Introducing climate change to NiGEM

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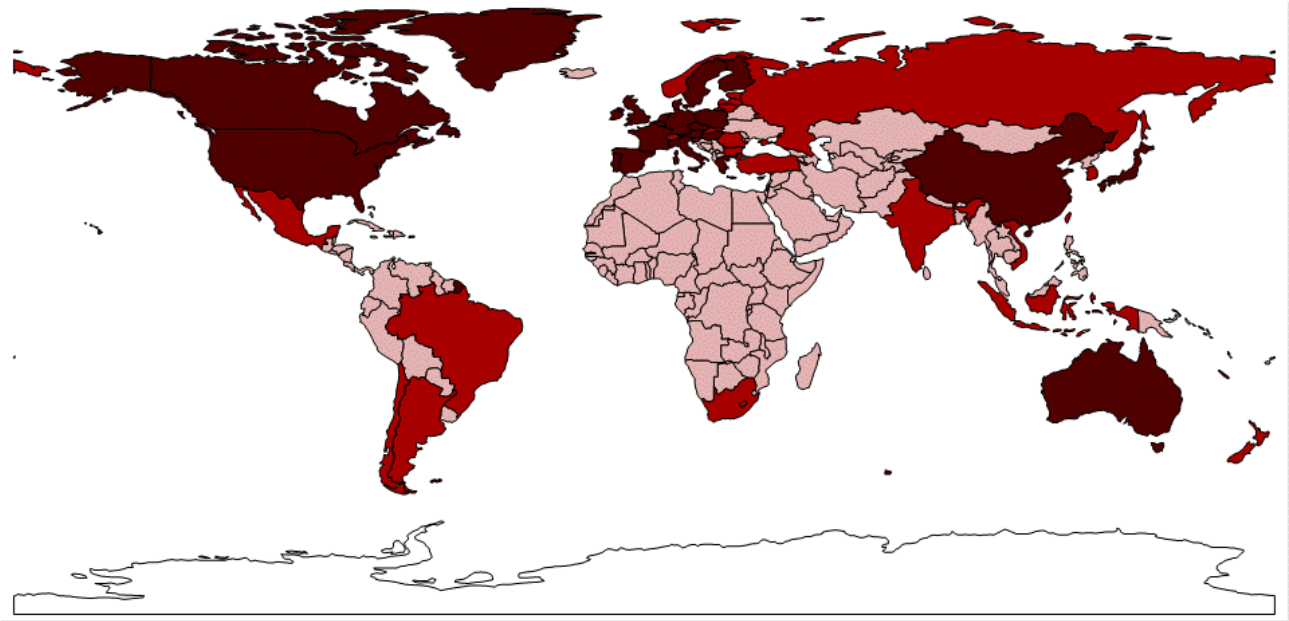
NiGEM: the leading global macroeconomic model

- A transparent, peer-reviewed, global econometric model maintained by NIESR that has evolved over 30 years of regular use
- Used by policymakers and private sector organisations around the world for economic forecasting, scenario analysis and stress testing
- Consists of individual country models for the major economies, linked through trade in goods and services and integrated capital markets.

NiGEM Country Coverage

+6 regional country blocks



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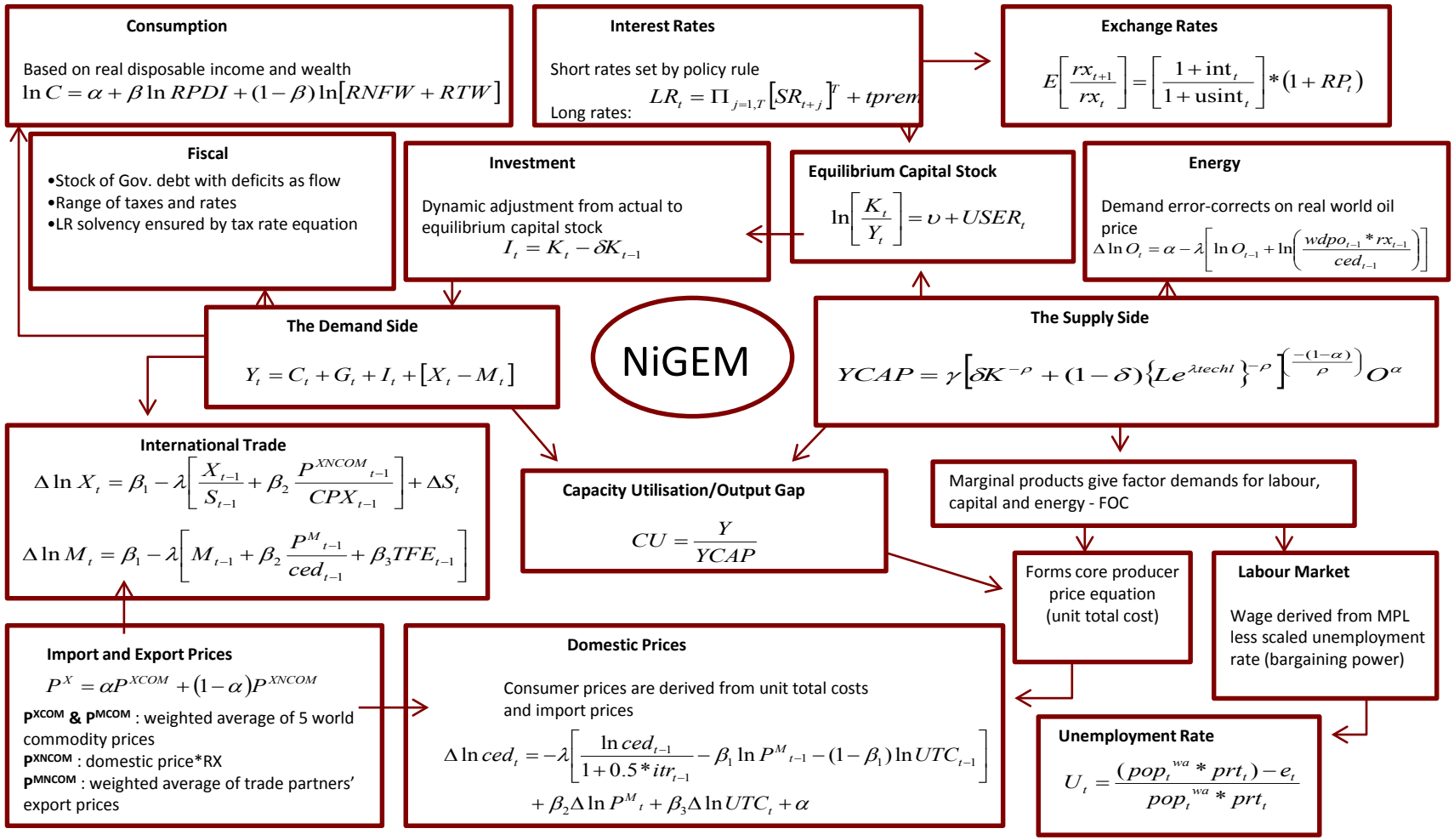
NiGEM Overview

- Discrete models for most **OECD** economies and other countries such as India, China, Brazil, South Africa etc. There are regional blocks for the remaining countries in Asia, America, Africa, the Middle East and Europe
- Models depend on both **theory and data**
- There is a common (estimated and calibrated) **underlying structure** across all economies
- **Long-run structure relatively rigid**
- Contains both **forward looking, rational expectations and adaptive learning**.
- **Flexible policy** environments

Structure of NiGEM

- The country models have complete demand and supply sides, also full asset structures
- Most behavioural equations estimated in error-correction format
- Rational expectations options
  - Financial markets
  - Labour markets
  - Consumption
- Country Linkages
  - trade and competitiveness
  - interacting financial markets
  - through international stocks of assets
- Supply-side
  - based on CES relationship between capital (K) and labour (L), embedded in a Cobb-Douglas framework with oil (M)
- Government
  - direct and indirect taxes, government spending and interest payments.
  - tax rule to ensure long run solvency

The Structure



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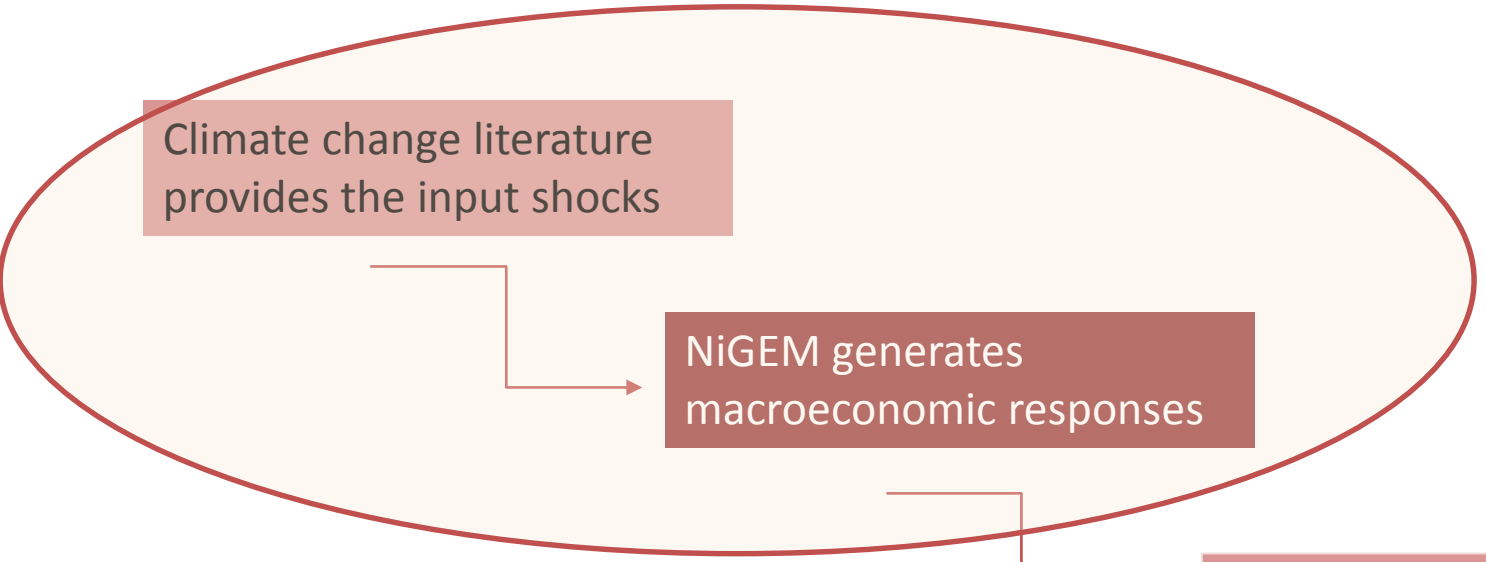
Where does NiGEM sit?

In a top-down approach, global macro models are a useful tool for understanding climate change because climate change is a global issue.

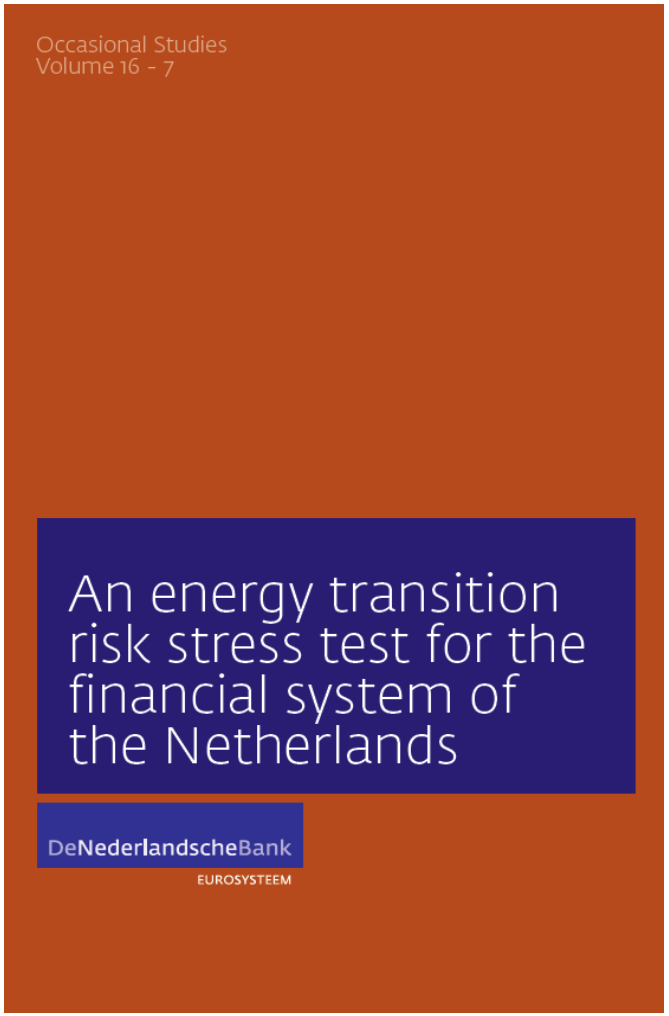


NIESR climate change scenarios

- Climate change channels
  - Temperature effects on GDP (TECHL)
  - Migration
  - Commodities
  - Uncertainty

- Mitigating climate change
  - Reducing emissions
  - Moderating climate effects in developing countries

Another example of climate change risk analysis on NIGEM



4 climate scenarios

- Carbon tax on coal, oil and natural gas
- Technological breakthrough: adjust the production function such that the fossil fuel used to produce a unit of output falls by 25%. This scenario can be interpreted as being equivalent to a doubling of the share of renewable energy in the global energy mix. The price of fossil fuels falls in this scenario
- Double shock: climate change mitigation policy + technological breakthrough. Carbon price increases and the cost of renewable energy falls
- Risk aversion: erosion in consumer confidence and rise in risk premium

Scenario 1: Commodities

NIESR: Volume impact

Scenario: total exports from Africa fall by 25% due to increase scarcity

Equation

Add a share value AFSH with a base value of 1.0 to the model

Modify all "S" variables to include the new variable

$$S_t = \sum_{0}^{af} \phi_{af}\, \epsilon_{af} mvol_{t,af} + \sum_{0}^{rw} \phi_{rw}\, mvol_{t,rw}$$

Shock

AFSH is reduced by 25%

DeNederlandscheBank: Price impact "Policy shock"

Scenario: A carbon price increase of $100 per tonne of CO2

Equation

PX and PM: weighted average of five commodities prices: oil, gas, coal, agriculture and metals.

PX and PM impact on trade volumes & domestic prices

Shock

Coal price: 870%

Oil: 80%

Gas: 58%

Scenario 1: Commodities

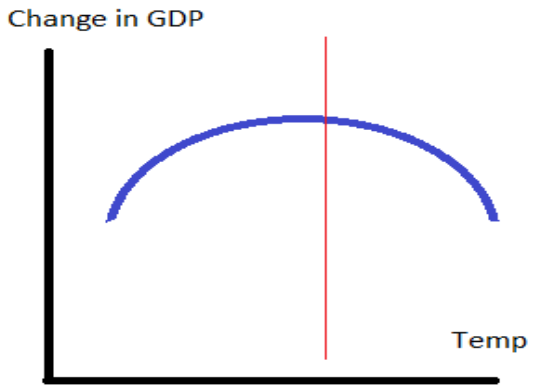
NIESR: Volume impact	DeNederlandscheBank: Price impact "Policy shock"
Impact AFY: around 1% lower in the long run USY: around 1% higher in the long run EAY: broadly flat	Impact - Higher cost of production, lower profitability and investment - Higher prices, lower real disposable personal income & consumption - Higher central bank policy rates

Scenario 2: Production function

NIESR: temperature & productivity

Scenario: climate change will lead to a rise in temperature. How will that impact productivity?

Optimum temperature: 13.9 degrees centigrade



DeNederlandscheBank: technological breakthrough

Scenario: breakthrough in R&D raises the share of renewable energy in the energy mix to double in five years.

IEA predicts that wind power will be the primary source of electricity in the EU by the 2030s. Around two-thirds of new power generation capacity in India over the last three years is from renewable sources (RBI, May 2019).

Battery storage costs continue to fall

Scenario 2: Production function

$$YCAP = \gamma[\delta K^{-\rho} + (1-\delta)(Le^{\lambda techl})^{-\rho}]^{-(1-\alpha)/\rho} M^{\alpha}$$

NIESR: temperature & productivity

Shock

We create a new equation which links labour augmenting technical change (techl) to temperature change. The equation parameters are calibrated so that a 1 degree rise in temperature changes GDP by a uniform amount across all countries.

DeNederlandscheBank: technological breakthrough

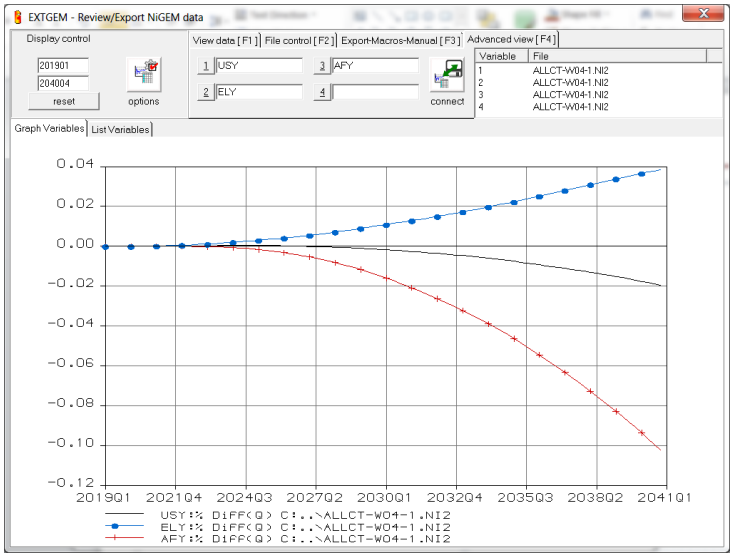
Shock

- The amount of fossil fuel used to produce a unit of energy falls by 25% over 5 years (equivalent to a doubling of the share of renewable energy).
- 6 percent of the capital stock is written-off in the first year and 4 percent in the second year.

Scenario 2: Production function

NIESR: temperature & productivity

Impact:



DeNederlandscheBank: technological breakthrough

Impact:

Short term losses to GDP because capital stock in written-off. There are gains further out because lower energy prices raises potential output.

Scenario 3: Uncertainty and confidence

NIESR: Uncertainty	DeNederlandscheBank: Confidence and cost of capital (USER)
Scenario: Climate change may increase financial turmoil, leading to a rise in risk, especially in parts of the globe not traditionally associated with such risks. There are winners and losers but financial markets are entangled and contagion is possible. *The cost of finance is higher for companies and governments.*	*Scenario: There is a gap between implementation and commitments made by countries in Paris. Delay in policy action will require a more drastic future response.* *This will lead to a drop in confidence among consumers, producers and investors. The cost of capital will rise as a result.*

Scenario 3: Risk premia

User cost of capital = f(LR, IPREM, PREM, CTAX)

NIESR: Uncertainty

Shock: Investment premium (IPREM) rises to reflect wider spreads between risky and risk-free interest rates and higher mark up charged by banks. IPREM falls by 1% in Europe/Canada and rise rises by 1% elsewhere)

TPREM: Confidence in the sovereign falls (Apply a 1% TPREM shock to all non-European countries except Canada)

DeNederlandscheBank: Confidence shock and cost of capital (USER)

Shock: Consumers delay their purchases (1 pp per relative to baseline over 5 years).

USER: rises by 1 pp relative to the baseline

PREM: rises by 1 pp

Scenario 3: Risk premia

User cost of capital = f(LR, IPREM, PREM, CTAX)

NIESR: Uncertainty	**DeNederlandscheBank: Confidence shock and cost of capital (USER)**
Impact: *2 versions: with and without contagion* *Euro area GDP: around 1% higher in the long run without contagion and around 0.8% higher with contagion* *US GDP: around 0.2% lower in the long run without contagion and around 0.4% lower with contagion.*	*Impact*: Both GDP and inflation fall relative to the baseline scenario.