An investigation of carbon taxes and terms-of-trade in a large macroeconometric model

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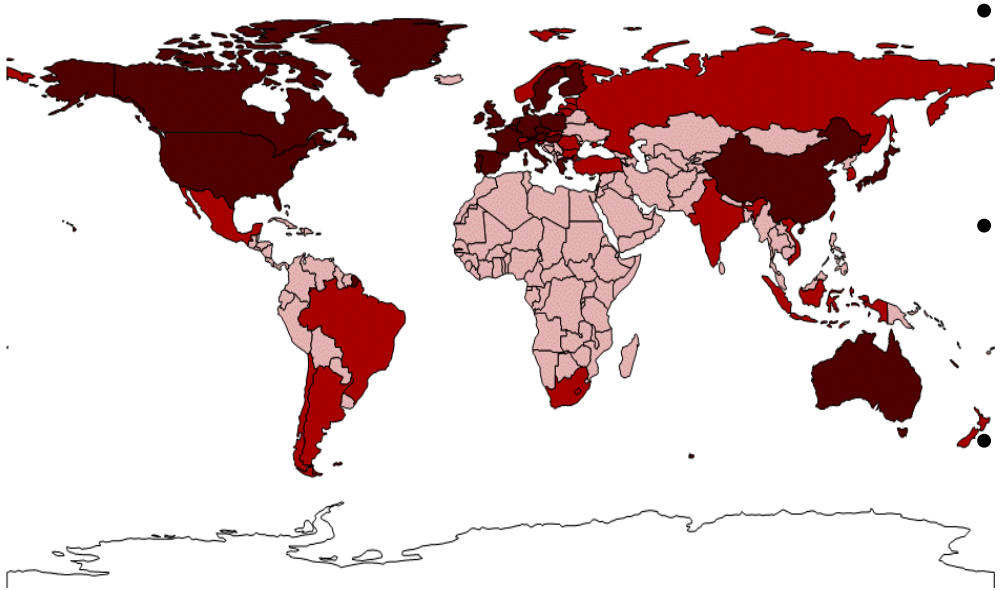
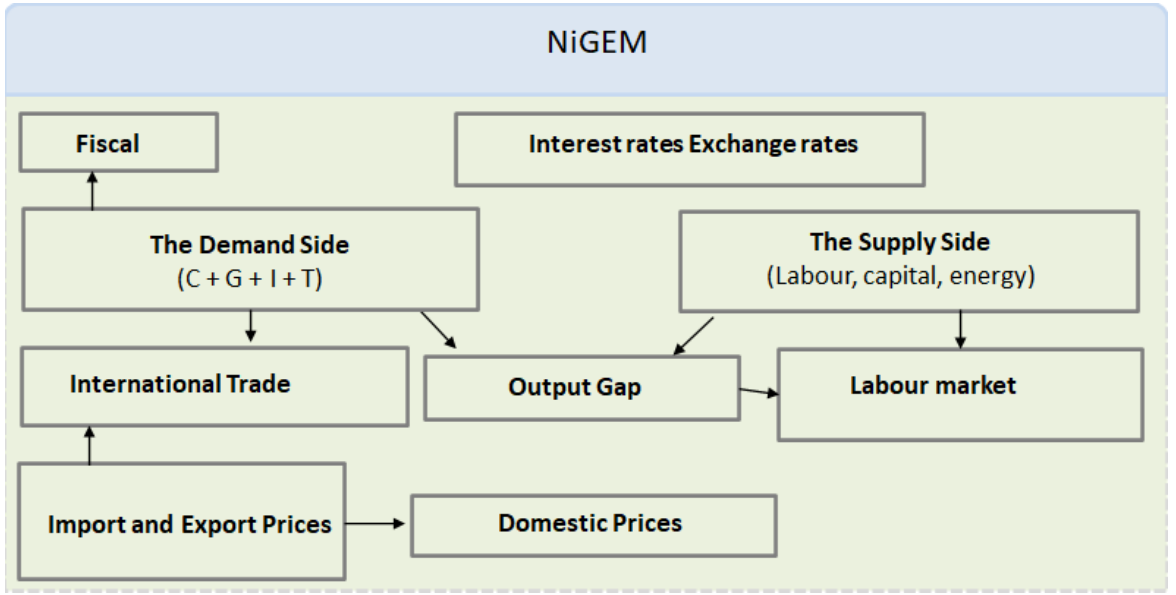
National Institute's Global Economic Model - NiGEM



- A transparent, peer-reviewed, global econometric model that has evolved over 30 years of 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.
- Models exist for most OECD countries plus country models for Argentina, Brazil, Bulgaria, China, Hong Kong, India, Romania, Russia, South Africa, Singapore, Taiwan and Viet Nam. Separate regional blocs cover the rest of the world.

NiGEM structure

- Individual country models have following features:
  - Sticky prices
  - Forward-looking economic agents
  - Taylor rule and other options for monetary policy
  - Long-run fiscal solvency
- A key feature of NiGEM is its flexibility, which allows scenarios to be developed under different policy regimes, and with rational versus adaptive expectation for consumers, firms, wage setters or financial markets



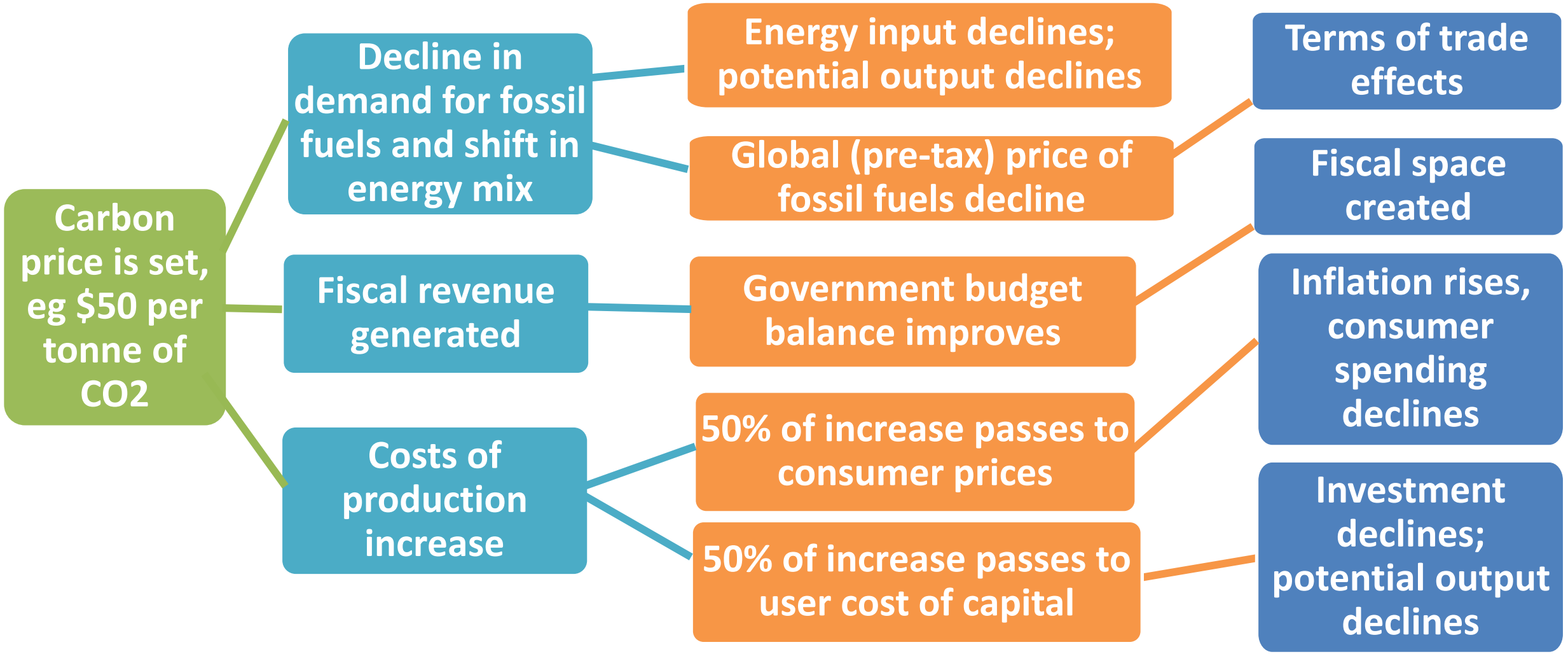
Introducing climate channels into a standard macroeconomic model

- A key challenge to understanding climate risks and preparing for the transition to a low-carbon economy is the multitude of uncertainties faced:
  - Temperature pathways?
  - Reaction of climate globally and regionally?
  - Policy pathways to support the transition?
  - Reactions of individuals (firms and households)?
  - How will investment needed to transition to a low-carbon economy be financed?
  - Will transition be “orderly” or “disorderly”?
- A well-specified global macroeconomic model may not deliver answers to all of these questions, but can act as a useful tool for understanding the macroeconomic implications of many of these areas of uncertainty

Introducing a carbon tax

- A significant reduction in carbon footprint requires (among others) a substantial increase in the share of low-carbon energy supply.
- A carbon tax is a policy instrument that can create incentives for the seismic size shift into low-carbon energy supply as well as increase in energy efficiency.
- It raises the price of high carbon-emitting activities relative to low-carbon activities, encouraging the shift towards a low-carbon economy
- We model an explicit carbon tax, but can also be interpreted as a proxy for the intensity of environmental policy.

Carbon tax channels



Country-specific impacts differ

- Energy intensity of production structure
- Carbon intensity of energy mix
- Net losses/gains in terms of trade
  - Share of domestic income derived from fossil fuel exports
  - Flexibility of the exchange rate regime
  - Capacity for structural transition towards low-carbon industry and/or domestically produced renewable energy sources
- Macroeconomic policy reaction

Modelling the terms of trade

- A country's terms of trade is determined by the revenue potential of the country's exports compared to the costs of importing desired goods and services from abroad.
- While headline GDP excludes terms-of-trade impacts, measures such as real gross domestic income (GDI) are impacted by terms of trade.
- GDI can be approximated by deflating exports and imports by the price of domestic demand, rather than their respective trade deflators:

$$GDI = DD + \frac{XV}{P^{DD}} - \frac{MV}{P^{DD}}$$

$$GDP = DD + \frac{XV}{P^{X}} - \frac{MV}{P^{M}}$$

Production function underpinning NiGEM

$$YCAP = \gamma \left\{ \left[s(K)^{-\rho} + (1-s)(Le^{\lambda t})^{-\rho} \right]^{-1/\rho} \right\}^{1-\alpha} M^{\alpha}$$

YCAP = Potential output

γ = A scaling factor, which we treat as a function of terms-of-trade

K = Productive capital stock

L = Potential labour input

λt = Labour augmenting technical progress

M = Effective energy input, adjusted for energy efficiency gains

α = The energy share of production costs

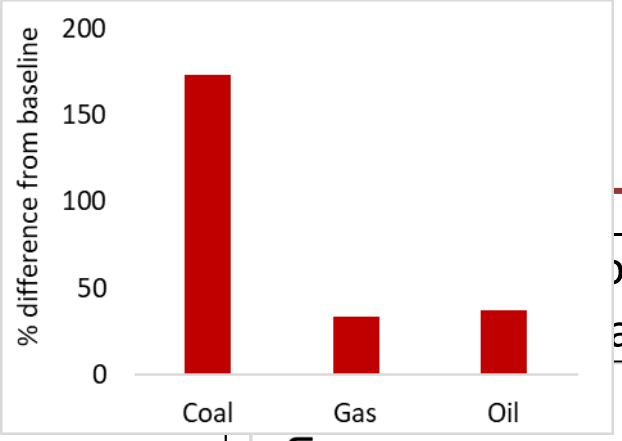
ρ = A parameter related to the elasticity of substitution between capital and labour ($\sigma = \frac{1}{1+\rho}$)

s = Scaling factor

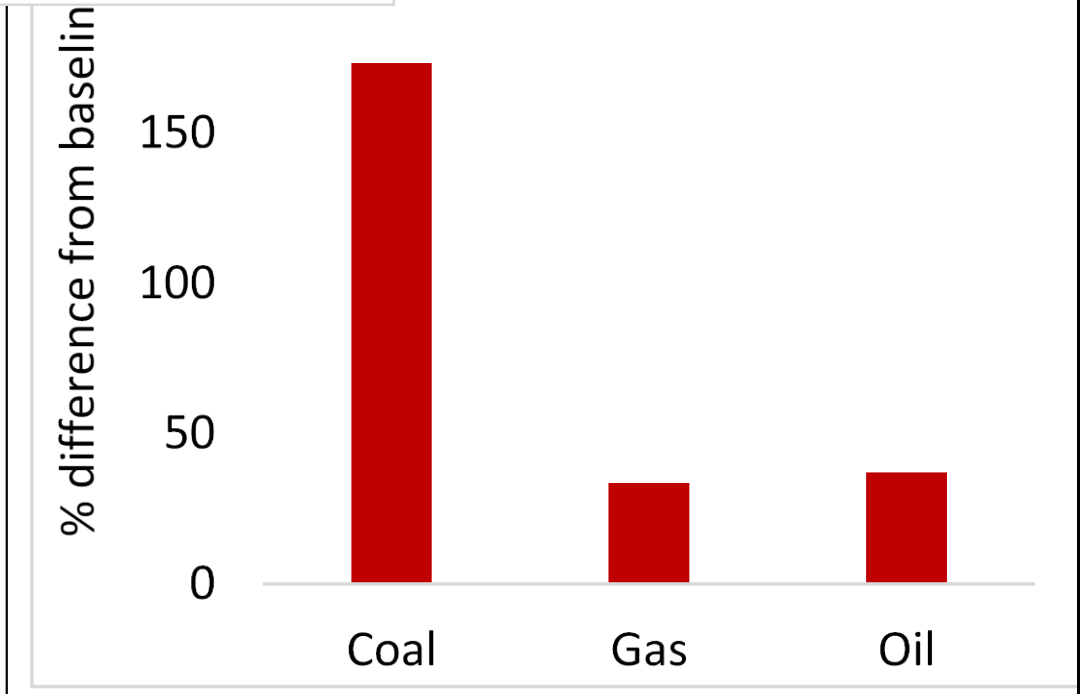
The scenarios

- Permanent $50 carbon price introduced in all countries in 2021
- Monetary policy is endogenous and follows the default 2-pillar rule in NiGEM
- Rational expectations assumed in financial markets and wage-setting behaviour
- 3 fiscal responses
  - Scenario 1: NiGEM's default solvency rule applied, so income tax rates adjust gradually to stabilize the fiscal balance
  - Scenario 2: All carbon revenue channeled into government investment
  - Scenario 3: No fiscal revenue generated

Impact of $50 carbon price

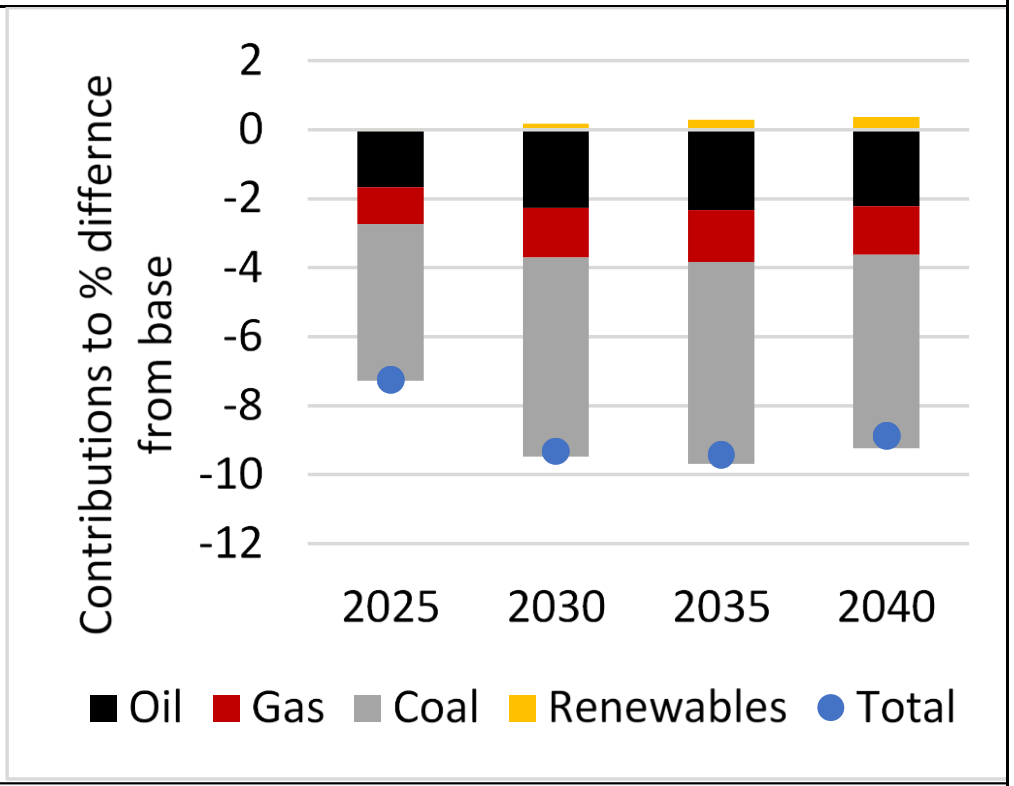


…n post-tax fossil fuel prices
…ables from $50 carbon tax



Source: NIGEM simulation

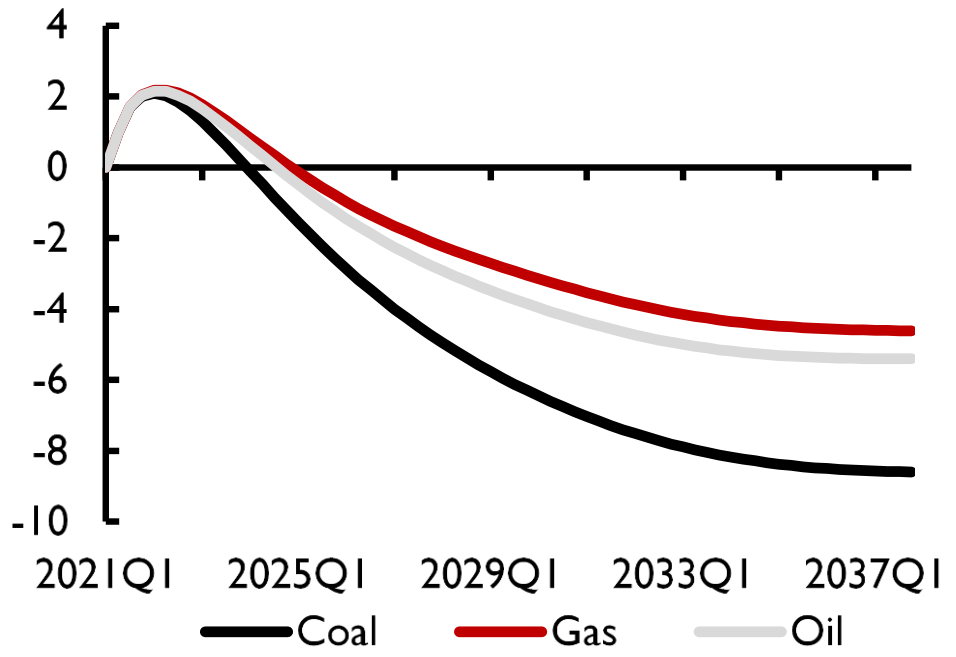
Figure 5: Impact on global energy demand of $50 carbon tax



Source: NIGEM simulation

Impact of $50 carbon price

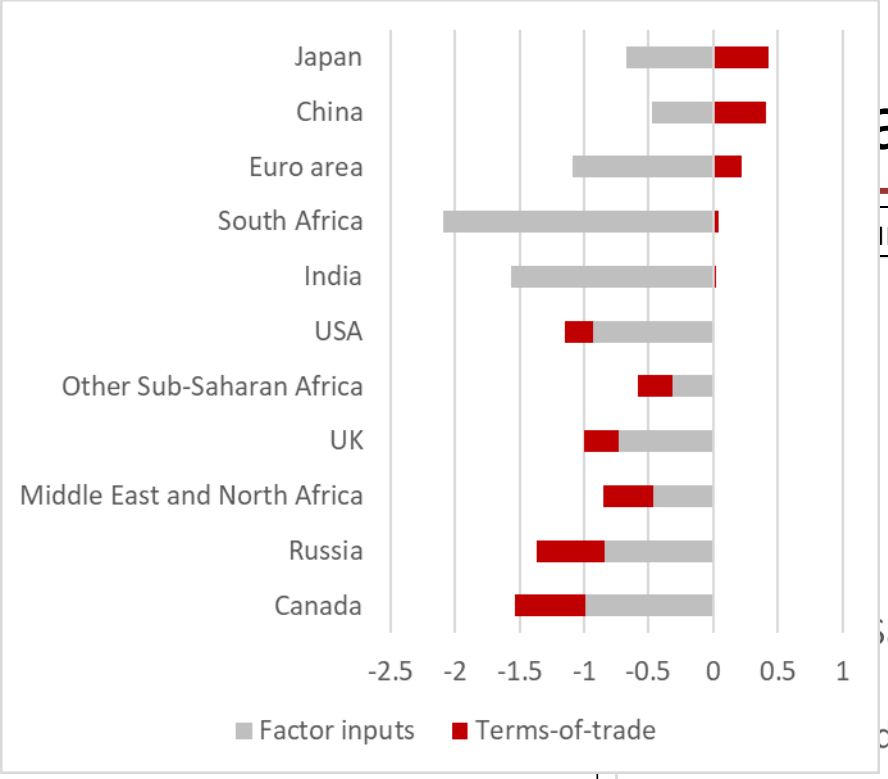
Figure 6: World price of oil, gas and coal (per barrel of oil/oil equivalent), percentage difference from base.



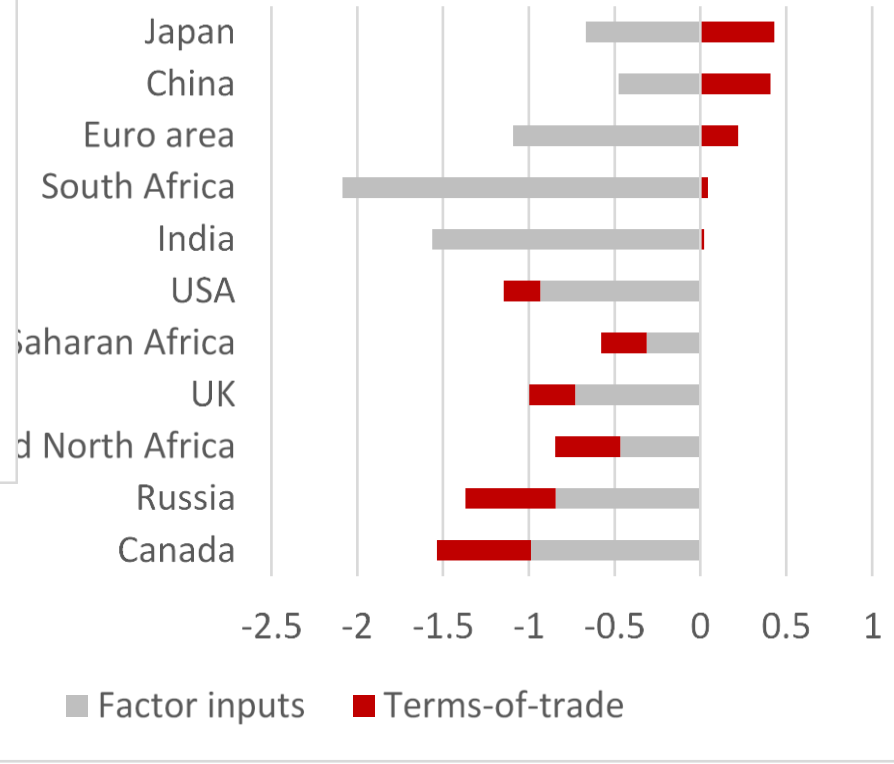
Source: NIGEM simulation

- Global (pre-tax) price of coal expected to decline by about twice the decline in the price of gas
- Reduces profitability of producing fossil fuels for export, accelerating transition
- Short-term rise may result from rise in global inflation

al output via terms of trade and other factors



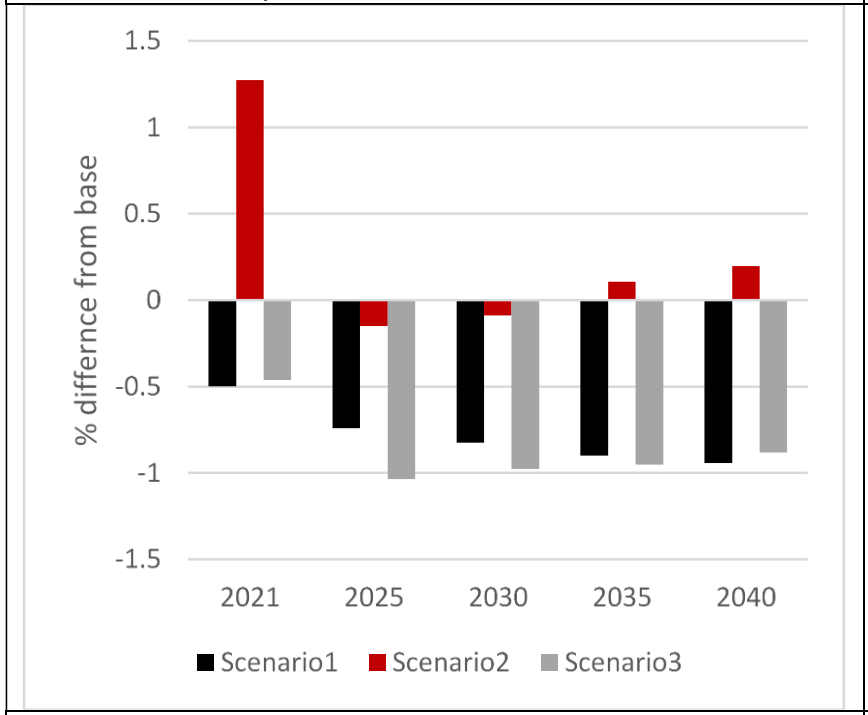
n impact on potential output of $50 carbon tax



Source: NIGEM simulation. Scenario run with NiGEM's default fiscal policy settings, with carbon revenue allowing a gradual adjustment in income taxes to maintain a stable fiscal balance.

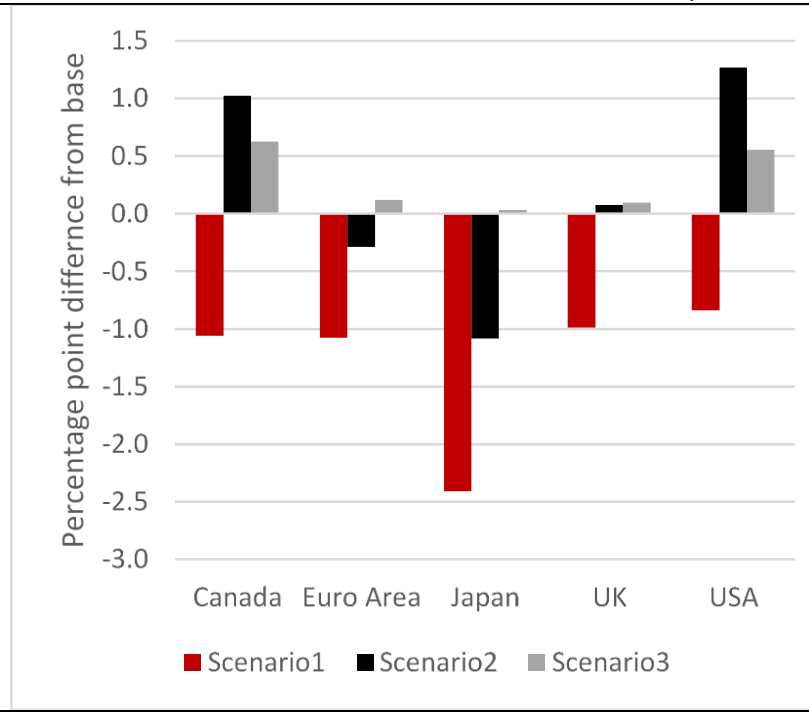
Impact of $50 carbon price

Figure 8: Impact on global GDP of $50 carbon tax under different fiscal options



Source: NIGEM simulation
Scenario 1: Gradual adjustment in income tax
Scenario 2: Carbon revenue channeled to government investment
Scenario 3: No government revenue generated

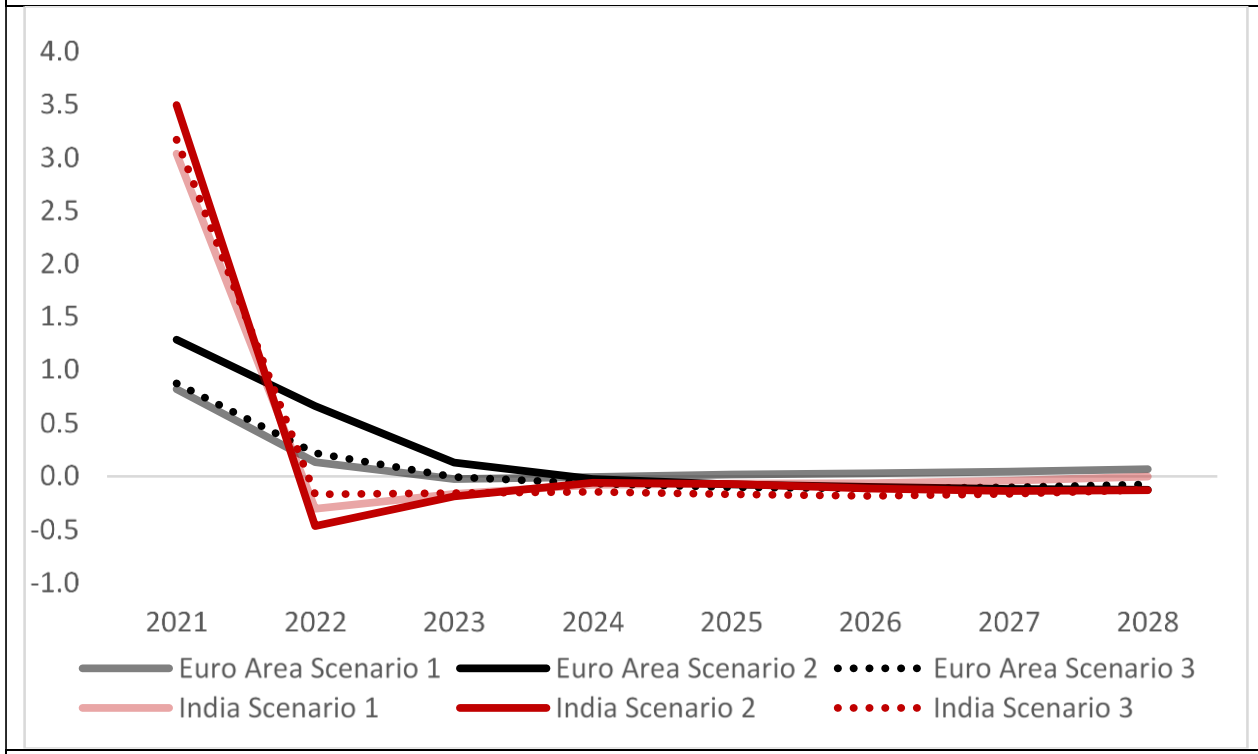
Figure 9: Impact on government debt (% of GDP) by 2040 of $50 carbon tax under different fiscal options



Source: NIGEM simulation
Scenario 1: Gradual adjustment in income tax
Scenario 2: Carbon revenue channeled to government investment
Scenario 3: No government revenue generated

Impact of $50 carbon price

Figure 10: Impact on inflation rate of $50 carbon tax under different fiscal options in the Euro Area and India



Source: NIGEM simulation
Scenario 1: Gradual adjustment in income tax
Scenario 2: Carbon revenue channeled to government investment
Scenario 3: No government revenue generated

Main conclusions

- A carbon price will have a transitory impact on inflation
- Country-specific responses will differ, depending on
  - Energy intensity of output
  - Carbon intensity of energy
  - Fossil fuel exporter vs. importer
  - How any revenue is recycled into the economy
- A policy that channels carbon revenue into investment has the potential to offset the bulk of the transition costs at the global level

Future work

- Country-specific pre-tax energy prices
- Experiment with different carbon prices across countries, with potential for BCA
- Acute and chronic physical climate impacts

THANK YOU!