the *distributional effects*. Similar to the IO analysis, a NAM analysis is considered transparent as it is mainly dependent on the NAM data and requires few assumptions. The final and full module activates prices in addition to the third module and simulates the *substitution* and *price effects*. The majority of a general equilibrium model's behaviour that is considered complex and untransparent are isolated in this module. Substitution relies on assumed elasticities and the type of model closure can define the result to a large extent.

A comparison of the modelling results between the four modules, allows for the dissociation of direct, indirect, investment, distributional and substitution/price effects. This modular approach thus enables a decomposition of modelling results. It increases the traceability of the many effects occurring

[1] FIDELIO stands for "fully interregional dynamic econometric long-term input-output" model.

simultaneously inside a general equilibrium model. This can improve the interpretation of general equilibrium modelling results as well as increase the understanding of a model's properties.

The paper is structured as follows. Section 2 describes in more detail the modular approach of FIDELIO, highlighting the main characteristics and equations. Section 3 and 4 describe the simulation scenario and results, respectively. Section 5 concludes.

2. Modular approach of FIDELIO

FIDELIO stands for Fully Interregional Dynamic Econometric Long-term Input-Output model. It is a flexible model that can switch from an IO analysis to a full general equilibrium model with Neo-Keynesian market imperfections. This flexibility is enabled by having four modules. Each module includes a different number of thematic blocks of equations described in this section and summarized in the table below.

Table 1: Overview of FIDELIO modules

Equation blocks	Module 1: Input-Output analysis	Module 2: Input-Output with Investment	Module 3: National Accounts Matrix	Module 4: Full model
Input-Output block	●	●	●	●
Production block	●	●	●	●
Investment block		●	●	●
Consumption block			●	●
Government block			●	●
Price block				●

Module 1: input-output analysis (direct and indirect effect)

Module 1 is the core of FIDELIO and represents a multi-regional IO model. It is a demand-driven model, in the tradition of the IO framework. Therefore, the output of each industry i in region r, $Q_{r,i}$,is determined by the aggregated demand for domestic commodities:

$$Q_{r,i} = \sum_c \left(MKT_{r,c,i}^{SHR} \; DTOT_{r,c} \right) \tag{1}$$

Where $MKT_{r,c,i}^{SHR}$ is the exogenous market shares matrix used to convert demand for commodities $DTOT_{r,c}$ to industry output.[2] The circular interdependence between sectors is captured through the IO coefficients. A change in one sector leads to a change in the supplying sectors. This is called the *direct effect*. In turn the changes in the supplying sectors lead to changes in their supplier sectors too and so on. This is called the *indirect effect*. The open Leontief model assumes exogenous final demand and exogenous production technology.

The IO block includes the equations for the technical coefficients, domestic (co)production, taxes less subsidies and trade and transport margins. As a multi-regional model, FIDELIO includes bilateral trade flows across countries. First, the model defines the demand for imported commodities of each

[2] In this section we refer to the key equations of each module to describe the main characteristics of the model. For a complete description of all equations of FIDELIO, see Rocchi et al. (2023).

country. Then, it splits import demand among trading partners. Finally, from import by trading partner, it derives the volume of export.

The production block assumes imperfect competition by including a mark-up over the costs. The production function follows the constant elasticity of substitution (CES) specification. As this module simulates an IO analysis, all prices, including the mark-up, appearing in the production function and trade equations are deactivated. Notice that prices are kept as exogenous variables in the equations, and they are activated only in module 4. Without endogenous prices, substitution is not possible between products, production factors or trading partners.

Module 2: Input-Output with investment (investment effect)

The second module includes the investments block, in addition to the blocks from module 1. Module 2 endogenizes the investment agent and activates capital accumulation. This module estimates the *investment effect* in addition to the direct and indirect effect from module 1. The investments are defined as follows:

$$I_{r,i} = I^{SHR}_{r,i} Q_{r,i} \left(\frac{K^{n}_{r,i,t-1}}{K_{r,i,t-1}}\right)^{0.05} \left(\frac{P^{K}_{r,i}}{P^{KLE}_{r,i} prod^{K}_{r,i}}\right)^{-\sigma KLE} \quad (2)$$

where I stands for the investments by region r and sector i, I^{SHR} for the share of investment, Q for the output, K^{n} for notional capital, K for effective capital, P^{K} for the price of capital, P^{KLE} for the price of capital-labour-energy and $prod^{K}$ for capital productivity. While the notional demand of capital is the one resulting from cost minimization, the effective demand of capital depends on the capital demand of the previous period, and the level of investment of the current period. The capital accumulation follows the Perpetual Inventory Method and is as follows:

$$K^{VAL}_{r,i,t} = (1-\partial) K^{VAL}_{r,i,t-1} + I_{r,i,t} P^{I}_{r,i,t} \quad (3)$$

Capital stock in value $K^{VAL}_{r,i,t}$ by region r, industry i and year t equals the capital stock in year $t-1$ minus depreciation, defined by the depreciation rate ∂, plus investments $I_{r,i,t}$ times the price of investments $P^{I}_{r,i,t}$. In module 1 this equation is not included. In modules 2 and 3 capital and investments become endogenous. The price of investments remains exogenous as all prices are exogenous in the first three modules. Then, in module 4 the investment price becomes endogenous and the full capital accumulation equation is used.

Table 2: Endogenous variables per module of capital accumulation equation

Equation/ Variable	Notation	Module 1: Input-Output analysis	Module 2: Input-Output with investment	Module 3: National Accounting Matrix	Module 4: Full model
Capital in value	$K^{VAL}_{r,i,t}$	-	endogenous	endogenous	endogenous
Investment	$I_{r,i,t}$	-	endogenous	endogenous	endogenous
Price of investment	$P^{I}_{r,i,t}$	-	exogenous	exogenous	endogenous

Module 3: national accounts matrix framework (distributional effect)

Compared to module 2, module 3 endogenizes the households and government choices. It includes the income distribution amongst institutions as well as the final consumption by households and government. The distribution of incomes refers to the transfer of generated income from sectors to households and government. Income is redistributed between households and the government through social transfers. This income is then used as expenditure by households and the government for the consumption of products. Thus, the income is given back to the sectors and thus the loop is closed.

Miming the main household income components of national accounts data, the model assumes that households receive their income through five main channels. First, they receive wages $VACOM_{r,i,w}^{VAL}$. A second source of income is the share of operating surplus that goes to households $HOPSUR_r^{VAL}$. Another key source of income is the income received by virtue of owning property, which is property income $HPROPINC_r^{VAL}$. The last two components of the total household income are transfers paid by the government to households $HTRAN_r^{VAL}$ and other transfers $HOTHTRAN_r^{VAL}$. Disposable income is the sum of the different sources of income, minus taxes $HTAX_r^{VAL}$ and social security contribution that households have to pay $HSSC_r^{VAL}$:

$$HDY_r^{VAL} = \sum_i \left(VACOM_{r,i,w}^{VAL}\right) + HOPSUR_r^{VAL} + HPROPINC_r^{VAL} + HTRAN_r^{VAL} + HOTHTRAN_r^{VAL} - HTAX_r^{VAL} - HSSC_r^{VAL} \quad (4)$$

Households consume depending on their disposable income HDY_r^{VAL} and their propensity to save $HSAVR_r$. The basic version of the consumption equation assumes a LES utility function. The notional level of consumption $USE_{r,c,pc}^{ppn}$ is then:

$$USE_{r,c,pc}^{ppn} = \overline{USE}_{r,c,pc}^{ppn} + \left(\frac{HUSE_{r,c}^{SHARE}\left((1-HSAVR_r)HDY_r^{VAL}\right)}{P_{r,c,pc}^{USE}}\right) \quad (5)$$

Where $\overline{USE}_{r,c,pc}^{ppn}$ stands for the minimum or subsistence level of consumption, $HUSE_{r,c}^{SHARE}$ for the product shares of any consumption on top of the subsistence level and $P_{r,c,pc}^{USE}$ for the household price of goods. Household consumption is another variable of the model assumed to adjust slowly to its optimal level. The savings rate depends on the interest rate ir_r, inflation $CPI_{r,pc,t-1}$ and unemployment rate U_r:

$$HSAVR_r = \overline{HSAVR}_r + \alpha_{s1}\left(ir_r - \Delta\ln\left(CPI_{r,pc,t-1}\right)\right) - \alpha_{s2}U_r \quad (6)$$

The consumption shares $HUSE_{r,c}^{SHARE}$ are exogenous only in the case of a Cobb-Douglas utility function where the elasticity of substitution between every commodity is one. To describe in more detail consumption choices, in FIDELIO the household consumption shares are modelled using the almost ideal demand system (AIDS). The advantage is that price elasticities γ_c differ per product and consumption patterns β_j depend on the household level of income, distinguishing between necessity and luxury goods (Henningsen, 2017).

$$HUSE_{r,c}^{SHARE} = \sum_c \gamma_c \, ln\left(CPI_{r,c,pc}\right) + \beta_j \, ln\left(\frac{USE_{r,c,pc}^{ppn}}{CPI_{r,pc}}\right) \quad (7)$$

The government block describes the accountancy relations between governmental revenues and expenses, with the resulting budget imbalance that determines the dynamic of the government debt.

The income distribution creates an additional multiplier effect, which we call the *distributional effect*. With this addition, the model is closed with respect to households and government and uses the full NAM framework. Note that a standard closed-loop Leontief system closes the income loop for households only and keeps the government account exogenous (Pyatt and Round, 1979; Defourny and Thorbecke, 1984).

Module 4: full model (substitution and price effect)

The full module includes all equations that describe prices. The behavioural prices that are determined by agents' rational choices are wages, production prices and interest rates. The Wage Setting curve is described as follows:

$$ln(W_{r,i}^{n}) = \bar{W}_{r,i}^{res} + ln(CPI_{r,pc,t-1}) + ln(fprod_{r,i,l}) - \alpha_u U_{r,t-1} \quad (8)$$

Where the notional wage $W_{r,i}^{n}$ is positively affected by inflation $CPI_{r,pc,t-1}$ and productivity $fprod_{r,i,l}$ but negatively by unemployment $U_{r,t-1}$. The notional price of output $PQ_{r,i}^{n}$, by region r and industry i, depends on the cost of factors of production $COSTQ_{r,i}$ and the producers mark-up $\mu_{r,i}$ as in the following equation:

$$PQ_{r,i}^{n} = \frac{(1+\mu_{r,i})COSTQ_{r,i}}{Q_{r,i}} \quad (9)$$

Finally, the Taylor rule defines the interest rate:

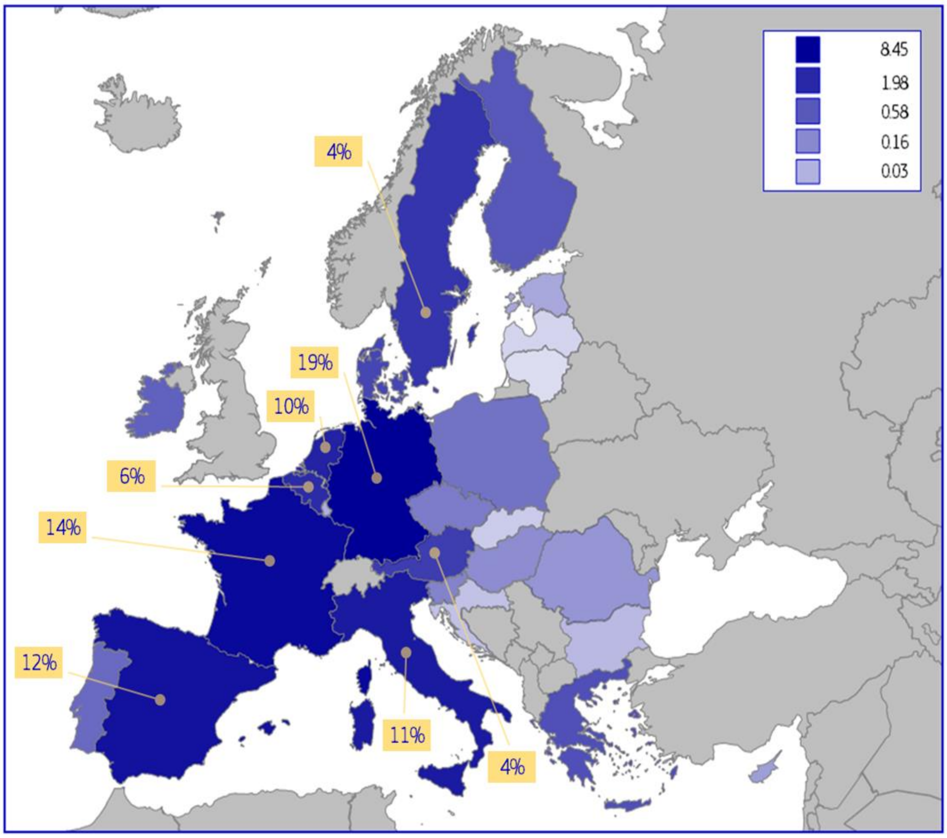
$$irn_r = \rho_1^{ir} + \rho_2^{ir} \Delta\, ln(CPI_{r,pc,t-1}) - \rho_3^{ir} U_r \quad (10)$$

To complete the price block, the model defines 16 other prices that are linear transformations of the behavioural prices and are used to define some of the variables of the model. All prices appearing in the equations in previous modules were exogenous but are changed to endogenous variables in this module. As a result, relative price differences can be simulated and *substitution* can take place. There is substitution amongst the different products, between imported and domestic products, amongst the trading partners and between factor inputs. Another result from having endogenous prices is the *price* effect. This refers to the fact that price changes affect demand. A product price drop would lead to an increase in demand of that product.

3. Simulation scenario

The proposed method will be applied to evaluate the Horizon 2020 program, the predecessor of Horizon Europe. Horizon 2020 is the European Union's Framework Programme for Research and Innovation covering the years 2014 to 2020. The funding program aims to ensure excellent science and industrial innovation, in order to ultimately secure Europe's global competitiveness. It has a budget of around 89 billion euros thereby causing it to be the largest EU Research and Innovation programme at the time of its implementation. This study focuses on the EU net contribution paid effectively to firms in the EU Member States which totals 43.7 billion euros.

Figure 1: Geographical distribution of H2020 fundi



Source: Funding & tender (Single Electronic Data Interchange Area - SEDIA) and own calculation

Projects under the H2020 are carefully selected on a competitive basis making an uneven participation and geographical budget distribution unlikely. Between 2014 and 2020, the majority of the funding went to EU15 countries and in particular to Germany (18.78%), France (13.92%), Spain (11.82%) and Italy (10.59%) while EU13 countries such as Malta, Lithuania, Latvia, Croatia, Slovakia and Bulgaria have received less than 1% of the same funds. These differences could be explained by the size and performance of the national research innovation systems and the country connection to European research collaboration networks.

According to the main objectives, H2020 has invested mostly in projects related to Societal Challenges (61,22k projects), Excellent Science (39.54k projects), Industrial Leadership (32.8k projects) and Science with and for Society (2.16k projects). Within these key aims, H2020 focussed on specific topics. "Excellent science" mainly targets 'Professional, scientific and technical activities' and education by investing in frontier research, collaborative research to open new fields of innovation, opportunities for training and career development and ensuring access to world class research infrastructure. "Industrial Leadership" mainly targets manufacturing and information and communication technologies, while "Societal Challenges" targets health, food security, clean and efficient energy, transportation and manufacturing. "Science for Society" again many targets the 'Professional, scientific and technical activities'. As a general result, all member states retrieve the majority of H2020 contributions in either Scientific R&D or Education, leaving a more diversified distribution at the industry level conditioned to the characteristics of the countries.

In this sense, two types of economic effects are expected. The first effect refers to the rippling effect throughout the economy brought about by spending on R&I. This is called the Keynesian multiplier effect and occurs with spending on any type of product. The second effect is the increase in productivity due to technical progress and only occurs through spending on R&I. This is called the return on R&I. The two different effects follow a different mechanism in the FIDELIO model.

The Keynesian multiplier effect is modelled as an increase in R&I spending. The Horizon 2020 funding leads to an increase in R&I activities in the sectors that receive funding. The sectoral R&I activities are embodied in the coproduction of product “CPA_M72 - Scientific research and development services” on the supply side. The coproduction of product M72 increases according to the allocation of Horizon 2020 funding by country and by sector as shown in Figure 1 and in Annex A.

The second order effect, that is the productivity increase, is modelled by introducing returns on R&I into FIDELIO exogenously. Econometrically estimated returns on R&I at country and sector level from Pedauga et al. (2022) are translated into additional value as a result from the Horizon 2020 funds. The additional value added by country and sector is included in FIDELIO as an exogenous trajectory.
The FIDELIO model is calibrated on the FIGARO multi-regional Supply and Use tables at 64 sectoral level, published by Eurostat. The FIDELIO database is further supplemented with indicators from Eurostat, UN, OECD, World Bank and ILO in order to produce the full National Accounting Matrix extended with demography and energy in physical units, see also Rocchi et al. (2023).

4. Simulation results

The simulated impact of the Horizon 2020 funding for firms in the EU27[3] is expressed as the additional GDP in percentage difference compared to the baseline scenario. The results of four simulation runs are shown, each using a different FIDELIO module.

Figure 2: Impact of H2020 on EU27 GDP in % difference compared to baseline scenario

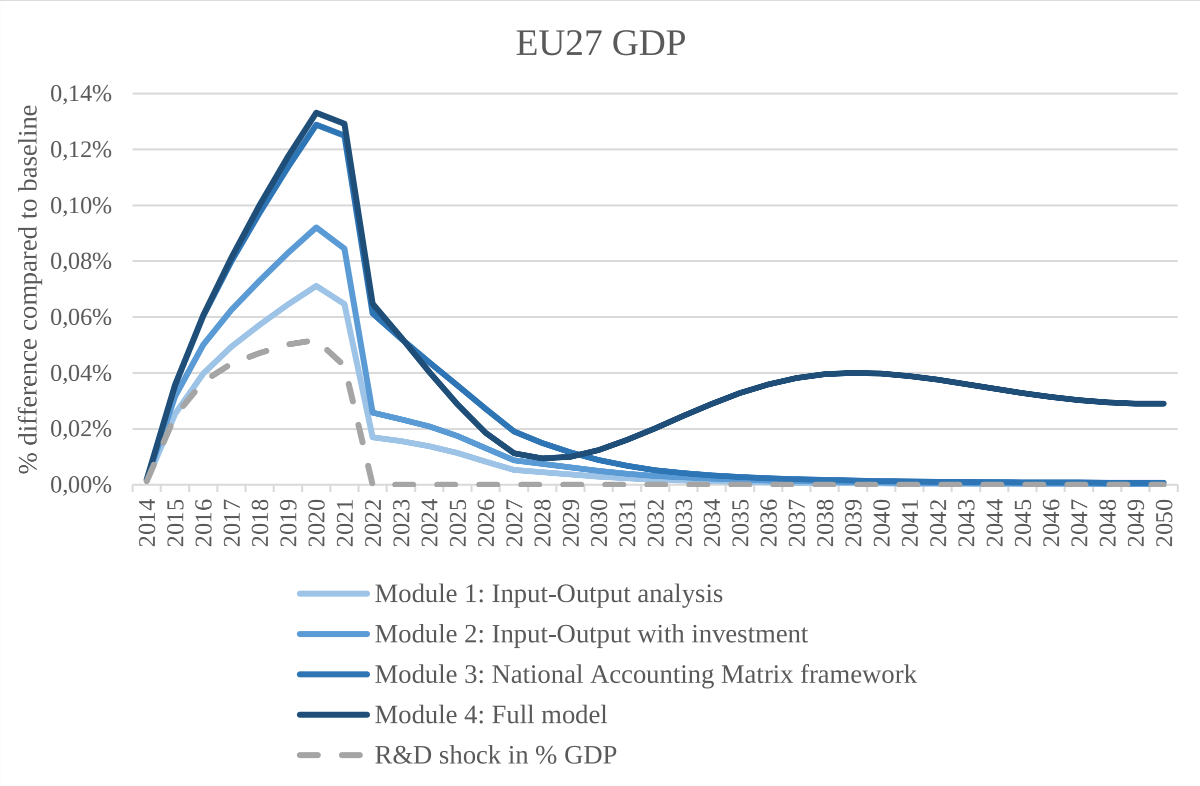


Table 3: Impact of H2020 on EU27 GDP in difference compared to baseline, accumulated between 2014-2050, in bln euro

	Module 1: Input-Output analysis		Module 2: Input-Output with Investment	Module 3: National Accounting Matrix	Module 4: Full model
	Direct effect / H2020	*Indirect effect*	*Investment multiplier effect*	*Distributional effect*	*Substitution and price effects*
Additional GDP per type of effect	43.7 (0.4%)	30.2 (0.3%)	27.2 (0.2%)	55.5 (0.5%)	196.3 (1.8%)
Additional GDP cumulative	43.7 (0.4%)	73.9 (0.7%)	101.2 (0.9%)	156.7 (1.4%)	353.0 (3.2%)

[3] EU27 refers to the EU27 from 2020 onwards, that is without the United Kingdom and with Croatia.

The first module applies an IO analysis. The estimated direct and indirect effect amounts to 0.7% additional GDP accumulated in the period 2014-2050. This effect stems from the sectoral interdependencies. The value added multiplier equals 1.2, meaning that for each euro of Horizon 2020 funding, 1.2 euro value added is created. The output multiplier equals 1.75.

Module 2 includes the effect of the investment agent and capital accumulation. The total additional GDP compared to the baseline is 0.9%. However, the additional GDP that can be attributed to the investment agent and the role of capital accumulation is 0.2%, that is the difference compared to the additional GDP from module 1.

The largest contributor to the total effect in the short run (until 2030) is the distributional effect modelled in module 3. The distributional effect is 0.5% of GDP. Households and the government benefit from the increased productivity and generated income. As a result, the government spends more on R&I as well. This additional income is used as additional expenditure that creates an extra stimulus.

However, in the long term the largest contributor to the total effect is the substitution and price effects from module 4. Where the impact of the first three modules fades over time, module 4 shows a permanent positive effect in the long run. This permanent effect comes from the fact that sectors receiving the Horizon 2020 funds, can benefit from substitution. Substitution is possible when relative price differences are modelled, which is only the case in module 4. Substitution ensures that sectors can benefit from their increases productivity compared to other sectors and trading partners can benefit from their new comparable advantages.

The price effect makes that a stimulus into the economy is counterbalanced with price increases. In the short run until 2030 it seems that the positive substitution effect compared to module 3 is offset by the price effect.

5. Conclusions

This paper proposes a modular approach for general equilibrium models to improve the robustness and transparency of general equilibrium models. Modules can be switched on and off to go from an IO analysis to a full econometric model. This isolates the effect of specific agents and mechanisms into one module giving transparent insights into the mechanisms of the model and thus improving its transparency. A comparison of results from the four modules also allows for validation of results, improving its robustness. The FIDELIO model is used for an impact assessment of the Horizon 2020 funding. Results show that substitution effects have a positive and permanent effect on the economy. Price effects offset this positive effect in the short run, making the net result similar to the result from a National Accounting Matrix framework with closed-loop effects for household and government. This effect can be further distinguished into the direct, indirect, investment and distributional effect. The distributional effect seems to be the largest effect, meaning that the spending by households and government of their additionally received income, resulting from the Horizon 2020 stimulus, has a large effect on the economy. The direct and indirect effect can be expressed as a multiplier. The output multiplier is 1.75. For every euro of Horizon 2020 funding, 1.75 euro production is generated. This comparison of results from the four modules acts as a check of the robustness of the FIDELIO model. It also provides transparency by being able to trade the effect of a specific agent or mechanism.

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Annex A: Distribution of Horizon 2020 funding per country and per sector

Table 4: Budget allocation of the Horizon 2020 effective EU net contribution paid to firms, per sector

Sector code	Sector name	Distribution
A01	Crop and animal production, hunting and related service activities	0.1%
A02	Forestry and logging	0.0%
A03	Fishing and aquaculture	0.0%
B	Mining and quarrying	0.1%
C10-C12	Manufacture of food products; beverages and tobacco products	0.2%
C13-C15	Manufacture of textiles, wearing apparel, leather and related products	0.1%
C16	Manufacture of wood and of products of wood and cork, except furniture; straw and plaiting mat.	0.0%
C17	Manufacture of paper and paper products	0.1%
C18	Printing and reproduction of recorded media	0.0%
C19	Manufacture of coke and refined petroleum products	0.0%
C20	Manufacture of chemicals and chemical products	0.8%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.3%
C22	Manufacture of rubber and plastic products	0.2%
C23	Manufacture of other non-metallic mineral products	0.2%
C24	Manufacture of basic metals	0.2%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.5%
C26	Manufacture of computer, electronic and optical products	2.4%
C27	Manufacture of electrical equipment	0.6%
C28	Manufacture of machinery and equipment n.e.c.	1.3%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.6%
C30	Manufacture of other transport equipment	1.6%
C31_C32	Manufacture of furniture; other manufacturing	0.4%
C33	Repair and installation of machinery and equipment	0.2%
D35	Electricity, gas, steam and air conditioning supply	0.8%
E36	Water collection, treatment and supply	0.1%
E37-E39	Sewerage, waste management, remediation activities	0.2%
F	Construction	0.5%
G45	Wholesale and retail trade and repair of motor vehicles and motorcycles	0.0%
G46	Wholesale trade, except of motor vehicles and motorcycles	0.9%
G47	Retail trade, except of motor vehicles and motorcycles	0.2%
H49	Land transport and transport via pipelines	0.2%
H50	Water transport	0.0%
H51	Air transport	0.0%
H52	Warehousing and support activities for transportation	0.4%
H53	Postal and courier activities	0.0%
I	Accommodation and food service activities	0.2%
J58	Publishing activities	0.4%
J59_J60	Motion picture, video, television programme production; programming and broadcasting activities	0.1%
J61	Telecommunications	0.9%
J62_J63	Computer programming, consultancy, and information service activities	5.1%
K64	Financial service activities, except insurance and pension funding	0.4%
K65	Insurance, reinsurance and pension funding, except compulsory social security	0.0%
K66	Activities auxiliary to financial services and insurance activities	0.1%
L68	Real estate activities	0.6%
M69_M70	Legal and accounting activities; activities of head offices; management consultancy activities	2.1%
M71	Architectural and engineering activities; technical testing and analysis	4.0%
M72	Scientific research and development	31.1%
M73	Advertising and market research	0.2%
M74_M75	Other professional, scientific and technical activities; veterinary activities	0.9%
N	Administrative and support service activities	1.3%
O84	Public administration and defence; compulsory social security	1.5%
P85	Education	31.3%
Q	Human health and social work activities	1.9%
R_S	Arts, entertainment and recreation; Other service activities	4.5%
T	Activities of households as employers; undifferentiated activities of households for own use	0.0%
U	Activities of extraterritorial organisations and bodies	0.0%
Total		100%

Source: Funding & tender (Single Electronic Data Interchange Area - SEDIA) and own calculation