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Macroeconomic assessment of possible Green Recovery scenarios in Visegrad countries

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ABSTRACT

The article discusses how and why Green Recovery could be beneficial for the Visegrad countries based on a modelling exercise using the E3ME macroeconometric model. Green Recovery is defined as including policies in recovery plans that not only target economic recovery, but also contribute to environmental targets. The paper proposes that a Green Recovery could be valuable and suitable for the region contributing to both restoring employment and boosting economic activity as well as reaching climate goals. This is tested through a macroeconomic simulation, using the E3ME model. E3ME is built on Post-Keynesian economic theory and on econometric estimations of macroeconomic relationships. The results of the analysis focus on three dimensions: (1) social – employment, (2) environmental – level of CO_2 emissions and (3) economic activity – gross domestic product (GDP). Outcomes indicate that a green recovery can shorten the time needed for employment and economic recovery as well as contributes to CO_2 emission reductions. In Hungary, Czechia and Poland, the impact persists into the long-term; however, the paper also concludes that countries with high reliance on coal (e.g. Poland) could return to coal in the long term if no further policies are introduced.

KEYWORDS

Green Recovery, renewable energy, V4 countries, Covid-19

JEL-CODES

E62, Q43, Q58

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1. INTRODUCTION

The COVID-19 pandemic is a health crisis that has happened on a scale not seen in recent decades. Its impact on people's lives and our society is significant and already the target of multiple research endeavours from various fields. Nevertheless, it is also an economic crisis, stemming from changes in consumer behaviour as well as government measures to curb the extent of the pandemic.

Against this backdrop, it is unquestionable that governments have an obligation to step up and provide relief for those who are in need, and to help stabilize the economy (Stiglitz 2020). They are already doing it with different policy responses, often focusing on providing credit guarantees, wage subsidies and loans (IMF 2020; O'Callaghan et al. 2020) to compensate reduced private sector demand. However, as the crisis passes, governments will also need to introduce longer-term recovery packages to help their economies recover and to provide new opportunities for those who lost their livelihoods.

How this will be done is an important question. For the short term, governments have already announced a multitude of "relief" programs. These programs include unprecedented spending plans (Bruegel 2020; IMF 2020; O'Callaghan et al. 2020), with a focus on keeping firms solvent and consumers spending. But for the long term, questions remain about the best policy response.

The looming crisis, with lockdowns and travel restricted, has also created the largest fall in CO_2 (carbon-dioxide) emissions ever seen (Evans 2020; Liu et al. 2020). However, it is recognised that, without policy interventions, rates of CO_2 emissions and environmental degradation could increase again as the economy recovers (Evans – Gabbatiss 2020; Hummelen et al. 2021; IEA 2020c; Pollitt et al. 2020; Shan et al. 2020). While United Nations (UN) Secretary General Antonio Guterres has already said that "Coal has no place in COVID-19 recovery plans" (Lewis 2020), there are countries where spending on fossil fuel based energy is a primary component of recovery plans (such as Australia) (Murphy 2020).

But even without direct spending on fossil-based energy, recovery plans without elements to induce a large-scale green-transition will likely have adverse effects on the environment. While policies that are "colourless", such as general consumption boosting policies (e.g. value-added tax reductions) or non-targeted investment policies, will probably not have a direct adverse effect on greenhouse gas emissions, they keep the *status quo* of environmental harm (Dafnomilis et al. 2020; Hepburn et al. 2020), meaning that their environmental effects are dependent on the current economic structures of production. Due to the lack of large-scale global economic decoupling,[1] these policies are still likely to have *negative impacts* on the environment (e.g. increasing carbon emissions in line with economic growth).

That is why there are now calls for a 'green recovery' and ideas 'to build back better' (Harvey 2020; Hepburn et al. 2020; IEA 2020b; OECD 2020b). Therefore, it has been proposed that economic recovery should have at least two goals now: to restore employment and economic activity, but also to support work towards reaching climate goals by limiting CO_2 emissions.

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[1] For a discussion on whether decoupling of CO_2 emissions and economic growth is underway either in absolute or relative terms see for example Cohen et al. (2017) or Mikayilov et al. (2018).

This paper proposes a 'Green Recovery Program' (GRP), which aims to contribute to both of these aims: *To restore employment (and economic activity) through working towards climate neutrality with government support.* The geographical coverage of the paper is the Visegrad group; we cover Poland, the Czech Republic, Hungary and the Slovak Republic individually in the analysis. At the point of writing, none of these countries have yet announced large-scale individual recovery programs, but all of them face substantial challenges from the crisis because of their open economies.

Furthermore, in the coming years, regardless of the impacts of COVID-19, these four countries have to make serious progress towards agreed environmental goals such as energy efficiency, cutting dependency on fossil fuels and the electrification of road transport. All countries have emission reduction targets at least in line with the EU's Effort Sharing Regulation (ESR), in the range of 7%–20% reduction of greenhouse gas emissions by 2030 compared to 2005 emission figures (European Commission 2020a). How far countries are from the target differs quite much, but progress is mostly needed. Based on latest available data Poland stands at +21% (over its 2020 goal of +14%), while Czechia stands at +4% (reaching its 2020 goal, below its long-term goal of −14%) and Slovakia stands at −5% (above its 2020 goal, below its ambitious long-term goal of −20%), while Hungary has already hit its long-term goal of −7% (European Commission 2020a). Nevertheless, all countries are well below their long-term renewable sources in power generation targets and mostly below their 2020 targets, which indicates that progress is still needed in this area.

The main contribution of this paper is not only to outline one such 'green' recovery pathway for these countries, but also to simulate, compare and explain this recovery's labour market, economic and emissions consequences. The exercise also necessarily includes an estimation of economic and labour market impacts of COVID-19, which is then used for a point of comparison for the GRP results presented. The approach used is an ex ante model-based one, specifically using the E3ME macroeconomic model.

This article is structured as follows: Section 2 details the opportunity and rational for a 'green' recovery in the Visegrad countries. Section 3 introduces the methodology used in our assessment and the scenarios that we assessed. Section 4 presents the estimated COVID-19 economic impacts in the Visegrad countries, in terms of employment impacts, emissions reductions and economic activity, followed up by the impacts of the GRP scenario and estimates of the required government financing. Section 5 summarizes the findings and concludes.

2. GREEN RECOVERY IN VISEGRAD COUNTRIES

Various groups have already discussed how a 'green' recovery program could work in the EU. For example, the World Wildlife Fund (WWF) has outlined a macro-level package (WWF European Policy Office 2020) and the cities of the C40 coalition have published an agenda focusing on "Green and Just" recovery (C40 2020). Early on, based on a survey of leading economists (Hepburn et al. 2020) categorised possible recovery measures and outlined their potential environmental impacts. This work has been continued by (O'Callaghan et al. 2020) who established the Global Recovery Observatory, collecting and categorizing announced recovery measures, taking their environmental impacts into account. The magnitude of these measures varies over a wide range, from energy efficiency measures, green energy investments or budget consolidation through carbon taxes, with large-scale projects also in the mix.

Grandiose projects such as WIIW's proposed '100% Renewable Energy Sources (RES) e-highway' (Creel et al. 2020) are certainly appealing, and could result in a large-scale boost to economic activity if completed. Nevertheless, as the IEA notes (Varro et al. 2020) – based on experiences after 2008–09 – what historically works well is rather the expansion, scaling up and financing of existing schemes and frameworks. In these cases, often there is existing administrative capacity, working processes and understanding from both funding agencies and recipients. This helps to build trust and does not put unnecessary burdens on granters and grantees.

These factors are especially important in times of uncertainty. In the Visegrad Countries, there is accumulated experience with such programs. After the 2008–09 crisis, multiple EU member states included 'green' elements in their recovery programs. A study for the European Commission (Cambridge Econometrics 2011) evaluated some of those programs, including those of the Czech Republic and Slovakia. At the time, both programs were deemed successful. The recovery program in Czechia included a 'Green Investment Scheme', which targeted energy efficiency improvements mostly in residential buildings. In Slovakia, there was a similar but smaller program, which was complemented with a renewable installation subsidy targeted towards households (Cambridge Econometrics 2011). Both programs also included a car scrappage scheme – similar to what we see in Germany now (Miller 2020).

The Visegrad countries therefore have experience with these programs and an opportunity to build on already-existing schemes, but there are other reasons for a 'green' recovery as well, these will be discussed in the following paragraphs.

Looking back to the 2008–09 crisis, the boosting of aggregate demand through government interventions happened mostly through tax cuts in developed countries and through public infrastructure investments in developing countries (International Institute for Labour Studies 2011). However, the standard alternative of general tax cuts may not be effective because V4 countries have lower savings and wealth than other countries[2] and therefore may not increase spending in response. When such measures were introduced after the financial crisis, it was questioned whether the effects can be significant even in countries like the UK (Phillips 2009).

Second, Visegrad countries are embedded in global value chains (Cieślik 2019; Grodzicki 2014). With these disrupted, it is important to increase investment in jobs that are producing for domestic demand. Creating a domestic market for renewable energy which is anyway expected to grow considerably in coming years (IEA 2020a) might serve this purpose. Although many of the components are sourced from imports (Pasimeni 2017), installation would need to be local.

Further, while the energy industry in general is more capital than labour intensive, renewable energy technologies have higher labour needs than conventional technologies do, both in installation and operation & maintenance; they could therefore provide stable jobs (ECOTEC 2002; ILO 2011). It has been also shown that energy efficiency investments in Europe could create employment gains (Cambridge Econometrics 2015). Furthermore, installation of renewables and energy efficiency improvements are fields where low-skill workers could find employment (ILO 2011). This factor is important because jobs lost due to the pandemic are largely in low-skilled sectors (according to Eurostat data available on 2020 Q2 and past employment, see Fig. 1). In Hungary, losses in low-skilled service, sales and elementary

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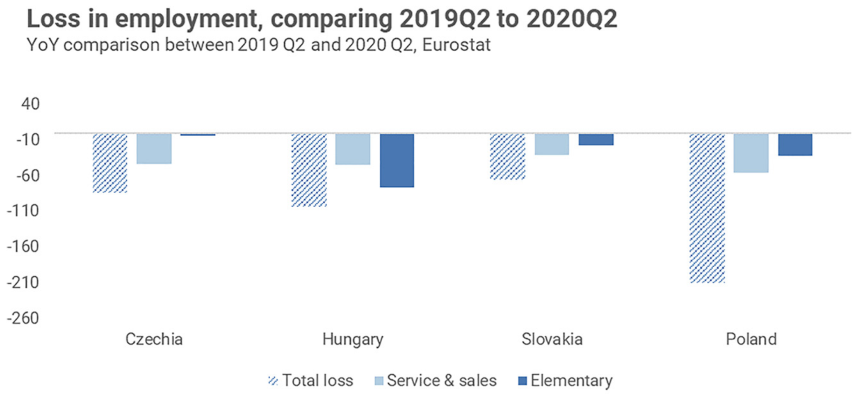
[2] Based on Eurostat data.



Source: author's based on data from Eurostat (2020).

Fig. 1. Employment loss in highlighted groups, comparing 2019Q2 to 2020Q2 in Visegrad countries

occupations amount to 117% of net losses; in Slovakia 76% of the net loss is in these occupations (Eurostat 2020). These figures are in line with earlier reports on the risk of employment loss in vulnerable groups (such as people with lower education) (Pouliakas – Branka 2020).

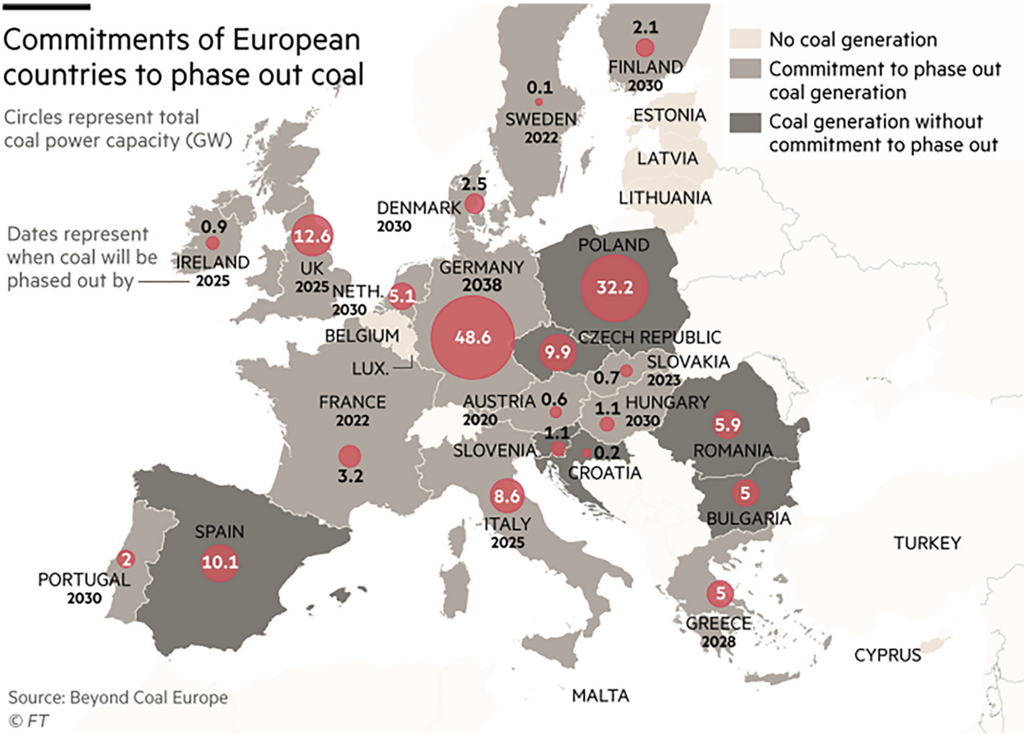
Finally, the region's energy profile largely calls for a 'green' recovery for two reasons: (1) energy security and (2) dependency on fossil energy sources (particularly coal and lignite) (BloombergNEF 2020). Energy security is a long-standing issue in the region; a high dependency on imported oil and gas from Russia long ago shifted the region towards a vision of greater energy independence (Cambridge Econometrics 2020). Building renewable capacities is an evident solution.

Second, Czechia and Poland are still some of the most coal-intensive electricity producers (see Fig. 2). Poland produces 79%, and Czechia 43%, of its electricity from coal (BloombergNEF 2020). Hungary and Slovakia have less reliance on coal, but all four Visegrad countries have existing coal and lignite plants that do not meet the environmental standards coming into force in 2021 (BloombergNEF 2020). Thus, there is a choice either to invest in retrofitting those plants, potentially creating "stranded assets" as both regulations and the market moves away from financing coal, or to start building new capacities, for which the current recovery provides a potential opportunity.

3. METHODOLOGY FOR ASSESSMENT

The modelling exercises in this paper are built around the E3ME macro-econometric model. First, following the methodology set out in Cambridge Econometrics and We Mean Business Coalition (2020) and Pollitt et al. (2020), the impacts of the COVID-19 pandemic on the selected countries' economy and emissions are modelled. Second, three long-term scenarios focusing on versions of a 'green' recovery scenario are modelled. In this section first the E3ME model is described briefly, followed by a description of the scenarios.

It worth mentioning that there have been similar modelling exercises, which intended to bring some of these measures together and present economic, labour and environmental



Source: Financial Times, Dempsey (2019).

Fig. 2. Commitments of European countries to phase-out coal (*source*: Dempsey 2019)

outcomes of these policies. The IEA’s Sustainable Recovery (IEA 2020b) report was one of these comprehensive exercises, where the authors have quantified possible global outcomes of a wide range of recovery measures. Another similar exercise was carried out by Pollitt et al. (2020) focusing on a range of “green” measures and comparing these to outcomes from a “consumption boosting” recovery. Not focusing on policies, but on assumptions about the “nature” of the recovery (Shan et al. 2020), published modelling of a series of global recovery scenarios with differing magnitude and carbon intensity. Similarly to other works, they show that while a recovery with the current *status quo* of carbon intensity of investments could boost CO_2 emissions, a less carbon intensive recovery could have important contributions to climate change mitigation (Shan et al. 2020).

3.1. E3ME model

E3ME is a macroeconomic model built on Post-Keynesian economic theory and on econometric estimations of macroeconomic relationships. The model was originally developed by an international team, operating under the European Commission research programs (Cambridge Econometrics 2019). Since then, the model has been maintained by Cambridge Econometrics and has regularly been used in high-profile scenario-based policy analyses, including assessing the EU's 2030 environmental targets (European Commission 2020b), the EU's skills projections (CEDEFOP – Eurofund 2018) and the 2018 New Climate Economy report[3] (New Climate Economy – World Resources Institute 2018).

Recently, the model has also been used in assessing various 'green' recovery scenarios globally (Hummelen et al. 2021; Pollitt et al. 2020), in Latin America and the Caribbean (CEPAL 2020) and in a number of selected countries (Cambridge Econometrics – We Mean Business Coalition 2020; Kiss-Dobronyi et al. 2021).

E3ME simulates 61 world regions in total, 27 of them representing individual EU member states. In each EU country the model works with 69 industrial sectors (corresponding to NACE Rev. 2 sectoral classification). Household consumption, which is divided to 43 categories, corresponding to COICOP classification, is linked to sectoral production in the model. Sectoral supply and demand are linked together through the use of input-output tables, while regions are linked through bilateral trade tables (Cambridge Econometrics 2019). The model is demand driven, assuming an adjustment on the supply side to fit demand, subject to constraints.

The input-output linkages provide channels between producing sectors and final demand. This means that as the model is demand driven, firms in the economy assumed to adjust their production (supply) to fulfil product demand. This process is subject to constraints, such as capacity constraints in labour and product markets, that feed back to prices and investment decisions (Pollitt et al. 2017), it is assumed that there is usually spare capacity in the economy (unlike in CGE models). Policies that draw upon this spare capacity may lead to increases in output and employment (Cambridge Econometrics 2019; Mercure et al. 2019). Nevertheless, the pandemic has effected this output gap, which is reflected by our assumptions on the reduction of supply capacities.

The model's behaviour is different from that of computable general equilibrium (CGE) models (e.g. GTAP, GEM-E3) which are often used for macroeconomic modelling. To highlight some important differences: E3ME adopts a 'bounded rationality' approach, represented through behavioural parameters estimated on historical data and the money supply is assumed to be fully endogenous (Pollitt – Mercure 2018). The model builds on economic relationships estimated on historical data. A full list of equations used to define these relationships can be found in Mercure et al. (2018), equations especially important in the current exercise are presented in the Annex. Historical data was collected from various sources such as Eurostat, OECD, and the UN. Model parameters were estimated on this data using the concepts of cointegration and error-correction, based on Engle and Granger (1987) and Hendry, Pagan, and Sargan (1984). To avoid issues with shorter time-periods and possible volatilities related to the economic transition of the 1990s, the model uses a shrinkage technique for estimating parameters of long-term equations in all EU member states who joined the Union in and after 2004 (Spicer – Reade 2005). Ščasný et al. (2009: 468) describes this as "essentially adopting a western-European average", with the estimation basically assuming that on the long-run member states will converge to long-run behaviour of Western economies. This, importantly, includes all countries in the focus of this exercise.

E3ME is primarily used for policy analysis, rather than forming absolute projections. Therefore, a baseline scenario is usually simulated first, which represents a "business-as-usual"

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[3] For details and further project references please see Cambridge Econometrics' website http://camecon.com.

state of the world going forward. In this paper the energy projections of the baseline are calibrated to the PRIMES 2016 Reference Scenario (Capros et al. 2016), while short-term economic-labour projections are calibrated to projections of the World Economic Outlook (IMF 2019). Long-term projections are calibrated to the Ageing Europe report (European Commission 2018). This is what we consider a "no-virus" baseline later in the paper. This approach is used to show how fast a 'recovery' can be achieved to pre-COVID levels of activity and employment.

The exercise also takes advantage of 'Future Technology Transformations' (FTT), a suite of bottom-up technology models integrated with E3ME. The FTT:Power and FTT:Transport submodels are used in the modelling exercise. These technology models assume technology diffusion and learning effects within individual technologies and employ discrete choice modelling to forecast path-dependent choices made by agents in the system (Mercure et al. 2014). FTT:Power is a bottom-up technology model following these principles (Mercure et al. 2014), while FTT:Transport uses a similar approach with heterogenous agents to simulate private passenger transport (Mercure et al. 2018). These sub-models are used to simulate impacts of the 'green' recovery scenarios: e.g. subsidies for car scrappage or capital subsidies for renewables.

The E3ME model manual, which is a detailed description of data used, underlying mechanisms and equations, which form the model, is available at www.e3me.com.

3.2. The COVID-19 impact scenario

The COVID-19 scenario uses data, estimations and assumptions collected at the end of July and beginning of August 2020. It is close to what OECD named a "double-hit" scenario (OECD 2020a). The scenario makes assumptions about the impacts mostly for the year 2020. In the case of the Visegrad countries, it includes a "second-wave" of economic restrictions that is less severe than the first-wave; the size of impacts thus increases from the damage done in spring but does not double in magnitude. Assumptions on demand, supply and investment shocks are presented in Tables 2–4 in the Appendix.

The scenario makes several assumptions, based on available data and estimates about the severity and effects of the crisis. These are mostly in line with what is described in Cambridge Econometrics and We Mean Business Coalition (2020) and Pollitt et al. (2020), but there are minor differences, so a summary of the inputs is provided here. Four main areas of inputs are considered (1) supply shocks, (2) demand shocks, (3) short-term government interventions and (4) effects on investments.

Supply shocks are driven by stay-at-home policies as well as health effects (people on sick leave or self-isolation). Impacts are calculated based on del Rio-Chanona et al. (2020). Effects in this paper are estimated based on sector and job level, taking the feasibility of remote work and essential jobs into account. The resulting sectoral level shocks were adjusted using Google Mobility (Google 2020) data: an annualized decrease of activity at workplaces was used as an adjustment factor for the sectoral assumptions. The strongest effects are in forestry, basic metals, personal services, metal products, machinery, but also tourism and sports activities sectors.

Demand shocks were calculated using Google Mobility data reports (Google 2020) on activity at transit stations (transport services), retail and recreation (retail and entertainment) and TomTom Traffic Index (TomTom 2020) data (private transport). An average activity reduction was estimated based on observed behaviour in the first half of the year. This number then was annualized, and to account for the second-wave a multiplier of 1.5 was applied to it. The resulting activity reduction numbers were then used as negative shocks (i.e. reduction) on selected household consumption categories. For two special sectors, tourism and air transport, industry association estimates were used from (ICAO 2020; WTTC 2020) because it would be hard to capture impacts on international travel with local indicators. Tourism reduction is adjusted with the international/domestic rate of tourism, therefore where international tourism is stronger, the demand reduction will be higher. The resulting supply shocks and demand reductions are shown in Tables 2 and 3 in the Annex.

Short-term government interventions are taken from two sources: (1) Bruegel's collection of government interventions (Bruegel 2020) and (2) IMF's Policy Tracker (IMF 2020). Government interventions are treated as partly excess government expenditure and partly lump-sum transfers to citizens (wage compensation).

Finally, *investment* reductions are calculated using a three-stage method. First, after applying supply and demand shocks, as well as short-term government fiscal interventions, an output effect for 2020 using E3ME was estimated. Second, this output effect has been adjusted using answers from Bank of England's Decision Maker Panel (DMP) (Bank of England 2020). The second step ensures that investment effects are applied to sectors which are likely to be effected through pessimistic expectations rather than direct impacts. Third, the time dimension of DMP was used to estimate the magnitude of investment effects for 2021. Sectoral investment effects predicted for 2021 in the DMP were compared to effects expected for 2020. From this a forward looking discount factor was calculated, which was then applied on top of effects simulated with E3ME. The direct investment shocks obtained by this calculation are shown in Table 4 in the Annex.

3.3. Green Recovery scenario

The Green Recovery scenario presented here builds on Pollitt et al. (2020), but considers the possible measure of the Green Recovery in the context of the Visegrad countries, plus introduces two sensitivities: a lighter and a stronger version of the recovery program. Contrary to 'green' recovery programs considered in Pollitt et al. (2020), in this exercise there is no assumption on VAT or sales tax reductions as part of the recovery programs. The different pathways will be referred to as follows:

- pre-Covid baseline;
- baseline with estimated COVID-19 impacts;
- Green Recovery Program (GRP) scenario;
- "light" GRP sensitivity;
- "strong" GRP sensitivity.

The GRP scenario considers four main measures:

1. capital subsidy to renewable technologies;
2. grid investment to accommodate the rapid uptake of renewable technologies;
3. car scrappage scheme, applied only to cars replaced by electric vehicles (EVs);
4. energy efficiency improvements in buildings, focusing on retrofitting.

First, three levels of capital subsidy are simulated. The main GRP scenario assumes a 50% capital subsidy to wind and solar PV technologies in 2021–2023, followed by 30% in 2024 and 2025. The "strong" sensitivity assumes a scaling-up of these numbers, 67% subsidy in the first period and 40% subsidy in the second period, while the "light" sensitivity uses 30%

subsidy up to 2023 and 5% up to 2025. Renewable technologies are becoming cost competitive in the world, even without subsidies, especially in Europe (IEA 2018). However, it is not just a question of becoming cheaper; renewables must first become established in the market (e.g. with ancillary services available) before they can grow quickly (Mercure et al. 2014). Reducing the costs of renewables accelerates this process. A connected *second* point is the need for national electricity grid investments to accommodate the increased uptake of renewable technologies. A 400 EUR/kW investment need is assumed, based on the average cost of grid-scale battery projects (IEA 2019). Renewable energy generation is also important considering the European Union's strategic renewable energy target of 32% by 2030 (European Commission 2020c).

Third, a car scrappage scheme was a popular 'green' policy tool after the 2008–2009 crisis, and it is gaining momentum once again (Cambridge Econometrics 2011; Evans – Gabbatiss 2020). However, in our scenario it is only applicable to new electric vehicle (EV) purchases, therefore pushing up the share of electric vehicles in the transport mix. In the "light" sensitivity of the scenario it is assumed that a total of 2% of the fleet in usage can be replaced in 3 years, this number is 3.5% in the main GRP scenario and 5% in the "strong" sensitivity one. A subsidy amount of 15% is assumed to reach these goals; this rate has been chosen based on the observed efficiency of such programs in other countries (International Transport Forum 2011).

Finally, through retrofitting, financed by government subsidies, an energy efficiency improvement primarily in buildings is assumed. The Intergovernmental Panel on Climate Change (IPCC) states that retrofitting the existing building stock is key to reducing emissions of the building sector (IPCC 2014). Retrofitting also provides co-benefits for residents, through savings in energy consumption and thus spending on energy. The overall effectiveness and extent of energy efficiency measures in buildings are dependent on several factors, including the building stock and the consumption reduction that can be achieved by retrofitting. The IEA's 2019 Sustainable Development Scenario assumes that, due to energy efficiency improvements, energy consumption of the buildings sector could be reduced by over 30% by 2030 (IEA 2018). It is of course a result of combined impacts of new buildings and retrofitting. Nevertheless, taking this and studies on the energy savings potential of public buildings in Hungary and Slovakia into account (Korytárová et al. 2017; Korytarova 2011) an 8% total reduction was introduced in the main GRP scenario (over 5 years). In the "strong" sensitivity scenario a 12% reduction is assumed, while in the "light" sensitivity one a 6% reduction is assumed in Visegrad countries. The costs of the measures are estimated based on Ürge-Vorsatz et al. (2010), assuming that 1.16 mEUR investment is required to reduce energy consumption in buildings by 1 GWh. This estimate is based on Hungarian data and there have been advancements in the area since, so it is probable that costs in this aspect are overestimated.

The scenarios are summarized in Table 1.

4. RESULTS

In this section, we present the country-level results from the modelling. The results focus on three dimensions and key indicators:

1. social dimension – employment;
2. environmental dimensions – level of CO_2 emissions; and
3. economic activity – gross domestic product (GDP).

Table 1. Green Recovery scenario assumptions in base version and sensitivities

	Cost assumptions	Green Recovery Program		“Light” sensitivity		“Strong” sensitivity	
Capital subsidy for renewables	Subsidy amount + related grid, battery investments 400 EUR/kW	50% (2021–23)	30% (2024–25)	30% (2021–23)	5% (2024–25)	67% (2021–23)	40% (2024–25)
Car scrappage scheme, fleet replacement in 3 years	15% subsidy on retail prices	3.5%		2%		5%	
Energy efficiency improvements, demand reduction in 5 years	1.16 mEUR investment/1 GWh demand reduction	8%		6%		12%	

Source: authors.

These measures have been selected as together they give a summarised picture of the economy, as well as a slice of the environmental harm done by the economic activity. The order of the indicators is also important: the authors believe that in the current situation keeping employment up and making sure that people can maintain their livelihoods could be the most important goal of a recovery program.

To provide insights about the financing needs for these programs, total government spending in GDP terms and the cost of the individual program components are also presented and discussed. It should be noted that the modelling does not make explicit assumptions on the cost of the program, costs are calculated based on endogenous responses to the introduced measures (i.e. there is no fixed budget for RES subsidies, but the cost of the measure depends on the endogenous response to the magnitude of the subsidy).

The text in this section focuses on the main GRP scenario, but results are presented for the “light” and “strong” scenarios as well in the figures. These results provide a range of potential impacts from the green recovery program.

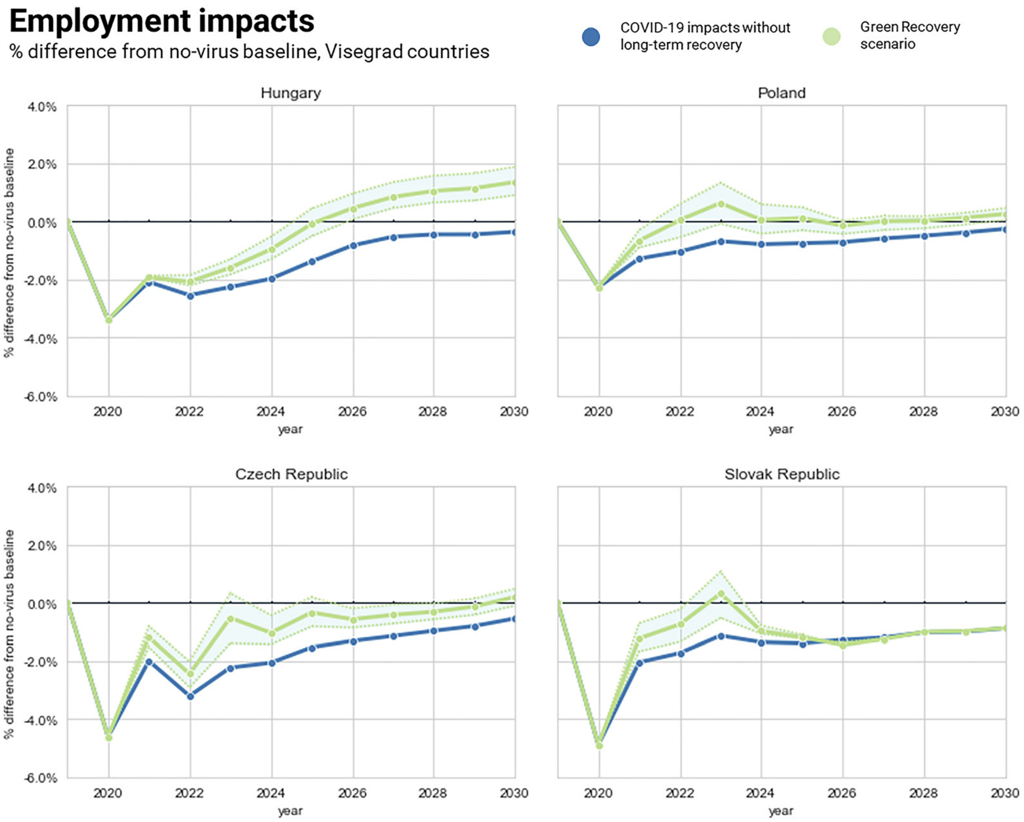
4.1. Employment

The initial employment impacts (presented in Fig. 3) of the GRP are positive for all four countries, although their magnitude differs substantially. In Hungary (HU), Czech Republic (CZ) and Poland (PL), there are also employment benefits after the support is withdrawn and beyond 2030. The main reason for the long-term benefits is the renewable subsidies; by putting these three countries on technology trajectories that rely more on domestic installation and less on imported fuel, there is a permanent boost to employment.

Total employment boost compared to the baseline with estimated COVID-19 impacts is about 213, 93, 34, 30 thousand additional full-time equivalent (FTE) employment by 2023 respectively in PL, CZ, SK and HU. Long-term employment increase (by 2030) is about 81, 41, 0, 76 thousand FTE employment in PL, CZ, SK and HU respectively.

The employment impacts result from a mix of drivers: an uptake of construction work is necessary because of energy efficiency and RES investment measures, this is complemented by an increase in auxiliary sectors such as architecture, engineering, landscaping. The manufacturing of motor vehicles (due to car scrappage) is also an important driver. The boost of employment in these (and connected) sectors also causes higher disposable income, which in turn boosts employment in sectors of consumption (e.g. retail, wholesale, tourism). Finally, due to the measures being government programs, administrative jobs (e.g. public administration, legal, accounting) increase as well.

In the Slovak Republic (SK) the employment impact of the GRP does not persist because there is limited renewables take-up despite the subsidies. Figure 7 in the Annex shows the magnitude of renewable take-up in the countries’ respective energy systems, highlighting this deficiency. Importantly, this effect is also a result of the current and expected energy pathways of the country, having a large share of its electricity generation from nuclear power. The short-term employment benefits (mainly the result of investment in energy efficiency and car scrappage) do not persist beyond the end of the support. In Hungary however, retail sectors react favourably to the recovery of consumption, inducing an employment increase in the long-term, complementing the above described effects.



Source: authors, based on E3ME modelling results.

Fig. 3. Employment impacts in the modelled scenarios, the light-green area shows the results of the sensitivities, with the "light" sensitivity being the lower bound, while the "strong" sensitivity being the upper

4.2. Environmental indicators

An interesting side-effect of the COVID-19 pandemic is that due to the significant reduction of economic activity, it has caused a drop in CO_2 emissions (IEA 2020a; Evans 2020). However, it is likely that this reduction of emissions will not persist once economic recovery takes place. This is where a 'green' recovery could make a substantial difference. As shown in the results, a GRP would not only keep the reduction of CO_2 emissions, that the world achieved unintentionally, but could also introduce further reductions.

The effects (presented in Fig. 4) are particularly evident and strong for Hungary, but also noticeable in the three other countries. In Hungary the reduction is driven by adoption of EVs (more than 70% of the reduction by 2025), while in Czechia both electricity (30%) and transport (50%) contribute substantially to the emission reductions (rest is energy efficiency and other spill-over effects).

In the case of Poland, the scenario leads to a substantial decarbonisation of the power sector, replacing some of the current dependency on coal and on gas with new energy sources. Under the

Source: authors, based on E3ME modelling results.

Fig. 4. CO_2 emission impacts in the modelled scenarios, the light-green area shows the results of the sensitivities, with the “light” sensitivity being the upper bound, while the “strong” sensitivity being the lower

GRP scenario, by 2025 the share of wind energy in power generation grows to 40% (up from around 13% in 2018). During the early stages of the pandemic it was already seen in Poland that the level of coal-fired generation dropped off, giving way to other energy sources. With a potential increase in carbon prices, competition from renewables and EU climate ambitions (BloombergNEF 2020), these recovery actions – as it was shown in the employment results – could help to change the track of the economic and energy systems. Even in our GRP results, however, Poland shows new investments, after the capital subsidies for RES end, for coal-based power generation (hence the upward curve in emissions). This is a stark reminder that without a restriction on new coal investments, coal will, at least to some extent, remain a dominant force in Poland.

It is noticeable that the sensitivities show quite a wide range in the emissions results. In CZ, SK and HU the difference between the ‘light’ and the ‘strong’ sensitivities is about 5 percentage points in reduction compared to the pre-Covid baseline by 2030. In the case of Poland, the difference is even stronger: the ‘strong’ version results in reductions of about 10%, while in the ‘light’ version it is only about 4%. To put the numbers into context: reductions in PL could total to 150 $MtCO_2$

over the 2021–2030 period, which is equal to about half a year's total emissions in the country. In absolute terms this is the highest reduction, as PL has the highest emissions across the four countries, however the reduction is comparable in Hungary (reduction amounting to about 8 months), in Czechia (about 5 months) and even in the Slovak Republic (4 months).

4.3. Economic activity

Results are presented in Fig. 5. In general the modelling indicates that there could be a bounce-back in GDP in 2021 following the easing of restrictions introduced because of the pandemic. The E3ME model parameter estimates determine the dynamics of the bounce-back. There is an immediate recovery in Poland, while the 'natural' pace of recovery is much slower in other countries.

Looking at the results of the GRP scenario in economic activity, just as in employment, two set of impacts are combined. First, the immediate effect of these government policies channelled through additional investments, and second the long-term effects of the induced transition.

Source: authors, based on E3ME modelling results.

Fig. 5. Economic activity impacts in the modelled scenarios, the light-green area shows the results of the sensitivities, with the "light" sensitivity being the lower bound, while the "strong" sensitivity being the upper bound

Economic recovery could be even faster in the GRP scenario than employment recovery, due to the slower reaction of labour markets.[4]

Long-term effects are positive in all cases when compared to the scenario with COVID-19 impacts and no recovery, and mostly positive even when compared to the pre-Covid baseline, showing effects of the energy transition as well as the recovery. This result is most prominent in Hungary, with an additional 4.0% of GDP (by 2030) compared to the scenario with COVID-19 impacts. Impacts in CZ, PL and SK, compared to the scenario with COVID-19 impacts, are 1.5, 1.3 and 0.3%, respectively by 2030. When compared to a pre-Covid baseline, the results are still positive, but the magnitude is much less prominent by 2030 in this case: Hungarian impacts show a 2.6% increase, with 0.8%, 0.6% and −0.5% in PL, CZ and SK, respectively.

As noted previously, due to the lack of large-scale energy system transition driven by subsidies, the results in the Slovak Republic do not show a stable increase, either in employment or in economic activity.

4.4. Financing

It is important to stress that the current simulation does not maintain government budget neutrality for its measures in the GRP scenario. Since the time of Keynes, fiscal stimulus has been a widely accepted response to recession (Keynes 1936). In the current economic climate, with the scope for monetary stimulus highly constrained, fiscal policy is expected to play a large role in economic recovery (Gopinath 2020). There is an ongoing debate on the magnitude and effect of this increased government spending, with some saying that much larger government deficits could be manageable (Greeley 2020), especially in countries with monetary sovereignty (Kelton 2020).

As noted previously, this paper takes an approach in which the costs of the policies are endogenous to the modelling. For example, a 50% percent capital subsidy on renewables was used as an input, without restricting the effect of such policy or restricting the amount of total subsidy. The total cost thus depends on the rate of renewables take-up. Furthermore, the COVID-19 impact scenario, which is treated as a point where the recovery starts, already includes announced short-term government fiscal interventions. This also provides an opportunity to compare the cost of the Green Recovery scenarios going forward.

The cost of the measures contained in the GRP scenario is estimated to be around 1% of GDP in Hungary and Slovakia, and to be about 1.5–2.5% in the Czech Republic and Poland annually. Figure 6 presents the composition and magnitude of the estimated costs. Although this is a substantial increase in current government spending, it is less than what has been already announced in other countries as an immediate response to the pandemic. For example, the immediate fiscal impulse in Germany is expected to be at least 8.3% of GDP. There are figures of 8.0 and 5.5% of GDP for the UK and Denmark respectively (Bruegel 2020). It should be noted that, in the case of the GRP the spending is a longer-term commitment, that could add up to larger amounts (e.g. in the case of Poland, the total is about 9% of 2020 GDP over the 5 year period), but even these amounts are within the ballpark range of already announced packages.

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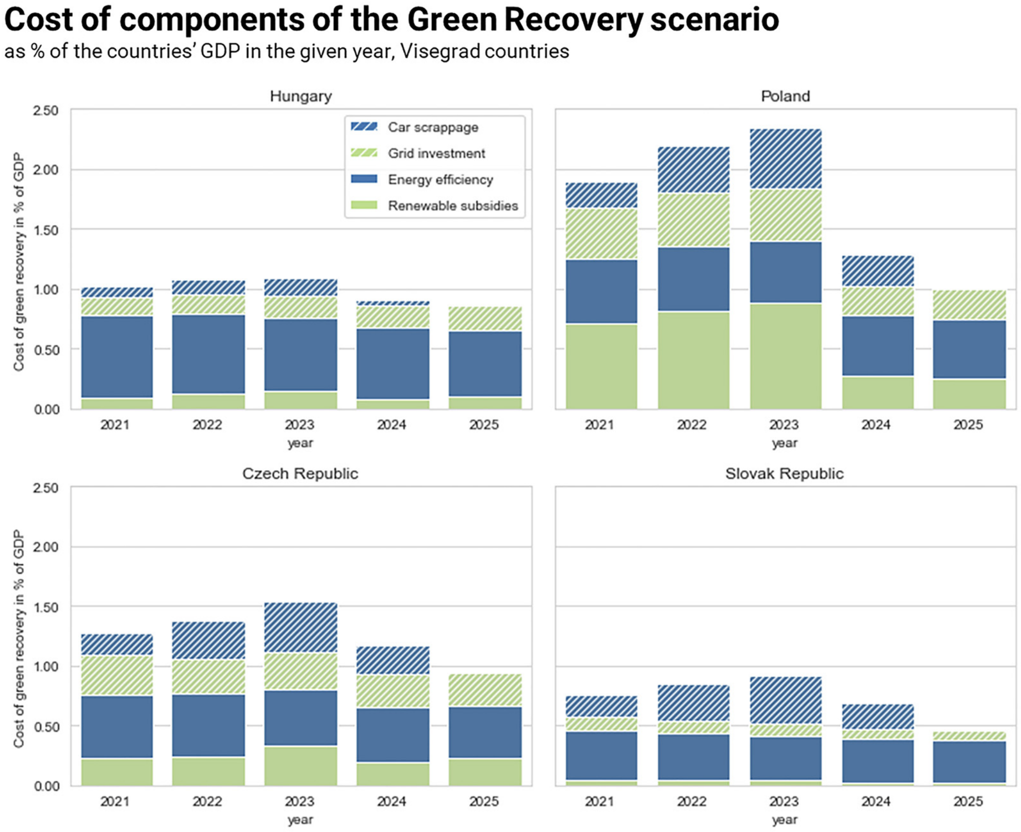
[4] This is a consistent result from econometric modelling. When demand increases, companies initially increase production without hiring more people (i.e. by improving efficiency or asking existing staff to work longer hours). Only once the increase in demand is seen to be permanent will companies increase employment levels. Recruitment also takes time, lengthening the lagged effect.



Source: authors, based on E3ME modelling results.

Fig. 6. Cost of components in the modelled scenarios

The composition of the costs for the Green Recovery scenario are quite different between countries. Energy efficiency costs are prominent in all countries, with car scrappage and RES subsidies, and thus grid investment, showing differing results. The differences are driven by the fact that, as noted previously, in these countries the subsidies bring down the costs of renewables by enough to trigger large scale deployments, which can replace a major share of the current fossil-based energy generation (BloombergNEF 2020). Energy efficiency is relatively more important in Hungary and the Slovak Republic, which is largely due to differences in current levels of energy efficiency and what has been done in this area historically (Enerdata 2020).

5. CONCLUSION

The analysis presented in this paper focuses on the macroeconomic potential of Visegrad countries to undertake a 'green' recovery. The paper sets the case for a 'green' recovery, arguing that it is not only important to move into the direction of climate goals, but also could provide an important push towards pre-Covid levels of employment and economic activity.

The E3ME macroeconometric model was used to assess first the macroeconomic effects of Covid-19 on the economies of the four countries, second to simulate the outcomes of different magnitudes of a ‘green’ recovery program. Results obtained from the modelling exercise indicate differing impacts for the program across countries. In all countries, significant positive impacts can be observed on the short-term: both in the Slovak Republic and the Czech Republic, as well as in Poland, the GRP induces a return in employment and economic activity to pre-Covid baseline within 3 years. In Hungary the effect is similar, somewhat more muted in the short-term, but more persistent in the long term. This is an impact driven by initial investment stemming from the program policies, e.g. energy efficiency investment causes construction employment and thus higher incomes with spill-over effects, while increased EV sales mean higher sectoral consumption.

It can be also observed that this initial period induces large-scale RES deployment (see Fig. 7 of the Annex), which in turn drives further take up of RES even after the subsidies have been phased out. This, compared with the overall effect of higher employment and activity in the early (2021–2023) period, leads to long-term effects in all countries except the Slovak Republic. This long-term effect, by 2030, means that countries gain employment and GDP compared to the economic pathway caused by the pandemic, and even greater or equal to the pre-Covid baseline.

The different pace of recovery and the lack of long-term effects in Slovakia requires some attention. Induced RES investment, resulting from the GRP, is smaller in the Slovak Republic, which consequently leads to smaller long-term impacts, as the magnitude of the investments will not trigger a large-enough market transition towards renewables, which drives long-term outcomes in other countries.

As ‘green’ recovery programs, it is important that the measures decrease carbon-dioxide emissions. This condition is reached in all countries; however, not only the magnitude of reduction differs, but also the trend. An important result is that in Poland: emissions actually increase by the end of the period (i.e. 2030 compared to 2025). Once the RES subsidies end, coal returns to near cost-parity and path dependency means that investment in coal resumes, unless other measures are put in place. However, even considering this, with the GRP, next to a relatively impactful economic recovery, these countries can achieve CO_2 emission reductions amounting to 4–8 months of their current total emissions.

There are of course significant limitations in the analysis. Annual COVID-19 impacts are estimates based on observed impacts and assumptions. The spread of COVID-19 is an ongoing health crisis and it may cause significant changes in our future economic behaviour. The assumptions of the design of the GRP are also largely based on previous studies (in some cases conducted outside of the region), which may not be relevant here.

However, it is firmly believed by the authors, that it is important to think about such packages and to understand how they can impact the economy, taking into national characteristics into account. It is an important task to understand whether pursuing climate change mitigation and economic recovery at the same time is feasible, and to be able to determine how best to do this as well. This paper aims to do just that, focusing on a region that faces an important challenge and opportunity to tackle in the near-future.

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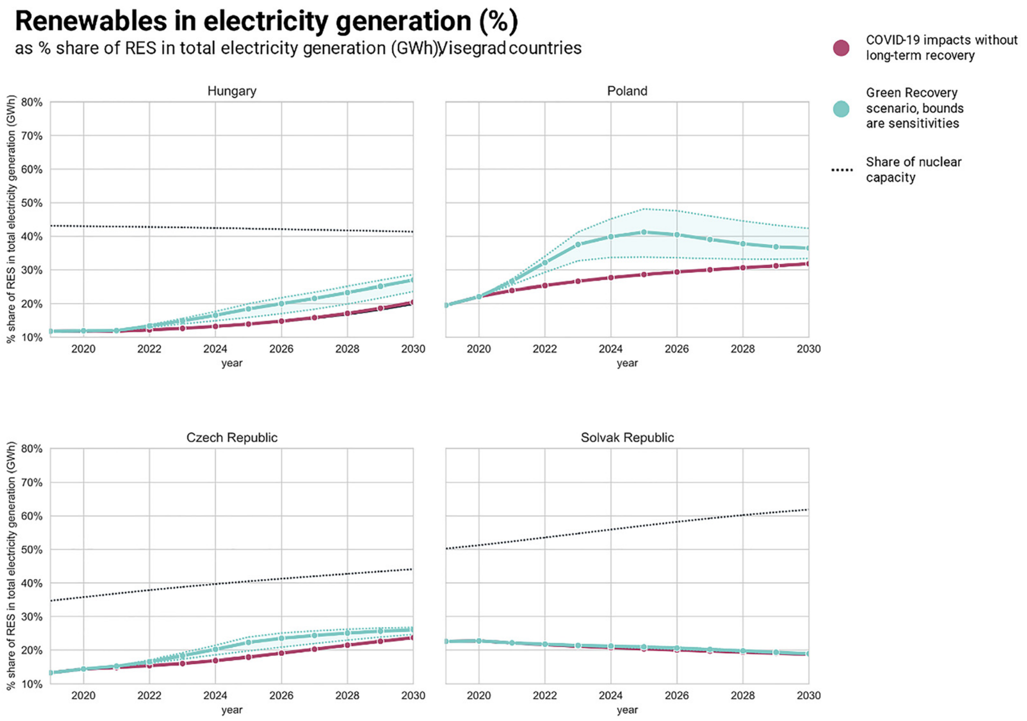
ANNEX

Additional results



Source: authors.

Fig. 7. Share of renewable energy sources in electricity generation in percentage of total power generation (GWh)

Summary of COVID-19 supply and demand shocks assumptions

Table 2. Summary table of supply shocks applied to countries

	Applied supply shock (aggregated on country level) in 2020		
	Mean	Minimum	Standard deviation
Czech Republic	−2.82%	−12.6%	0.034
Hungary	−3.51%	−15.7%	0.0429
Poland	−3.08%	−13.8%	0.0376
Slovak Republic	−3.57%	−15.9%	0.0436

Source: authors.

Table 3. Summary table of demand shocks applied to countries

	Applied demand shock (aggregated on country level) in 2020				
	Transport services	Retail & recreation	Private transport	Air transport	Tourism
Czech Republic	−17.2%	−21.3%	−19.3%	−76.5%	−66.4%
Hungary	−21.5%	−17.4%	−20.5%	−76.5%	−72.6%
Poland	−26.7%	−20.7%	−22.1%	−76.5%	−70.6%
Slovak Republic	−24.7%	−26.8%	−24.3%	−76.5%	−65.6%

Source: authors.

Table 4. Summary table of investment shocks applied to countries

	Applied investment shock (aggregated on country level), in % of baseline investment level		
	2020	2021	2022
Czech Republic	−19.6%	−0.9%	−6.1%
Hungary	−22.1%	−5.4%	−5.1%
Poland	−17.1%	−5.5%	−6.5%
Slovak Republic	−20.1%	−6.3%	−4.3%

Source: authors.

Selected equations from the E3ME model

This section presents specifications for some of the E3ME econometric equations that are important from the perspective of the present paper. For details on further equations used in the model as well as rationale behind the variables selected, please see Mercure et al. (2018b) or the E3ME model manual (Cambridge Econometrics 2019).

Aggregate consumption
Co-integrating long-term equation

$$\ln(RSC_{t,i}) = \alpha + \beta_1 \ln(RRPD_{t,i}) + \beta_2 \ln(RRLR_{t,i}) + \beta_3 \ln(CDEP_{t,i}) + \beta_4 \ln(ODEP_{t,i}) + \beta_5 \ln(RVD_{t,i}) + ECM$$

Dynamic equation

$$\delta \log(RSC_{t,i}) = \gamma + \lambda_1 \delta \ln(RRPD_{t,i}) + \lambda_2 \delta \ln(RRLR_{t,i}) + \lambda_3 \delta \ln(CDEP_{t,i}) + \lambda_4 \delta \ln(ODEP_{t,i}) + \lambda_5 \delta \ln(RVD_{t,i}) + \lambda_6 \ln(RUNR_{t,i}) + \lambda_7 \delta \ln(RPSC_{t,i}) + \lambda_8 \delta \ln(RSC_{t-1,i}) + \lambda_9 ECM_{t-1,i}$$

where

- α and β_1 to β_5 are estimated long-term parameters,
- γ and λ_1 to λ_9 are estimated dynamic parameters,
- RSC is the aggregated consumption in million EUR 2010 prices,
- $RRPD$ is the real gross disposable income in million EUR 2010 prices,
- $RRLR$ is the real rate of interest,
- $CDEP$ and $ODEP$ are the child and old age pensioner dependency ratios,
- RVD is a proxy for household wealth (cumulative sum of investments in dwellings million EUR 2010 prices),
- $RUNR$ is the unemployment rate (percentage of labour force),
- $RPSC$ is the consumer price inflation (percentage terms),
- RSC_{t-1} is the lagged change in consumer expenditures,
- ECM is the error term in the long-run equation and ECM_{t-1} is the lagged error correction term
- Indexes t and i refer to the year and the region (country in EU) of the observation

Industrial investment
Co-integrating long-term equation

$$\ln(KR_{t,i}) = \alpha + \beta_1 \ln(QR_{t,i}) + \beta_2 \ln\left(\frac{PKR_{t,i}}{PYR_{t,i}}\right) + \beta_3 \ln(YRWC_{t,i}) + \beta_4 \ln\left(PQRM_{t,i}^{oil}\right) + ECM$$

Dynamic equation

$$\delta \log(KR_{t,i}) = \gamma + \lambda_1 \delta \ln(QR_{t,i}) + \lambda_2 \delta \ln\left(\frac{PKR_{t,i}}{PYR_{t,i}}\right) + \lambda_3 \delta \ln(YRWC_{t,i}) + \lambda_4 \delta \ln\left(PQRM_{t,i}^{oil}\right) + \lambda_5 \ln(RRLR_{t.i}) + \lambda_6 \ln(YYN_{t,i}) + \lambda_7 \delta \ln(KR_{t-1,i}) + \lambda_8 ECM_{t-1,i}$$

where

- α and β_1 to β_4 are estimated long-term parameters,

- γ and λ_1 to λ_8 are estimated dynamic parameters,
- KR is real investment expenditure in million EUR 2010 prices,
- QR is real output in million EUR 2010 prices,
- PKR/PYR is the relative price of investment (industry investment price divided by industry output price, both in local currency, 2010 = 1.0),
- $YRWC$ real average labour cost, which is real wage costs divided by employees,
- $PQRM^{oil}$ effect of real oil price (import prices in local currency, 2010 = 1.0),
- $RRLR$ real rate of interest,
- YYN actual/normal output (ratio of gross output to normal or potential output),
- KR_{t-1} is the lagged change in investment expenditures,
- ECM is the error term in the long-run equation and ECM_{t-1} is the lagged error correction term
- Indexes t and i refer to the year and the region (country in EU) of the observation

Industrial employment

Co-integrating long-term equation

$$\ln\left(YRE_{t,i}\right) = \alpha + \beta_1 \ln\left(QR_{t,i}\right) + \beta_2 \ln\left(YRWC_{t,i}\right) + \beta_3 \ln\left(YRH_{t,i}\right) + \beta_4 \ln\left(PQRM^{oil}_{t,i}\right) + \beta_5 \ln\left(YKNO_{t,i} + YCAP_{t,i}\right) + ECM$$

Dynamic equation

$$\delta \log\left(YRE_{t,i}\right) = \gamma + \lambda_1 \delta \ln\left(QR_{t,i}\right) + \lambda_2 \delta \ln\left(YRWC_{t,i}\right) + \lambda_3 \delta \ln\left(YRH_{t,i}\right) + \lambda_4 \delta \ln\left(PQRM^{oil}_{t,i}\right) + \lambda_5 \delta \ln\left(YKNO_{t,i} + YCAP_{t,i}\right) + \lambda_6 \delta \ln\left(YRE_{t-1,i}\right) + \lambda_7 ECM_{t-1,i}$$

where

- α and β_1 to β_5 are estimated long-term parameters,
- γ and λ_1 to λ_7 are estimated dynamic parameters,
- YRE is total employment in thousands of persons,
- QR is real output in million EUR 2010 prices,
- $YRWC$ real average labour cost, which is real wage costs divided by employees,
- YRH is average hours worked per week,
- $PQRM_{oil}$ effect of real oil price (import prices in local currency, 2010 = 1.0),
- $YKNO+YCAP$ is the stock of knowledge and capital aggregated in million EUR 2010 prices,
- YRE_{t-1} is the lagged change in employment,
- ECM is the error term in the long-run equation and ECM_{t-1} is the lagged error correction term
- Indexes t and i refer to the year and the region (country in EU) of the observation