Climate Risk Management through Structural Adjustment and Regional Relocation: A Case of Rice Industry in Australia

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Climate Risk Management Symposium
Guayaquil, Ecuador
October 10-12, 2011
1. Background, rice industry significance

2. Climate change, water availability and rice production

3. Methodology: structural adjustment, hypothesis, regional CGE

4. Evidence of structural adjustment

5. CRM: regional relocation prospective

6. Conclusions and policy implications for CRM
Background

- Agriculture is risk business due to climatic variability, and irrigated agriculture is no exception. Climate change is making it riskier.

- It is expected that with climate change:
  - In south east Australia future average water availability will decline and the frequency of extreme events (eg drought) will increase.
  - In northern there could be an increase in annual average rainfall.
  - Government’s water and environmental policies (such as new MDB plan and water buyback) further increasing pressure on irrigators.
  - To be efficient, irrigators need to manage their exposure to the risks associated with changing water availability conditions.
Rice industry significance

• Australian rice is only 0.2% of world production but exports (80% of the rice produced) are more than 4% of world trade.

• Australia has one of the highest yields of rice per hectare (10 t/ha), owing to plenty of sunlight and suitable temperatures, excellent water quality, and good soils.

• The rice industry directly employs over 8,000 people and supports over 60 towns. Indirectly, the industry further supports 33,000 people.

• During the late 1990s, production reached at 1-1.2 million tonnes of rice per year. This contributed about $300m at the farm gate and $800m value added to Australian economy.

• Net returns range from $1,750 to $2,000 per ha, depends on rice and market conditions.
<table>
<thead>
<tr>
<th>System</th>
<th>Allocation %</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Australian Murray</td>
<td>100</td>
</tr>
<tr>
<td>Victorian Murray (high security)</td>
<td>200</td>
</tr>
<tr>
<td>Victorian Goulburn (high security)</td>
<td>100</td>
</tr>
<tr>
<td>NSW Murray (high security)</td>
<td>100</td>
</tr>
<tr>
<td>NSW Murray (general security)</td>
<td>95</td>
</tr>
<tr>
<td>Murrumbidgee (high security)</td>
<td>100</td>
</tr>
<tr>
<td>Murrumbidgee (general security)</td>
<td>90</td>
</tr>
</tbody>
</table>
Climate change and water availability: rice area and yield

**Historical rice area and yield**

- Area (1000 ha):
  - Linear equation: $y = 0.56x + 82.2$
  - $R^2 = 0.024$

- Yield (tha):
  - Linear equation: $y = 0.06x + 5.7$
  - $R^2 = 0.45$
Climate change and water availability: water allocation, rice area and farms

**Relationship between annual water allocation and rice area and rice farms**

- **Rice Area Harvested (000s ha)**
  
  \[ y = 124.3 \text{water} + 13.1 \]
  
  \[ R^2 = 0.70 \]

- **Number of Rice Farms**
  
  \[ y = 1914.1 \text{water} + 335.3 \]
  
  \[ R^2 = 0.78 \]
Methodology

- Climate change and variability
- Sustainability and profitability
- Policies (e.g., NWI, CPRS, etc.)

**Climate Modelling**
- GCM modelling for rainfall, temperature, and solar radiations and other relevant factors.

**Water Availability Scenario**
- Water availability modelling scenario.

**Crop Modelling**
- Application of APSIM model to evaluate crop (cotton, rice, and tomato) performance under climate change.

**Farm-level Modelling**
- Application of APSFarm model to evaluate the net farm-level impact* of relocation of crops to northern area.

**Farm-Level Structural Adjustment**
- Assessment of farm-level adjustments.

**Industry-level Assessment**
- Industry-level adjustment and modelling to assess industry-related impacts.

**Regional Assessment**
- Estimate the regional impact** through Regional GE/Input-output modelling.

**Key drivers of agriculture industry location**
- Climate, crop and farm-level modelling and impact.

**Modelling structural adjustments and agricultural industry and regional impact**
Structural change – links to Industry and social analysis

Crop and Farm-level Modelling

Farm A
- A
- B
- Rice
- Wheat

Social/Industry

New South Wales

Industry Level and Regional Modelling

Farm B
- A
- Sugarcane
- B
- Rice
- Sugarcane

Social/Industry

Northern Area
The hypotheses include:

- an expected increase in farm sizes to make a viable living;
- the substitution of rice with dryland wheat while increasing the total farm area;
- water trading in low water availability year when prices are high to support income; and
- decreases in the rice area; and changes in off-farm income and financial impact.
Structural Adjustment at Rice Farms

Water availability, rice area, total irrigated area and area operated
Crop shifting: rice to wheat

Water allocation and wheat and rice production by area (per farm)
Water trading
Rice area and water trading

Relationship of net water trading (water trading in - water trading out) and rice area

Rice = 0.2059***trade + 20450
R² = 0.647
Rice area and price

Relationship of rice area (per farm) to price
Model used: $\Delta A = \alpha_0 + \alpha_1 \Delta(Price^{-1})$
Financial impact

Relationship of water availability and farm business profit and total family income

Total family income = 400**water + 16,736
$R^2 = 0.24$

Farm business profit = 763***water - 71,059
$R^2 = 0.38$

Water Allocation (%) (1990-2009)

- Farm business profit ($)
- Total family income ($)
Regional Relocation Prospective: CGE Modelling

Maps of the key regions for this analysis
Calculating regional costs and benefits and estimating the ‘net economic impact’ of relocating the rice industry to northern regions as an adaptive response to increase water scarcity as a result of climate change.

- **Baseline scenario**: For the baseline scenario, the 2004 water availability was selected against which other scenarios are compared

- **Scenario 1**: Rice is grown on fallow sugarcane land with no competition with sugarcane

- **Scenario 2**: Rice is grown on displaced sugarcane land in competition with sugarcane
Cumulative change in real income under scenario 1

<table>
<thead>
<tr>
<th></th>
<th>Real income</th>
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<tbody>
<tr>
<td></td>
<td>2029-30</td>
</tr>
<tr>
<td>Southern Rice</td>
<td></td>
</tr>
<tr>
<td>Burdekin LGA</td>
<td></td>
</tr>
<tr>
<td>Rest of Australia</td>
<td></td>
</tr>
<tr>
<td>Total Australia</td>
<td></td>
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<table>
<thead>
<tr>
<th></th>
<th>2010-11$m</th>
<th>2010-11$m</th>
<th>2010-11$m</th>
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</thead>
<tbody>
<tr>
<td>Southern Rice</td>
<td>-72</td>
<td>-161</td>
<td>-1,298</td>
</tr>
<tr>
<td>Burdekin LGA</td>
<td>58</td>
<td>178</td>
<td>1,149</td>
</tr>
<tr>
<td>Rest of Australia</td>
<td>6</td>
<td>-26</td>
<td>9</td>
</tr>
<tr>
<td>Total Australia</td>
<td>-8</td>
<td>-9</td>
<td>-140</td>
</tr>
</tbody>
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Cumulative change in real income under scenario 2

<table>
<thead>
<tr>
<th></th>
<th>2029-30</th>
<th>2069-70</th>
<th>NPV (2010-11 to 2069-70)</th>
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</thead>
<tbody>
<tr>
<td>Southern Rice</td>
<td>−71</td>
<td>−148</td>
<td>−1,251</td>
</tr>
<tr>
<td>Burdekin LGA</td>
<td>−83</td>
<td>−324</td>
<td>−1,888</td>
</tr>
<tr>
<td>Rest of Australia</td>
<td>72</td>
<td>253</td>
<td>1,523</td>
</tr>
<tr>
<td>Total Australia</td>
<td>−82</td>
<td>−219</td>
<td>−1,616</td>
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Conclusions and Policy Implications

- Climate variability and climate change will shape the nature of Australian water availability.
- Food production in Australia is going to get more difficult despite the resilience that has evolved in farming communities and sectors.
- Major adjustments in farming systems will need to be made to manage climate risk and food security risks.
- Climate change and on-going policy reform will reduce the average area of rice production which cannot be offset by productivity gains given current production techniques and increasing temperatures and rainfall variability.
Conclusions and Policy Implications

- The rice industry and rice growers have adopted a risk-averse approach. Australian rice growing communities have demonstrated great skill and capacity in adjusting to changing circumstances.

- The increase in wheat production will not compensate for the reduction in the higher value commodity. This will be a cost to the economy over and above the direct cost of the environmental water.

- There could be very large effects on some regional economies, especially if one or more mills close or operate only occasionally, as the employment effects multiply through the community.
There is unlikely to be any major autonomous expansion of a northern rice industry, which raises questions for whether or not governments should provide additional support to accelerate industry development.

The four main arguments for support would be:

• cushioning the impacts on the national economy of reducing southern production;

• providing hard infrastructure (e.g. landscape transformation, transport and milling facilities),

• soft infrastructure (e.g. skills development for new forms of production); and:

• smart infrastructure (e.g. production research)
Thank you