Employing a CGE model in analysing the environmental and economy-wide impacts of CO₂ emission abatement policies in Malaysia

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HIGHLIGHTS

• CO₂ abatement policies do not have substantial negative effects on Malaysia.
• A carbon tax with revenue-recycling is the most efficient carbon abatement policy.
• Emission standards cause mild contractions in the overall economy.
• Production of renewable energy would increase strongly under a carbon tax policy.
• Energy sectors affected substantially by the CO₂ abatement policies

ABSTRACT

The impact of global warming has received much international attention in recent decades. To meet climate-change mitigation targets, environmental policy instruments have been designed to transform the way goods and services are produced as well as alter consumption patterns. The government of Malaysia is strongly committed to reducing CO₂ gas emissions as a proportion of GDP by 40% from 2005 levels by the year 2020. This study evaluates the economy-wide impacts of implementing two different types of CO₂ emission abatement policies in Malaysia using market-based (imposing a carbon tax) and command-and-control mechanism (sectoral emission standards). The policy simulations conducted involve the removal of the subsidy on petroleum products by the government. A carbon emission tax in conjunction with the revenue neutrality assumption is seen to be more effective than a command-and-control policy as it provides a double dividend. This is apparent as changes in consumption patterns lead to welfare enhancements while contributing to reductions in CO₂ emissions. The simulation results show that the production of renewable energies is stepped up when the imposition of carbon tax and removal of the subsidy is augmented by revenue recycling. This study provides an economy-wide assessment that compares two important tools for assisting environment policy makers evaluate carbon emission abatement initiatives in Malaysia.

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1. Introduction

Many nations are seeking to reduce CO₂ emissions through various intergovernmental and country initiatives such as the United Nations Framework Convention on Climate Change (UNFCCC). Recently, the
UNFCCC was adopted on December 2015 at COP21 \(^1\) in Paris as a means to mitigate greenhouse gas emissions (GHGs) through the adoption of various measures including financing beginning in 2020. By 2016, a total of 121 out of 197 parties (including Malaysia) had ratified the convention \((\text{UNFCCC, 2015})\).

Governments have sought to institute stronger measures to address the increasing concentrations of GHGs and their impact on natural resources, environment, and society. During COP15 \(^2\) in Copenhagen, Malaysia pledged to reduce CO2–equivalent gas emissions as a proportion of its gross domestic product (GDP) by 40% by 2020 over 2005 levels \((\text{UNCC, 2009})\). According to the Malaysia’s second national communication (NC2) to the UNFCCC, the estimated total CO2–eq \(^3\) GHG in 2005 equalled 449.6 million tonnes while the emissions intensity of GDP stood at 0.62 tonnes of CO2–eq/thousand Malaysian Ringgit in 2005. Based on the 40% target for 2020, the emission intensity should be reduced to 0.37 tonnes of CO2–eq per thousand Malaysian Ringgit \(^4\) unit of GDP. This can be achieved when GHG emissions in 2020 are reduced to 60% of 2005 levels. In other words, based on the estimated GDP of MYR906.6 billion in 2020, total emissions need to be limited to about 335 million tonnes of CO2–eq \((\text{Ministry of Natural Resources and Environment, 2011})\). International Energy Agency (2015) data shows that compared to other Southeast Asian nations, Malaysia has relatively high CO2 emissions growth per capita and per GDP rates at 6.97 (tonnes CO2 per capita) and 0.35, respectively. Table 1 shows the indices related to CO2 emissions for six Southeast Asian countries from 2005 to 2013 \((\text{IEA, 2015})\).

### Table 1

<table>
<thead>
<tr>
<th>Country</th>
<th>CO2 emission (MtCO2)</th>
<th>CO2/TPES</th>
<th>CO2/GDP(ppp)</th>
<th>CO2/POP</th>
<th>CO2 emission (MtCO2)</th>
<th>CO2/TPES</th>
<th>CO2/GDP(ppp)</th>
<th>CO2/POP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>321.56</td>
<td>42.72</td>
<td>0.25</td>
<td>1.44</td>
<td>424.6</td>
<td>47.5</td>
<td>0.21</td>
<td>1.70</td>
</tr>
<tr>
<td>Malaysia</td>
<td>154.60</td>
<td>55.4</td>
<td>0.37</td>
<td>5.98</td>
<td>207.2</td>
<td>55.6</td>
<td>0.35</td>
<td>6.97</td>
</tr>
<tr>
<td>Myanmar</td>
<td>10.58</td>
<td>17.03</td>
<td>0.19</td>
<td>0.21</td>
<td>13.3</td>
<td>19.2</td>
<td>0.14</td>
<td>0.25</td>
</tr>
<tr>
<td>Philippines</td>
<td>71.48</td>
<td>43.94</td>
<td>0.19</td>
<td>0.83</td>
<td>89.6</td>
<td>48.0</td>
<td>0.16</td>
<td>0.91</td>
</tr>
<tr>
<td>Singapore</td>
<td>37.86</td>
<td>41.92</td>
<td>0.16</td>
<td>8.87</td>
<td>46.6</td>
<td>42.6</td>
<td>0.13</td>
<td>8.62</td>
</tr>
<tr>
<td>Thailand</td>
<td>200.20</td>
<td>48.30</td>
<td>0.31</td>
<td>3.05</td>
<td>247.4</td>
<td>44.1</td>
<td>0.30</td>
<td>3.69</td>
</tr>
</tbody>
</table>

Source: author’s based on IEA (2015).

\(^a\) Total primary energy supply.

\(^b\) Purchasing power parities.

Malaysia’s total CO2 emissions from fuel combustion in 2013 (207.2 MtCO2) was generated by the power generation sector. Fig. 2 shows the rising trend in CO2 emissions from coal due to the rapid rise in its consumption when it replaced natural gas in the power generation sector from 2011. The increasing trend for oil is also due to the increase in demand for this fuel by the transportation sector. Further, the contribution of gas in total CO2 emissions is mainly due to its high demand by the power sector.

Fossil fuel combustion is a major factor to be considered in efforts to reduce GHG emissions. Providing subsidized fossil fuels increases their consumption leading to environmental pollution in terms of CO2 emissions and significantly reduces Malaysia’s oil reserves due to their high extraction and consumption rates, as noted by Othman and Jafari \((2012)\). Therefore, the formulation and implementation of appropriate emission abatement policies to address environmental and natural resources depletion issues are among the key concerns facing Malaysia’s macro-economic policy makers.

Malaysia’s economy has been growing rapidly since the 1970s \((\text{Economic Planning Unit, 2010})\) and this has major implications for its sustainable development agenda. These issues include the rising levels of CO2 emissions from fuel combustion, unsustainable energy supply owing to the domination of fossil resources in the country’s energy mix, and low levels of renewable energy production and consumption. As noted in the literature on environmental economics, environmental instruments such as CO2 tax and emission standards would effectively help to address the abovementioned issues. Imposing carbon taxation or implementing sectoral emission standards to reduce CO2 emissions could have political and social implications. In addition, opinions vary on the impact of carbon taxation and emission standards on GDP growth and energy prices, and how conventional energy industries will be affected. It is important to explore how these instruments may affect the Malaysian economy as a whole.

The objective of this paper is to provide empirical analysis of alternative carbon abatement scenarios and discuss policy implications for Malaysia using a static CGE model with environment-energy-economy interactions. The analysis contributes to the current literature by examining the impact of introducing a carbon tax and implementing command-and-control measures together with removing petroleum product subsidies on energy consumption, estimating sectoral CO2 emissions, renewable-energy production, and socio-economic factors such as household welfare.

Specifically, this paper has three main objectives, that is: i) to estimate the sectoral and total level of CO2 emissions resulting from removing the subsidy for petroleum products, imposing CO2 taxation with revenue-recycling and introducing sectoral emission limits; ii) to estimate the economy-wide impact of the above mentioned policies on economic variables including real GDP, employment, sectoral output, commodity prices and demand, returns to factors of production, sectoral employment, welfare consequences, and external trade measurements; and iii) to provide policy recommendations for formulating a comprehensive CO2 abatement policy in Malaysia.
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