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Growth, Prosperity and the environment: Integrating environmental and social indicators into QUEST

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Abstract: Currently the EU and the world face several complex and interconnected challenges. These range from climate change and loss of biodiversity to high levels of inequality and precarious work. At the same time, there is a growing discontent with politics not being able to provide appropriate problem solutions. Over the last years, however, an enormous quantity of ecological and social indicators has been brought up that may serve as a new compass in addressing these challenges and accessing wellbeing and sustainability at the same time. Our contribution shows how these indicators can help to better navigate policymaking while considering sustainability and wellbeing and to replace the currently dominant, GDP-focused approach. The paper gives an insight into the results of an ongoing research project funded by the German Federal Environment Agency, exploring how ecological and social indicators can be better integrated into macroeconomic models (Diefenbacher et al. 2019). The focus of the paper lies on integrating new ecological and social indicators into QUEST, the global macroeconomic policy simulation model of the European Commission's Directorate-General for Economic Affairs and Finance (DG ECFIN).

Keywords: Sustainability, Beyond GDP, macroeconomic models, QUEST, ecological and social indicators

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1 Introduction

> "Taking the EU and the world on a sustainable path requires a deep economic and societal transformation across the board [...] recognising the unique sustainability struggles that Europe faces [...]: not just climate change, air pollution and loss of biodiversity, but also ageing populations, fiscal unsustainability, depressed productivity growth, high levels of unemployment and the spread of more precarious forms of work." (European Political Strategy Centre 2019)

In light of this dramatic transformation, the complexity of policymaking today could not be any higher. Policymaking is confronted with various but often conflicting objectives like decarbonizing the economy, providing social inclusion and ensuring high levels of employment.

In the past, a rising GDP was the major and easily understandable proxy for societal and economic development and a means to simultaneously achieving different objectives. For several decades, GDP has been quite successful in this role. However, it was never designed to be a comprehensive measure of prosperity, sustainability and well-being.

Therefore, in recent history various approaches have emerged, addressing the question of how *"to find a new measure to assess the health of our economies and – more importantly – the people living in them"*, as the World Economic Forum describes the challenge of our time (World Economic Forum 2019).

In 2009, the "Commission on the Measurement of Economic Performance and Social Progress" (CMEPSP) (Stiglitz et al. 2009) and in 2013 the European Commission's Communication on "Progress on 'GDP and Beyond' actions" (European Commission 2013) proposed a comprehensive list of social and ecological indicators that resulted in new data collection by EUROSTAT (Eurostat 2019). On the supranational level the OECD developed the "Better Life Index"[1] in 2011, which measures different dimensions of well-being and progress (Organisation for Economic Cooperation and Development 2011). Since 2016, the Sustainable Development Goals (SDGs) offer an even bigger set of indicators, altogether 17 goals and 169 targets.

On the national level, Slovenia reoriented its national policies combining the SDGs with their citizens' vision of 2050 (Government Office for Development and European Cohesion Policy 2017). Finland used the SDGs as an inspiration to determine its national budget (Hege and Brimont 2018). Further examples include the initiative of Scotland, New Zealand and Iceland, which in 2018 launched the Wellbeing Economy Governments initiative, aiming at *"sharing [...] experience and expertise among officials working to embed wellbeing outcomes in economic policy"* (Wellbeing Economy Governments 2019).

[1] http://www.oecd.org/statistics/measuring-well-being-and-progress.htm.

However, even if the data are available, their application in practice remains limited, as the EU funded project BRAINPOoL has shown for the EU (Whitby et al. 2014). A relevant bottleneck are macroeconomic models, which are an important tool in assessing the impact of policy proposals. Traditional economic models often focus on economic indicators such as GDP as main categories of success, too often neglecting interlinkages of economic with environmental and social aspects (Pollitt et al. 2010; Diefenbacher et al. 2019).

Motivated by this observation, we describe how different ecological and social indicators could be put at the core of economic models. We thereby draw from the analysis of different model classes within an ongoing research project funded by the German Federal Environment Agency. The project itself is not explicitly concerned with the development of new macroeconomic models or indicators of its own. Instead, it aims to answer the question how existing environmental and wellbeing indicators can be integrated into existing economic models. The innovative aspect of the project lies in bringing together actors associated with indicator development with modelers from different theoretical and methodological backgrounds and thus initiating a discourse on the limits and possibilities of current economic modelling.

The focus of the present paper lies on QUEST, the global macroeconomic policy simulation model of the European Commission's Directorate-General for Economic Affairs and Finance (DG ECFIN). By assessing possibilities for adjustments within QUEST, we aim to show how different dimensions of development can be made accessible and more relevant for policymakers in the EU, demonstrating how the extension of economic models can be one cornerstone of navigating policymaking beyond GDP in a comprehensive and satisfactory way.

2 Integrating new indicators into macroeconomic models

One source for newer approaches in modelling wellbeing is the field of ecological economics. Often, ecological economists are driven by the question how an economy is capable of providing sustainable prosperity within planetary boundaries (Rezai and Stagl 2016; Hardt and O'Neill 2017). In pursuit of an answer, the field has developed new macroeconomic approaches which integrate aspects of the sustainability transition like environmental impacts, inequality outcomes and financial stability (Jackson et al. 2014). This approach, referred to as "Ecological Macroeconomics", enriches the possibilities of macroeconomic modelling. As it includes the whole spectrum of macroeconomic models, it can draw from the strength of different modelling approaches like optimisation models (CGE, DSGE), macro-econometric approaches, Input-Output models, System Dynamics models, Stock-Flow Consistent models or Integrated Assessment

models (Scrieciu et al. 2013; Hardt and O'Neill 2017).

The project uses a two-step approach to answer the research question: Firstly, a comprehensive list of promising environmental and social indicators has been developed. From this list, a reduced set of core indicators has been derived. These indicators have then been mapped to a list of established policy relevant macroeconomic models as well as a selection of innovative less well-known models in order to determine the status quo of already integrated indicators and identify potentials for integrating the analysed indicators.

2.1 Step one: Deriving a list of indicators for possible model extensions

Macroeconomic models have different backgrounds and objectives. Consequently, the extent to which ecological and social indicators are already integrated in models is highly diverse. Concerning ecological indicators, it ranges from models with little or no reference to environmental issues to models that explicitly take environmental issues into account.

The project therefore developed a comprehensive list of indicators and proposes an integration of selected indicators based on the existing coverage of environmental and welfare issues within the type of model at hand (see Figure 1). In doing so, it was ensured that despite different levels of already integrated indicators, it was still possible to realize the potential for improvement.

In the case of models with little or no reference to environmental issues, indicators that aim to give a first outlook on the environment-economy interrelation are included. If the model already has some links to environmental issues, further indicators based on environmental costs are available as a possible extension. For models that are explicitly oriented towards dealing with environmental topics, the depth of indicator assessment can go to a level that can give an appropriate insight into the critical loads and quality of the ecosystem.

Regarding wellbeing indicators, accounting-indices like the national welfare index (Diefenbacher et al. 2016), as well as supplementing indicators like the distribution of income and composed indicators like the amount of "happy life years" are chosen.

2.2 Step two: Model categorization and selection

In order to identify politically relevant models suitable for an integration of environmental and social indicators, three criteria where developed. They should:

a) be used in Germany, at EU level or by international organizations

b) be used for decision-making

c) have a significant public perception.

In addition, models from the relatively new research field of Ecological Macroeconomics were identified that do not fulfil the criteria a – c but could provide possible new approaches regarding the integration of environmental and welfare indicators.

Altogether, 35 models were identified, of which 10 are General Equilibrium models (DART, DICE ENV Linkages, GEAR, GEM-E3, ICES-FEEM-SI, NAWM, NiGEM QUEST, REMIND, WIOD-CGE), 7 macro econometric models (DEFINE, E3ME, GINFORS, IMAGE, IMK, PANTA RHEI, VIEW), 13 models with a system-dynamics background (ASTRA, D3, D3EE, D3 Planspiel, EURO-GREEN, FALSTAFF, GEER, ICES-FEEM-SI, InternationalFutures, LowGrow SFC, Medeas, METANOIA, WoW) and 5 agent-based models (ENGAGE, EURACE, Lagom, MOTMO, STOEMSys).

According to their modelling class, relevance, contacts to the modelers and improvement possibilities, out of the 35 models 8 were identified for a feasibility study, (E3ME, NAWM, PANTA RHEI, WoW, IMK-Model, MEDEAS, NiGEM, QUEST).

3 The Example of QUEST

3.1 Integrating environmental indicators into QUEST

In this section, a summary of the feasibility study for the QUEST model is presented. QUEST is used for policy simulations in the EU mainly to assess the impact of structural reforms in individual member states, the domestic and EU-wide effects of fiscal and monetary policy measures, questions of foreign trade imbalances between member states or the impact of EU cohesion funds. The model's core is a medium-scaled Dynamic Stochastic General Equilibrium (DSGE) model, which is in principle suitable for welfare analysis via an integrated utility function of a representative household. This household aims to maximize its utility from consumption and leisure time (as opposed to work time) under income and time constraints. Generally, the model is quickly adaptable to new research questions, which is reflected in the amount of publications concerning timely policy issues related to the QUEST model (Institute for Monetary and Financial Stability 2018).

The analysed target variables are usually monetary variables such as GDP, price level, state budget and social variables such as employment or the unemployment rate. Other social and environmental factors do not play a dominant role in the basic version of the model. However, there is an extension to a green version of QUEST (Conte et al. 2010) that focuses on the environmental sector and the effects of policy measures to promote investment in CO_2-reducing innovations. Moreover, (Roeger et al. 2019) use another variant of QUEST to study the effects of structural reforms on income distribution. Starting from the green version of QUEST, the integration of ecological indicators is discussed,

Figure 1: Overview of possible ecological and welfare indicators and indices (Diefenbacher et al. 2019).

followed by social indicators.

Green QUEST distinguishes two forms of energy production: "dirty and non-regenerative" and "regenerative". The model has integrated various economy-environment interdependencies. The five producing sectors already include the impacts on CO_2-emissions, where CO_2 is used as a proxy for all greenhouse gases. A more complex modelling of other greenhouse gases is principally possible with differentiated product groups. Consumer behaviour is interdependent with emissions. The intertemporally optimizing households consider how climate change may affect the quality of leisure time within their utility function. That is, how climate change may affect consumer behaviour and production. However, the model also incorporates typical public goods externalities such that the private provision of environmental protection and related innovations is insufficient, leaving a role for policy interventions.

Structural changes to the economy resulting from policy interventions targeting CO_2-emissions either with certificates, taxes or subsidies can be analysed with the model. Due to the use of input-output tables, detailed figures on energy and material consumption are available for the various sectors. Therefore, an extension of the model to further integrating energy productivity and raw material equivalents seems feasible. This would allow modellers to report on the efficiency and the absolute usage of exhaustible resources and analyse the major role of energy in the production process (Kümmel 2011). Consequently, the environmental consequences related to increasing production would be more visible leading to more realistic policies.

Concerning energy, the built-in technological change in production techniques makes it possible to map different energy productivities. These also have a steering function in the model, because optimizing firms and investors will in consequence use more productive techniques. Raw material equivalents could be included for different commodity classes. Even though there is only one representative final product, its material structure would change and thus might foster a change in household preferences.

One other line of extension lies in the analysis of global interdependencies. Green QUEST has only a rough representation of the rest of the world. Other versions of QUEST

III, however, have a more sophisticated foreign sector, which may also be implemented in Green QUEST. In this case, effects of technological spill over, global ecological footprints, carbon leakage and the relocation of resource intensive production technologies could be better understood.

3.2 Integrating social welfare indicators into QUEST

From a social welfare perspective, the project analysed whether the National Welfare Index (NWI), which is the German version of the ISEW, can serve as an index for assessing welfare gains of QUEST. The NWI includes several ecological indicators which are already discussed above. Additional social welfare elements are usually part of a multi-dimensional approach to welfare measuring. Indicators, which are discussed here, include unpaid care work and voluntary work, costs of traffic and crime, the distribution of income and expenditures on education and health.

Addressing the welfare derived from unpaid care work and volunteering would require a major reorganisation of the model. The resulting value added must be integrated into the output calculation, including a determination of prices and substitution relationships between domestic work and market services. The most difficult part, however, would certainly be to model a suitable micro-foundation for the preferences of households, e.g. integrating voluntary work or the care of relatives into the optimization calculus.

The costs of traffic accidents and crime are very specific individual factors that could probably only be adequately integrated at great expenses. In addition, the required data from sub-indicators of the NWI are not available for all EU countries. Comparative values from similar countries would then have to be used for calibration.

Distributional effects can only be integrated in a very rudimentary way. "Green QUEST" is based on a Cobb-Douglas production function leading to a fixed functional income distribution. There are some elements in QUEST which soften this limit, for example the use of "overhead labour costs" as well as the circumstance of monopolistic competition in the product markets leading to rents, which are also regarded as capital income and thus make the functional distribution dependent on the degree of monopoly. In the version of (Roeger et al. 2019), household incomes and wealth are differentiated by two dimensions: qualification (low, medium, high) which is exogenously given and determines incomes and consumption rules which determine savings and thus the availability of wealth or credits. In sum, it is possible to create an artificial distribution measure between the different income groups ignoring differences within the groups. A comparison of personal inequality, e.g. by means of the widely used Gini index, is not possible since within-group inequality is not modelled. In addition, the existence and impact of super-rich households does not seem to be easily capable of being integrated into the model, even though their specific impact on global consumption, production, emissions and innovation seems to be relevant (Kaplan et al. 2014; Autor et al. 2017).

In a very simplified version, the NWI could thus be integrated into the model and policy simulations could be evaluated based on the expected welfare effects.

Another aspect of a wider look at prosperity is education, which is a major determinant of social inclusion. The integration of the aggregated educational index seems rather difficult, as in QUEST education is only modelled through exogenous human capital. Here, some improvements seem workable, albeit with quite some effort. One approach might be to endogenize training costs by the introduction of investments into education. At the same time, the household budget constraints will have to include training time and household utility would be affected by the overall education level, which would also be affected by a more disaggregated government consumption including education expenses.

Health is not part of QUEST, as for simplification reasons it includes the assumption of eternal life. In the green version there is an indirect link to health by the negative influence of climate change on leisure, which could be interpreted as a proxy.

4 Conclusions and recommendations

The analysis of the EU's Green QUEST model shows possibilities and limits to introduce more sophisticated environmental and social indicators into existing macroeconomic models. Technically, there is some space for improvements. As a first step, existing elements of the model could be enriched with a higher level of detail. The second step lies in endogenizing the relevant indicators, depicting feedback elements within the model. The latter is by far more time consuming but also much more promising regarding the assessment of policy impacts on different dimensions of sustainability and wellbeing.

However, extensive research will be necessary to include more complex feedback mechanisms between the economy and its environmental and social components into the model, if one aims to go well beyond simple extensions. Currently, the model structure does not integrate a variety of important aspects that are relevant for policies at the interface of social and ecological spheres. These include the quality of jobs, distributional consequences of environmental policies and impacts and feedbacks with respect to the condition of ecosystems. Nevertheless, given the availability of resources, the extension of QUEST might rather be hindered by technical trade-offs between tractability and realism of the model than definite limits.

Besides these rather technical questions the project's interviews and workshops revealed some softer obstacles for a successful reorientation:

- **Changing the perspective of the research question:** Modelers and users are used to frame their research question in a GDP-orientated way, often judging success on comparing GDP growth rates (Gran 2017).

Changing perspective is essential for analysing the impact of policies on ecological and social indicators instead of GDP.

- **Interest and motivation of model users:** Up to date there has not been a clear communication to modelers that new or other indicators should be analysed. Given the strong and rising interest in sustainability indicators at relevant national and international institutions, these users should clearly address their desire for new or extended models.
- **Restriction to one accustomed modelling technique:** There are limits in extending existing models. It might be useful to develop complementary models with a different theoretical background, set of assumptions and focus in order to have a more complex understanding of the impact of socio-ecological policy proposals. Adding other modelling approaches like System Dynamics or Stock-Flow Consistent models to the existing optimisation approach of DSGE and CGE models would strengthen the assessment of impacts.
- **The silos of modelers:** Modelers may lack exchange with users and modelers who are trained in other modelling philosophies. One possible solution lies in initiating a scientific dialogue, bringing together users and modelers with different theoretical and methodological backgrounds to generate innovative ideas of model and indicator integrations.

The commission's reflection paper on the 2030-strategy (European Commission 2019) as well as the question of how so solve the "Europe's Sustainability Puzzle" (European Political Strategy Centre 2019) clearly call for a contribution of economic modelers. One possible contribution is analysed in this paper: the integration of ecological and social variables into well established and influential economic models like QUEST. This step will improve the understanding of complex interactions between the economy, the environment and the society. Thereby, such an extension will enable politics to better understand for example the distributional consequences of CO_2-taxes or the structural changes associated with the target of net-zero emissions by 2050. From our perspective, grasping these interlinkages between economic, social and environmental issues in economic models is necessary to make sure that policymaking addresses the fears of European citizens regarding the "deep economical and societal transition" mentioned above.

Even if the range of extensions within QUEST is limited, it may serve as a first step to close the gap between the idea and the practical implementation of moving policymaking in the EU beyond growth. In this light, "Europe's Sustainability Puzzle" does not appear to be an unsolvable challenge to the European model of progress. Instead it may well prove to be a source for inspiration opening new perspectives on how policymaking and economic modelling in the 21st century should look like.

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