Supplementary Information for
The perceived effectiveness and hidden inequity of post-pandemic fiscal stimuli

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Supplementary Methods

1 Impacts Assessment based on ARIO Model

1.1 Economic Impacts Model

We use an extended Adaptive Regional Input-Output (ARIO) model (1, 2) to simulate the economic impact of the COVID-19 pandemic and different fiscal stimuli. The ARIO model is one of the most effective tools to simulate the short-term economic shock of disasters and post-disaster economic recovery (3–6). It characterizes how the impact of the pandemic is transmitted throughout the supply chains and thereby enables the estimation of both direct and induced impacts of the pandemic and the fiscal stimuli. One advantage of the ARIO model is that it avoids the problem of the "complete rigidity” assumption of Leontief production function (i.e., non-substitutability between products) in the traditional input-output model. It allows firms and consumers to seek "backorder" from other producers in the case of supply shortage. Such modelling mechanism enhances the model’s ability to depict the resilience of supply chains in the real world. The model has been used (3, 4) to simulate how the supply chains are affected by COVID-19 lockdown measures and how the fiscal stimuli affect global emissions. Our model improves upon the previous versions (3) from the following aspects: a) the ARIO model is soft-linked with various fiscal stimulus scenarios through final demand changes; b) an employment impact module is integrated to simulate employment demand and income changes under the pandemic; c) parameters are set and calibrated according to the latest available data, including big data on working, travelling and lockdown measures, to reflect the realistic impact of the pandemic. The extended version of ARIO model after such adjustments (named E-ARIO) is appropriate to explore the impacts of diverse fiscal stimuli in the post-COVID-19 era. The E-ARIO model contains four main modules and one extended module: production function module, intermediate input module, labor supply module, demand module and extended labor & income module. A detailed description of the model structure, equations, parameters and model simulation is provided below.

Production function. The E-ARIO model is based on the Leontief Production Function. Sector $i$ in region $r$ at time $t+1$ produces output $IOX_{rt+1}^i$, which is determined by intermediate inputs $IOZ_{rt+1}^i$, initial inputs (machine, labor) $IOV_{rt+1}^i$, and the orders from the last time period $OD_{it}^r$. COVID-19 lockdown measures mainly affect the supply of labor force $IOL_{rt+1}^i$ through bans on coming to workplace, which leads to a lag in machine work. Therefore, the limit on primary input is represented by labor shortage, and the production function is:

$$IOX_{rt+1}^i = \min \left( \frac{IOZ_{rt+1}^i}{I_i^r}, \frac{IOV_{rt+1}^i}{I_i^r}, OD_{it}^r \right)$$

where $z_i^r$ is the intermediate input coefficient (quantity of input for each unit of output) for sector $i$ in region $r$. $I_i^r$ is the labor input coefficient (quantity of labor for each unit of output). Since the pandemic condition is a sudden change and firms have limited reaction time, the relations of production cannot change elastically in the short term, the intermediate input and Labor coefficients are kept constant in short term. They are calculated based on production at the initial state ($t=0$):

$$z_i^r = \frac{IOZ_{t0}^i}{IOX_{t0}^i}$$

$$I_i^r = \frac{IOV_{t0}^i}{IOX_{t0}^i}$$

The calculation of $IOZ_{rt+1}^i$, $IOV_{rt+1}^i$, and $OD_{it}^r$ is elaborated in the modules of Intermediate Inputs, Labor Supply and Demand below.

Intermediate inputs. Intermediate inputs at time $t+1$ in sector $i$ of region $r$ is represented as $IOZ_{rt+1}^i$. It is determined by the inventory in the last time period $SG_{it}^r$:

$$IOZ_{rt+1}^i = SG_{it}^r$$

$SG_{it}^r$ equals the inventory at time $t - 1$ ($SG_{it-1}^r$) minus the usage during time $t$ ($SG_used_{it}^r$) plus the inventory increase during time $t$ ($SG_{added_{it}}^r$):
\[ SG_i^r = SG_i^{r-1} - SG_{used_i}^r + SG_{added_i}^r \]  

\[ SG_i^r = \partial \times IOZ_i^r \]  

\[ SG_{used_i}^r = IOY_i^r \times z_i^r \]  

Inventory used during time \( t \) \((SG_{used_i}^r)\) is: 

\[ IOZ_i^r = IOY_i^r \times z_i^r \]  

Inventory added in time \( t \), \( SG_{added_i}^r\), is the actual intermediate input allocated to sector \( i \) in time \( t \), the \( AOF_i^r \):  

\[ SG_{added_i}^r = AOF_i^r \]  

\[ AOF_{ij,t}^{sr} \] is the products of sector \( j \) in region \( s \) allocated to sector \( i \) in region \( r \), which is jointly determined by the production of sector \( j \) in region \( s \) and the proportion of demand of sector \( i \) in region \( r \). Assuming that each sector decides the allocation of products according to the orders it gets from the last time period:  

\[ AOF_{ij,t}^{sr} = \frac{FOD_{ij,t-1}^{rs}}{\sum_s FOD_{ij,t-1}^{rs}} \times IOX_{st}^s \]  

where \( FOD_{ij,t-1}^{rs} \) represents the orders that for sector \( j \) in region \( s \) from sector \( i \) in region \( r \) at time period \( t-1 \), \( HOD_{hi,t}^{rs} \) is the final demand \( h \) of region \( r \) during \( t-1 \), and \( IOX_{st}^s \) is the production of sector \( j \) in region \( s \). Calculation of \( FOD_{ij,t-1}^{rs} \) and \( HOD_{hi,t}^{rs} \) is explained in the Demand module.

**Labor supply.** Labor supply from different sectors depends on the strictness of lockdown measures during the pandemic and fiscal stimuli in the recovery processes. Assuming that the pandemic lockdown measure in region \( r \) lasts from \( t_1 \) to \( t_2 \), then labor supply equals its initial state \( IOI_{i,0} \) when \( t < t_1 \) \((IOI_{i,0}^r)\), and remains limited during the lockdown \((t_1 \leq t \leq t_2)\). The labor constraint is represented by an average decline of labor force in its region \( \omega_i^r \), and the sector’s sensitivity to lockdown measures \( \gamma_i \). Labor supply of sector \( i \) in region \( r \) returns to its normal level with the recovery rate of \( \theta_i^r \) after lockdowns \((t > t_2)\). Labor supply \( IOI_{i,t}^r \) is calculated as:  

\[ IOI_{i,t}^r = \begin{cases} IOI_{i,0}^r, & t < t_1 \\ (1 - \gamma_i \omega_i^r) \times IOI_{i,0}^r, & t_1 \leq t \leq t_2 \\ (1 + \theta_i^r) \times IOI_{i,t_2}^r, & t > t_2 \end{cases} \]  

**Demand.** Demand consists of orders from firms and final consumers:  

\[ OD_i^r = \sum_s \sum_j FOD_{ji,t}^{sr} + \sum_s \sum_h HOD_{hi,t}^{rs} \]  

Where \( FOD_{ji,t}^{sr} \) is the order that sector \( j \) in region \( s \) sends to sector \( i \) in region \( r \) (intermediate demand), and \( HOD_{hi,t}^{rs} \) is the final (consumption or investment) demand \( h \) of region \( s \) for sector \( i \) in region \( r \) (final demand). Firms are both producers and consumers in the supply chain. While producing, they make purchase decisions to restore the inventory to ensure sufficient supply of raw materials or intermediate products. The orders for product \( i \) by sector \( j \) in region \( s \) during time period \( t \), \( FOD_{ji,t}^{s,\text{sum}} \), is  

\[ FOD_{ji,t}^{s,\text{sum}} = SG_{ji,s}^{s,\text{TG}} - SG_{ji,t}^s \]  

where \( SG_{ji,s}^{s,\text{TG}} \) represents the inventory target, and \( SG_{ji,t}^s \) represents real inventory at time \( t \). \( SG_{ji,s}^{s,\text{TG}} \) is proportional to \( SG_{ji,0}^s \):  

\[ SG_{ji,s}^{s,\text{TG}} = \varepsilon \times SG_{ji,0}^s \]  

Producers issue orders to suppliers based on targeted inventory. The E-ARIO simulates the decision process according to the principle that if supply falls short of demand at current period \((AOF_{ji,t}^r < FOD_{ji,t}^{s,\text{sum}})\), the company turns to other suppliers with surplus production for replenishment, and the amount of replenishment equals \( IOD_{ji,t}^s \):  

\[ IOD_{ji,t}^s = \sum_r (FOD_{ji,t}^{sr} - AOF_{ji,t}^{sr}) \]  

Replenishment orders (that are backordered) \( BO_{ji,t}^{sr} \) are allocated based on the proportion of surplus supply \( OC_{ji,t}^{sr} \) among suppliers.
where \( AOF_{ij,t}^{r,s,max} \) represents the maximum amount of product that sector \( i \) in region \( r \) supplies to sector \( j \) in region \( s \). It is determined by the maximum capacity of the producer (sector \( i \)) regardless of order (\( 10X_{i,t}^{r,max} \)):

\[
AOF_{ij,t}^{r,s,max} = \frac{FOD_{ij,t-1}^{r,s} + \sum_s HOD_{ij,t-1}^s}{\sum_r HOD_{ij,t-1}^r} \times 10X_{i,t}^{r,max}
\]

(17)

\[
10X_{i,t}^{r,max} = \min\left(\frac{10I_i^s}{t_s^i}, \frac{10I_{i,t}}{t_{i,t}}\right)
\]

(18)

Assuming that firms have a constant preference for suppliers, and make orders from initial supplier. Orders to the initial suppliers \( FOD_{ij,t}^{sr} \) are:

\[
FOD_{ij,t}^{sr} = \sum_r \frac{10I_i^s}{t_s^i} \times (FOD_{ij,t}^{s,\text{sum}} - \sum_s BO_{ij,t}^{sr}) + BO_{ij,t}^{sr}
\]

(19)

When all the suppliers have sufficient supply (supplies in this period could satisfy Demand from last period, \( AOF_{ij,t}^{r,s} = FOD_{ij,t-1}^{r,s} \)), supplier allocates the orders for sector \( j \) in region \( s \) will be kept constant with the previous period, and therefore backorder \( \sum_r BO_{ij,t}^{sr} = 0 \).

Final demand at time \( t \) is sent to the original suppliers according to the demand proportions at the initial equilibrium:

\[
FOD_{ij,t}^{sr} = \frac{\sum_r \frac{10I_i^s}{t_s^i} \times HD_{ij,t}}{\sum_r \frac{10I_i^s}{t_s^i} \times HD_{ij,t}}
\]

(20)

where \( HD_{ij,t}^{sr} \) is the order from \( h \)th final demand in region \( s \) for sector \( i \) in region \( r \) during time \( t \), and \( HD_{i,t}^s \) represents the total demand from \( h \)th final demand for sector \( i \) in region \( s \).

Final demand \( HD_{i,t}^s \) is sensitive to pandemic lockdown measures and fiscal stimuli. If lockdown measures in region \( s \) start from \( t_1 \) and end at \( t_2 \), the \( h \)th final demand to sector \( i \) equals to its initial level \( HD_{i,0}^s \) (\( t < t_1 \)). During the lockdown period (\( t_1 \leq t \leq t_2 \)), the \( h \)th final demand to sector \( i \) is decided by the degree to which the lockdown measures affect the demand (represented by the change in final demand \( \beta_{ij,t}^s \)). After the lockdown period (\( t > t_2 \)), the final demand in region \( s \) recovers at a recovery rate of \( v_{hi,t} \) every week. Final demand \( HD_{i,t}^s \) is therefore calculated as:

\[
HD_{i,t}^s = \begin{cases} 
HD_{i,0}^s, & t < t_1 \\
(1 - \beta_{ij,t}^s) \times HD_{i,0}^s, & t_1 \leq t \leq t_2 \\
(1 + v_{hi,t}) \times HD_{i,t}^s, & t > t_2 
\end{cases}
\]

(21)

In fiscal stimuli scenarios, stimuli will affect output through stimulating the final demand (through investment or consumption). The target sectors of the fiscal stimuli will add \( MS_{hi}^s \) to their demands in the self-adaptive-recovery-only scenarios:

\[
MS_{hi}^s = \mu_h^s \times MS_{sum}^s
\]

(22)

where \( \mu_h^s \) is the proportion of stimulus allocated to the \( h \)th final demand in region \( s \) for sector \( i \). Economic stimulus \( MS_{sum}^s \) is kept constant across policy scenarios in order to ensure comparability. \( p \) represents the number of periods with economic stimulus, and the financial input of stimulus for each period \( MSP_{hi}^s \) is:

\[
MSP_{hi}^s = \frac{MS_{hi}^s}{p}
\]

(23)

Therefore, the final demand under the stimulus \( HD_{i,t}^s \) is:

\[
HD_{i,t}^s = \begin{cases} 
HD_{i,0}^s, & t < t_1 \\
(1 - \beta_{ij,t}^s) \times HD_{i,0}^s, & t_1 \leq t < t_2 \\
(1 + v_{hi,t}) \times HD_{i,t}^s, & t_2 \leq t < t_3 \\
(1 + v_{hi,t}) \times HD_{i,t}^s + MSP_{hi}^s, & t \geq t_3 
\end{cases}
\]

(24)

### 1.2 Employment and Income Impacts Estimation
To evaluate the employment impact of the pandemic recovery processes, we calculate the labor demand and sectoral income as follows:

\[
Employment_{it}^{r,k} = E_{it}^{r,k} \times IOX_{it}^r
\]

\[
Wage_{it}^{r,k} = I_{it}^{r,k} \times IOX_{it}^r
\]

where \(Employment_{it}^{r,k}\) is the labor demand for the \(k\)th labor type from sector \(i\) in region \(r\) during time period \(t\), and \(Wage_{it}^{r,k}\) is the wage of the \(k\)th labor type in sector \(i\) in region \(r\) during time period \(t\). \(E_{it}^{r,k}\) is the demand coefficient (the amount of labor required for each unit of economic output) for the \(k\)th labor type, and \(I_{it}^{r,k}\) is the income coefficient (income provided by each unit of product). \(IOX_{it}^r\) represents the economic output of sector \(i\) in region \(r\) at time \(t\). The two factors are calculated based on the initial state (\(t = 0\)):

\[
E_{it}^{r,k} = \frac{Employment_{i,0}^{r,k}}{IOX_{i,0}^r}
\]

\[
I_{it}^{r,k} = \frac{Wage_{i,0}^{r,k}}{IOX_{i,0}^r}
\]

where \(Employment_{i,0}^{r,k}\) is the demand for the \(k\)th labor type from sector \(i\), and \(Wage_{i,0}^{r,k}\) is the initial wage provided by sector \(i\).

1.3 Model Simulation

Our model runs iteratively. In each iteration period (i.e., time step), the firm makes optimal production decisions (Production Function Module) in accordance with inventory stocks (Intermediate Input Module), labor availability (Labor Supply Module) and previous orders from consumers and other firms (Demand Module). During this time step, goods produced by firms are allocated to consumers and other firms, satisfying the final demand and forming new inventories of the firm, respectively. Meanwhile, new orders are issued by firms and consumers, which are used to make production decisions for the next period. Firms’ production activity in the same sector represents sectoral economic output, which in turn reflects employment demand (Extended Labor & Income Module). This discrete-time dynamic procedure can simulate the spread of exogenous shocks (i.e., the pandemic) and the recovery of supply chain in the economic network, both from the firm and household sides, which will provide a brief overview of the economic system equilibrium (3).

1.4 Key Assumptions and Data Sources for Model Simulation

Global supply chain. We simulate the global supply chain based on the widely-used input-output database EXIOBASE 3.8.1 (7). Since key factors, such as energy/emissions, are updated to 2015 IEA energy balances at detailed level in the database, we adopt the economic data in 2015 from EXIOBASE 3.8.1. The data describe the complex economic flows among 163 sectors in 44 countries/territories and 5 regions (see Table S2 & S3). The 44 countries/territories account for 86% of the global GDP in 2019 (8), 80% of the global CO2 emission in 2018 (9), and 61% of the global labor supply in 2019 (10). The 5 regions cover the rest of the world. The wide coverage and the detailed sectoral categorization enable comprehensive analyses on how the backward or upstream effect of the economic shocks through the global supply chain.

Employment and income impacts. We use the satellite matrix data from EXIOBASE 3.8.1 (7) to estimate employment and income impacts. In the database, both sectoral employments and incomes are divided into three categories: the high-, medium- and low-skilled workers. Based on this categorization, we discuss the impact on the demands for different types of workers under various fiscal stimuli plans. Based on the sectoral average income, we also categorize sectors into three groups: the low-income group (40% of the urban labor force number), the middle-income group (40%), and the high-income (20%) group (31-33). Low- and medium-skilled workers account for more than 97% of the labor in the low-income group, while high-skilled workers dominate the high-income group (about 40%).
**Time frame and time step.** Since the model predicts short-term impact and there is the possibility that the pandemic might end with worldwide vaccination(35), we design the model with a time frame of 3 years, from January 2020 to January 2023. As mentioned above, the model operates iteratively, and the iteration period (i.e., the time step) is set to two weeks considering the practical response time of firms and the development of the pandemic. The yearly data is therefore divided into 26 groups to align with the time steps in the simulations, with each group representing bi-weekly production and trade status. This time step is consistent with other related studies which also use self-adaptive input-output models to evaluate pandemic and disaster footprints. The time steps in these studies range from one day to one month. (1–6, 11–14). Hallegatte et al.(2, 13), Li et al. (12) and Wu et al.(14) use one month as the time step to study the economic impact of hurricanes, floods, and earthquakes. Studies choosing one week as the time step include Zeng et al.(1) and Zeng et al.(6) 's research on the impact of floods, and Guan et al.(3) and Shan et al.(4)’s the evaluation of the impact of and recovery from the pandemic. Inoue et al.(11) and Wang et al.(5) run a simulation of the economic recovery process after disasters on a daily time step. The setting of 2 weeks in this study refers to similar analyses on economic recovery processes from the COVID-19 pandemic, including studies of Guan et al.(3) and Shan et al.(4). On the one hand, the two-week timestep reflects the flexible response of companies’ decision-making process on production(15–17). Moreover, a two-week step can depict the changes in labor demand and supply during the pandemic period in a proper way. If the simulation is run by a daily step, the study might overestimate the efficiency of corporate decision making; if by the monthly step, the simulation might omit significant details on the pandemic development, and thus underestimating its real impacts.

**Pandemic lockdown measures.** Since lockdown measures are altered with the periodic fluctuation of the pandemic, the strictness of lockdown measures and their economic shock are estimated in different phases of the pandemic. For this reason, the 3-year time frame is divided into two periods based on the latest available information. The first one is from Jan 19, 2020, to May 23, 2021, where we use real-world lockdown data based on actual policies and mobility data. For this phase, we use Google Community Mobility Report (GCMR) (37) and the Oxford Global Recovery Observatory (OxGRO) (18) (until May 22, 2021) to check whether residents work from home or going to the office (for example, if ‘workplace’ transportation decreases by 20%, the labor force is assumed to decrease by 20%). Factors of labor sensitivity to the pandemic are individually calculated for each sector (Table S3) (29). Google Community Mobility Report (37) also reports transportation to other destinations (retail store, grocery and pharmacy, parks, transportation hubs, and residential areas), which are used to calibrate the demand data during the pandemic. Since the GCMR provide limited data for China, we use Baidu Map data to calibrate China’s measures during the pandemic period (38-40). The second period is May 23, 2021 to Jan 13, 2023, where we assume the labor supply and final demand will recovery at a certain rate for Non-Stimulus Scenarios and policy scenarios. We also conduct sensitivity analysis for these parameters in the Supplementary Discussion.

All parameters for model calibration and simulation are presented in Table S2-S4, along with the data sources.
2 Scenarios Design

2.1 Fiscal Stimuli Scenarios
We establish five sets of scenarios based on three conditions: whether there is the pandemic, whether there is a stimulus plan, and how to allocate the fiscal stimulus (Table S7). Counterfactual Business-As-Usual (BAU) scenarios are designed to reflect the economic situation without the pandemic, which will provide a reference point against which the impact of the pandemic is evaluated. Non-Stimulus (NS) scenarios are formulated to reflect the recovery process from the pandemic without fiscal stimuli. NS scenarios are used as a reference point to evaluate the effectiveness and the equity impact of different fiscal stimuli. A total of three sets of fiscal stimulus scenarios are designed to evaluate the impacts of the stimuli structure. Three stimulus structures are compared: Currently-pledged Stimulus (CS) scenarios, which are based on the real-world structure announced by each country; Traditional Stimulus (TS) scenarios and Low-carbon Stimulus (LS) scenarios, which allocate the stimuli to traditionally advantageous sectors and low-carbon sectors, respectively. The scale of the stimuli is same for three scenarios. Details of scenarios are provided below.

We assume that fiscal stimuli will be performed at the end of the first round of pandemic in accordance with policy gathered by Aura Vision (19). Noting that the timing of fiscal stimulus may affect its effect, thus the related sensitivity analysis can be seen in Supplementary Discussion.

2.2 Data Sources and Main Assumptions for Scenarios

2.2.1 BAU and NS scenarios
BAU is the counterfactual scenario without the impact of pandemic, which is predicted based on the economic estimation from IMF to present the economic output from 2020 to 2022 (20).

Under the impact of pandemic, labor supply and final demand are restrained by lockdown measures, which gradually recover as the lockdown measures are lifted. Information on lockdown measures for each country is retrieved from the Google Community Mobility Report and the Oxford COVID-19 Government Response Tracker (OxCGRT) (detailed in Section 1.4). NS scenarios describe the gradual economic recovery without additional fiscal stimulus as lockdown measures are eased and removed. According to the Google Community Mobility Report, the recovery rate of labor supply and final demand in most countries after the first round of pandemic is 2%~4% per week and we thus set NS scenarios based on this estimation. Three fiscal stimulus scenarios are following the basic setting of NS scenarios.

2.2.2 Currently-pledged Stimulus (CS) Scenarios
CS scenarios are designed according to the actual scale and structure of the fiscal stimuli announced by countries.

Scale of stimulus. The latest available data were retrieved in May, 2021 from the database of the Oxford Global Recovery Observatory (OxGRO) (20). The OxGRO database collects financial stimulus data from 89 major economies, and is updated weekly since January 1, 2020. Note that our results may be sensitive to fiscal stimulus scale, sensitivity analysis of this parameter is conducted based on the information from the other two databases, i.e., International Monetary Fund (IMF) (18) and Oxford COVID-19 Government Response Tracker (OxCGRT) (19). The IMF database covers 187 countries/regions and their data starts from January 2020 to March 2021. The OxCGRT database covers 183 countries/regions and the information starts from January 1, 2020. A detailed comparison of these databases is shown in Table S9 and Fig. S9. Sensitivity analysis of stimulus scale is detailed in Supplementary Discussion.

Structure of stimulus. The OxGRO database also provides detailed information on the fiscal stimuli, which is categorized into 5 categories, and further into 40 classes and 158 types. The amount of each is also documented. We match each country’s stimulus policies to the sectors in
the E-ARIO model (detailed in Dataset S1), and aggregate to obtain the current fiscal stimulus structure for each country.

### 2.2.3 Low-carbon Stimulus (LS) Scenarios

LS scenarios allocate the investments (the same as the stimulus scale of CS scenarios) to the 1.5-degree-oriented sectors recommended by IEA (21).

**Scale of stimulus.** The scale of fiscal stimulus in each country is the same as that of CS Scenarios.

**Structure of stimulus.** The IEA report estimates that the annual global investment needs to be 4.5–4.9 trillion USD to achieve the 1.5-degree target (21). The money shall be invested in four main sectors including energy, transportation, building, and industry, with each accounting for 43%, 14%, 35% and 7% of the total amount. We then allocate the investments to the four main sectors to sub-sectors based on country-specific situations, such as each country’s technology, capital and talent accumulation in the sub-sectors, and each country’s low-carbon development challenges (e.g., the high proportion of coal power in the electricity mix).

1) **The energy sector.** Investments in renewable energy include the final demand for renewable energy (e.g., wind and solar) and for sectors that supply the necessary equipment (e.g., solar panels). We allocate the stimuli according to Wiebe et al. (22). The specific industries included are manufacture of machinery and equipment (29), manufacture of electrical machinery and apparatus (31), construction (45), insurance and pension funding (66) and other business activities (74). The allocation ratios are shown in Table S8.

2) **The transportation sector.** The stimulus allocated to the transportation sector in each country will be further allocated according to the final demand of each sub-sector such as demands for public transportation and railway etc.

3) **The construction sector.** Low-carbon measures in the construction sector will depend on major construction projects as well as building refurbishment. Thus, investment amount will mainly focus on the construction sector itself in the near run.

4) **The industrial sector:** The industrial sector includes 74 sub-sectors (Sector No.20-93 in EXIOBASE). We select the advantageous low-carbon sub-sectors in each country according to the total carbon emission coefficient of each country’s industries (sub-sectors with lower total carbon emission coefficients). Then the low-carbon stimulus fund for the industrial sector will be allocated to these low-carbon industrial sub-sectors with the initial proportions of these sub-sectors.

Supporting sectors: In addition to the above sectors, global low-carbon development means more needs for R&D and talents (23). Therefore, we have included matching funds in R&D, education and digitalization sectors following the initial proportions, which account for 10% of the total amount of stimulus.

### 2.2.4 Traditional Stimulus (TS) Scenarios

TS scenarios distribute the announced fiscal stimuli (the same as the total amount of CS scenarios) into traditional advantageous sectors of each country.

**Scale of stimulus.** The scale of fiscal stimulus in each country is the same as that of CS Scenarios.

**Structure of stimulus.** The fiscal stimuli are allocated to the traditionally advantageous sectors in each country. We rank the fixed capital formation (i.e., final investment volume) of each sector in each country in year 2015 and the stimulus structure follows the initial proportions of the top-ranked dominant sectors (total number of sectors consistent with the LS scenarios). Investment in these industries accounts for more than 96% of investment in the countries.

We find that the results are sensitive to the number of sectors receiving stimuli, that is, the more sectors the stimulus plans cover, the better the economic output becomes. Thus, we align the number of sectors of the TS scenarios stimulus with the LS scenarios, to make the scenarios
2.2.5 Main Assumptions of Scenario Design

Our main assumptions in establishing scenarios include the counterfactual economic growth for BAU scenario, economic recovery in NS scenario driven by easing lockdown measure and proxied by the recovery rate of labor availability and final demand, and the timing of fiscal stimulus.

First, we assume that in the counterfactual BAU scenario, where COVID-19 does not exist, economic output will grow at the expected rate of growth, and the growth rate for each country remains the same within the entire process. Similar scenario settings have been used in Shan et al. (13) and Kikstra et al. (60).

Second, NS scenario describes both the process of the economy being shocked by the pandemic and economic recovery as the lockdown measures are lifted. We assume that the gradual economic recovery without additional fiscal stimulus as lockdown measures are eased and removed through the gradual recovery of labor supply and final demand, which is measured by labor recovery rate and demand recovery rate. According to the Google Community Mobility Report, the recovery rate of labor supply and final demand in most countries after the first round of pandemic is 2%–4% per week and we thus set NS scenarios based on this estimation. Three fiscal stimulus scenarios are following the basic setting of NS scenarios. We also identify the sensitivity of these two parameters and further set sub-scenarios for NS scenario and policy scenarios based on the estimated parameter ranges.

Third, fiscal stimulus timing is a key parameter influencing the results of policy scenarios. In the scenario simulation, we assume that fiscal funds will be allocated into sectors at the end time of the first round of lockdown measures, thus the stimulus timing varies among different countries. To robust our assumption, another two fiscal timing options are set in the sensitivity analysis, that is, 5- and 8-weeks delay. We found the delay of fiscal stimulus will make an 8%–16% increase in economic reboot and job creation. The impact of fiscal stimulus timing on results can be explained by the stimulus policy will take remarkable effect with the easing lockdown measures and recovering labor supply. To consolidate our conclusion, these assumptions of fiscal timing are involved in the scenario design for further uncertainty analysis.

3 Methods for Equity Assessment

Equality index. We quantify inequality with two indicators, namely the Gini index and the Theil index. The Gini index is a measure of the distribution of income across a population (24–26). The Theil index is a measure of income disparity between individuals or regions, calculated using the concept of entropy in information theory (27).

The Gini index is calculated as:
\[
Gini = 1 - \frac{\sum_g A_l g \times r_g}{0.5 \times A_{max}}
\]  \hspace{1cm} (5),

where \(A_l g\) is the \(g\)th worker group’s average income, while \(r_g\) is the proportion of \(g\)th worker group in all workers. \(A_{max}\) represents the average income of the worker groups with the highest income. A higher value of the Gini index indicates a greater income gap and increased social inequality.

The Theil coefficient is calculated as:
\[
T(\alpha) = \frac{1}{(\alpha - 1)} \sum_{g=1}^{G} \left( \frac{Q_g}{P_g} \right) ^ \alpha - 1
\]  \hspace{1cm} (31),

where \(P_g\) is the proportion of population in different groups, and \(Q_g\) indicates the proportion of different group income. \(\alpha\) reflects the degree of aversion to inequality, with smaller values
representing higher aversion to inequality. When $\alpha = 0$, $T(0)$ is the second Theil index, namely the Theil L index, which is sensitive to changes in the lower-income groups (28):

$$T(0) = \sum_{g=1} P_g \ln \left( \frac{Q_g}{P_g} \right) \tag{32},$$

If $\alpha = 1$, $T(1)$ is called the Theil T index, which is sensitive to changes in higher-income groups:

$$T(1) = \sum_{g=1} Q_g \ln \left( \frac{Q_g}{P_g} \right) \tag{33},$$

As we aim to emphasize the inequality between the top and the bottom of the spectrum, we adopt the Theil L index to characterize the degree of income inequality. A larger Theil L index means a larger gap between different income groups.
Supplementary Discussion

1 Effectiveness and Equity of Stimuli at the Country Level

Based on whether CS is more effective than TS and LS in stimulating the labor demand and whether it increases inequality, the impact of fiscal stimuli on different skilled labor forces in different countries can be divided into four categories (Fig. S12). First, among the countries with a stronger pulling effect in the CS scenario, the inequity of the CS scenario rises in developed countries such as the European Union, the United States and the United Kingdom, where the inequality coefficient of the CS scenario increases by 8%~45% compared with the LS scenario. This is mainly because the labor growth effects of the CS scenario in these countries are mainly driven by the demand growth of high-skilled workers. From the perspective of fiscal stimulus structure, the R&D, education, and public health sectors receive as much as 40%~80% of total stimulus funds in developed countries. As these sectors possess higher demand for high-skilled labor (25%~40% of highly skilled people are in these sectors), the number of high-skilled jobs in these sectors is 1.2~3.1 times that of low-skilled workers.

Among the countries where CS provides more job demand, inequity in South Africa and India does not show a significant increase. For India, its currently pledged fiscal stimuli include the construction of traditional energy facilities (for example, new or reclaimed coal mines and oil/gas fields, new or reclaimed infrastructure for transport and transmission of fossil energy), inducing most fiscal funds (as much as 40%) to flow to traditional sectors. These sectors provide more jobs for low- and medium-skilled workers, who are 3~12 times more prevalent than high-skilled workers. For South Africa, the fiscal stimulus structure is similar to that of developed countries. A large number of financial stimulus funds are directed to the education sector (including worker training and education, worker retraining and job creation, and education investment). Because the number of low-skilled workers in these sectors is approximately 1.4 times that of high-skilled workers, CS in South Africa directly provides more employment opportunities for low-skilled workers.

Among the countries where the CS scenario poses a weaker employment increase, Japan, China, Brazil, Mexico and Switzerland still face rising inequity (that is, the inequality coefficient of CS increases by approximately 0.1%~12%). The stimulus-favored sectors in these countries all require a large number of high-skilled people (2.4~7.2 times the number of low-skilled people). In Russia, the pulling effect of the CS scenario is relatively weak, and there is no significant increase in inequality. Approximately 37% of the fiscal stimuli in these countries are devoted to infrastructure construction (renewable energy, transportation, and digital economy infrastructure). These sectors require significantly more low-skilled workers than high-skilled workers (2.8 times the number of high-skilled workers). The stimuli in these sectors provide more job opportunities for low-skilled workers and ensure equitable economic recovery.
2 Sensitivity analysis and uncertainty analysis

Two uncertainties, i.e., uncertainties in model calibration data and scenario design parameters, could result in the uncertainty of the estimates. To examine how the results change with the variance in these uncertainties, we conduct three groups of sensitivity analysis covering five key parameters (Table S5). The methods and results for the sensitivity analysis are presented in the following sub-sections.

2.1 Model Calibration Data

Lockdown strictness. One of the main influencing channels through which the pandemic affects the economy and employment is lockdown policies and distancing measures. These measures change labor availability and consumers’ behavior. We focus on this channel and use the big data for mobility (i.e., Google COVID-19 Community Mobility Reports (GCMR) (29) and Baidu map data (30–32)) as proxies of lockdown strictness. This proxy is reasonable because people’s mobility activities are directly correlated with lockdown strictness. As validation, we compare our proxy with the Oxford Government Response Tracker (OxCGRT) database, which provides the estimations of lockdown strictness based on the collection, evaluation and rating of government response policies, and conduct sensitivity analysis on the lockdown strictness (the comparison of lockdown strictness from GCMR(+Baidu) and OxCGRT can be found in Fig. S10). We found that based on the OxCGRT database, the impacts of the pandemic on the economy and employment are larger, while the effectiveness of final demand stimuli is smaller than those using GCMR and Baidu map data (33%–37% less than the job demand estimation from GCMR and Baidu map data). The differences are probably because the lockdown strictness assessed by the OxCGRT database is sometimes higher than those shown by the mobility data (Fig. S2). Stricter lockdown leads to more labor loss and final demand decrease, which consequently brings more serious economic disruption and reduces the effectiveness of fiscal stimuli. We further include this parameter into our scenario setting.

2.2 Scenario Design Parameters

Recovery rate of labor availability. In the Non-stimulus (NS) scenario, economic recovery is driven by easing the lockdown policies, which influences the recovery rate of labor availability and final demand. The other three policy scenarios are built on NS scenario. Thus, the result of NS and policy scenarios are associated with the setting of these two parameters. We set the range of these two parameters according to the mobility data. The mobility data, especially those heading to the working place, also provides information for labor availability. Google COVID-19 Community Mobility Reports (GCMR) (29) provides real-world mobility data since January 2020. We use these data and set two levels of labor recovery rate, i.e., 2% and 4% increase per week according to the historical trend of the recovery (Fig. S11), in the projections afterwards. The results (Fig. S3) show that our main findings -- the comparison among scenarios -- are in general robust to the changes.

In terms of the absolute values of the economic and employment impacts, increasing the recovery rate of labor availability from 2% to 4% per week leads to the 42%–44% and 71%–78% increase in economic output and labor demand, respectively. This is consistent with our expectations, since the rapid recovery of labor market reduces the constraints on productivity, which should be further designed in the scenario.

Recovery rate of final demand. Similar to the recovery rate of labor availability, the data for final demand recovery are also divided into two periods. Mobility data are used to reflect consumers’ behavior changes by May 2021 (the time point by which the latest real-world mobility data are available) and different levels of recovery rates are set for the prediction afterwards. We set 2% and 4% increase per week as well, according to the historical trends (Fig. S11). Fig. S4 shows that the faster final demand recovers, the more effective the economy reboots and job demand increases. The increase of demand recovery rate from 2%/week to 4%/week will lead to the 36%–42% and 127%–137% increase in economic output and labor demand, respectively. Thus,
the sensitivity of the result to the recovery rate of final demand should be taken into account in the
scenario design.

**Fiscal stimulus scale.** The fiscal stimulus scale is another key parameter that could affect the
results. In our study, we adopt the original stimulus size from the OxGRO database and investigate
how a ±10% variance of the stimulus scale affects the results. The sensitivity analysis, shown in
Fig. S5, indicates that the variance in stimulus scale leads to ±8%~10% changes in economic
growth and job creation. Thus, the range of fiscal stimulus scale will be involved in the scenario
design for further uncertainty analysis.

In addition, we test three databases for the sensitivity analysis of the pledged stimulus scale, i.e.,
the OxGRO(18), IMF (33) and OxCGRT(34). The OxCGRT database covers 183 countries/regions
and the information starts from January 1 2020. The spending covers financial stimulus, medication
spending, investments in vaccination, etc. The OxGRO database collects financial stimulus data
from 89 major economies starting from January 1 2020. Financial stimulus is categorized into 5
categories, and further into 40 classes and 158 types, the amounts of which are also documented.
The IMF database covers 187 countries/regions and their data starts from January 2020 to March
2021. Stimulus spending covers on public health, emergency aids and salary subsidies, as well as
tax deductions and public financing. The OxCGRT database covers 183 countries/regions and the
information starts from January 1 2020. The spending covers financial stimulus, medication
spending, investments in vaccination, etc. The detailed comparison of these databases is shown
in Fig. S9 and Table S9. The three databases are quite different because of the difference in
documentation standards. The stimulus scales are about 1%~55% of GDP of each country in the
IMF database, 1%~54% in the OxCGRT database and 0.02%~19% in the OxGRO database,
respectively. None of the three databases provides stimulus plans’ duration, which makes it
impossible to accurately estimate the stimulus amount of each year. However, according to the
existing literature, it is reasonable that the annual stimulus scale can be up to 10% of GDP (4).
Therefore, we use the investment scale of the OxGRO database in this study, and conduct
sensitivity analysis with investment scales of the other two databases. For ease of comparison, the
stimulus scale of the IMF database and OxCGRT are converted from a total number of 2 or 5 years
to a yearly amount. After converting the stimulus scale to the constant price as those in the
EXIOBASE v3.8.1 database, we find that the fiscal stimulus scale reported by the IMF and
OxCGRT database increases the economic output by 4%~6% and the job creation by 17%~34%
relative to those reported by the OxGRO database. Our major results, however, are generally valid
when comparing the various scenarios in Fig. S6.

**Fiscal stimulus timing.** The timing of fiscal stimulus is also a key parameter influencing the results.
Inadequate control measures at the beginning of the outbreak may have a negative impact on the
subsequent pandemic development, and then continuously affect the overall level of labor
availability. In this case, fiscal stimulus shows different economic and employment pulling effects
at different stages of epidemic development. Here, we use the end time of the first round of
lockdown measures in various countries as the fiscal stimulus time, and set up sub-scenarios of 5-
and 8-weeks delay. Fig. S7 shows that the delay of fiscal stimulus will make an 8%~16% increase
in economic reboot and job creation. The impact of fiscal stimulus timing on results can be
explained by the stimulus policy will take remarkable effect with the easing lockdown measures
and recovering labor supply.

After analyzing all of the above-mentioned factors, we find that results are sensitive to the
**lockdown strictness, the total amount of fiscal stimulus, the recovery rate of labor supply,**
**final demand recovery rate, and the timing of fiscal stimulus.** To consolidate our conclusion,
we conduct uncertainty analysis by combining orthogonal experimental design (OED) with scenario
design. OED is an effective method for arranging and analyzing multi-factor interactions. It could
present full factorial scenarios and is widely used in scenario design to perform the uncertainty
analysis(3, 4, 35, 36). We include 72 sub-scenarios (the lockdown strictness (2) × the total amount
of fiscal stimulus (3) × the recovery rate of labor supply (2) × final demand recovery rate (2) × the
timing of fiscal stimulus (3)) in each set of scenario groups (1 BAU scenario, 1 non-stimulus
scenario and 3 policy stimulus scenarios). The parameter ranges are summarized in Table S6.

An uncertainty not considered in our current analysis is the inherent uncertainty in the E-ARIO
model. Specifically, for a given lockdown strictness change, the resulting economic output change
modeled by E-ARIO is subject to uncertainty because sectoral sensitivity to lockdown strictness
and their reaction processes may not be exactly the same as those in the real world. For example,
the retail sector is shocked heavily by the pandemic due to public social distance policies, which
may be reflected as a higher sensitivity to the lockdown strictness in the model. However, in reality
some stores adopt the “call and collect” pattern to meet the daily requirement of the public, which
shows the resilience of real economic system. It has to be admitted that it remains extremely difficult
to fully quantify this uncertainty in simulations because of the complex and non-optimal economic
processes. We adopt the sensitivity of sectors from the previous researches to limit the
uncertainty(3). Also, this study excludes the uncertainty from the time step setting. We adopt a two-
week as time step, which assumes that all sectors will make the production decisions in the same
step. It is acknowledged that a higher-resolution time step setting can reflect more precise details
of lockdown measures. However, we aim to investigate the impact of the pandemic and the fiscal
stimulus policy on the labor demand and social inequality, in which the time step is used as a proxy
to stimulate the economic procedure. In accordance with our objective, we focus on the uncertainty
in labor demand and social inequality change induced by the pandemic and the fiscal stimulus
policy, rather than the inherent uncertainty in the E-ARIO model.
Fig. S1. The unemployment risk of low-skilled labors relative to high-skilled labors at the national level. The lines represent fifth and 95th percentiles of the unemployment risk of low-skilled labors relative to high-skilled labors for each country.
Fig. S2. Sensitivity analysis of lockdown strictness. Error bars represent the 95% CIs.
Fig. S3. Sensitivity analysis of recovery rate of labor supply. Error bars represent the 95% CIs.
Fig. S4. Sensitivity analysis of recovery rate of final demand. Error bars represent the 95% CIs.
Fig. S5. Sensitivity analysis of the amount of fiscal stimuli (Comparing between the stimuli from OxGRO and ±10% of total amount.). Error bars represent the 95% CIs.
Fig. S6. Sensitivity analysis of the amount of fiscal stimuli (Comparing between the stimuli from IMF, OxGRO and OxCGRT). Error bars represent the 95% CIs.
**Fig. S7. Sensitivity analysis of fiscal stimulus timing.** Error bars represent the 95% CIs.
**Fig. S8. Comparison of fiscal stimulus from three databases: IMF, OxCGRT and OxGRO.**

This shows the sizes of fiscal stimuli for 44 territories/areas in the world. The information is gathered from three different databases. IMF database summarizes key fiscal measures governments have announced or taken in selected economies in response to the COVID-19 pandemic as of March 17, 2021 for selected economies. It includes COVID-19 related measures since January 2020 and covers measures for implementation in 2020, 2021, and beyond. The OxGRO tracks and assesses every individual COVID-19 related fiscal spending policy announced by the 50 leading economies for potential impacts on the environment and the socio-economy weekly. The OxCGRT provides the monetary value and statement date of fiscal measures for over 180 countries/regions since Jan 1, 2020, with data updated weekly. All of data shown here were current as of May 22, 2021.
Fig. S9. Comparison of lockdown strictness from two databases: GCMR(+Baidu) and OxCGRT. The relative stringency for 44 territories/regions from February 16, 2020 to April 10, 2021 is depicted in these figures. GCMR(+Baidu) refers to the Google community mobility report, here Baidu map data is used as complementary for China. The OxCGRT systematically collects information on several different common policy responses that governments have taken to respond to the pandemic such as lockdown restrictions and closures. Although OxCGRT is somewhat higher than GCMR(+Baidu), these databases show a similar lockdown strictness pattern. This could be because the lockdown strictness of GCMR is directly presented through actual mobility data in the real world, while the lockdown strictness of OxCGRT is a score based on policy evaluation. The strictness level may be tightened by the evaluation principles.
Fig. S10. Recovery rate for labor availability and final demand at the end of the first round of pandemic. We assume that additional stimulus plans cannot be implemented immediately at the end of the first phase of pandemic, thus the change of labor supply and final demand during this time can be regarded as the recovery rates without additional stimulus plans.
Fig. S11. Effectiveness and equity of fiscal stimulus among countries/regions.
Supplementary Tables

Table S1. Changes of inequality index of CS scenarios compared to LS scenarios.

| Country/Territory/Region | Gini Index | Theil Index | Average |
|--------------------------|------------|-------------|---------|
| European Union           | 4%         | 15%         | 9%      |
| United Kingdom           | 0%         | 5%          | 2%      |
| United States            | 16%        | 7%          | 11%     |
| Canada                   | -1%        | 1%          | 0%      |
| South Korea              | -3%        | 8%          | 3%      |
| Australia                | -9%        | 19%         | 5%      |
| Norway                   | 45%        | 46%         | 45%     |
| Japan                    | 0%         | 13%         | 6%      |
| Switzerland              | 4%         | 10%         | 7%      |
| Mexico                   | 26%        | -2%         | 12%     |
| China                    | 0%         | 0%          | 0%      |
| Brazil                   | -1%        | 1%          | 0%      |
| India                    | 1%         | -3%         | -1%     |
| South Africa             | -1%        | 0%          | -1%     |
| Russia                   | 0%         | -12%        | -6%     |
| No. | Country/Territory /Region | Included in the evaluation of the Covid-19 | Included in the evaluation of fiscal stimuli |
|-----|---------------------------|------------------------------------------|---------------------------------------------|
| 1   | Austria                   | Yes                                      | Yes                                         |
| 2   | Belgium                   | Yes                                      | Yes                                         |
| 3   | Bulgaria                  | Yes                                      | No                                          |
| 4   | Cyprus                    | Yes                                      | No                                          |
| 5   | Czech Republic            | Yes                                      | No                                          |
| 6   | Germany                   | Yes                                      | Yes                                         |
| 7   | Denmark                   | Yes                                      | Yes                                         |
| 8   | Estonia                   | Yes                                      | No                                          |
| 9   | Spain                     | Yes                                      | Yes                                         |
| 10  | Finland                   | Yes                                      | Yes                                         |
| 11  | France                    | Yes                                      | Yes                                         |
| 12  | Greece                    | Yes                                      | No                                          |
| 13  | Croatia                   | Yes                                      | No                                          |
| 14  | Hungary                   | Yes                                      | No                                          |
| 15  | Ireland                   | Yes                                      | Yes                                         |
| 16  | Italy                     | Yes                                      | Yes                                         |
| 17  | Lithuania                 | Yes                                      | No                                          |
| 18  | Luxembourg                | Yes                                      | No                                          |
| 19  | Latvia                    | Yes                                      | No                                          |
| 20  | Malta                     | Yes                                      | No                                          |
| 21  | Netherlands               | Yes                                      | No                                          |
| 22  | Poland                    | Yes                                      | Yes                                         |
| 23  | Portugal                  | Yes                                      | Yes                                         |
| 24  | Romania                   | Yes                                      | No                                          |
| 25  | Sweden                    | Yes                                      | Yes                                         |
| 26  | Slovenia                  | Yes                                      | No                                          |
| 27  | Slovakia                  | Yes                                      | No                                          |
| 28  | United Kingdom            | Yes                                      | Yes                                         |
| 29  | United States             | Yes                                      | Yes                                         |
| 30  | Japan                     | Yes                                      | Yes                                         |
| 31  | China                     | Yes                                      | Yes                                         |
| 32  | Canada                    | Yes                                      | Yes                                         |
| 33  | South Korea               | Yes                                      | Yes                                         |
| 34  | Brazil                    | Yes                                      | Yes                                         |
| 35  | India                     | Yes                                      | Yes                                         |
| 36  | Mexico                    | Yes                                      | Yes                                         |
| 37  | Russia                    | Yes                                      | Yes                                         |
| 38  | Australia                 | Yes                                      | Yes                                         |
| 39  | Switzerland               | Yes                                      | Yes                                         |
| 40  | Turkey                    | Yes                                      | No                                          |
|   | Country                          | Yes | No  |
|---|----------------------------------|-----|-----|
| 41 | Taiwan, China                    | Yes | No  |
| 42 | Norway                           | Yes | Yes |
| 43 | Indonesia                        | Yes | No  |
| 44 | South Africa                     | Yes | Yes |
| 45 | RoW Asia and Pacific             | Yes | No  |
| 46 | RoW America                      | Yes | No  |
| 47 | RoW Europe                       | Yes | No  |
| 48 | RoW Africa                       | Yes | No  |
| 49 | RoW Middle East                  | Yes | No  |
Table S3. Sectoral sensitivity parameter and concordance between E-ARIO model and Google COVID-19 Community Mobility Reports. Google Mobility data classification: 0 – Other demand; 1 – Retail and recreation; 2 – Parks; 3 – Transit stations; 4 – Residential; 5 – Health.

| No. | Sector                                                                 | Sectoral sensitivity parameter | Corresponding to Google mobility data classification |
|-----|------------------------------------------------------------------------|--------------------------------|------------------------------------------------------|
| 1   | Cultivation of paddy rice                                             | 0.1                            | 0                                                    |
| 2   | Cultivation of wheat                                                  | 0.1                            | 0                                                    |
| 3   | Cultivation of cereal grains n.e.c.                                   | 0.1                            | 0                                                    |
| 4   | Cultivation of vegetables, fruit, nuts                                | 0.1                            | 0                                                    |
| 5   | Cultivation of oil seeds                                              | 0.1                            | 0                                                    |
| 6   | Cultivation of sugar cane, sugar beet                                 | 0.1                            | 0                                                    |
| 7   | Cultivation of plant-based fibers                                     | 0.1                            | 0                                                    |
| 8   | Cultivation of crops n.e.c.                                           | 0.1                            | 0                                                    |
| 9   | Cattle farming                                                        | 0.1                            | 0                                                    |
| 10  | Pigs farming                                                          | 0.1                            | 0                                                    |
| 11  | Poultry farming                                                       | 0.1                            | 0                                                    |
| 12  | Meat animals n.e.c.                                                   | 0.1                            | 0                                                    |
| 13  | Animal products n.e.c.                                                | 0.1                            | 0                                                    |
| 14  | Raw milk                                                              | 0.1                            | 0                                                    |
| 15  | Wool, silk-worm cocoons                                               | 0.1                            | 0                                                    |
| 16  | Manure treatment (conventional), storage and land application          | 0.1                            | 0                                                    |
| 17  | Manure treatment (biogas), storage and land application                | 0.1                            | 0                                                    |
| 18  | Forestry, logging and related service activities (02)                 | 0.1                            | 0                                                    |
| 19  | Fishing, operating of fish hatcheries and fish farms; service activities incidental to fishing (05) | 0.1 | 0 |
| 20  | Mining of coal and lignite; extraction of peat (10)                   | 0.1                            | 0                                                    |
| 21  | Extraction of crude petroleum and services related to crude oil extraction, excluding surveying | 0.1 | 0 |
| 22  | Extraction of natural gas and services related to natural gas extraction, excluding surveying | 0.1 | 0 |
| 23  | Extraction, liquefaction, and regasification of other petroleum and gaseous materials | 0.1 | 0 |
| 24  | Mining of uranium and thorium ores (12)                               | 0.1                            | 0                                                    |
| 25  | Mining of iron ores                                                   | 0.1                            | 0                                                    |
| 26  | Mining of copper ores and concentrates                                | 0.1                            | 0                                                    |
| 27  | Mining of nickel ores and concentrates                                 | 0.1                            | 0                                                    |
|   | Activity Description                                                                 | Value 1 | Value 2 |
|---|--------------------------------------------------------------------------------------|---------|---------|
| 28| Mining of aluminum ores and concentrates                                            | 0.1     | 0       |
| 29| Mining of precious metal ores and concentrates                                       | 0.1     | 0       |
| 30| Mining of lead, zinc and tin ores and concentrates                                   | 0.1     | 0       |
| 31| Mining of other non-ferrous metal ores and concentrates                               | 0.1     | 0       |
| 32| Quarrying of stone                                                                   | 0.1     | 0       |
| 33| Quarrying of sand and clay                                                            | 0.1     | 0       |
| 34| Mining of chemical and fertilizer minerals, production of salt, other mining and quarrying n.e.c. | 0.1 | 0       |
| 35| Processing of meat cattle                                                             | 1       | 0       |
| 36| Processing of meat pigs                                                              | 1       | 0       |
| 37| Processing of meat poultry                                                            | 1       | 0       |
| 38| Production of meat products n.e.c.                                                    | 1       | 0       |
| 39| Processing vegetable oils and fats                                                    | 1       | 0       |
| 40| Processing of dairy products                                                          | 1       | 0       |
| 41| Processed rice                                                                       | 1       | 0       |
| 42| Sugar refining                                                                       | 1       | 0       |
| 43| Processing of Food products n.e.c.                                                    | 1       | 0       |
| 44| Manufacture of beverages                                                              | 1       | 0       |
| 45| Manufacture of fish products                                                          | 1       | 0       |
| 46| Manufacture of tobacco products                                                       | 1       | 0       |
| 47| Manufacture of textiles (17)                                                           | 1       | 0       |
| 48| Manufacture of wearing apparel; dressing and dyeing of fur (18)                      | 1       | 0       |
| 49| Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear (19) | 1 | 0       |
| 50| Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials (20) | 1 | 0       |
| 51| Re-processing of secondary wood material into new wood material                      | 1       | 0       |
| 52| Pulp                                                                                 | 1       | 0       |
| 53| Re-processing of secondary paper into new pulp                                        | 1       | 0       |
| 54| Paper                                                                                | 1       | 0       |
| 55| Publishing, printing and reproduction of recorded media (22)                          | 0.1     | 0       |
| 56| Manufacture of coke oven products                                                    | 0.5     | 0       |
| 57| Petroleum Refinery                                                                   | 0.5     | 0       |
|   | Category                                      | Value | Details                                      |
|---|-----------------------------------------------|-------|----------------------------------------------|
| 58| Processing of nuclear fuel                    | 0.5   |                                              |
| 59| Plastics, basic                               | 0.5   |                                              |
| 60| Re-processing of secondary plastic into new plastic | 0.5 |                                              |
| 61| N-fertilizer                                  | 0.5   |                                              |
| 62| P- and other fertilizer                       | 0.5   |                                              |
| 63| Chemicals n.e.c.                              | 0.5   |                                              |
| 64| Manufacture of rubber and plastic products (25)| 0.5 |                                              |
| 65| Manufacture of glass and glass products       | 0.5   |                                              |
| 66| Re-processing of secondary glass into new glass | 0.5 |                                              |
| 67| Manufacture of ceramic goods                  | 0.5   |                                              |
| 68| Manufacture of bricks, tiles and construction products, in baked clay | 0.5 |                                              |
| 69| Manufacture of cement, lime and plaster       | 0.5   |                                              |
| 70| Re-processing of ash into clinker            | 0.5   |                                              |
| 71| Manufacture of other non-metallic mineral products n.e.c. | 0.5 |                                              |
| 72| Manufacture of basic iron and steel and of ferro-alloys and first products thereof | 0.5 |                                              |
| 73| Re-processing of secondary steel into new steel | 0.5 |                                              |
| 74| Precious metals production                    | 0.5   |                                              |
| 75| Re-processing of secondary precious metals into new precious metals | 0.5 |                                              |
| 76| Aluminum production                           | 0.5   |                                              |
| 77| Re-processing of secondary aluminum into new aluminum | 0.5 |                                              |
| 78| Lead, zinc and tin production                 | 0.5   |                                              |
| 79| Re-processing of secondary lead into new lead, zinc and tin | 0.5 |                                              |
| 80| Copper production                             | 0.5   |                                              |
| 81| Re-processing of secondary copper into new copper | 0.5 |                                              |
| 82| Other non-ferrous metal production            | 0.5   |                                              |
| 83| Re-processing of secondary other non-ferrous metals into new other non-ferrous metals | 0.5 |                                              |
| 84| Casting of metals                             | 0.5   |                                              |
| 85| Manufacture of fabricated metal products, except machinery and equipment (28) | 0.5 |                                              |
| 86| Manufacture of machinery and equipment n.e.c. (29) | 1 |                                              |
| Code | Industry Description                                                                 | Value 1 | Value 2 |
|------|--------------------------------------------------------------------------------------|---------|---------|
| 87   | Manufacture of office machinery and computers (30)                                   | 1       | 0       |
| 88   | Manufacture of electrical machinery and apparatus n.e.c. (31)                        | 1       | 0       |
| 89   | Manufacture of radio, television and communication equipment and apparatus (32)     | 1       | 0       |
| 90   | Manufacture of medical, precision and optical instruments, watches and clocks (33) | 0.1     | 0       |
| 91   | Manufacture of motor vehicles, trailers and semi-trailers (34)                      | 1       | 0       |
| 92   | Manufacture of other transport equipment (35)                                        | 1       | 0       |
| 93   | Manufacture of furniture; manufacturing n.e.c. (36)                                  | 1       | 0       |
| 94   | Recycling of waste and scrap                                                         | 1       | 0       |
| 95   | Recycling of bottles by direct reuse                                                 | 1       | 0       |
| 96   | Production of electricity by coal                                                   | 0.1     | 4       |
| 97   | Production of electricity by gas                                                    | 0.1     | 4       |
| 98   | Production of electricity by nuclear                                                 | 0.1     | 4       |
| 99   | Production of electricity by hydro                                                   | 0.1     | 4       |
| 100  | Production of electricity by wind                                                   | 0.1     | 4       |
| 101  | Production of electricity by petroleum and other oil derivatives                    | 0.1     | 4       |
| 102  | Production of electricity by biomass and waste                                       | 0.1     | 4       |
| 103  | Production of electricity by solar photovoltaic                                      | 0.1     | 4       |
| 104  | Production of electricity by solar thermal                                           | 0.1     | 4       |
| 105  | Production of electricity by tide, wave, ocean                                       | 0.1     | 4       |
| 106  | Production of electricity by Geothermal                                             | 0.1     | 4       |
| 107  | Production of electricity n.e.c.                                                    | 0.1     | 4       |
| 108  | Transmission of electricity                                                          | 0.1     | 4       |
| 109  | Distribution and trade of electricity                                                | 0.1     | 4       |
| 110  | Manufacture of gas; distribution of gaseous fuels through mains                     | 0.1     | 4       |
| 111  | Steam and hot water supply                                                           | 0.1     | 4       |
| 112  | Collection, purification and distribution of water (41)                              | 0.1     | 4       |
| 113  | Construction (45)                                                                   | 1       | 0       |
| 114  | Re-processing of secondary construction material into aggregates                    | 1       | 0       |
|   | Description                                                                 | Sector Code | Value |
|---|-----------------------------------------------------------------------------|-------------|-------|
| 115| Sale, maintenance, repair of motor vehicles, motor vehicles parts, motorcycles, motor cycles parts and accessories | 1           | 1     |
| 116| Retail sale of automotive fuel                                              | 1           | 1     |
| 117| Wholesale trade and commission trade, except of motor vehicles and motorcycles (51) | 1           | 1     |
| 118| Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods (52) | 1           | 1     |
| 119| Hotels and restaurants (55)                                                 | 1           | 1     |
| 120| Transport via railways                                                     | 1           | 5     |
| 121| Other land transport                                                        | 1           | 5     |
| 122| Transport via pipelines                                                     | 1           | 5     |
| 123| Sea and coastal water transport                                             | 1           | 5     |
| 124| Inland water transport                                                     | 1           | 5     |
| 125| Air transport (62)                                                          | 1           | 5     |
| 126| Supporting and auxiliary transport activities; activities of travel agencies (63) | 1           | 3     |
| 127| Post and telecommunications (64)                                             | 0.1         | 0     |
| 128| Financial intermediation, except insurance and pension funding (65)         | 0.5         | 0     |
| 129| Insurance and pension funding, except compulsory social security (66)       | 0.5         | 0     |
| 130| Activities auxiliary to financial intermediation (67)                       | 0.5         | 0     |
| 131| Real estate activities (70)                                                 | 1           | 0     |
| 132| Renting of machinery and equipment without operator and of personal and household goods (71) | 0.1         | 0     |
| 133| Computer and related activities (72)                                        | 0.1         | 0     |
| 134| Research and development (73)                                               | 0.1         | 0     |
| 135| Other business activities (74)                                              | 0.5         | 0     |
| 136| Public administration and defense; compulsory social security (75)          | 0.1         | 0     |
| 137| Education (80)                                                             | 0.1         | 0     |
| 138| Health and social work (85)                                                | 0.1         | 4     |
| 139| Incineration of waste: Food                                                 | 1           | 0     |
| 140| Incineration of waste: Paper                                                | 1           | 0     |
| 141| Incineration of waste: Plastic                                              | 1           | 0     |
| 142| Incineration of waste: Metals and inert materials                           | 1           | 0     |
|   | Description                                      | Activity | Non-Activity |
|---|--------------------------------------------------|----------|--------------|
|143| Incineration of waste: Textiles                  | 1        | 0            |
|144| Incineration of waste: Wood                      | 1        | 0            |
|145| Incineration of waste: Oil/Hazardous waste       | 1        | 0            |
|146| Biogasification of food waste, incl. land application | 1    | 0            |
|147| Biogasification of paper, incl. land application  | 1        | 0            |
|148| Biogasification of sewage sludge, incl. land application | 1    | 0            |
|149| Composting of food waste, incl. land application  | 1        | 0            |
|150| Composting of paper and wood, incl. land application | 1    | 0            |
|151| Waste water treatment, food                      | 1        | 0            |
|152| Waste water treatment, other                     | 1        | 0            |
|153| Landfill of waste: Food                          | 1        | 0            |
|154| Landfill of waste: Paper                         | 1        | 0            |
|155| Landfill of waste: Plastic                       | 1        | 0            |
|156| Landfill of waste: Inert/metal/hazardous         | 1        | 0            |
|157| Landfill of waste: Textiles                      | 1        | 0            |
|158| Landfill of waste: Wood                          | 1        | 0            |
|159| Activities of membership organization n.e.c. (91) | 1    | 0            |
|160| Recreational, cultural and sporting activities (92) | 1    | 3            |
|161| Other service activities (93)                    | 1        | 0            |
|162| Private households with employed persons (95)     | 1        | 0            |
|163| Extra-territorial organizations and bodies        | 1        | 0            |


| Module               | Parameter | Parameter description                                           | Data source                                                                 |
|----------------------|-----------|----------------------------------------------------------------|-----------------------------------------------------------------------------|
| Production function  | $IOZ_{i,0}$ | Intermediate input at initial state ($t=0$)                      | Stadler et al., 2018 (7)                                                    |
|                      | $IOX_{i,0}$ | Total output at initial state ($t=0$)                           |                                                                            |
|                      | $IOl_{i,0}$ | Labor supply at initial state ($t=0$)                           |                                                                            |
| Intermediate input   | $\partial$ | Proportion of initial storage to initial intermediate input     | Guan et al, 2020 (3)                                                       |
|                      | $t_1$, $t_2$ | Starting and ending time of pandemic controlling measures     | Aura Vision, 2020 (19)                                                     |
|                      | $\gamma_i$ | Sensitivity of labor supply for sector $i$ to the pandemic      | Guan et al, 2020 (3)                                                       |
|                      | $\omega_i^r$ | Average change in labor at region $r$                          | Google, 2020, Kissler et al., 2020, Baidu Map, 2020 and Hale et al., 2020 (29–32, 34, 37) |
|                      | $\theta_{i,t}$ | Labor recovery rate after lockdown stops                       | Scenario setting                                                           |
|                      | $\epsilon$ | Proportion of storage target to initial target                 | Guan et al, 2020 (3)                                                       |
|                      | $\beta_{hi,t}$ | Change rate of final demand of sector $i$ during lockdowns   | Google, 2020 & Baidu Map, 2020 (29–32)                                     |
|                      | $\nu_{hi,t}$ | Rate of demand recovery of sector $i$ after lockdown stops    | Google, 2020 & Baidu Map, 2020 (29–32)                                     |
|                      | $\mu_{hi}$ | Proportion of economic stimulation allocated to sector $i$    | Scenario setting                                                           |
|                      | $M_{Stim}^S$ | Total amount of economic input as economic stimulus           | IMF, 2020 (33)                                                            |
|                      | $t_s$ | Starting time of economic stimulus                            | Scenario setting                                                           |
|                      | $\rho$ | Number of periods with economic stimulus                     | Scenario setting                                                           |
| Employment           | $Employment_{i,0}$ | Labor demand of sector $i$, categorized according to labor skill | Stadler et al., 2018 (7)                                                  |
|                      | $Wage_{i,0}$ | Wage of sector $i$, categorized according to labor skill      |                                                                            |
Table S5. Summary of parameters and sensitivity setting.

| Category                      | Parameter                        | Setting                                                                 | Data sources |
|-------------------------------|----------------------------------|-------------------------------------------------------------------------|--------------|
| Model calibration data        | Lockdown strictness              | The impact of lockdown measure on labor availability and consumer's behavior from GCMR(+Baidu) and OxCGRT | (29–32, 34) |
| Scenario design parameters    | Recovery rate of labor availability | 2% and 4% per week                                                      | (3, 29)      |
|                               | Recovery rate of final demand    | 2% and 4% per week                                                      | (3, 29)      |
|                               | Fiscal stimulus scale            | The original size and ±10% of fiscal stimulation                        | (18, 33, 34) |
|                               | Fiscal stimulus timing           | Fiscal stimuli stars at the end of first round lockdown, 5-week delay and 8-week delay | (4, 37)      |
Table S6. Key assumptions in the orthogonal experimental design (OED).

| No. | Parameters                        | Assumptions                                                                 |
|-----|-----------------------------------|-----------------------------------------------------------------------------|
| 1   | Fiscal stimulus structure         | 1 BAU scenario, 1 non-stimulus scenario and 3 policy stimulus scenarios     |
| 2   | Fiscal stimulus scale             | The original size and ±10% of fiscal stimulation from the OxGRO database     |
| 3   | Lockdown strictness               | Lockdown strictness from Google Community Mobility Report (+Baidu map) and the Oxford Global Recovery Observatory |
| 4   | Recovery rate of labor availability | 2% and 4% per week.                                                        |
| 5   | Recovery rate of final demand     | 2% and 4% per week.                                                        |
| 6   | Fiscal stimulus timing            | Stimulation at the first end of lockdown measures or with a 5-week/8-week delay |
### Table S7. Scenario description.

| Scenario name          | Abbreviation | Pandemic | Scale of Stimulus | Stimulus structure |
|------------------------|--------------|----------|-------------------|-------------------|
|                        |              | Without  | With Announced in real-world stimuli | Real-world structure | Traditional sectors | Low-carbon sectors |
| Business as usual      | BAU          | ✓        |                   |                   |                   |                   |
| Non-stimulus           | NS           | ✓        |                   |                   |                   |                   |
| Currently pledged stimulus | CS     | ✓        | ✓                 | ✓                 | ✓                 |                   |
| Traditional stimulus   | TS           | ✓        | ✓                 |                   | ✓                 |                   |
| Low-carbon stimulus    | LS           | ✓        | ✓                 |                   |                   | ✓                  |


Table S8. Shares of redistributed capital cost for renewable investment.

| Electricity products                                  | Shares in capital costs (%) |
|-------------------------------------------------------|----------------------------|
|                                                       | 29 | 31 | 45 | 66 | 74 |
| 1 Production of electricity by nuclear                 | 42.00 | 9.00 | 40.00 | 0.00 | 9.00 |
| 2 Production of electricity by hydro                   | 100.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 3 Production of electricity by wind                    | 60.50 | 13.50 | 18.50 | 2.50 | 5.00 |
| 4 Production of electricity by biomass and waste       | 68.00 | 7.00 | 14.00 | 1.00 | 10.00 |
| 5 Production of electricity by solar photovoltaic      | 0.00 | 76.00 | 12.00 | 1.00 | 11.00 |
| 6 Production of electricity by solar thermal           | 0.00 | 100.00 | 0.00 | 0.00 | 0.00 |
| 7 Production of electricity by tide, wave, ocean       | 100.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 8 Production of electricity by Geothermal              | 37.00 | 4.00 | 52.00 | 0.00 | 7.00 |
| 9 Production of electricity nec                        | 50.94 | 26.19 | 17.06 | 0.56 | 5.25 |
| 10 Transmission of electricity                         | 30.00 | 40.00 | 30.00 | 0.00 | 0.00 |
| 11 Distribution and trade of electricity               | 30.00 | 40.00 | 30.00 | 0.00 | 0.00 |

Note: The data are referred to Wiebe et al., (2018) (22). The numbers in the second row represent sectors: 29-Manufacture of machinery and equipment n.e.c.; 31-Manufacture of electrical machinery and apparatus n.e.c.; 45-Construction; 66-Insurance and pension funding, except compulsory social security; 74-Other business activities. The numbers in the remaining rows are the share of capital cost for renewable investment redistributed in these sectors.
Table S9. Fiscal stimuli in countries/regions (the size and start time).

| No. | Territory/region | Size of fiscal stimuli (%, relative to 2015) | The start time of fiscal stimuli |
|-----|------------------|---------------------------------------------|--------------------------------|
|     |                  | OxCGRT | OxGRO | IMF |                          |
| 1   | Austria          | 17.9   | 0.5   | 17.8 | 2020/4/12                |
| 2   | Belgium          | 3.5    | 0.3   | 23.9 | 2020/5/10                |
| 3   | Bulgaria         | 12.1   | 0.0   | 11.2 | 2020/5/10                |
| 4   | Cyprus           | -      | -     | -    | -                         |
| 5   | Czech Republic   | 2.6    | 0.1   | 31.0 | 2020/4/12                |
| 6   | Germany          | 3.6    | 3.3   | 48.7 | 2020/4/26                |
| 7   | Denmark          | 17.1   | 4.8   | 24.2 | 2020/5/10                |
| 8   | Estonia          | 15.1   | 0.0   | 12.5 | 2020/5/10                |
| 9   | Spain            | 0.0    | 19.0  | 24.2 | 2020/5/10                |
| 10  | Finland          | 0.2    | 2.1   | 11.8 | 2020/5/10                |
| 11  | France           | 37.2   | 4.3   | 24.7 | 2020/5/10                |
| 12  | Greece           | 19.0   | 0.0   | 17.0 | 2020/5/24                |
| 13  | Croatia          | 14.8   | 0.0   | 10.6 | 2020/5/10                |
| 14  | Hungary          | 31.1   | 0.0   | 18.5 | 2020/4/26                |
| 15  | Ireland          | 14.1   | 3.6   | 28.1 | 2020/5/10                |
| 16  | Italy            | 54.8   | 3.3   | 45.9 | 2020/4/26                |
| 17  | Lithuania        | 14.3   | 0.0   | 13.4 | 2020/5/24                |
| 18  | Luxembourg       | 37.2   | 0.0   | 25.6 | 2020/5/10                |
| 19  | Latvia           | -      | -     | -    | -                         |
| 20  | Malta            | -      | -     | -    | -                         |
| 21  | Netherlands      | 6.7    | 4.1   | 17.5 | 2020/6/7                 |
| 22  | Poland           | 20.3   | 2.9   | 17.2 | 2020/4/26                |
| 23  | Portugal         | 26.3   | 1.0   | 13.3 | 2020/4/26                |
| 24  | Romania          | 2.0    | 0.0   | 8.2  | 2020/5/10                |
| 25  | Sweden           | -      | -     | -    | -                         |
| 26  | Slovenia         | 19.9   | 0.0   | 20.8 | 2020/5/10                |
| 27  | Slovakia         | 16.3   | 0.0   | 12.4 | 2020/5/10                |
| 28  | United Kingdom   | 34.0   | 14.7  | 33.2 | 2020/6/7                 |
| 29  | United States    | 32.3   | 0.7   | 35.2 | 2020/5/10                |
| 30  | Japan            | 41.8   | 4.7   | 54.4 | 2020/4/26                |
| 31  | China            | 27.3   | 4.1   | 8.6  | 2020/3/29                |
| 32  | Canada           | 16.1   | 1.9   | 20.2 | 2020/4/26                |
| 33  | South Korea      | 22.7   | 16.6  | 19.9 | 2020/6/21                |
| 34  | Brazil           | 8.3    | 0.0   | 9.2  | 2020/5/10                |
| 35  | India            | 14.2   | 0.7   | 10.0 | 2020/6/7                 |
| 36  | Mexico           | 0.4    | 1.9   | 1.5  | 2020/5/10                |
| 37  | Russia           | 0.2    | 0.0   | 5.3  | 2020/5/10                |
|   | Territory                | Cases | Deaths | Recoveries | Date       |
|---|--------------------------|-------|--------|------------|------------|
| 38| Australia                | 16.9  | 9.8    | 18.3       | 2020/5/10  |
| 39| Switzerland              | 14.5  | 0.6    | 20.6       | 2020/5/10  |
| 40| Turkey                   | 1.4   | 0.2    | 7.0        | 2020/4/26  |
| 41| Taiwan, China            | -     | -      | -          | -          |
| 42| Norway                   | 5.5   | 1.6    | 7.1        | 2020/4/26  |
| 43| Indonesia                | 7.9   | 0.0    | 6.4        | 2020/6/21  |
| 44| South Africa             | 16.3  | 0.7    | 8.3        | 2020/4/26  |
| 45| RoW Asia and Pacific     | -     | -      | -          | 2020/5/10  |
| 46| RoW America              | -     | -      | -          | 2020/5/24  |
| 47| RoW Europe               | -     | -      | -          | 2020/5/10  |
| 48| RoW Africa               | -     | -      | -          | 2020/4/26  |
| 49| RoW Middle East          | -     | -      | -          | 2020/5/10  |

Note: The short line represents that the territory/region didn't take lockdown measures or lack of recovery fiscal stimulus information.
Table S10. The uneven effect of the COVID-19 on low-skilled labors comparing to high-skilled labors.

| Country/Territory/Region | Min  | Max  |
|--------------------------|------|------|
| Austria                  | 5.4% | 5.7% |
| Belgium                  | 4.7% | 4.8% |
| Bulgaria                 | 12.8%| 13.1%|
| Cyprus                   | 11.2%| 11.4%|
| Czech Republic           | 7.1% | 7.6% |
| Germany                  | 6.8% | 7.3% |
| Denmark                  | 13.3%| 13.5%|
| Estonia                  | 3.3% | 3.7% |
| Spain                    | 6.5% | 7.4% |
| Finland                  | 1.4% | 2.0% |
| France                   | 4.7% | 4.9% |
| Greece                   | 6.3% | 6.4% |
| Croatia                  | 6.6% | 6.8% |
| Hungary                  | 8.4% | 9.2% |
| Ireland                  | 8.2% | 8.7% |
| Italy                    | 9.9% | 10.8%|
| Lithuania                | 9.3% | 9.7% |
| Luxembourg               | 3.6% | 4.3% |
| Latvia                   | 9.0% | 9.1% |
| Malta                    | 2.9% | 3.3% |
| Netherlands              | 11.2%| 11.5%|
| Poland                   | 6.6% | 6.9% |
| Portugal                 | 6.7% | 7.4% |
| Romania                  | 18.4%| 19.0%|
| Sweden                   | 7.5% | 7.7% |
| Slovenia                 | 4.5% | 4.7% |
| Slovakia                 | 6.3% | 6.3% |
| United Kingdom           | 9.3% | 9.4% |
| United States            | 30.7%| 32.1%|
| Japan                    | 20.3%| 20.5%|
| China                    | 40.6%| 56.3%|
| Canada                   | 4.6% | 5.2% |
| South Korea              | 11.2%| 12.4%|
| Brazil                   | 1.9% | 3.4% |
| India                    | 7.8% | 8.3% |
| Mexico                   | 4.1% | 5.5% |
| Russia                   | 16.1%| 16.9%|
| Australia                | 5.5% | 5.9% |
| Switzerland              | 9.1% | 9.2% |
| Turkey                   | 8.4% | 8.6% |
| Country                     | 2022       | 2023       |
|-----------------------------|------------|------------|
| Norway                      | 12.7%      | 13.0%      |
| Indonesia                   | 11.5%      | 16.1%      |
| South Africa                | 1.6%       | 2.3%       |
| RoW Asia and Pacific        | 10.9%      | 13.0%      |
| RoW America                 | 21.0%      | 21.2%      |
| RoW Europe                  | 11.3%      | 11.4%      |
| RoW Africa                  | 7.8%       | 9.1%       |
| RoW Middle East             | 9.8%       | 11.2%      |
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