

Integrating Representative Agricultural Pathways into a Regional Economic Model for Wheat

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Overview and approach

The objective is to introduce Representative Agricultural Pathways (RAPs), which describe narratives and trends in key drivers at a regional or global scale, into a Computable General Equilibrium (CGE) economic model designed for the REACCH study area.

The CGE model traces a shock in one part of the Pacific Northwest (PNW) economy, such as a weather shock that changes wheat yields, to all other parts of the PNW economy, including consumers, producers, government, and businesses that otherwise might seem far removed from wheat producers. Exports and imports are also tracked.

RAPs for the PNW region are taken from the REACCH presentation *Representative Agricultural Pathways and Climate Impact Assessment for Pacific Northwest Agricultural Systems* by J. Antle, J. Mu, H. Zhang, S. Capalbo, S. Eigenbrode, C. Kruger, C. Stockle, J.D. Wulffhorst, J. Abatzoglou. Three RAPs are outlined:

- Business-as-Usual (RAP1)
- Dysfunctional World (RAP2)
- Aggressive Climate Policy (RAP3)

The connection of RAPs to the CGE model will be made through a series of hypothetical scenarios, that is, model-specific parameters that are consistent with a pathway.

Sectors of model

1. Wheat (PNW grain farming)
2. Wheat products (made from wheat)
3. Agricultural inputs
4. Wheat substitutes in production (alternative land uses)
5. Manufactured goods
6. Other agriculture (all other crop farming, livestock, etc)
7. Processed food
8. Construction, utilities and mining
9. Wholesale and retail trade
10. Other services and miscellaneous

Regions of model

1. Pacific Northwest (PNW): Oregon, Washington, Idaho
2. Rest of U.S. (the U.S. without the PNW)
3. Rest of World (all countries outside U.S.)

Importance of wheat (IMPLAN data)

- PNW output of wheat: \$2,288.6 million (year 2011)
- PNW exports to rest of U.S.: \$451.7 million
- PNW exports to rest of World: \$720.0 million
- PNW inventories of wheat: \$55.6 million
- Value added in the PNW wheat sector:
Income generation for labor: \$112.1 million
Income generation for capital: \$628.0 million

Econometric models

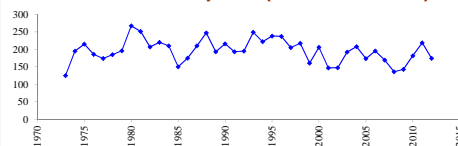
- The models below are estimated with historical data, and provide detail on certain aspects of the RAPs that otherwise would not be captured by the CGE model.
- **Foreign demand for PNW wheat:** modeled as a function of price, population of the top six major importers, the real weighted exchange rate, and certain key historical policy changes. The fitted equation is:

$$\ln \text{Export}_t = 1.32 - 0.10 \ln \text{Price}_t + 0.50 \ln \text{Pop}_t - 0.55 \ln \text{ExRate}_t + 0.14 \ln \text{Embargo}_t + 0.23 \ln \text{FarmBill}_t - 0.24 \ln \text{PriceSpike}_t$$

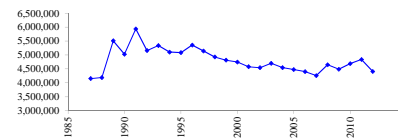
- **PNW wheat acreage planted:** modeled as a function of lagged price, lagged acres planted, lagged yield, cost of nitrogen fertilizer, technology, and policy. The fitted equation is:

$$\ln \text{Acre}_t = 6.85 + 0.17 \ln \text{Price}_{t-1} + 0.56 \ln \text{Acre}_{t-1} + 0.13 \ln \text{Yield}_{t-1} - 0.18 \ln \text{Nitro}_{t-1} + 0.00 \text{Tech}_t - 0.06 \ln \text{FarmBill}_t$$

PNW wheat exports (million bushels)



PNW wheat acreage planted (acres)



Scenario 1

Population in key export markets is projected to rise 35% by the year 2050.

Model predictions (with all else held constant):

- PNW wheat foreign exports grow 17.5%
- Quantity of PNW wheat output rises 8.9%
- Regional price of exported wheat rises 3.8%
- Value added price of wheat activity rises 0.04%
- Wheat farmers demand 3.9% more labor and capital
- PNW state governments' revenues rise 0.02%

Scenario 2

Assume: Fertilizer costs double (all else held constant). Predictions:

- PNW wheat acreage and output falls 18%
- Exports to outside fall 25.3%
- Producer price rises 5.3%
- Composite commodity price rises 4.7%
- Regional price of wheat rises 9.9%
- PNW wheat demand (all classes of wheat) falls 0.03%
- Wheat farmers demand 4.9% less labor and capital
- PNW state governments' revenues fall 0.05%

Scenario 3

Assume: Yields increase 10% on average (all else held constant).

Predictions:

- PNW wheat output rises 13% (includes 1.3% increase in acreage)
- Wheat farmers demand 3.7% more labor and capital
- Exports to outside PNW rise 18.8%
- Value added price of wheat falls 8.2%
- Regional price of wheat falls 5.5%
- Producer price falls 2.8%
- Composite commodity price falls 2.8%

Scenario 4 (combine scenarios 1, 2, 3)

Assume: Population in key export markets rises 35%, fertilizer costs double, and yields rise 10% by 2050 (all else held constant).

Predictions:

- PNW wheat output falls 0.9%
- Exports to outside PNW fall 0.05%
- Producer price rises 2.1%
- Wheat farmers demand 5.5% more labor and capital
- Value added price of wheat rises 6.4%
- Regional price of wheat rises 1.7%
- PNW wheat demand falls 0.2%



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