Early action vs. early emissions reduction
– Evaluation of policy proposals for Kyoto compliance -

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Optimal Early Actions vs. Optimal Early GHG Emissions Reduction – Evaluation of Proposed Policy Tools for Kyoto Compliance

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\textbf{Abstract}

The increasing “Kyoto gap” has raised concerns about the likely costs for businesses to meet the target if early action is not taken to help smooth the transition. Meeting the targets of significantly lower level of GHG emissions will require major technological adjustments such as R&D and capital investments. This adjustment process will likely be less costly if action is initiated well before the compliance period. The purpose of this paper is to assess the main early action policy proposals currently under consideration in several countries using a simple, two period model. The simulation is calibrated to the Australian economy.

In the model, time is divided into two periods. In Period 1 (2003-2008) there are no internationally binding restrictions on GHG emissions. In Period 2 (2008-2012) the total emissions reduction is fixed, relative to BAU baseline. In the model, there are two types of action by the firms to reduce GHGs: Research and development investments (R&D) and capital investments. Both R&D and CI change the underlying technology and therefore the relationship between the economic activity and the associated level of GHG emissions. While CI, however, results in GHG emissions reduction in the period when they were undertaken, R&D investments in Period 1 result in emissions reduction only with a lag, in Period 2.

The scenarios considered are:

\begin{itemize}
  \item No Policy Tool (Benchmark)
  \item International Emissions Trading (ET) in Period 2 only
  \item Emissions Tax in Period 1 and International ET (Auction) in Period 2
  \item Credits for Early Action Program in Period 1 and International ET in Period 2 (Auction)
  \item Public Early Action Program in Period 1 and International ET in Period 2
  \item International ET (Grandfathering with Baseline Protection) in Period 2
  \item Banking Early Emission Credits
  \item International ET (Grandfathering with No Baseline Protection) in Period 2
  \item Cap-and-Trade Program in Period 1 and International ET in Period 2
  \item Trading in Emissions Futures
\end{itemize}

The environmental benefits of early reductions are due to the associated actual early emissions reduction, while the compliance cost savings stem from well planned early action that \textit{may or may not} yield early actual emissions reduction. This has important implications for the design of the policy.

This paper argues some policies have the potential to be highly distorting. The policy approach advocated in this paper is a early cap-and-trade (CAT) program in Period 1, coupled with emissions trading in Period 2 or an emissions trading system in Period 1 with Grandfathering and Baseline Protection.

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Motivation – Rationale for Early Action

- environmental and social benefits (reduced pollution, healthcare cost savings, etc.)
- economic sense (shifting to less carbon-intensive technologies during the course of normal capital stock turnover, i.e. cost-smoothing opportunities)
- international competitiveness (increased R&D on energy efficiency, renewable energy, and other GHG mitigation techniques is likely to result in less reliance on international flexibility mechanisms)
- political (early emission reduction lowers the risk of non-compliance with the Kyoto protocol if it is to be ratified)

Defining the Policy Objective

Early Action vs. Early Actual Emissions Reduction

Economic efficiency or environmental effectiveness?

- The environmental and social benefits of early action are due to the associated actual early emissions reductions. Compliance cost savings and other economic benefits, however, do not necessarily require actual reductions in emissions.
- The policy objective has important implications for the choice and the details of the design of the early action policy (e.g. carbon tax, emissions permit trading system, Credit for Early Action program or a combination of one or more of the above implemented together with various market-based incentives, fiscal policies and funding for research and development)

Goal: develop a simple framework for the assessment of the main early action policy proposals

Previous Studies

- Kennedy (2000)
  - five-sector simulation model calibrated to Canadian economy
  - comparison of 6 emission paths in 15 scenarios
  - Conclusions: "... policies ... for early emission REDUCTION per se will not necessarily create the correct incentives for optimal early ACTION, and can in fact be highly distorting"
  - advocates modest cap-and-trade prg coupled with trading in emission futures (permits for period 2 are issued gradually in period 1 and are allowed to trade freely)

- Parry and Toman (2001)
  - model calibrated to the U.S. economy
  - extend/modify Kennedy model
  - calculate impact of Learning-by-Doing
  - Conclusions:
    - suggests KP to be amended to allow credits in period 1 to offset emissions in period 2 (banking)
    - if no banking: cap-and-trade prg more advantageous over early credits
international trading, and A$8-A$52 with the 
∑
Permits for a tonne of CO2-e emissions in the commitment period could be
ƒ
Number of firms in Australia responsible for energy extraction to be 250 (N),
Assuming a 5% annual discount rate translates into a five-year discount factor of
Further assumptions. 1) Australia will not introduce a domestic emissions trading
system prior to an international scheme, but will participate in the latter 2) trading
system will be cap-and-trade (CAT) system, with the cap being the aggregate
national caps of the participating nations 3) Australia is price-taker

The Model
- N number of emitting entities
- Period 1: 2003-2008 > no internationally binding restrictions
- Period 2: 2008-2012 > the total emissions by the emitting entities is limited (Commitment Period)
- Types of action to reduce GHG emissions: (1) capital investments (CI) and (2) investment into research and development (RD)
- key distinction: temporal relationship between the action and the associated emissions reduction
  - CI yields emissions reduction in the same period in which they are undertaken
  - DR does not result in an immediate GHG emissions reduction in the period when
  they were undertaken, only in next period

Cost Functions
\[ c_{id} = \frac{1}{2} \alpha_{id} \delta_{id}, \]
\[ c_{i} = \frac{1}{2} \beta_{i} \delta_{i}, \]
\[ c_{i} = \frac{1}{2} \beta_{i} \delta_{i}, \]
\[ \alpha, \beta, \delta, \beta_{i} \text{ non-negative} \]
1. RD investment undertaken in Period 1 has an impact on the abatement cost in Period 1 but results in emissions reduction in Period 2 only.
2. CI in Period 1 has a learning-by-doing (LBD) effect on the cost of the CI investment
in Period 2.
3. RD in Period 1 also has an impact on the cost of CI in Period 2 but to a lesser extent than Period 1 CI.
4. Period 2 cost parameter for CI depends on the weighted sum of a technology
specification of the firm and by all other firms together.

Total Cost, Emissions and Benefits
\[ C_i = \sum_{t=1}^{T} e_{it} \delta_{it}, \]
\[ E_i = \sum_{t=1}^{T} \epsilon_{it}, \]
\[ B_i = \sum_{t=1}^{T} \beta_{it} \delta_{it}. \]
The model thus intends to encompass the following key properties:
1. RD yields emission reductions only with a lag.
2. CI and RD undertaken in Period 1 reduces the cost of emissions reduction due to CI in Period 2, representing learning effect and an impact from RD.
3. Ceteris paribus, emission reductions due to CI are less costly when the investment is
spread between Periods 1 and 2 than when it is concentrated in Period 2 alone.
4. Environmental benefits of early actions are due to the associated actual early
emission reductions, while the compliance cost savings are not necessarily.

The Model - Benefits

FOR HOUSEHOLDS
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<tr>
<td>Climate change</td>
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</tr>
<tr>
<td>Secondary</td>
<td>Yes (health, clean air, etc.)</td>
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FOR FIRMS
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<tr>
<th>Benefit</th>
<th>Abatement</th>
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</thead>
<tbody>
<tr>
<td>Climate change</td>
<td>no</td>
</tr>
<tr>
<td>Secondary</td>
<td>Yes (reputation)</td>
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</table>

Calibration to the Australian Economy
- Energy sector responsible for 69.5% of Australia’s GHG emissions
- The “Kyoto budget” (K) is 5 x 566.6 = 2,833 billion tonne CO2-e.
- The Kyoto Protocol requires a total of 633 Mt CO2-e emissions reduction over
the 5 years.
- AGD estimates Australia’s cost of climate action to be between A$1 billion and A$3.2 billion per annum. For the five year this means a total of A$5 to A$16 billion.
- Assuming a 5% annual discount rate translates into a five-year discount factor of
0.78. Objectives of implementing a policy tool in the pre-commitment period is to
lower the cost of Kyoto compliance >> Benchmark Scenario is in the upper
range
- Number of firms in Australia responsible for energy extraction to be 250 (N),
assume firms are homogenous
- Permits for a tonne of CO2-e emissions in the commitment period could be valued A$40-A$200 with the international trading, and A$8-A$52 with the possibility of international Trading.
- Further assumptions. 1) Australia will not introduce a domestic emissions trading
system prior to an international scheme, but will participate in the latter 2) trading
system will be cap-and-trade (CAT) system, with the cap being the aggregate
national caps of the participating nations 3) Australia is price-taker

Kyoto Requirement

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<th>Year</th>
<th>Target</th>
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<tr>
<td>2000</td>
<td>566.0</td>
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<tr>
<td>2005</td>
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<td>2010</td>
<td>524.6</td>
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The Kyoto Protocol requires a total of 633 Mt CO2-e emissions reduction over
the 5 years.
1. No Policy Tool – Benchmark

Min. \( C_1 - R_1 + \phi (C_1 - R_1) \)

s.t. \( E_1 = R_1 \)

2. International Emissions Trading in Period 2

Min. \( C_1 - R_1 + \phi C_1 + \phi \gamma P_2 - \phi R_1 \)

s.t. \( E_2 + P_2 = R_2 \)

Ec1 drops to 2% of total domestic reductions from benchmark scenario 5%

Social planner: IET is optimal only if revenue can compensate households for the lost secondary benefits.

In case the secondary (social) benefits non-observed by the firms exceeds $A 12.5 per unit of emissions (assuming constant marginal benefits) then revenue cannot compensate for benefit loss.


Min. \( C_1 - \tau (R_{U1} - E_1) - R_1 + \phi C_1 + \phi \gamma P_2 - \phi R_1 \)

s.t. \( E_2 = P_2 - R_1 \)

4. Non-Tradable Credits for Early Action in Period 1 and International Emissions Trading (Auction) in Period 2

Min. \( C_1 - R_1 - \omega EC_1 + \phi C_1 + \phi \gamma P_2 - \phi R_1 \)

s.t. \( E_2 + P_2 = R_2 \)

Credits are generated when an entity reduces its emissions below a credit generation baseline (here: BAU1)

\( W_1 \) represents the rate at which credits are recognised

Credits rather act like a subsidy

5. International Emission Trading (Grandfathering with Baseline Protection and Auction) in Period 2

Min. \( C_1 - R_1 + \phi C_1 + \phi \gamma (P_2 - k) - \phi R_1 \)

s.t. \( E_2 + P_2 + k = R_2 \)

where \( k = \omega_{U1} \)

6. International Emission Trading (Grandfathering without Baseline Protection and Auction) in Period 2

The optimization problem is the same as in Case 5 but \( k \) is independent of Period 1 emissions reduction.

\( k = \omega_{U1} \)

Min. \[ C_1 + p_1P_1 - R_1 + \phi C_2 + \phi p_2P_2 - \phi R_2 \]

S.t. \[ E_1 + P_1 = R_1 \] and \[ E_2 + P_2 = R_2 \]

8. Public Early Action Program in Period 1 and International Emissions Trading in Period 2

Min. \[ C_1 - \alpha E_1 + \phi C_2 + \phi p_2P_2 - \phi B \]

s.t. \[ E_1 + P_2 = R_2 \]

where \[ \alpha = \left(1 + \frac{2}{\kappa}\right) \]

9. Banking Early Emission Credits

Banking emission credit may be simulated by setting the parameter value in Case 5

\[ \omega_2 = 1 \]

10. Trading in Emission Futures

Trading in emissions futures may be simulated by setting the price in Case 2

\[ p_i = \phi \mathbb{E}_i[p_2] = \phi p_2 \]

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<th>Scenario</th>
<th>Abatement P1</th>
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<th>Total Abatement</th>
<th>Abatement P2</th>
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<th>Elasticity</th>
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For further information, please refer to the original document.
Thank you for your attention!