Increased households energy efficiency: can it boost the Scottish economy?

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Rebound Effect: A Long Story

William Stanley Jevons *The Coal Question [...] (1865).*

He observed that increasing the efficiency of coal use in British Industries actually increased the consumption of coal and other resources, rather than decreasing it.

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Rebound Effect(s)

Suppose that a Scottish household installs a 5% more efficient boiler

- **Engineering Effect** The family consumes 5% less energy for heating its home and save 5% on the gas bill.
- **Direct Rebound** The family takes advantage of the 'relatively' cheaper energy service and enjoys a warmer home by using the heater more hours per day.
- **Indirect Rebound** The savings from the cheaper bill are used to buy goods and services 'other than energy' (i.e. clothing, leisure, etc.) but those goods require energy to be produced or supplied! Note that also energy services requires energy to be produced and supplied.
- **Economy-Wide Rebound** The increased Energy efficiency triggers a series of 'demand' and 'supply' responses in the markets of goods and services, affecting the energy used by consumers and producers.

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Do Scottish Households 'rebound'?

- In this study we analyse the 'economy wide' effects of introducing a 5% efficiency improvement in the Scottish households energy use.
- For the purpose of this analysis we use a regional dynamic CGE model (AMOS-ENVI) of the Scottish economy.
- We use data from the Scottish SAM 2009, aggregate to 21 economic sectors, four of which are energy sectors, gas, electricity, refined oil (mainly petrol and diesel) and coal, and including Scottish families, Scottish Government, Import and Export.

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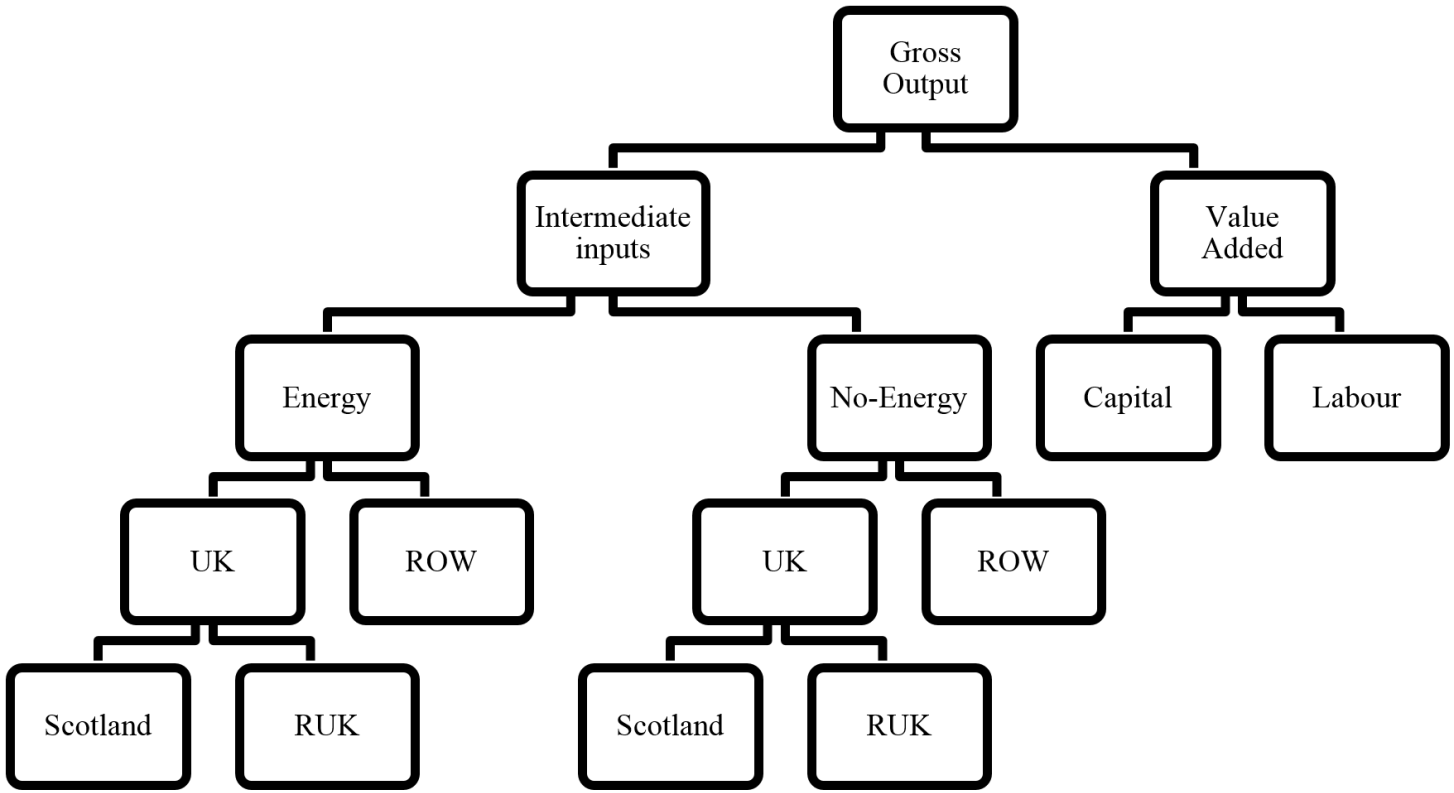
The Structure of Production



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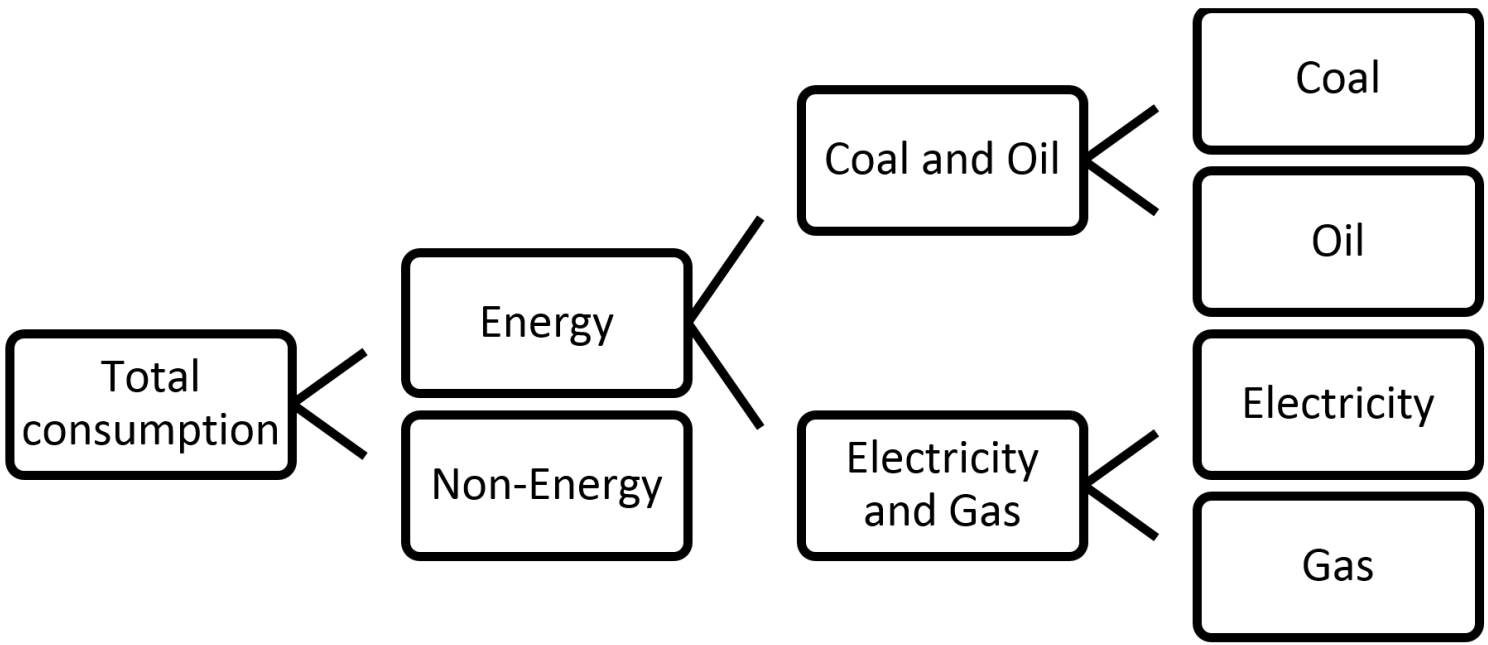
The Structure of Consumption



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The Labour Market

Wages are determined by the following wage curve, where the unemployment rate is inversely related to the real consumption wage.

$$ln\left[\frac{w_t}{cpi_t}\right] = \omega - \epsilon ln(u_t) \quad (1)$$

Net migration is positively related to the gap between national and regional real wage and negatively related to the gap between national and regional unemployment rate.

$$nim_t = \zeta - v^u\left[ln(u_t) - ln(\bar{u}^N)\right] + v^w\left[ln\left(\frac{w_t}{cpi_t}\right) - ln\left(\frac{\bar{w}^N}{\overline{cpi}^N}\right)\right] \quad (2)$$

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Dataset and Simulation

Three main type of parameters are used to inform the model:

- **Structural Parameters** taken from the 2009 Scottish SAM aggregate to 21 sectors, 4 of which are energy sectors.
- **Parameters** based on econometric estimates.
- **Parameters** obtained through the calibration process.

At time 0 a 5% permanent, exogenous increase energy efficiency of households is introduced

- **Simulations** we repeat the simulation for a 50 years period
- **Different Scenarios** are considered, here we focus on the central case scenario, and on the special case of migration

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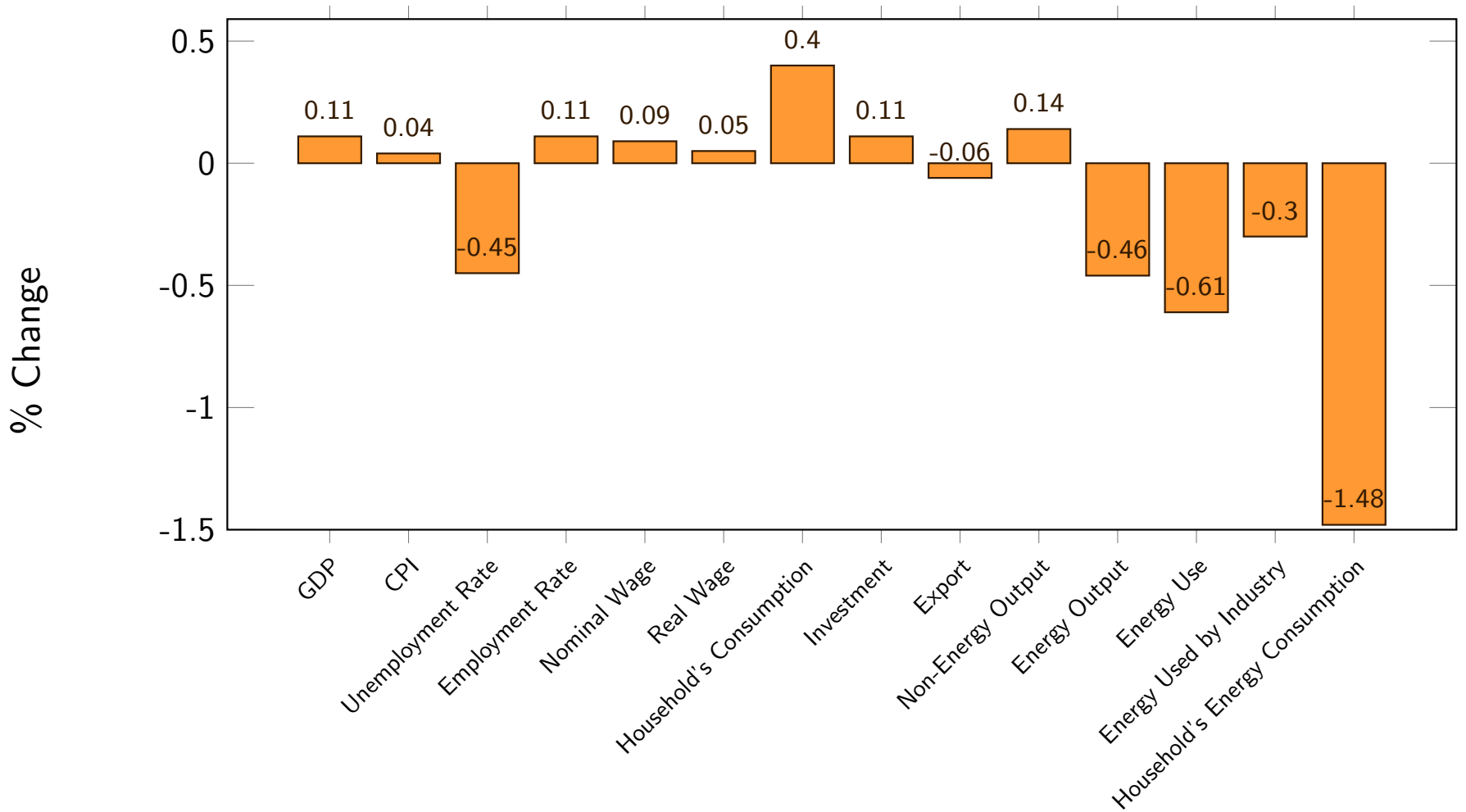
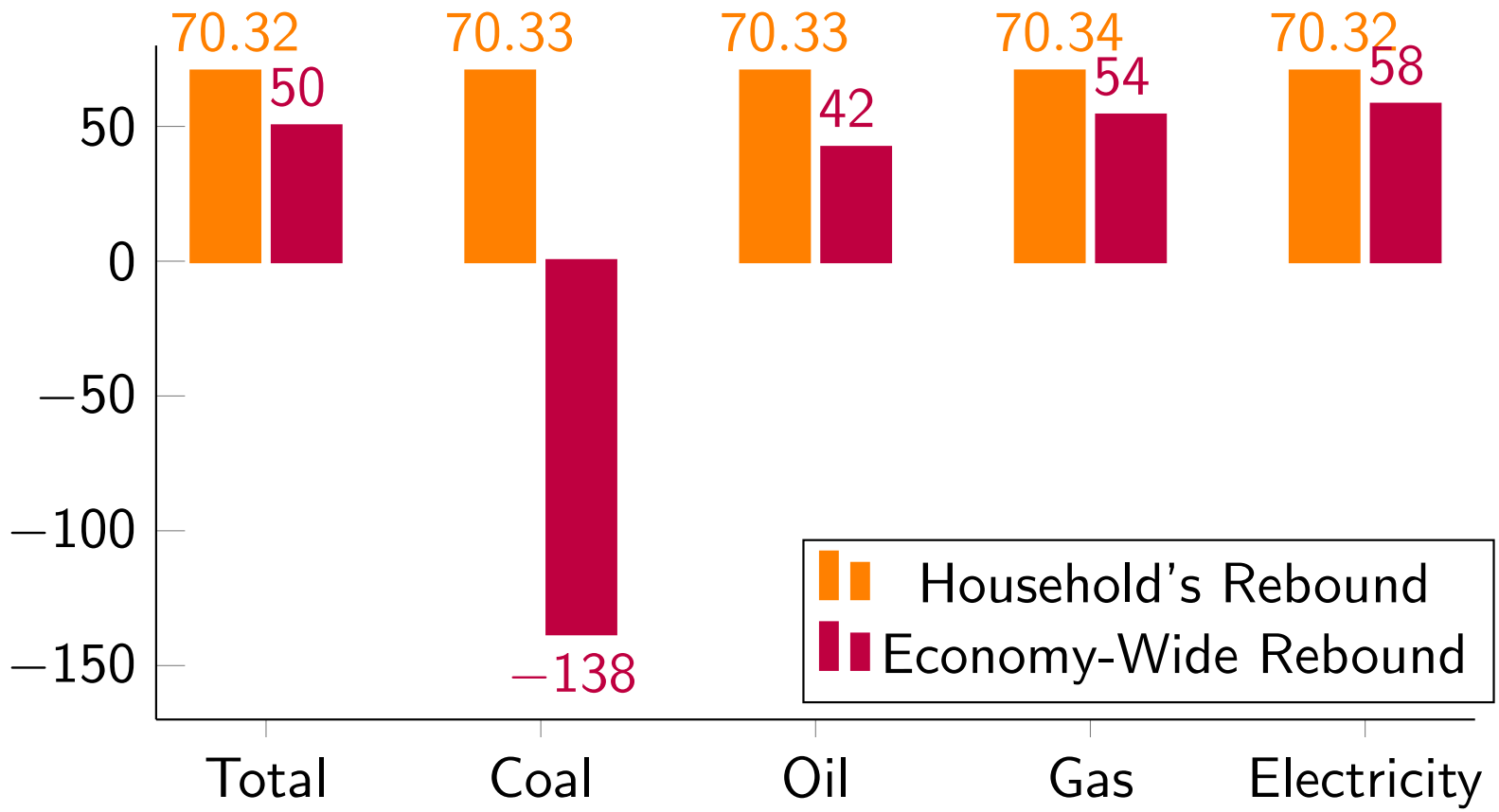
Central case scenario long-run results

Figure: Key variables long-run percentage change from the base year



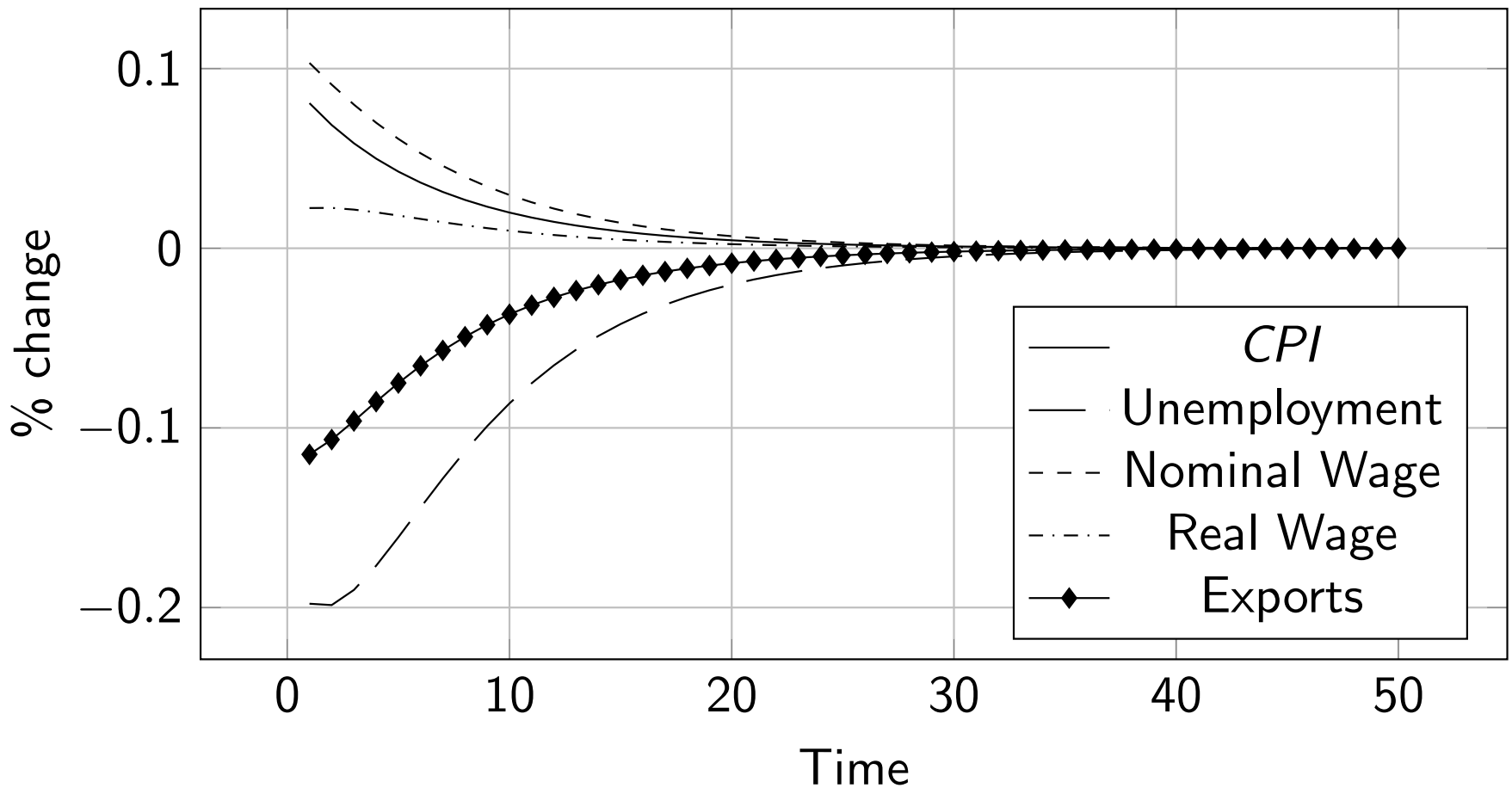
Rebound effects

Figure: Long-run Economy-Wide and Households' Rebound Effect per Energy Sector



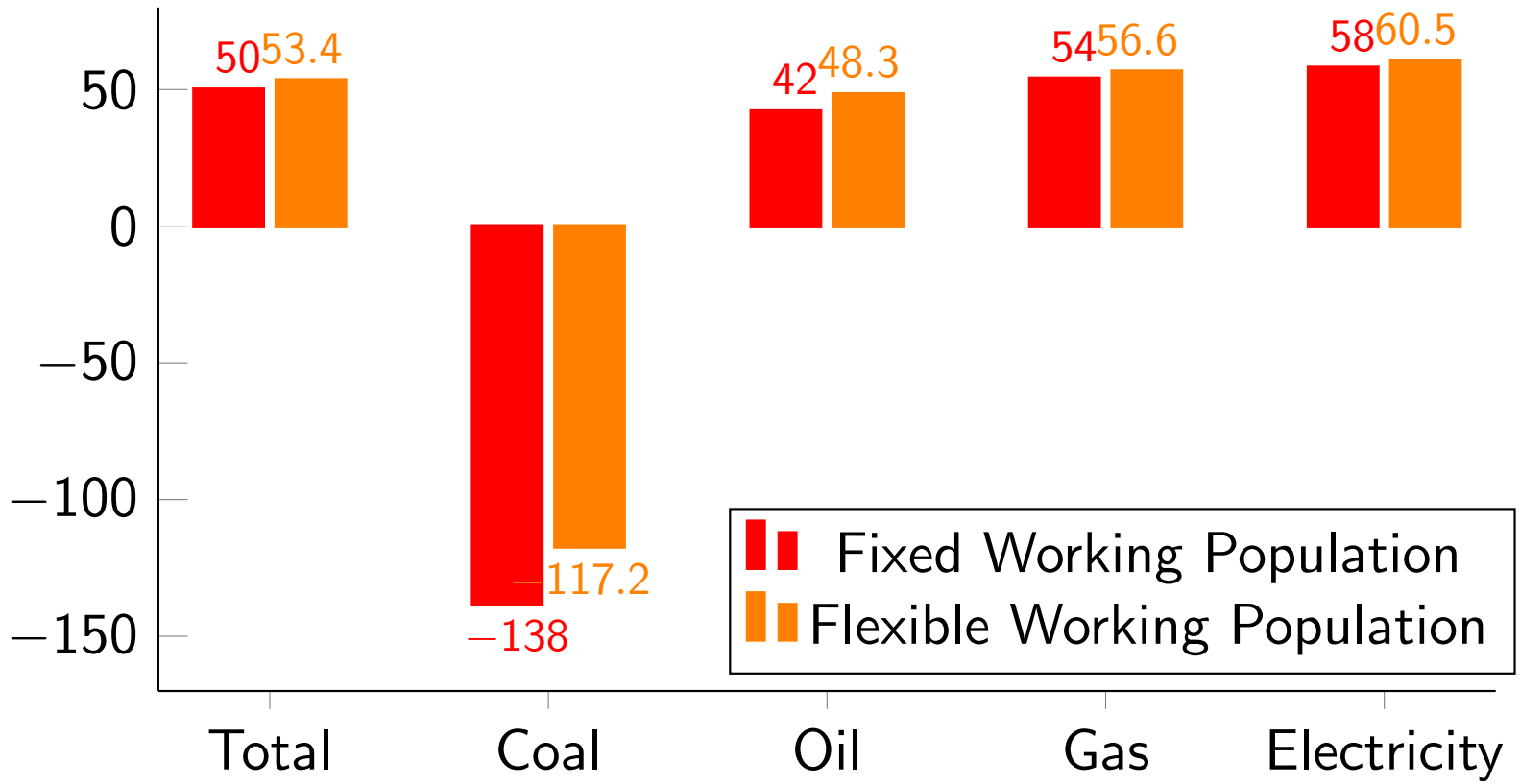
The AMOS-ENVI Model with Flexible Working Population

Figure: Transition Path of Key Variables



Fixed vs Flexible Working Population

Figure: Long-run Economy-Wide Rebound Effect in the Two Scenarios



Energy Efficiency and Rebound Effects

- Substitution between energy goods and non-energy goods would increase the aggregate demand.
- The higher consumption pushes prices up crowding out exports.
- There would be some contraction in capacity in energy producers sectors, generating a disinvestment effect.
- Migration would push wages down and report unemployment to the original level.
- GDP expansion would be higher in the migration case, but more energy is consumed.

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Is Rebound Effect Good or Bad for Policy Purposes?

It depends on policy priorities!

- **Economic Welfare.** Rebound effect occurs together with a series of macroeconomic responses that can improve the economic well being. Mitigating rebound would reduce the macroeconomic response as well, limiting the welfare effect.
- **Energy Saving/Emissions Cut**. Energy savings objective will not be (fully) achieved in presence of rebound effect. At the simplest level, if we want a 10% reduction in energy use, and we know we get 50% rebound, we know we need a 20% improvement in energy efficiency. In some extreme cases the result is an actual increase in energy consumption, so called Backfire Effect (i.e. rebound higher than 100 %). Better to consider also other instruments.

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Thank You for Your Attention

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