Policy needs for BECCS: A cost effective analysis

Olivia RICCI
University of Orléans, Laboratoire d’Economie d’Orléans-CNRS

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Motivations

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- Since $\text{CO}_2$ from biomass transformation is considered neutral, traditional environmental policy instruments, such as environmental taxes, are not appropriate for this technology
- In the Kyoto framework, $\text{CO}_2$ emissions are accounted for in different ways depending on their origin
- Thus, there are currently no incentives for a firm to capture and store $\text{CO}_2$ from biomass
Objectives

- Compare qualitatively the efficiency of several policy instruments regarding the adoption of CCS and BECCS.
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- Compare quantitatively the cost-efficiency of those instruments. Does the instrument attain the environmental target at least cost?

⇒ 2 criteria: technologies adoption criteria / cost-efficiency criteria.
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Qualitative analysis results

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- A specific subsidy per unit of captured emissions. It is designed such that it makes no distinction between fossil and biomass emissions.

- A combination of a carbon tax and a subsidy per unit of captured emissions from biomass (two part instrument).
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- A specific subsidy per unit of captured emissions. It is designed such that it makes no distinction between fossil and biomass emissions.
- A combination of a carbon tax and a subsidy per unit of captured emissions from biomass (two part instrument).
- A carbon tax where tax’ revenues are recycled to subsidize biomass emissions captured with CCS.
The methodology employed in our quantitative analysis is a dynamic general equilibrium model which include CCS and BECCS.
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- A general equilibrium approach offers a comprehensive representation of price dependant market interactions based on Walrasian equilibrium theory.
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We study the equilibrium in a decentralized economy; it allows us to examine how the economy reacts to environmental policy changes.
Model structure
Scenarios

Emissions target: a decrease of 20% in total emissions from the secondary energy sector such as:

- S1: A subsidy on captured emissions is implemented. It develops CCS and BECCS. It is financed by a lump sum transfer from consumer.

- S2: A two-part instrument or a tradable allowance system is used to develop CCS and BECCS. The carbon tax rate is equivalent to the subsidy rate. Net revenues are returned to consumers as a lump sum transfer.

- S3: A carbon tax is implemented. Revenues are recycled to subsidize biomass emissions captured with CCS.

- S4: A carbon tax is implemented. Revenues are returned to consumers as a lump sum transfer.
Calibration of the model with world data for 2005.

We can compare the cost of achieving the given emissions reduction using our instrument in terms of economic welfare variation (intertemporal utility variation). The economic welfare function is:

\[
W = \sum_{t=0}^{\infty} \frac{1}{(1+\rho)^t} \left( U(C_t) \right)
\]

The initial steady state \((W_i)\) and the final steady state \((W_f)\) values of the utility can therefore be computed. The intertemporal welfare variation is given by:

\[
\left( \frac{W_f - W_i}{W_i} \right) \times 100
\]
### Long term results

<table>
<thead>
<tr>
<th>Shocks/Variables</th>
<th>S1 $\frac{s_{ccs}}{s_{bccs}} = 61.8$</th>
<th>S2 $\frac{t_{c}}{s_{bccs}} = 22$</th>
<th>S3 $t_{c} = 12$</th>
<th>S4 $t_{c} = 22.9$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass demand</td>
<td>0.001</td>
<td>0.976</td>
<td>2.784</td>
<td>1.000</td>
</tr>
<tr>
<td>Fossil demand</td>
<td>3.994</td>
<td>-12.929</td>
<td>-7.800</td>
<td>-13.422</td>
</tr>
<tr>
<td>Sec. energy demand</td>
<td>1.016</td>
<td>-3.031</td>
<td>-0.219</td>
<td>-3.161</td>
</tr>
<tr>
<td>Output</td>
<td>0.102</td>
<td>-0.309</td>
<td>-0.022</td>
<td>-0.322</td>
</tr>
<tr>
<td>Investment</td>
<td>0.102</td>
<td>-0.309</td>
<td>-0.022</td>
<td>-0.322</td>
</tr>
<tr>
<td>Consumption</td>
<td>0.0048</td>
<td>-0.072</td>
<td>-0.022</td>
<td>-0.0766</td>
</tr>
<tr>
<td>Biomass price</td>
<td>-0.520</td>
<td>1.430</td>
<td>-0.803</td>
<td>1.499</td>
</tr>
<tr>
<td>Fossil price</td>
<td>-1.860</td>
<td>6.561</td>
<td>2.877</td>
<td>6.842</td>
</tr>
<tr>
<td>Sec. energy price</td>
<td>-0.904</td>
<td>2.807</td>
<td>0.197</td>
<td>2.932</td>
</tr>
<tr>
<td>Fossil resource price</td>
<td>10.259</td>
<td>-29.298</td>
<td>-18.392</td>
<td>-30.222</td>
</tr>
<tr>
<td>Wages</td>
<td>0.102</td>
<td>-0.309</td>
<td>-0.022</td>
<td>0.322</td>
</tr>
<tr>
<td>Economic welfare</td>
<td>-0.0004</td>
<td>-0.0019</td>
<td>-0.001</td>
<td>-0.00204</td>
</tr>
</tbody>
</table>
Long term results

CCS and BECCS deployment (captured emissions %)

<table>
<thead>
<tr>
<th></th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCS</td>
<td>22%</td>
<td>8%</td>
<td>4%</td>
<td>8%</td>
</tr>
<tr>
<td>BECCS</td>
<td>16%</td>
<td>6%</td>
<td>65%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Relative cost of instruments (ratio)
Relative cost of instruments (ratio)
Conclusion

- Main results:
  - Only a specific subsidy on captured emissions from biomass will increase the deployment of BECCS.
  - A specific subsidy is the most welfare improving instrument. However it has the disadvantage of encouraging the use of fossil fuel.
  - It is less costly to use a carbon tax and to recycle its revenues to subsidize BECCS than to create a two part instrument or a cap and trade system that recognizes negative emissions.

- Limits of the model:
  - There is a substantial uncertainty regarding the parameters that determine the cost of BECCS technologies.
  - Policy recommendations are therefore pertinent if a global policy based on a unique carbon price is assumed.