Greening the COVID-19 Economic Recovery:
Lessons from the Financial Crisis

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COVID-19 Pandemic and Fiscal Spending

- The global economic downturn caused by the COVID-19 pandemic is the worst since the Great Depression.
- Global economy shrank by 3.5%; losses particularly high in advanced economics with 4.9% (IMF, 2021).
- Massive fiscal spending as a reaction: USD 16.58 Trillion in 50 leading economics according to the Oxford University Economic Recovery Project (OUERP, 2021).
- In the short run, Corona dominated political and administrative action with environmental priorities fading into the background (Helm, 2020).
- Main focus: immediate health and economic crises caused by the pandemic and the required lockdown measures.
- Little of the fiscal spending was directed at green investments such as clean energy or pollution abatement (Barbier, 2020).
During the crisis, the focus shifted towards challenge of a long-term recovery; so far, USD 2.16 Trillion (OUERP, 2021).

Increasing number of calls from economists, climate activists, journalists, etc. for an economic recovery is in line with the transition towards sustainable low-carbon economy (Hepburn et al., 2020).

Emission reductions during the crisis, around 4% in 2020 compared to 2019 (Le Quéré et al. 2020), very likely only temporary.

Around 19% of recovery spending, or 2.5% of total spending, is expected to enhance sustainability (green spending) (O’Callaghan & Murdock, 2021).

How important is a green economic recovery for the transition towards sustainable low-carbon economy?
Lessons from the Financial Crisis

This paper analyses the environmental impacts of green stimulus measures based on the experience from the Financial Crisis:

- Between 2008 and 2010, major economies spend more than USD 3.3 Trillion on stimulus packages with 16% devoted to green measures such as low-carbon energy, energy efficiency, recycling, and pollution abatement (Barbier, 2016).

- In contrast to COVID-19 recovery, long term effects can be analysed.

- Several studies have analyzed or discussed the impacts of these measures in order to derive lessons learned for the post-pandemic recovery (e.g., Barbier, 2020; Jäger et al., 2020; Kröger et al., 2020).

- However, systematic empirical analyses of the impacts of economic stimulus packages on investments or environment are lacking.

This paper uses a panel of OECD countries to answer:

- What is the impact of green recovery spending the environment?
- Is there an impact of recovery spending dedicated to renewable energy on RE investments?
Our main data source is Barbier (2016):
- Total recovery spending and its timing in G20 countries.
- Green stimulus differentiated into several sub-categories, e.g. low-carbon energy, energy efficiency, or water, waste, and pollution management and control.

Extension the dataset based on data from other studies (e.g. Pollitt, 2011, Strand & Toman, 2010) and various government reports and documents.
⇒ Sample of 27 OECD countries.
Green Stimulus Spending: COVID-19 Crisis

Figure 1: COVID-19 crisis green recovery spending as a percentage of total recovery spending versus recovery spending as percentage of GDP.
Figure 2: Financial Crisis green recovery spending as a percentage of total recovery spending versus recovery spending as percentage of GDP.
RE Investment, Environmental Impact, and Controls

Renewable energy (RE) investment (2000-2019):

- Data source: Bloomberg New Energy Finance (BNEF).
- BNEF contains project-level data on investments in utility-scale renewable energy plants that we aggregate to annual national investments.
- Investment deal recorded at financial close, i.e. closer to investment decision than other measures of RE deployment (e.g. $\triangle$ capacity).

Environmental impacts (2000-2016):

- World Bank data on CO2 emissions per capita.
- Ecological footprint of production per capita form the Global Footprint Network.

Control variables:

- Data for controls, such as GDP, energy use, and manufacturing/services value added, are obtained from World Bank.
### Descriptive Statistics

**Table 1: Descriptive Statistics**

<table>
<thead>
<tr>
<th></th>
<th>Obs.</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2 Emissions p.c. (Metric tons)</td>
<td>455</td>
<td>8.90</td>
<td>3.83</td>
<td>2.68</td>
<td>20.2</td>
</tr>
<tr>
<td>Ecol. Footprint of Prod. p.c. (gha)</td>
<td>459</td>
<td>5.93</td>
<td>3.04</td>
<td>2.09</td>
<td>14.2</td>
</tr>
<tr>
<td>GDP p.c. (constant 2010 USD)</td>
<td>540</td>
<td>34129.2</td>
<td>18526.8</td>
<td>6928.3</td>
<td>92556.3</td>
</tr>
<tr>
<td>Energy Use p.c. (kg of oil equiv.)</td>
<td>430</td>
<td>3971.9</td>
<td>1656.2</td>
<td>1516.6</td>
<td>8455.5</td>
</tr>
<tr>
<td>Manufacturing VA (share of GDP)</td>
<td>534</td>
<td>14.9</td>
<td>4.79</td>
<td>5.65</td>
<td>28.2</td>
</tr>
<tr>
<td>Services VA (share of GDP)</td>
<td>534</td>
<td>62.3</td>
<td>5.90</td>
<td>47.2</td>
<td>77.6</td>
</tr>
<tr>
<td>Urban population share</td>
<td>540</td>
<td>75.4</td>
<td>11.1</td>
<td>50.8</td>
<td>98.0</td>
</tr>
<tr>
<td>Green Stimulus Share</td>
<td>520</td>
<td>0.21</td>
<td>0.23</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>RE Stimulus (Dummy)</td>
<td>540</td>
<td>0.44</td>
<td>0.50</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
Empirical Approach

- Almost all countries in the sample have some green recovery spending.
- We analyse the impact of the share of green stimulus on CO2 per capita the ecological footprint of production per capita.

**Model 1: Are there any lasting environmental impacts of green recovery spending?**

\[
ENV_{it} = \beta_0 + \beta_1 STIM_{it} + \beta_2 POST_{it} + \beta_3 STIM_{it} \times GREEN_i + \beta_4 POST_{it} \times GREEN_i + \beta_5 X_{it} + \mu_i + \varphi_t + \varepsilon_{it}, \tag{1}
\]

- \(ENV_{it}\) : CO2 emissions / Ecological footprint in country \(i\) at time \(t\),
- \(GREEN_i\) : green stimulus as a share of total stimulus spending,
- \(STIM_{it}\) : dummy equal to one for stimulus period,
- \(POST_{it}\) : dummy equal to one for post stimulus period,
- \(X_{it}\) : control variables.
Table 2: Environmental Impacts of Green Stimulus: Fixed Effects Estimates

<table>
<thead>
<tr>
<th></th>
<th>(1) CO2 Emissions</th>
<th>(2) Ecol. Footprint of Prod.</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP p.c. (constant 2010 USD)</td>
<td>0.0001**</td>
<td>-0.0000</td>
</tr>
<tr>
<td>Energy Use p.c. (kg of oil equiv.)</td>
<td>0.0026***</td>
<td>0.0008***</td>
</tr>
<tr>
<td>Manufacturing VA (share of GDP)</td>
<td>0.0542</td>
<td>0.1382**</td>
</tr>
<tr>
<td>Services VA (share of GDP)</td>
<td>-0.0312</td>
<td>0.0040</td>
</tr>
<tr>
<td>Urban population share</td>
<td>0.0844***</td>
<td>-0.0015</td>
</tr>
<tr>
<td>Stimulus Period</td>
<td>-1.1030***</td>
<td>-0.0153</td>
</tr>
<tr>
<td>Post Stimulus Period</td>
<td>-0.8542**</td>
<td>0.1690</td>
</tr>
<tr>
<td>Stimulus Period × Green Stimulus Share</td>
<td>-0.5569**</td>
<td>-0.3798***</td>
</tr>
<tr>
<td>Post Stimulus Period × Green Stimulus Share</td>
<td>-1.3286***</td>
<td>-0.9136***</td>
</tr>
</tbody>
</table>

Observations 413 415

R\(^2\) 0.855 0.517

Estimates include year-fixed effects.
Robust standard errors clustered at firm level in parentheses.
* p < .1, ** p < .05, *** p < .01.
Empirical Approach

- Green stimulus data contains the information how much stimulus was allocated to renewable energy.
- Less than half of the countries in the sample had spending on low-carbon power, such that the other countries can be used as a control group.
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- Less than half of the countries in the sample had spending on low-carbon power, such that the other countries can be used as a control group.

**Model 2: Does RE recovery spending impact RE investment?**

\[
REINV_{it} = \beta_0 + \beta_1 STIM_{it} + \beta_2 POST_{it} + \beta_3 STIM_{it} \times RE_i \\
+ \beta_4 POST_{it} \times RE_i + \beta_5 X_{it} + \mu_i + \varphi_t + \epsilon_{it},
\]

- \(REINV_{it}\): Renewable energy investment in country \(i\) at time \(t\),
- \(RE_i\): dummy equal to one for countries with RE stimulus spending,
- \(STIM_{it}\): dummy equal to one for stimulus period,
- \(POST_{it}\): dummy equal to one for post stimulus period,
- \(X_{it}\): control variables.
Table 3: The Impact of Renewable Energy Stimulus on Renewable Investments: Fixed Effects Estimates

<table>
<thead>
<tr>
<th></th>
<th>(1) Renewables</th>
<th>(2) Wind</th>
<th>(3) Solar</th>
<th>(4) Biomass</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP p.c. (constant 2010 USD)</td>
<td>0.0025</td>
<td>0.0016</td>
<td>0.0009**</td>
<td>-0.0001</td>
</tr>
<tr>
<td></td>
<td>(0.0021)</td>
<td>(0.0017)</td>
<td>(0.0005)</td>
<td>(0.0005)</td>
</tr>
<tr>
<td>Manufacturing VA (share of GDP)</td>
<td>-5.8780**</td>
<td>-4.8020**</td>
<td>-0.9465</td>
<td>0.1245</td>
</tr>
<tr>
<td></td>
<td>(2.3129)</td>
<td>(2.1773)</td>
<td>(1.1873)</td>
<td>(0.8040)</td>
</tr>
<tr>
<td>Services VA (share of GDP)</td>
<td>1.3705</td>
<td>0.9238</td>
<td>1.4136</td>
<td>-0.8546</td>
</tr>
<tr>
<td></td>
<td>(3.9313)</td>
<td>(3.6682)</td>
<td>(1.1884)</td>
<td>(0.7658)</td>
</tr>
<tr>
<td>Stimulus Period</td>
<td>13.8668</td>
<td>-1.9023</td>
<td>20.0437</td>
<td>-2.4549</td>
</tr>
<tr>
<td></td>
<td>(30.4762)</td>
<td>(26.0163)</td>
<td>(12.4483)</td>
<td>(6.2632)</td>
</tr>
<tr>
<td>Post Stimulus Period</td>
<td>-16.4697</td>
<td>-7.5371</td>
<td>-5.9895</td>
<td>-1.1761</td>
</tr>
<tr>
<td></td>
<td>(21.7369)</td>
<td>(19.1052)</td>
<td>(5.8031)</td>
<td>(4.3788)</td>
</tr>
<tr>
<td>RE Stimulus × Stimulus Period</td>
<td>-18.5615</td>
<td>7.6217</td>
<td>-24.2806**</td>
<td>-1.4958</td>
</tr>
<tr>
<td></td>
<td>(15.6092)</td>
<td>(10.3760)</td>
<td>(10.6219)</td>
<td>(4.3068)</td>
</tr>
<tr>
<td>RE Stimulus × Post Stimulus Period</td>
<td>43.7633**</td>
<td>27.5154*</td>
<td>8.8832</td>
<td>6.5406</td>
</tr>
<tr>
<td></td>
<td>(18.6632)</td>
<td>(14.3462)</td>
<td>(6.2237)</td>
<td>(4.4504)</td>
</tr>
<tr>
<td>Observations</td>
<td>534</td>
<td>534</td>
<td>534</td>
<td>534</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.234</td>
<td>0.178</td>
<td>0.151</td>
<td>0.075</td>
</tr>
</tbody>
</table>

Estimates include year-fixed effects. Robust standard errors clustered at firm level in parentheses.

* $p < .1$, ** $p < .05$, *** $p < .01$. 
Preliminary Conclusions

- Overall, CO2 emissions per capita decreased after the financial crisis; the ecological footprint of production did not.
- Higher green stimulus spending yields:
  1. additional CO2 emission reductions and
  2. a lower ecological footprint of production in the post stimulus period.
- RE Investments recovered relatively quickly after the Financial Crisis.
- Dedicated stimulus packages, however, resulted in higher renewable energy investments in the post stimulus period.
- Overall, the findings seem to indicate that type of stimulus spending has persistent impacts, which stresses the importance of greening the post-COVID19 recovery to enable the transition towards sustainable low-carbon economy.
Thank you for your attention!

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