The BIS Multisector Model

Introduction and application to oil supply shocks

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The views expressed are my own and not necessarily those of the BIS or its members.

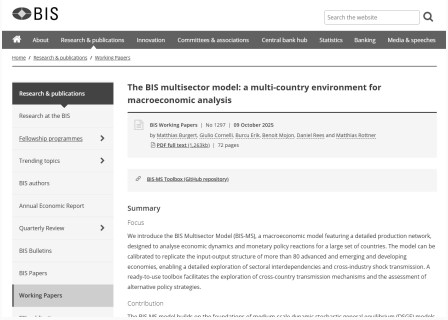
Outline

- The BIS Multisector Model
- Application: How do the effects of oil price shocks vary across countries?

BIS-MS

- Material based on

Burgert, Cornelli, Erik, Mojon, Rees and Rottner (2025). The BIS multisector model: a multi-country environment for macroeconomic analysis, BIS Working Papers 1297, `https://www.bis.org/publ/work1297.htm`



BIS-MS: Overview

- Quantitative NK model with a multisector production structure
- Calibrated using input-output tables for 18+ sectors for 80+ countries
- Impact of aggregate and sectoral shocks on economic activity and inflation
- Easily adaptable: e.g. alternative monetary policy rules
- Flexible shock design: temporary shocks and permanent structural changes
- Expectation formation mechanism: possibility of alternative expectation paths

$\Rightarrow$ Toolbox that can be easily adapted to use different countries and features

$\Rightarrow$ Small open economy extension almost ready – will use this in the application today – with additional features and a simpler toolbox.

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Model

Start off with medium-scale DSGE model à la Smets-Wouters:

- Nominal rigidities: Sticky prices and wages
- Real rigidities: Habits in consumption and investment adjustment costs
- Two agents: unconstrained and hand-to-mouth households

Combine with a multisector structure:

- On production – input-output structure
- On preferences – consumption, investment and labour supply
- Imperfect substitution in production and demand

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Input-output structure – Sectors

Standard setup aggregates detailed IO tables into 18 sectoral groups:

- OECD ICIO: (1) Agriculture, (2) Mining, (3) Oil, (4) Utilities, (5) Construction, (6) Manufacturing, (7) Wholesale and retail, (8) Transport, (9) Information, (10) Finance, (11) Real Estate, (12) Professional, (13) Administration, (14) Social services, (15) Arts, (16) Recreation, (17) Other, and (18) Government

Code easily modified for alternative IO sources ...

... or to change the number of sectors (e.g. oil application separates oil production from refining)

Input-output structure – Countries/regions

- Model can be calibrated to 80+ countries/regions in total
  - ARG, AUS, AUT, BEL, BGD, BGR, BLR, BRA, BRN, BTN, CAN, CHE, CHL, CHN, CIV, CMR, COL, CRI, CYP, CZE, DEU, DNK, EGY, ESP, EST, FIN, FJI, FRA, GBR, GRC, HKG, HRV, HUN, IDN, IND, IRL, ISL, ISR, ITA, JOR, JPN, KAZ, KGZ, KHM, KOR, LAO, LKA, LTU, LUX, LVA, MAR, MDV, MEX, MLT, MMR, MNG, MYS, NGA, NLD, NOR, NPL, NZL, PAK, PER, PHL, POL, PRT, ROU, RUS, SAU, SEN, SGP, SVK, SVN, SWE, THA, TUN, TUR, TWN, UKR, USA, VNM, ZAF, euro area

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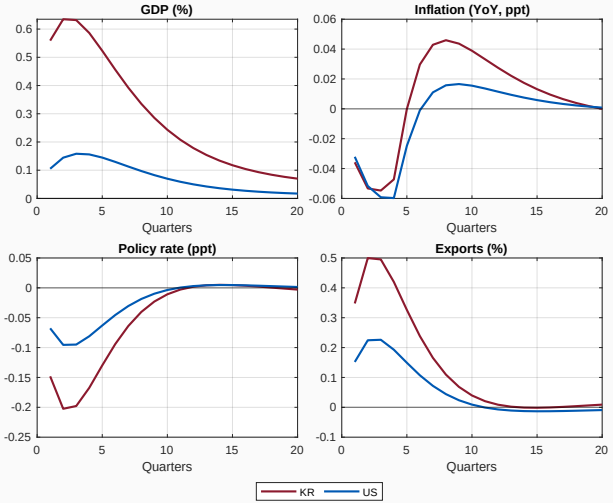
Industrial structure matters

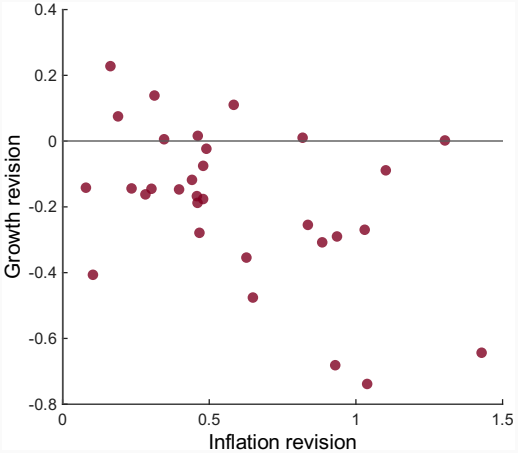


Application: Oil supply shocks

Motivation

- Revision to Consensus Forecasts: Feb to April 2026
- Generally (not always) $\downarrow$ for growth and $\uparrow$ for inflation.
- Large cross-country heterogeneity.

Consensus Forecast Revisions: Feb – Apr 2026



Research Questions

- How do the effects of oil supply shocks on inflation and output differ across countries?
- What explains these differences?
  - industrial structure (incl. oil intensity);
  - oil's weight in the consumption basket;
  - net oil importer versus net oil exporter status;
- What does this mean for monetary policy?

Approach

- Multi-sector open economy New Keynesian DSGE model.
- Calibrated to match input-output tables and industry structure of demand and employment for 17 industries across 41 countries.
- Simulate the effects of an oil supply shock under different monetary policy rules.

Research Answers

- How do the effects of oil supply shocks on inflation and output differ across countries? Substantially
- What explains these differences?
  - industrial structure (incl. oil intensity); Yes, especially for output.
  - oil's weight in the consumption basket; Yes, but indirect exposure also matters.
  - net oil importer versus net oil exporter status; Yes - trade-offs are smaller for oil exporters.
- What does this mean for monetary policy? The inflation-output trade-off is country-specific; strict stabilisation can be costly.

Roadmap

- Build intuition with a smaller model.
- Present the full model and calibration.
- Show results and inspect mechanisms.
- Assess alternative monetary policy rules.

Intuition: A smaller model

To build intuition, start with a two-sector small open economy model.

- Three goods: a foreign produced good, a domestically produced good and oil.
- Oil is a factor of production and consumed directly. It is homogenous and can be traded internationally.
- Flexible prices, pre-determined wages.
- Financial autarky - trade balance holds each period.
- Complete exchange rate pass-through.

This model captures key mechanisms while remaining tractable for analysis and diagrammatic representation.

Environment

At t = 0

- The domestic nominal wage is predetermined and normalised to $W_0 = 1$.
- All prices are flexible.
- World experiences an oil supply shock that raises the foreign relative price of oil.

At t = 1.

- Oil supply shock resolved, all prices and wages are flexible.
- World returns to initial equilibrium.

=> Can limit attention to t = 0

Foreign Economy

Key foreign variables (exogenous for small economy):

- foreign output Y_0^*;
- foreign oil price $P_{O,0}^*$;
- foreign good price $P_{F,0}^*$.

Assumption: Foreign central bank stabilises non-oil components of prices (normalised to 1):

$$P_{F,0}^* = (P_{O,0}^*)^{\alpha^*}.$$

where α^* is the share of oil in foreign production.

Domestic Economy: Production

Domestic oil endowment: $Y_{O,0}$

Domestic firms produce non-oil goods using labour and oil:

$$\underbrace{Y_{D,0}}_{\substack{\text{domestic}\\ \text{output}}} = \underbrace{\left(\frac{M_{D,0}}{\alpha}\right)^{\alpha}}_{\substack{\text{oil}\\ \text{demand}}} \underbrace{\left(\frac{N_{D,0}}{1-\alpha}\right)^{1-\alpha}}_{\substack{\text{labour}\\ \text{demand}}}$$

Domestic non-oil good price index (recall $W_0 = 1$):

$$P_{D,0} = P_{O,0}^{\alpha} = \left(e_0 P_{O,0}^{*}\right)^{\alpha}.$$

Domestic Economy: Consumption

Consumption aggregator:

$$\underbrace{C_0}_{\substack{\text{aggregate}\\ \text{consumption}}} = \underbrace{\left(\frac{C_{O,0}}{\omega_O}\right)^{\omega_O}}_{\substack{\text{oil}\\ \text{consumption}}} \underbrace{\left(\frac{C_{D,0}}{\omega_D}\right)^{\omega_D}}_{\substack{\text{domestic-good}\\ \text{consumption}}} \underbrace{\left(\frac{C_{F,0}}{\omega_F}\right)^{\omega_F}}_{\substack{\text{foreign-good}\\ \text{consumption}}}$$

Consumer price index:

$$\begin{aligned} P_{C,0} &= P_{O,0}^{\omega_O} P_{D,0}^{\omega_D} P_{F,0}^{\omega_F} \\ &= e_0^{\omega_O+\omega_D\alpha+\omega_F} (P_{O,0}^*)^{\omega_O+\omega_D\alpha+\omega_F\alpha^*}. \end{aligned}$$

- Blue: Direct effects of oil prices
- Orange: Indirect effects

Domestic Economy: Trade and market clearing

Net oil exports:

$$NX_{O,0} = Y_{O,0} - C_{O,0} - M_{D,0}.$$

Foreign demand for domestic exports:

$$X_{D,0} = \eta Y_0^* p_{D,0}^{-1}.$$

Domestic good market clearing:

$$Y_{D,0} = C_{D,0} + X_{D,0}.$$

Trade balance is implied by market clearing and the household budget constraint:

$$P_{D,0}X_{D,0} + P_{O,0}NX_{O,0} = P_{F,0}C_{F,0}.$$

Monetary policy

Model closure

- No asset trade
- No role for interest rates
- Central bank chooses the nominal exchange rate e_0

Transmission through the exchange rate

- Relative prices: real wage and domestic-good price
- Quantities: domestic consumption and export demand
- Inflation: oil, foreign-good, domestic-good and consumer prices

Monetary Policy Closure: Three examples

Consider three alternative monetary policy rules:

- Labour market clearing: $N_{D,0}(e_0) = N_{S,0}(e_0)$.
- CPI stabilisation: $P_{C,0} = 1$.
- Non-oil CPI stabilisation: $P_{NO,0} = 1$.

Each closure implies a different exchange-rate response to the oil shock and thus different output and inflation outcomes.

Monetary Policy Closure 1: Labour market clearing

If wages were flexible $\rightarrow$ labour demand $=$ labour supply.

But nominal wage is fixed at $W_0 = 1 \rightarrow$ employment is demand-determined $\rightarrow$ $N_{D,0} \neq N_{S,0}$ except for one specific e_0.

The central bank chooses e_0^N so that:

$$N_{D,0}(e_0^N) = N_{S,0}(e_0^N).$$

Interpretation:

- Replicates flexible price / wage allocation;
- Employment is at its efficient level (may still be affected by oil shocks);
- CPI inflation may move substantially.

Monetary Policy Closure 2: CPI Stabilisation

The central bank chooses e_0 to stabilise headline CPI:

$$P_{C,0} = 1.$$

Since

$$P_{C,0} = e_0^{\omega_O+\omega_D\alpha+\omega_F}(P^*_{O,0})^{\omega_O+\omega_D\alpha+\omega_F\alpha^*},$$

the policy rule is

$$\boxed{e_0^C = (P^*_{O,0})^{-\frac{\omega_O+\omega_D\alpha+\omega_F\alpha^*}{\omega_O+\omega_D\alpha+\omega_F}}.}$$

Exchange rate appreciates to offset the direct effect of higher oil prices and spillovers to foreign prices.

Monetary Policy Closure 3: Non-Oil CPI Stabilisation

Define the non-oil CPI:

$$P_{NO,0} = P_{D,0}^{\frac{\omega_D}{1-\omega_O}} P_{F,0}^{\frac{\omega_F}{1-\omega_O}}.$$

The central bank chooses e_0 so that:

$$P_{NO,0} = 1.$$

The policy rule is:

$$e_0^{NO} = \left(P_{O,0}^*\right)^{-\frac{\omega_D \alpha + \omega_F \alpha^*}{\omega_D \alpha + \omega_F}}.$$

This blocks second-round non-oil price effects, but not direct oil inflation.

How do oil prices affect the economy?

Oil price changes affect the small economy in several ways:

- Mechanism 1: Relative oil intensity of production;
- Mechanism 2: Weight of oil in consumption;
- Mechanism 3: Oil exporter / importer;
- Mechanism 4: Foreign demand.

Mechanism 1: Relative oil intensity of production

Domestic-good price relative to the foreign-good price:

$$\frac{P_{D,0}}{P_{F,0}} = e_0^{-(1-\alpha)} (P^*_{O,0})^{\alpha-\alpha^*}.$$

- If $\alpha > \alpha^*$, domestic production is relatively oil-intensive.
- Higher oil prices raise the domestic-good price relative to the foreign-good price, $\frac{P_{D,0}}{P_{F,0}}$, for a given exchange rate.
- This raises domestic producer-price pressure and lowers export demand.

Mechanism 2: Oil in Consumption

Recall Consumer Price Index:

$$P_{C,0} = P_{O,0}^{\omega_O} P_{D,0}^{\omega_D} P_{F,0}^{\omega_F}.$$

A larger ω_O means:

- stronger direct effect of oil prices on CPI;
- larger gap between headline CPI and non-oil CPI stabilisation;
- harder output-inflation trade-off after oil shocks.

Mechanism 3: Oil exporter / importer

- Net oil exporter: higher oil prices raise external purchasing power.
- Net oil importer: higher oil prices absorb resources and weaken real income.
- This affects output and the exchange-rate movement needed under labour-market clearing.

Mechanism 4: Foreign Demand

Assume foreign income falls when oil prices rise:

$$\frac{d \log Y_0^*}{d \log P_{O,0}^*} < 0.$$

- Falling Y_0^* shifts export demand down.
- This lowers domestic output through goods-market clearing.
- Under labour-market clearing, weaker labour demand may require depreciation, increasing inflation pressure.

Inspecting the mechanisms: A diagramatic representation

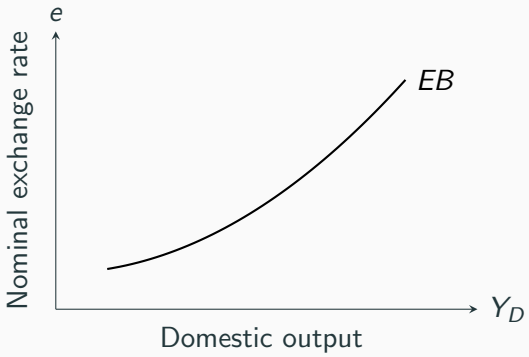
To understand the mechanisms, map the model into a modified Salter-Swan Diagram.

For given exogenous variables and parameters, define:

- External balance curve (EB): combinations of $Y_{D,0}$ and e_0 that satisfy the trade balance condition.
- Internal balance curve (IB): combinations of $Y_{D,0}$ and e_0 that satisfy the labour market clearing condition.
- Consumer price stability curve (P_C): value of e_0 that stabilises the CPI.
- Non-oil consumer price stability curve (P_{NO}): value of e_0 that stabilises the non-oil CPI.

Note: Equilibrium is at the intersection of EB and IB only under the labour market clearing policy rule.

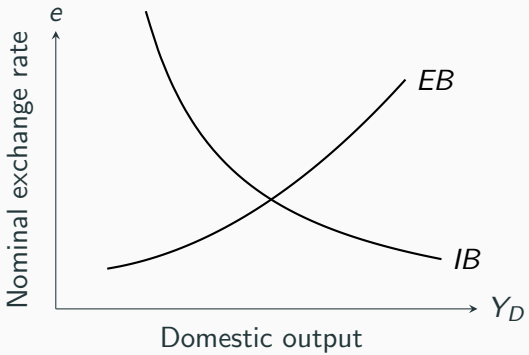
A Salter-Swan View of the Model



External balance

The *EB* curve slopes up - weaker exchange rate requires higher domestic output to maintain external balance.

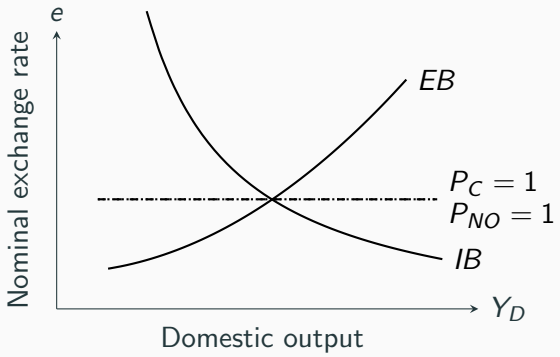
A Salter-Swan View of the Model



Internal balance

The *IB* curve slopes down - higher domestic output raises labour demand, requiring a stronger exchange rate (higher real wage) to clear the labour market.

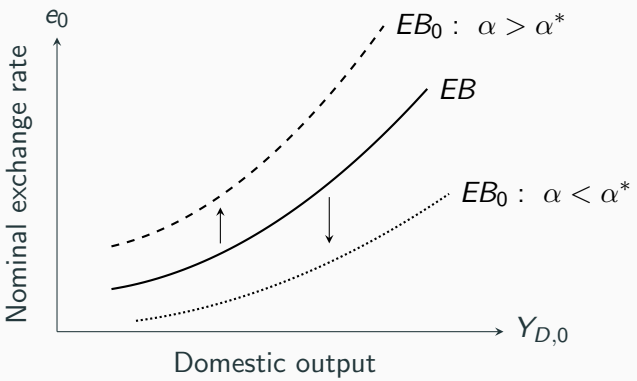
A Salter-Swan View of the Model



Price stability

With fixed nominal wage, $P_C = 1$ and $P_{NO} = 1$ do not depend on domestic output. Assume at initial equilibrium they align with intersection of EB and IB.

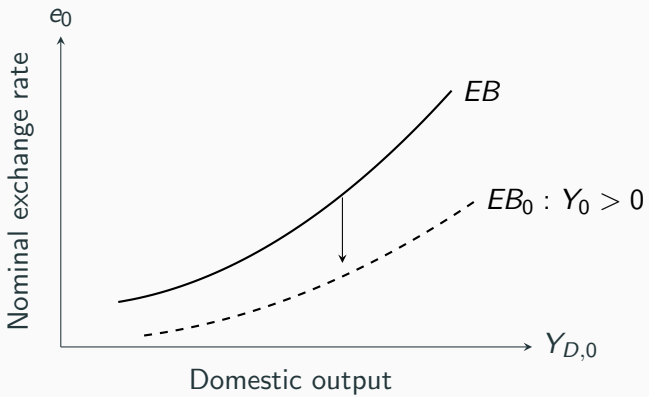
Oil Price Rise: External balance



Relative oil intensity

When $\alpha > \alpha^*$, the domestic economy is more oil-intensive. Higher oil prices raise domestic costs and reduce competitiveness, shifting the *EB* curve up and left.

Oil Price Rise: External balance

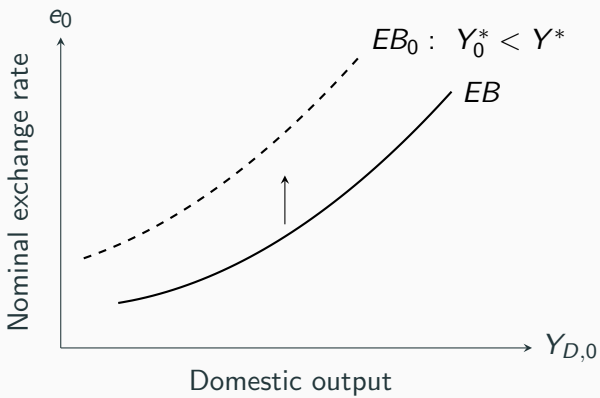


Oil revenue channel

With positive oil output, a higher oil price raises oil revenues.

External balance can then be achieved with a stronger exchange rate for given domestic output.

Oil Price Rise: External balance

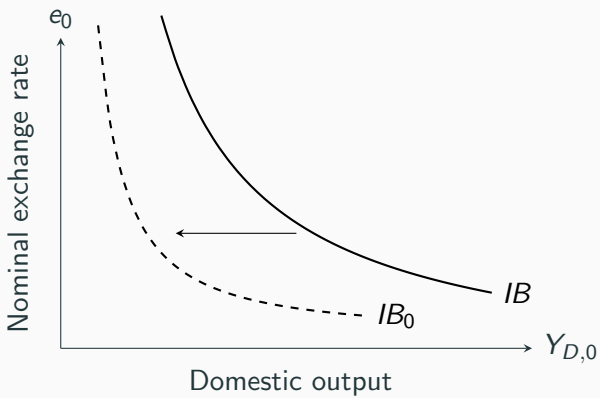


Foreign demand

Lower foreign demand reduces export demand.

For a given exchange rate, domestic output must be lower to maintain external balance.

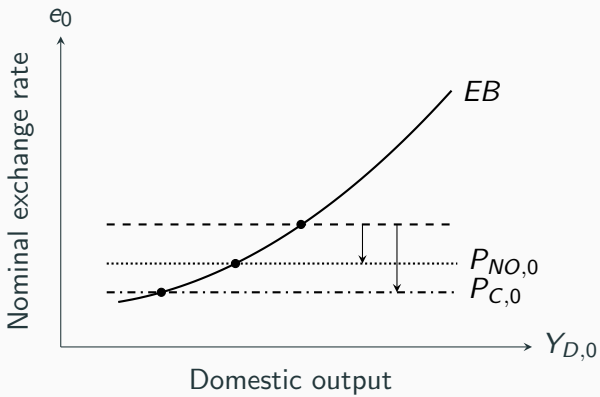
Oil Price Rise: Internal balance



For given exchange rate, higher oil prices lower real wages and so labour supply. Output must fall to equate labour supply and demand.

For given output, labour demand rises. Stronger exchange rate required to raise labour supply.

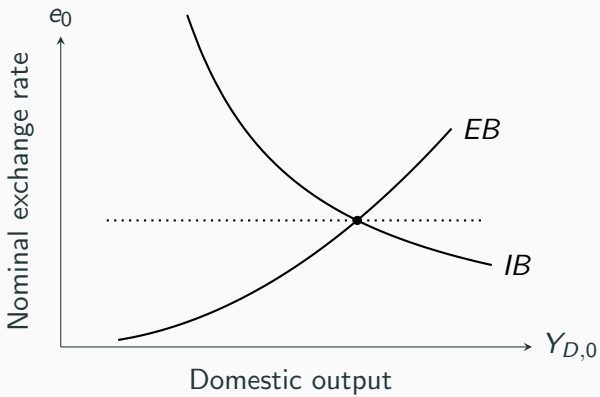
Oil Price Rise: Price stability



Headline CPI stabilisation calls for tighter policy than non-oil stabilisation.

$P_{C,0}$ lies below $P_{NO,0}$. Gap depends largely on oil share in consumption (+) and oil intensity in production (-).

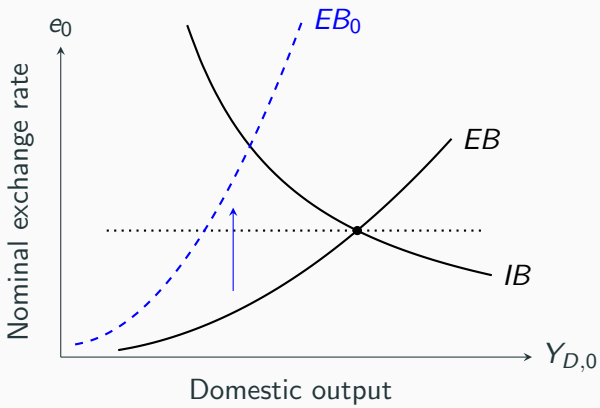
Example: Oil intensive net oil importer



Oil intensive importer

Initial equilibrium is at the intersection of EB, IB, and the initial price-stability line.

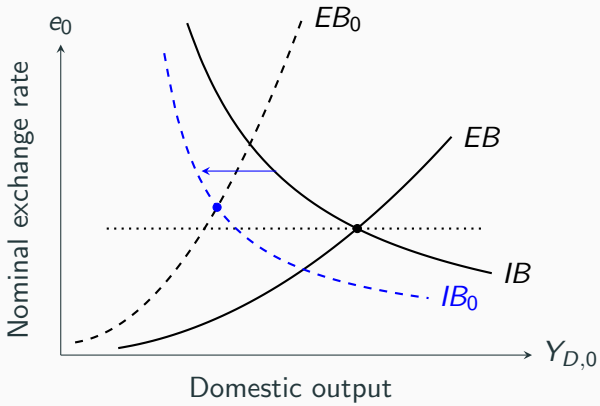
Example: Oil intensive net oil importer



Oil intensive importer

Higher oil prices worsen external balance, shifting *EB* up.

Example: Oil intensive net oil importer

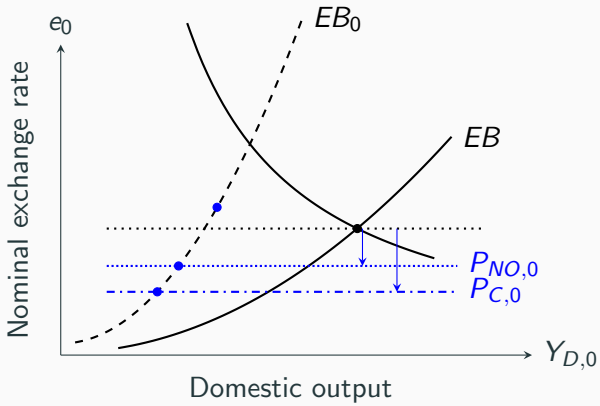


Oil intensive importer

Internal balance shifts left as labour-market-clearing output falls.

Labour market clearing exchange rate may appreciate or depreciate.

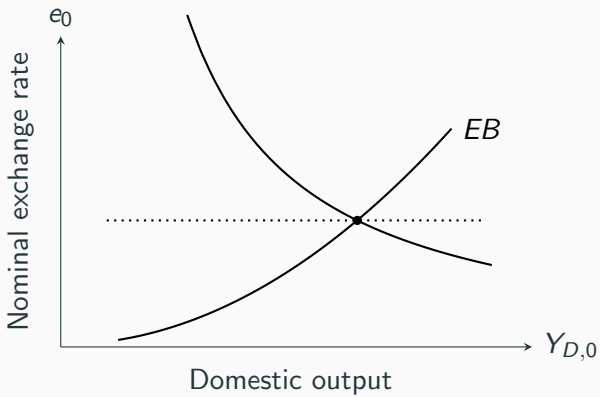
Example: Oil intensive net oil importer



Oil intensive importer

Price stability requires stronger exchange-rate line (i.e. tighter monetary policy), with $P_{C,0}$ below $P_{NO,0}$. Output gap stabilisation may call for weaker exchange rate.

Example: Oil non-intensive net oil exporter



Non-intensive exporter

Initial equilibrium is at the intersection of EB, IB, and the initial price-stability line.

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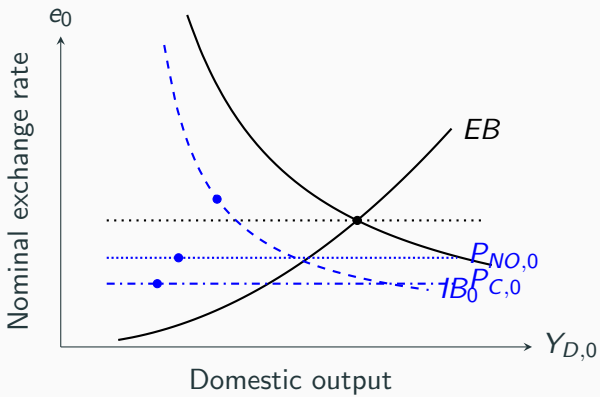
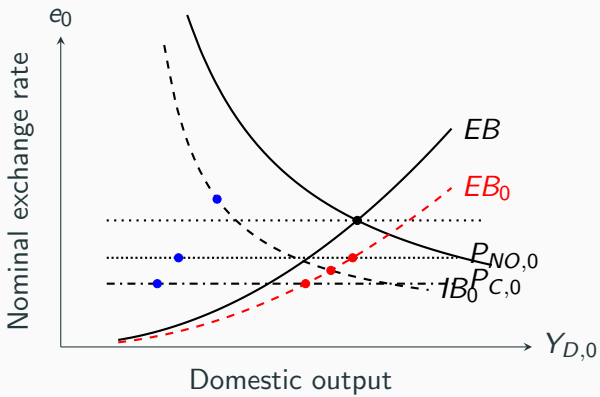


Non-intensive exporter

The internal-balance and price-stability movements are directionally as before.

Example: Oil non-intensive net oil exporter



Non-intensive exporter

Oil-export revenues improve external balance, shifting EB down.

Trade-off between inflation and output stabilisation smaller than for oil importers.

Key takeaways from the small model

Oil shocks are most stagflationary when:

- domestic production is oil-intensive;
- oil has a large weight in the consumption basket;
- the economy is a net oil importer;
- foreign demand falls sharply;

Oil shocks create trade-offs for monetary policy

- These are more severe for oil importers

Full model

We now move to the full model. Core mechanisms remain:

- Mechanism 1: Relative oil intensity => maps into IO production structure
- Mechanism 2: Weight of oil in consumption => maps into consumption basket shares
- Mechanism 3: Net oil position => maps into oil production / consumption
- Mechanism 4: Foreign demand => maps into external demand spillovers

But it features: Empirical industry structure, sticky prices, international asset trade, monetary policy etc.

- Intertemporal consumption smoothing
- Monetary policy works through demand as well as exchange rate

Input-output structure

Calibrate to input-output tables for 41 countries.

Industries: Agriculture, Mining, Oil production, Oil refining, Manufacturing, Utilities, Construction, Trade, Transport, Information services, Financial services, Real estate services, Professional services, Administrative services, Government services, Social services, Recreation services.

The oil industry in the model

	Oil (I)	Manufact. (II)	Services (III)	Total (I)+(II)+(III)	C (IV)	I (V)	G (VI)	Final Demand (IV) + (V)+ (VI)	Gross Output
Oil (A)	10	5	3	18	20	5	5	30	48
Manufact. (B)	4	8	6	18	25	6	6	37	55
Services (C)	7	6	9	22	31	7	7	45	67
Total Int. (A) + (B) + (C)	*21*	*19*	*18*	*58*					
Wages (D)	18	24	33						
Capital Returns (E)	9	12	16						
Value Added (D) + (E)	*27*	*36*	*49*	*112*					
Total	**48**	**55**	**67**		**76**	**18**	**18**		**170**

- Stylised input-output structure with three industries
- Rows: Use of industry output
- Columns: Production requirements

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- Oil is an input into production of other industries
- Low substitution possibilities between oil and other inputs (e.g. intermediates, capital, labour)
- Higher oil prices raise production costs for other industries

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Total	**48**	**55**	**67**		**76**	**18**	**18**		**170**

- Oil is a component of final demand (impacts CPI directly)
- Oil is also imported and/or exported (not shown)

The oil industry in the model

	Oil (I)	Manufact. (II)	Services (III)	Total (I)+(II)+(III)	C (IV)	I (V)	G (VI)	Final Demand (IV) + (V)+ (VI)	Gross Output
Oil (A)	10	5	3	18	20	5	5	30	48
Manufact. (B)	4	8	6	18	25	6	6	37	55
Services (C)	7	6	9	22	31	7	7	45	67
Total Int. (A) + (B) + (C)	*21*	*19*	*18*	*58*					
Wages (D)	18	24	33						
Capital Returns (E)	9	12	16						
Value Added (D) + (E)	*27*	*36*	*49*	*112*					
Total	**48**	**55**	**67**		**76**	**18**	**18**		**170**

- Oil is a produced good - but largely price inelastic in the short run

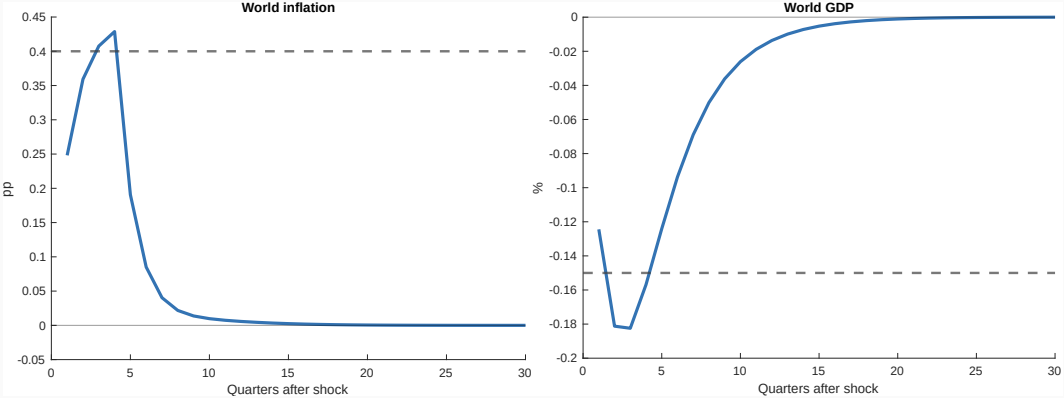
Parameterisation

- Model is calibrated to country-specific input-output tables and national accounts data.
- Other parameters based on the literature
- To do: use empirical estimates of responses to oil price shocks to discipline key parameters

Assumption: All countries follow the same monetary policy rule.

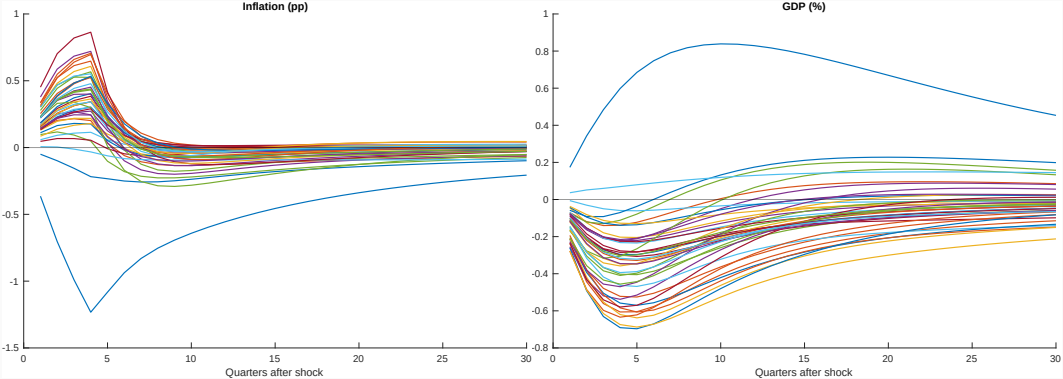
Oil price shock: Global variables

Consider a 10% temporary increase in the world oil price.

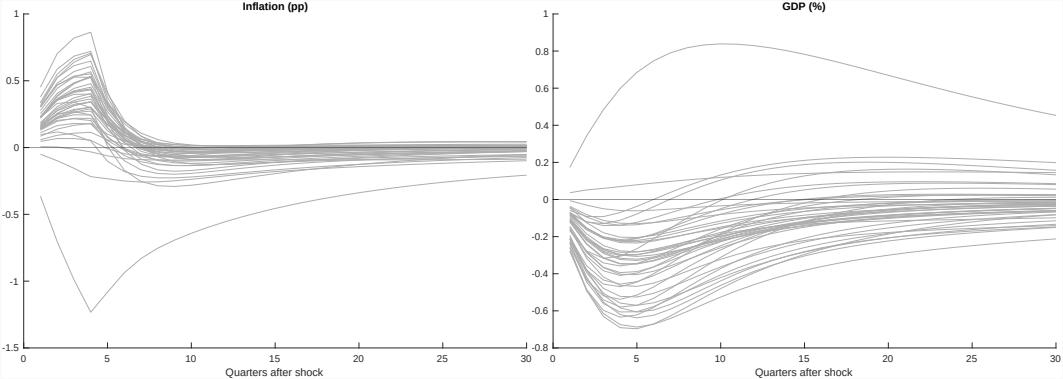


Dashed lines show IMF WEO elasticities.

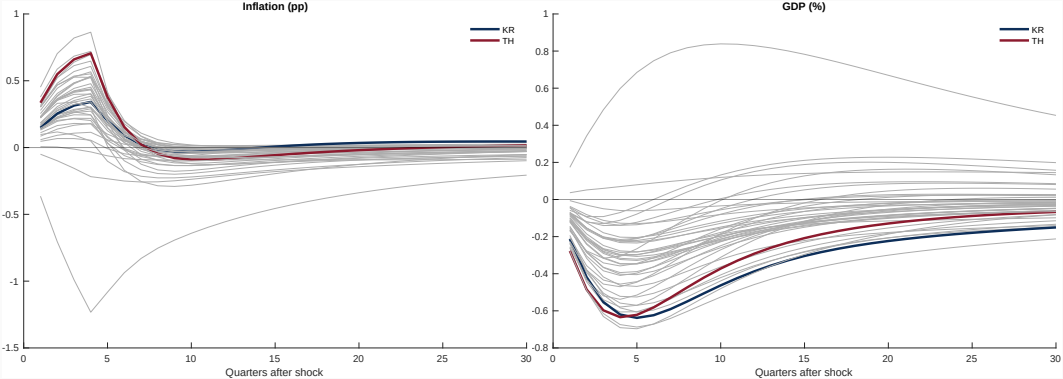
Oil price shock: Inflation and output



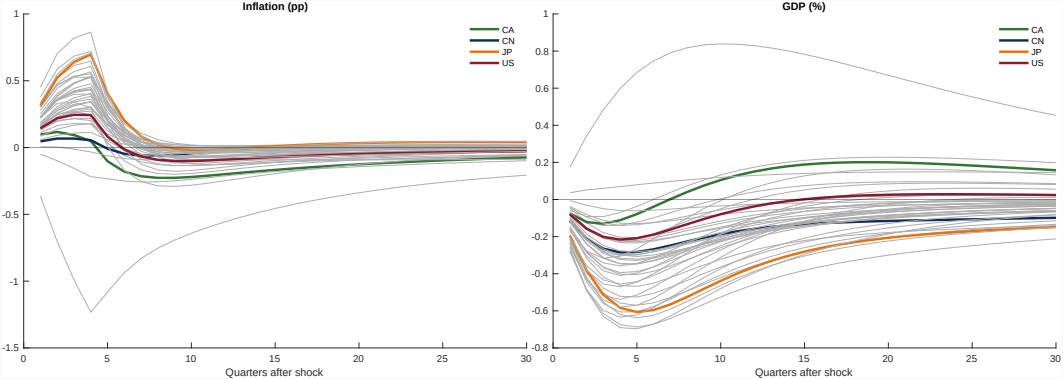
Oil price shock: Inflation and output



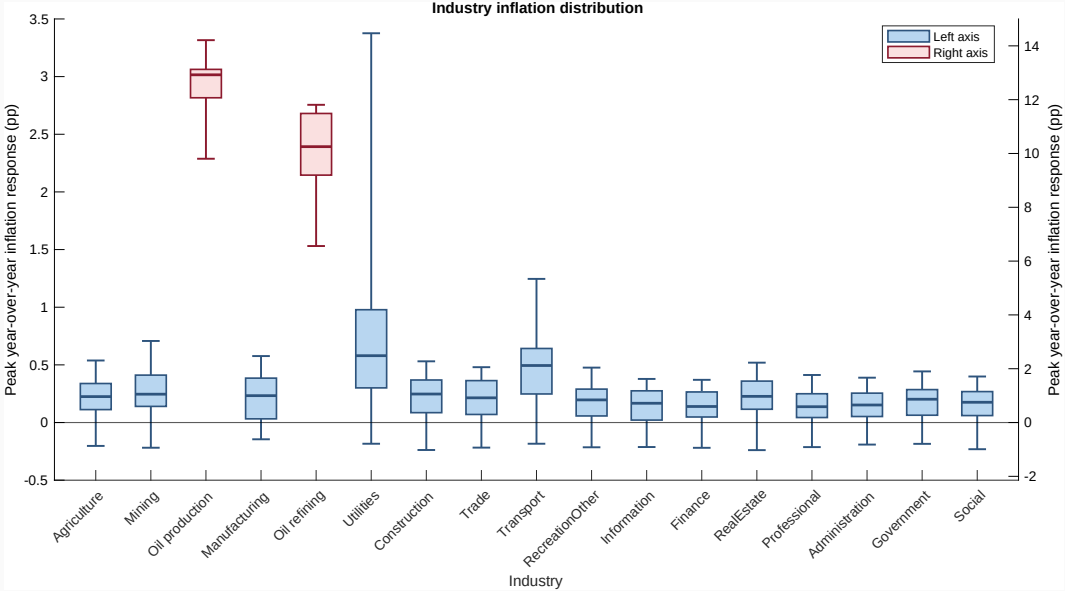
Oil price shock: Inflation and output



Oil price shock: Inflation and output



Oil price shock: Industry price growth



Inspecting the mechanisms

What could drive the cross-country differences?

Consider four candidates:

1. Share of oil products in consumption;
2. Oil intensity of domestic consumption;
3. Oil intensity of domestic economic activity;
4. Oil exporter / importer status.

Inspecting the mechanisms

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Inspecting the mechanisms: Oil intensity of consumption

Consumption-weighted Hulten-Acemoglu influence weight:

$$\lambda_i^C = \sum_j \Omega_j^C L_{j,i}$$

where Ω_j^C is the share of industry j in consumption and $L_{j,i}$ is the Leontief inverse element for industry j and oil production i.

- Captures the direct and indirect oil intensity of consumption;

Inspecting the mechanisms: Oil intensity of domestic economic activity

Final demand-weighted Hulten-Acemoglu influence weight:

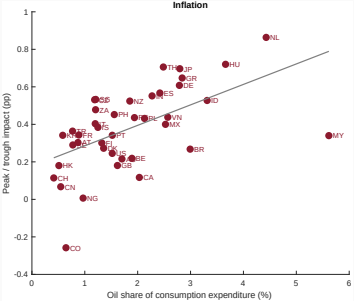
$$\lambda_i^{FD} = \sum_j \Omega_j^{FD} L_{j,i}$$

where Ω_j^{FD} is the share of industry j in final demand and $L_{j,i}$ is the Leontief inverse element for industry j and oil production i.

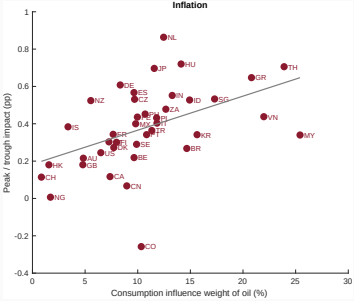
- Captures the direct and indirect oil intensity of domestic economic activity;

Inspecting the mechanisms: Inflation

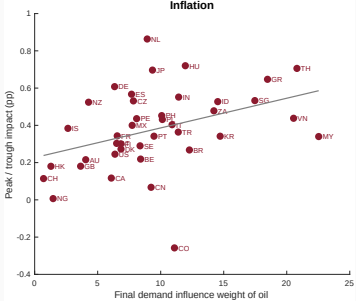
Consumption weight



Consumption influence weight



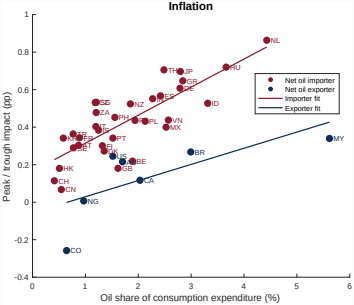
DFD influence weight



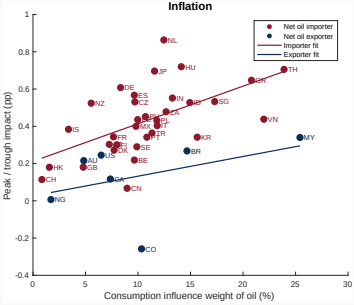
- Direct oil intensity of consumption explains much of CPI inflation impact.

Inspecting the mechanisms: Inflation

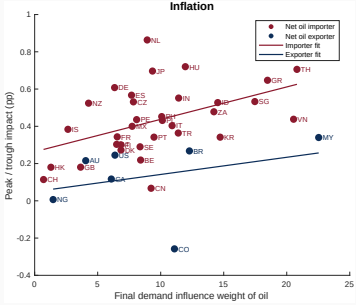
Consumption weight



Consumption influence weight



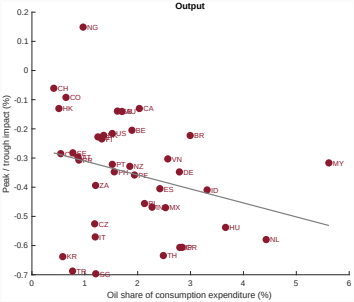
DFD influence weight



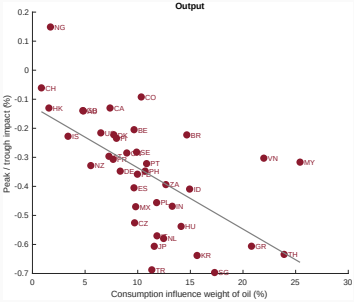
- Particularly when you separate net oil exporters and importers.

Inspecting the mechanisms: Output

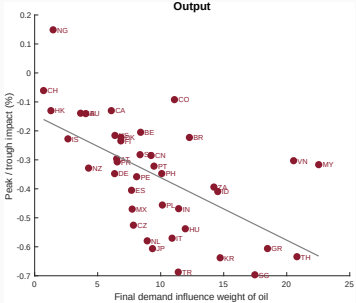
Consumption weight



Consumption influence weight



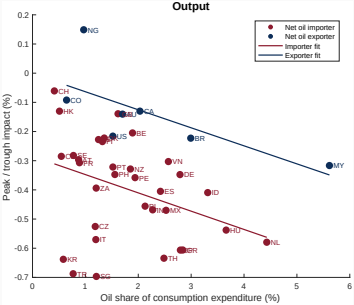
DFD influence weight



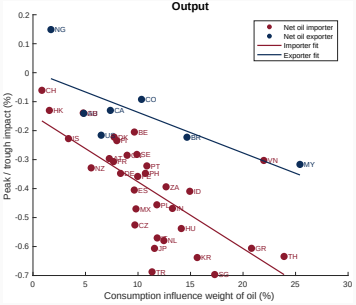
- Oil use through the entire production network matters more than direct consumption.

Inspecting the mechanisms: Output

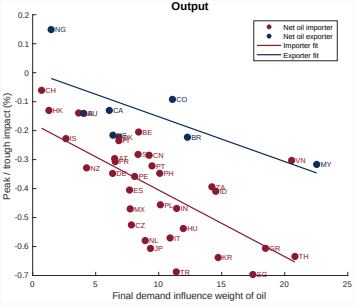
Consumption weight



Consumption influence weight



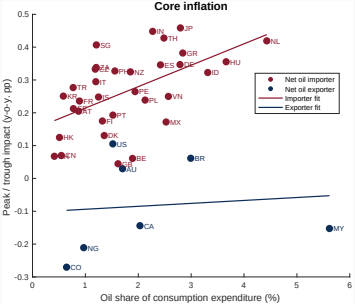
DFD influence weight



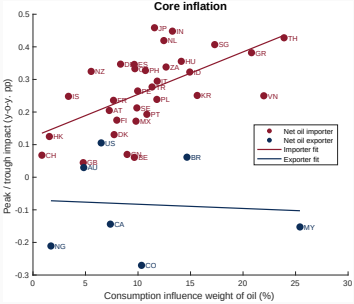
- Relationship again stronger when controlling for net export status.

Inspecting the mechanisms: Core inflation

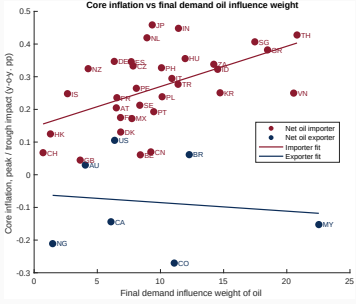
Consumption weight



Consumption influence weight



DFD influence weight

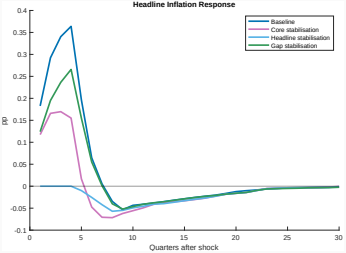


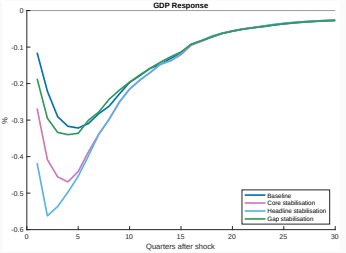
Alternative monetary policy: Stabilisation rules

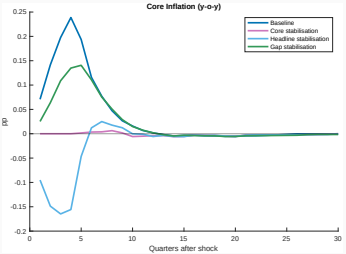
Consider three alternative monetary policy rules:

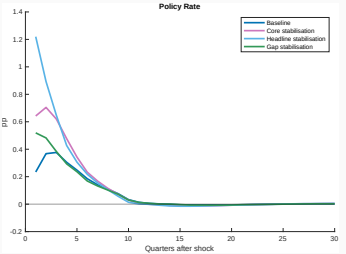
1. Headline inflation stabilisation
2. Core inflation stabilisation
3. Output gap stabilisation

Alternative monetary policy: Cross country medians

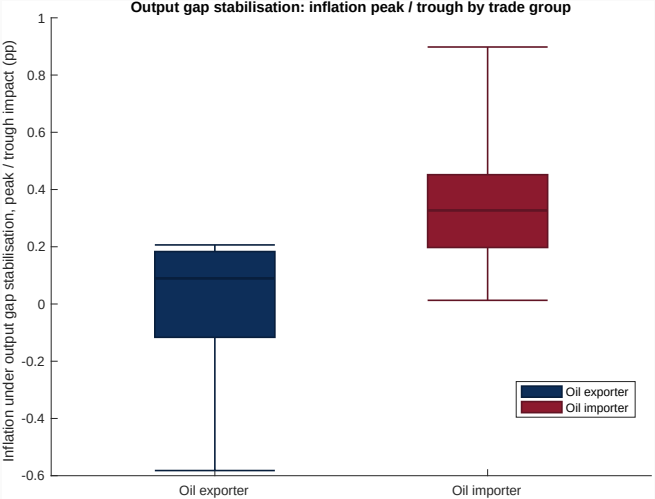




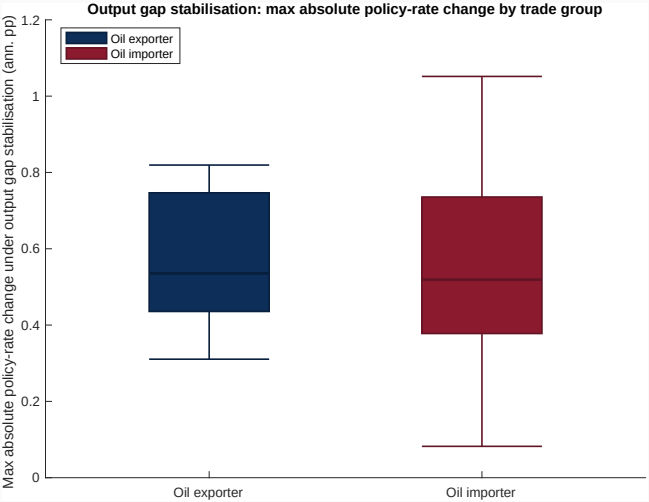




Inflation cost of gap stabilisation lower in oil exporters

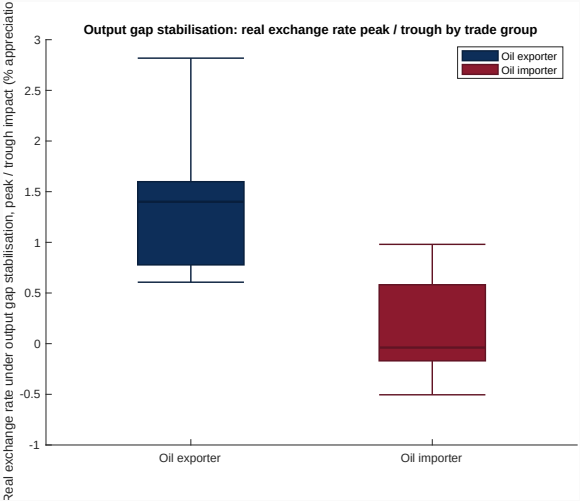


Policy rate response similar in importers and exporters



Real exchange rate response

Appreciation



Intuition

Temporary oil price rise has two effects:

- Intertemporal substitution:
  - Potential output falls everywhere **if** oil supply response is small
  - Households seek to smooth consumption
- Income: Transfer from oil importers to exporters

Interest and exchange rates affect different adjustment margins:

- Interest rate: Intertemporal substitution $=>$ similar across countries
- Exchange rate: Adjusts for income to stabilise net foreign assets over time

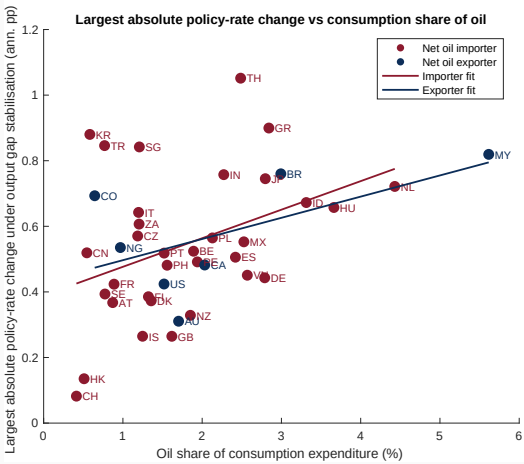
Conclusion

- Use calibrated multi-industry DSGE model to quantify effects of oil price shocks within and across countries
- Industry structure and oil intensity of activity influence the size of the effects *and* monetary policy trade-offs
- In most cases, stabilising the output gap calls for some spillover to non-oil inflation

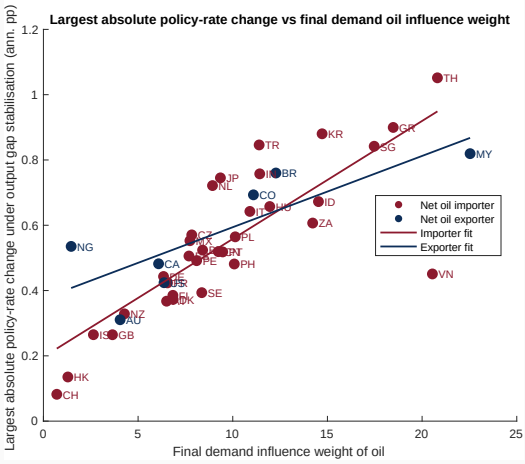
Annex

Policy rate

Consumption weight

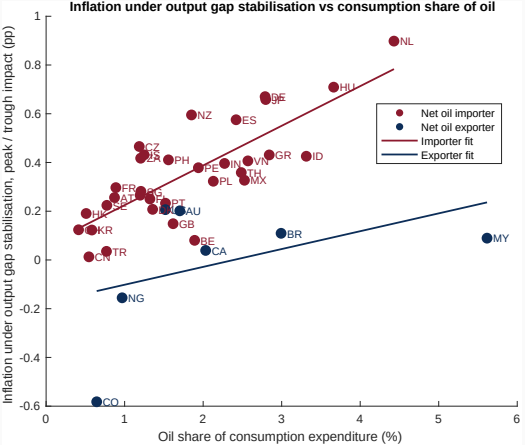


DFD influence weight

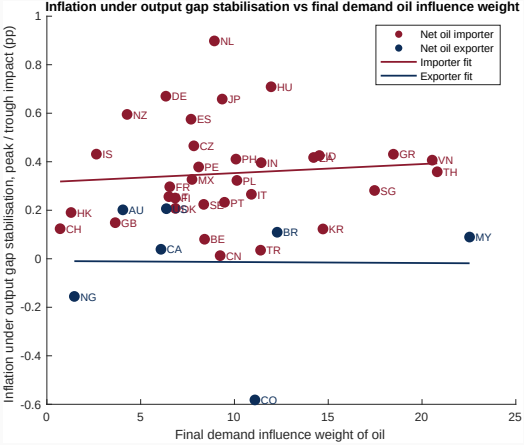


Inflation

Consumption weight

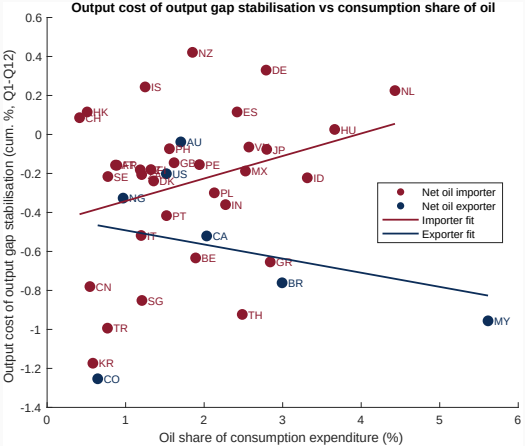


DFD influence weight



Output

Consumption weight



DFD influence weight