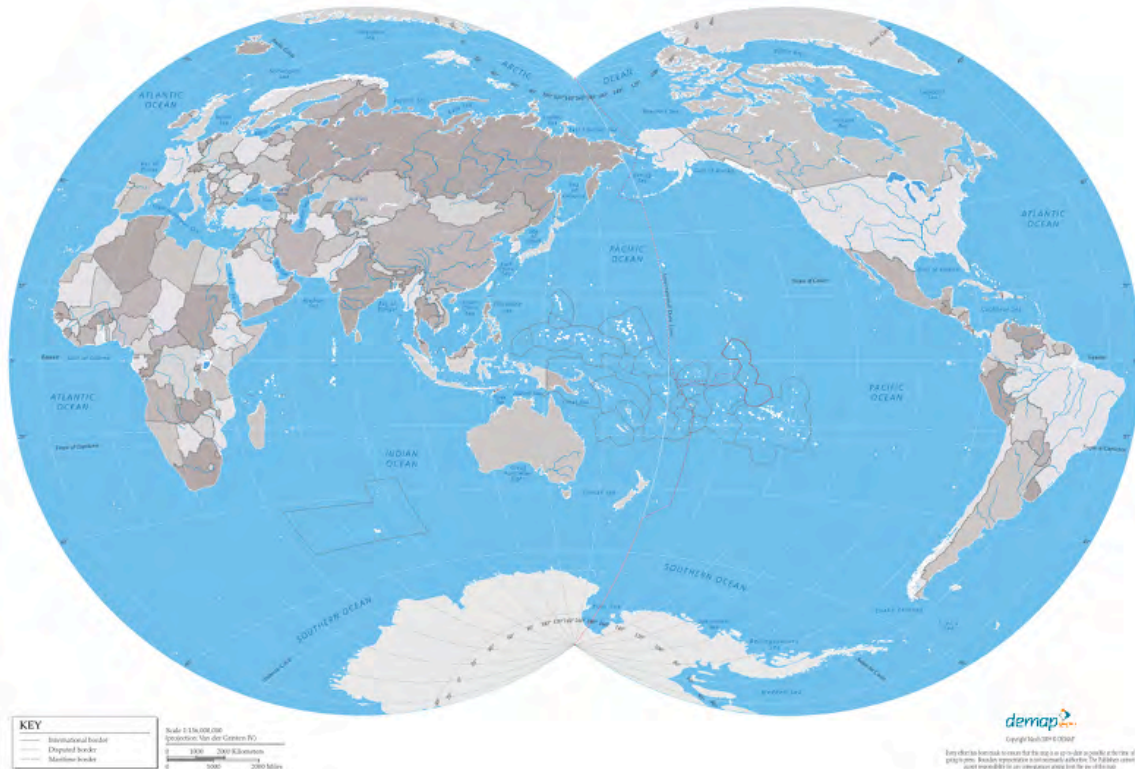




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**Climate change and trade: Perspectives from Australia and Indonesia**



**Frank Jotzo and Budy P. Resosudarmo**  
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## Synopsis

Frank Jotzo and Budy Resosudarmo of the Australian National University present a preliminary analysis of “the possible impacts from climate change and actions to mitigate climate change on trade which explores some causal relationships, flow-on effects and feedbacks. Trade effects of climate change are examined first as they apply in principle, and then in the specific cases of Australia and Indonesia respectively.” “Climate change and climate policies”, they argue, “will affect the supply, demand and prices for different traded commodities, products and services, and may also affect institutional frameworks that govern international trade. Changes in trade flows are closely interconnected with changes in domestic economic structure. Changes in domestic production and consumption affect trade, but changing trade opportunities also affect driving change in domestic economic activity.” For Indonesia and Australia Jotzo and Resosudarmo examine the interaction of climate change impacts on commodity supply, greenhouse gas emission mitigation pricing and regulation policies, policies for and investment in new and clean technologies, and issues of carbon finance and emissions trading.

## About the Authors

**Frank Jotzo** is an environmental economist specializing in climate change economics and policy, including in the context of development. He is a research fellow at the Australian National University's College of Asia and the Pacific, and a deputy director of the ANU Climate Change Institute.

**Budy P. Resosudarmo** is a Fellow at the Economics Division of the Research School of Pacific and Asian Studies, Australian National University (ANU). His research interests include determining the economy-wide impact of environmental policies, analysing the impact of fiscal decentralisation on regional economies, and understanding the political economy of natural resource utilization. He has published papers in scientific journals such as *Economic Record*, *Ecological Economics*, *Oxford Development Studies* and *Bulletin of Indonesian Economic Studies*. In 2009, he co-edited a book, *Working with Nature against Poverty: Development, Resources and the Environment in Eastern Indonesia* published by the ISEAS-Singapore. Before joining the ANU, he was a lecturer at the Graduate Program in Economics, University of Indonesia, as well as a researcher at the Indonesian Agency for the Assessment and Application of Technology. Resosudarmo received his PhD degree in development economics from Cornell University.

## **Introduction**

This paper maps out possible impacts from climate change and actions to mitigate climate change on trade, and explores some causal relationships, flow-on effects and feedbacks.

Trade effects of climate change are examined first as they apply in principle, and then in the specific cases of Australia and Indonesia respectively. The two countries share some similarities especially in their resource and energy sectors, but the differences far outweigh similarities. Differences of note include the status of economic development, structure of the economy, composition and direction of trade flows, existing and likely future international policy framework, and likely treatment under a future international climate policy framework.

Climate change and climate policies will affect the supply, demand and prices for different traded commodities, products and services, and may also affect institutional frameworks that govern international trade. Changes in trade flows are closely interconnected with changes in domestic economic structure. Changes in domestic production and consumption affect trade, but changing trade opportunities also affect driving change in domestic economic activity.

Selected effects to do with trade, and their interactions, are drawn up in the tables at the end of the paper, starting with a description of generic effects that could apply to any country, followed by particular assessments for Australia and Indonesia respectively. This preliminary analysis only sketches some of the effects and interrelationships, it does not go into detailed analysis.

## **Australia**

Australia's trade could be affected in a major way by climate change in the longer term, and by climate change mitigation policies in the short to medium term.

### ***Trade effects of climate change***

Agricultural production could experience large changes, especially if rainfall patterns change, with significant drying of South-Eastern Australia a possibility. In such a scenario, Australia's agricultural exports as a whole would decline. This in itself would give upward pressure on prices for some commodities, but it would occur in the context of changing agricultural supply in many regions of the world, so the net effect on Australia's terms of trade is unclear.

Production and trade of other commodities could be affected through secondary effects, such as infrastructure that is not well suited to changed climatic conditions. These effects would likely be small compared to agricultural changes, and could in large measure be addressed through adaptive action.

### ***Trade effects of mitigation policies***

Mitigation policies will have a much more imminent effect on Australia's trade. Australia is likely to introduce a system of emissions pricing through an emissions trading system. This will provide incentives on the supply side to shift to less carbon intensive technologies and practices, but also shift out of carbon intensive production. Where such a shift would be merely a relocation of industrial production to countries that do not impose carbon constraints, it is referred to as 'carbon leakage'. This is an important factor in the domestic political debate over emissions trading, with government plans to allocate permits for free to trade-exposed emissions-intensive industries. There are arguments over how significant carbon leakage would in fact be.

On the demand side, it will cause some substitution away from carbon-intensive goods and services, insofar as the increased production costs are reflected in the prices faced by consumers.

This occurs in the context of other countries implementing similar policies. Looking ahead to a possible, or in fact likely, future where many countries implement emissions control policies, the global demand for fossil fuels will fall. This is particularly so for coal, the most carbon-intensive of the main fossil fuels. Coal prices and export volumes are expected to fall significantly, *unless* 'carbon capture and storage' (CCS) technology proves technically feasible in a broad range of applications as well as commercially attractive, given costs of other low-carbon technologies. Demand for gas, the least carbon intensive fossil fuel, is likely to rise under moderate emissions constraints, as it is a ready substitute for coal (and oil) in many applications. However under more severe emissions constraints, gas demand would also fall. Demand for uranium would increase, as nuclear would substitute for coal in base load power generation in many countries.

Australia has large reserves of coal, gas and uranium. A likely scenario is for coal exports and prices to fall and keep falling, gas exports and prices to rise then fall (though trade volumes also depend on the domestic energy mix under carbon constraints), and uranium exports and prices to rise.

Complementary to carbon pricing policies, it is likely that public funding will be made available on a large scale for the development of low-carbon technologies. Promising technologies in which Australia could become a leader include CCS, bio-sequestration of carbon dioxide in algae and similar, specific kinds of geothermal power, and solar power. Leadership (and exports) would be in design and engineering rather than manufacturing, in line with existing specialization. Success in such technologies would reinforce commitments to mitigation policies, as mitigation would not need to be seen as predominantly an economic cost, but also a business and trade opportunity.

### ***Carbon finance***

Australia is likely to enter international carbon markets to help fulfil domestic greenhouse gas commitments. Depending on the stringency of targets relative to abatement costs, and

relative to commitments and abatement opportunities in other countries, Australia is likely to become and remain a net buyer of emissions entitlements (or credits). The reason for net purchases would be to cover remaining emissions from export industries in mining and processing as well as agriculture; and also because of its reliance on coal, and geographical features such as long distances.

Australia will be looking for trading opportunities. A regional orientation makes sense especially if trading is at least partly through government gateways, as it can then tie in with other policies, programs and objectives. This in turn could make large scale transfers more acceptable domestically. Australia in future is likely to look for options that go beyond the project-based CDM.

## **Indonesia**

### ***Impacts***

Indonesia is likely to see climate change impacts on commodity supply, especially in agriculture, like many other countries. The main driver is expected to be changes in rainfall patterns, with strong inter-regional variation. In many areas, a shorter but more intense rainy season may eventuate. The aggregate effect on agricultural output and trade is unclear, with lower volumes of some commodities likely, and higher volumes for others. Adaptation (development of new cultivars and varieties and of growing practices, and improvement of agricultural infrastructure) could at least partly offset negative effects from climate change.

Rice is the critical commodity, with Indonesia currently around the point of self-sufficiency. Again it is not clear how this would be affected by climate change, as any changes in Indonesia would need to be assessed against changes in global rice supply and demand to determine trade.

### ***Mitigation***

For fossil fuel demand and trade, the story is similar to that in Australia, especially if and when Indonesia adopts emissions control policies in the power and industrial sectors. In any event, international demand for coal will fall if there is significant greenhouse gas control policy internationally and unless CCS is not widely used. This will bring lower export volumes and prices for Indonesia's coal. Gas exports and prices meanwhile may further increase.

Energy intensive commodities in Indonesia could increase their competitiveness in some cases even under a global 'level playing field for carbon emissions', that is with full emissions pricing in Indonesia and elsewhere. An example is aluminium smelting using electricity from hydro, or in future even geothermal sources.

Domestic carbon constraints or effective transmission of international policy approaches would trigger expansion of low- or zero-emissions sources, in particular hydro and

geothermal power, and also biomass/biofuels. This could help with development in relatively remote areas.

If biofuel energy takes off, this places further pressure for land conversion to palm oil and other energy crops. This could run counter to the mitigation objective, if the resultant carbon loss from standing forests is not captured by forestry and land-use change mechanisms. In addition, the pressure on biodiversity values from large-scale biofuel production is an important downside, and is increasingly regarded as such by Western countries especially those in the European Union. Thus, Western countries may tailor their climate and trade policies to avoid supporting forest conversion for biofuel production in Indonesia and elsewhere in the tropics. That in turn can be seen as economically disadvantaging tropical forested countries on account of hosting significant biodiversity, and raises the question of proper valuation of biodiversity, and incentive mechanisms to preserve it.

Forests are a potentially very important part of Indonesia's mitigation efforts. Deforestation accounts for the largest share of Indonesia's annual emissions. Indonesia is a prime location for the application of international mechanisms to provide incentives to reduce deforestation. If an international agreement on a meaningful scale and using a practical approach can be struck, and if the right institutional frameworks are created domestically, then Indonesia's deforestation rates could slow significantly faster than would be the case without mitigation action. There are, however, big institutional hurdles to be overcome in putting in place an effective incentive regime.

Less deforestation would mean less supply of logs and timber to the international market; and also less supply of palm oil and other commodities grown on converted lands. The drop in export revenue could be – and arguably would need to – be (more than) made up for by payments for avoided deforestation. Significant changes in economic structure would occur in forest-dependent areas that decide to take carbon payments and embark on other economic strategies instead of logging and/or conversion to plantations or agriculture.

### ***Technology***

As a flow-on effect of high-income countries' technology policies for mitigation, Indonesia is likely to get better access to 'clean' technologies, and to relevant financing from international sources. This would likely cause shifts in technology imports toward higher-technology supplies, and can provide ancillary benefits like reduced air pollution. It might conceivably also pave the road for greater investment flows in other sectors if there are positive demonstration effects of successful investment projects and improved domestic investment capacity as a result of the higher-tech mitigation investments.

### ***Carbon finance***

Indonesia could be a large supplier of emissions entitlements or credits to developed countries, yielding significant trading revenues. Carbon trading could be an important source of financing not just for low-carbon investment, but broader infrastructure investment for example in power supply and transport systems. If carbon finance turns

out an attractive model, this could become self-reinforcing by unlocking further carbon abatement potential. However it would need to be on a much larger scale than current Clean Development Mechanism (CDM) to make an appreciable difference.

## Climate change and trade: a generic framework for selected impacts and interactions

Category	Primary effects	Impact on trade	Flow-on effects	Feedbacks and interactions
Climate change impacts on commodity supply	<p>Agriculture: changes in production. Decreases output in some areas and for some products, increases in others. Adaptation process tends to give higher costs and lower output.</p> <p>Other commodities: Only second-order impacts likely, unless in cases of very severe climate change.</p>	<p>Large shifts in agricultural trade flows likely.</p> <p>Significant changes in relative prices between commodities possible.</p>	<p>Consumption of traded agriculture commodities shifts in line with global production, with transmission through the price mechanism in int'l markets.</p> <p>Climate-induced changes in agriculture production are felt not just in the country/region where they occur but everywhere.</p>	<p>Substitution away from commodities in shorter supply (negative feedback).</p> <p>Greater efforts to increase output of commodities in short supply through dedicated agriculture research, and more growing area dedicated</p> <p>Policies to countervail price changes (possible positive feedbacks)</p>
Mitigation policies: Emissions pricing and regulation for climate change mitigation	<p>Energy: demand for fossil fuels falls, especially for coal. Gas demand may increase during a transition phase. Uranium demand up. Price changes in line with changes in demand.</p> <p>Energy intensive commodities (steel, aluminium etc): Effective production costs increase where industries are subject to mitigation policy.</p> <p>Forestry products: supply of timber from primary forests declines, if effective policies to curb deforestation implemented.</p>	<p>Energy: coal exports reduced. Gas exports likely to increase during transition phase (unless outweighed by domestic demand). Impacts depend on policies in importing countries.</p> <p>Energy intensive industries: exports from countries that do not impose carbon policies can gain a competitive advantage and increase trade, depending on policies in other countries. ("Carbon leakage")</p> <p>Timber: shift in trade volumes away from primary forests and towards plantation timber.</p> <p>Direction of changes to trade in timber, steel and other building</p>	<p>Less investment and economic activity in fossil fuel extracting and using industries.</p> <p>Economic decline in some regional areas heavily dependent on fossil fuel extractive and using industries.</p> <p>Rise of renewable energy sources, including biofuels. Also nuclear power.</p> <p>Sweeping changes in economies in some forest-rich areas.</p>	<p>Increased demand for biofuels interacts with changes in agriculture growing opportunities and trade.</p> <p>Biofuels drive prices of many agriculture commodities up, and could exacerbate any shortages of such commodities.</p>



		materials unclear.		
Technology: Policies for and investment in new and clean technologies for climate change mitigation	<p>Cost of new technologies comes down because of greater R&amp;D effort.</p> <p>Cost of capital equipment generally rises because of greater demand for new investment.</p> <p>Advanced technologies more readily available, including in developing countries through targeted policies by technology producing countries.</p>	<p>Freer trade in high technology equipment, especially in the energy sector</p> <p>Finance for clean energy equipment more readily available, including from developed to developing countries.</p>	<p>Boost for technology developing and producing countries and regions.</p> <p>Ancillary benefits from cleaner technologies where it is applied, especially air quality (power stations, industry, landfills)</p>	<p>If carbon capture &amp; storage (CCS) technology is successful, this can keep coal (and later gas) competitive in a carbon constrained world, and reduce fossil fuel adjustments.</p>
Carbon finance, emissions trading	<p>International mechanisms and funds for carbon finance set to expand greatly, in scope and in scale.</p> <p>Possibilities:</p> <ul style="list-style-type: none"> <li>• Broader CDM</li> <li>• Sector-based mitigation mechanisms, including for avoided deforestation</li> <li>• National targets</li> <li>• Finance for climate change adaptation</li> </ul>	<p>Countries will be net sellers or buyers depending on their underlying emissions trajectories and mitigation action, relative to their commitments.</p> <p>Developing countries expected to be sellers. They will receive financial inflows from sale of permits, offsets etc. Inflows can offset and may exceed domestic abatement costs.</p>	<p>Greater domestic incentive to mitigate because of carbon finance.</p> <p>Financial benefits including to current high polluting industries, if they mitigate.</p> <p>If financial inflows are large relative to size of the economy- similar effect to a resource price boom on a resource exporter: raises domestic price levels, makes other exports less competitive.</p>	

## **Australia: Climate change and trade, selected impacts and interactions**

<b>Category</b>	<b>Primary effects</b>	<b>Impact on trade</b>	<b>Flow-on effects</b>	<b>Feedbacks and interactions</b>
Climate change impacts on commodity supply	Agriculture: likely decreases especially from irrigated agriculture. Reductions in output of dairy, horticulture, possibly meat.	Lower export volumes of some agriculture commodities. May coincide with increases in global prices, partly offsetting reduced volumes in terms of trade revenue.		Australian agriculture is highly adaptable. Shifts to different growing areas and commodities expected, and resulting changes in trade patterns
Mitigation policies: Emissions pricing and regulation for climate change mitigation	Coal becomes a more expensive fuel to use. International demand for coal falls, if there is significant greenhouse gas control policy internationally unless CCS is widely used.	Energy: Australia's coal exports fall and fetch lower prices. Gas production expanded. Gas exports may increase or decrease depending on domestic policies and market developments.  Energy intensive commodities: Reductions in coal-based production and exports, especially aluminium. (Energy-intensive industries in Australia are to a large extent coal-based.)	Re-orientation away from coal and towards other forms of energy, including for export.	
Technology: Policies for and investment in new and clean technologies for climate change mitigation	Greatly increased public and private funding for technology development: CCS, biosequestration, some renewables.	Australia could become low-emissions technology exporter, if and where new technologies are successful. I.e. CCS, biological sequestration (algae), geothermal power, solar. If so, likely to be for engineering rather than manufacturing outputs.		Exporting success would reinforce public and private efforts to support technological development (positive feedback)
Carbon finance, emissions	Australia entering international carbon markets to help fulfill domestic	Australia looking for trading opportunities, especially in the	Carbon finance/ trading could tie in with other policies, programs and objectives,	Successful trading with regional partners would reinforce political support for

trading	greenhouse gas commitments. Australia a very likely net buyer because of remaining export industries in mining and processing, agriculture. Also because of endowments: coal, long distances.	region.	where trading/finance is controlled by government.	GHG policies.
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## **Indonesia: Climate change and trade, selected impacts and interactions**

Category	Primary effects	Impact on trade	Flow-on effects	Feedbacks and interactions
Climate change impacts on commodity supply	Agriculture: likely various changes, in response to expected changes in rainfall patterns. Strong regional variation. Aggregate effect unclear.	Lower trade volumes of some agriculture commodities, higher for others. Rice is the critical commodity, with Indonesia currently around the point of self-sufficiency; not clear how this would change under climate change impacts.		Adaptation (development of new cultivars and varieties and of growing practices, and improvement of agriculture infrastructure) could counteract negative effects from climate change.
Mitigation policies: Emissions pricing and regulation for climate change mitigation	Coal becomes a more expensive fuel to use, <i>if and when</i> Indonesia adopts emissions control policies in the power and industrial sectors.  International demand for coal falls, if there is significant greenhouse gas control policy internationally and unless CCS is not widely used.  Forests: if there are effective international mechanisms to provide incentives to reduce deforestation, and if the right institutional frameworks are created domestically, then deforestation rates could slow.	Energy: Indonesia's coal exports fall and fetch lower prices Gas production expanded. Gas exports likely to increase for some time, as other countries implement mitigations policies ahead of (or stronger than) Indonesia.  Energy intensive commodities: Indonesia could increase its competitiveness, for example for aluminium smelting using hydroelectricity.  Less supply of logs and timber to the international market. Also lower supply of palm oil etc. Drop in export revenue could be (more than) made up for by payments for avoided deforestation.	Re-orientation away from coal and towards gas in particular, especially for export.  Expansion of low- or zero-emissions sources, in particular hydro and geothermal power, and also biomass.  Significant changes in economic structure in forest-dependent areas that decide to take carbon payments and embark on other economic strategies instead of logging and/or conversion to plantations or agriculture.	Renewable energy development could help with development in relatively remote areas.  If biomass energy takes off, this places further pressure for land conversion to (for example) palm oil.
Technology: Policies for and investment in	Indonesia likely to get better access to 'clean' technologies, and to relevant financing from international	Shifts in technology imports toward higher-technology suppliers.	Some ancillary benefits i.e. less air pollution.	

new and clean technologies for climate change mitigation	sources.		Could help with non-climate related foreign investment through demonstration effects or improving investment capacity.	
Carbon finance, emissions trading	Indonesia could be a large supplier of emissions entitlements or credits to developed countries, i.e. to Australia, Japan.  Preconditions are workable international agreements and mechanisms, a suitable domestic policy framework, and political will.	Significant financial revenue from sale of entitlements, credits etc. Could be important source of financing not just for low-carbon investment, but broader infrastructure investment i.e. power supply and transport systems.		If carbon finance on a much larger scale than current CDM turns out an attractive model, this could become self-reinforcing by unlocking further abatement potential.

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