



# Macroeconomic Implications of a Hydrogen Economy

## A Case Study for Germany

### Overview

The global economy has faced three major macroeconomic crises induced by **energy price shocks** since 1945: the oil crises of 1973-74 and 1979-80, and the 2023 natural gas price spike following Russia's invasion of Ukraine. These events had significant economic impacts, particularly in Europe and Germany, **where industrial sectors rely heavily on affordable energy**. While it is well-established that energy price volatility affects economies dependent on affordable energy, the implications of such shocks in an **all-renewable energy world** remain unexplored.

This study investigates the macroeconomic effects of a hydrogen-based energy system in Germany by developing an **open-source** input-output (IO) stock-flow consistent (SFC) macroeconomic model [1,2]. By transforming today's **input-output structure** into a hydrogen-based economy and embedding it into an **empirically founded SFC model** we are able to examine future macroeconomic interdependencies in the production and output structure.

### Change in Production Structure

As Germany develops a hydrogen-based economy, a distinct **hydrogen sector** emerges as a new industrial node with strong interconnections across the input–output (IO) structure.

#### Backward Linkages:

Hydrogen production relies on upstream sectors such as:

- **Electrolyzer manufacturing** (machinery, electronics)
- **Renewable energy generation** (solar, wind)
- **Construction and infrastructure** (pipelines, storage)

#### Forward Linkages:

Hydrogen acts as a key intermediate input for:

- **Steel, chemical, and paper** industries replacing fossil fuels [3]
- **Transport and power sectors** through fuel cells and energy storage

### Employment Effects

By **embedding** the new hydrogen-based production structure into our model, we assess both static and dynamic effects of **investment demand** related to hydrogen production.

We distinguish between **static input-output (IO) effects** and **dynamic SFC-IO effects**, which include second-round impacts such as increased production, employment and consumption. The magnitude of these effects depends on the **hydrogen import share**: lower import shares strengthen domestic investment and employment but lead to higher **consumer price effects**.

Moreover, **technology exports** may contribute positively: even if hydrogen is produced abroad, German firms could benefit by exporting hydrogen production technologies. This will be explored through scenario-based analysis.

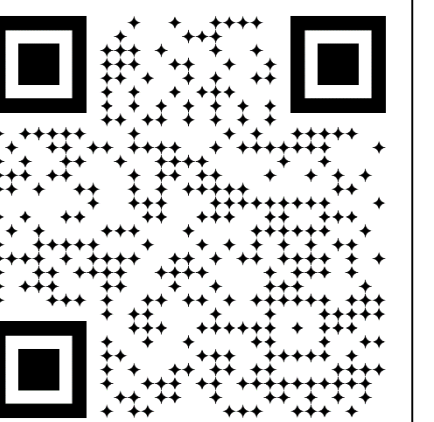
### Hydrogen vs. Fossil Gas Price Shocks

As a preliminary case study, we compare the macroeconomic impacts of a 250% **fossil gas import price shock**, within an unchanged input-output structure, with a corresponding **hydrogen import price shock**, assuming a green hydrogen-based production system.

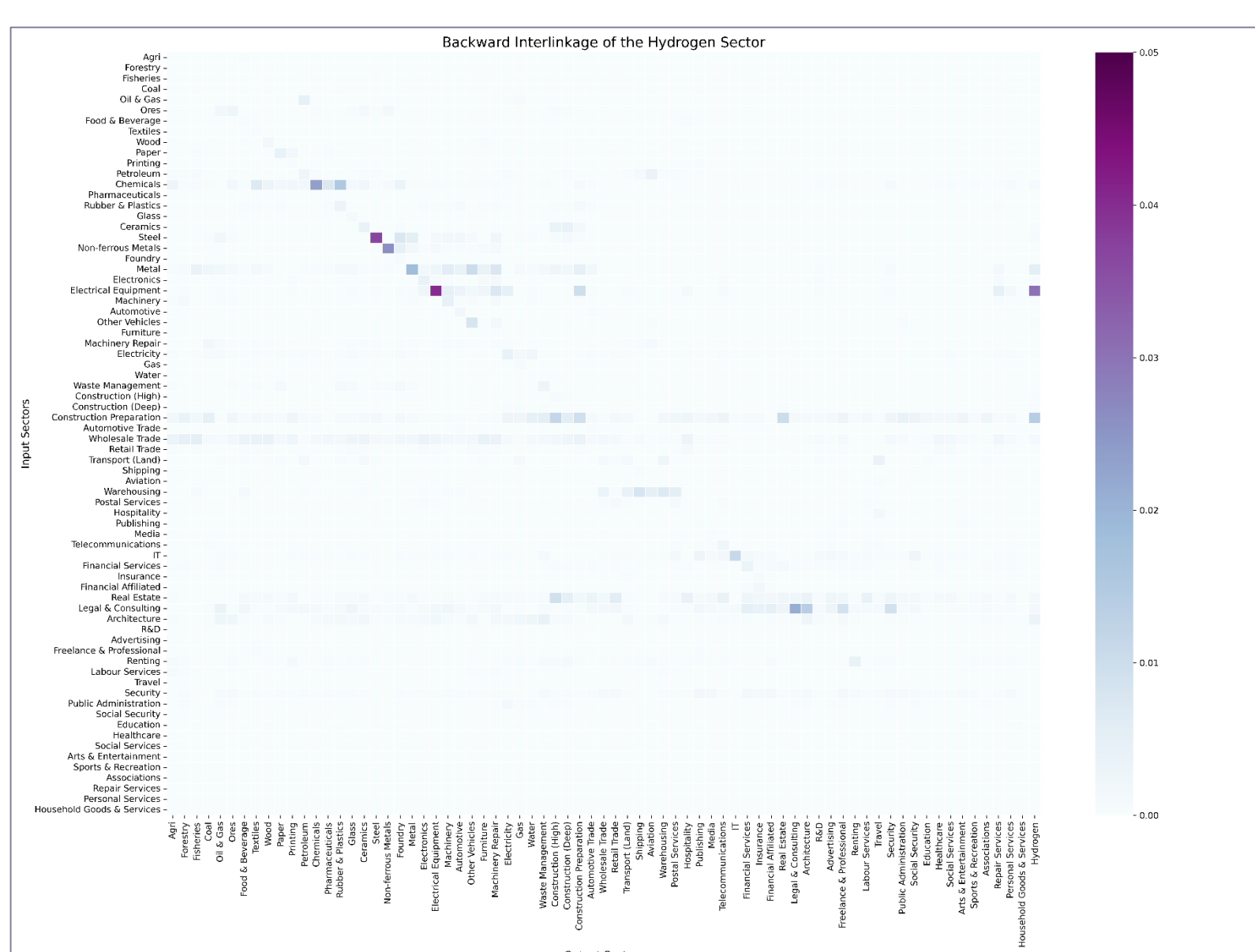
**Preliminary findings** indicate that the primary effect on consumer prices arises from the **direct consumption channel**, rather than from propagation through the production structure. This favors a hydrogen-based system, as **household hydrogen consumption is significantly lower** than that of fossil gas. Instead, households are more likely to transition to heat pumps rather than adopt hydrogen-based residential heating [4]. Moreover, **hydrogen imports** are expected to account for a **smaller share** of total hydrogen demand compared to fossil gas [5]. Together, these factors contribute to a **more moderate impact** on consumer prices and broader macroeconomic indicators.

“*The emerging hydrogen economy is giving rise to new macroeconomic interdependencies that ought to be reflected in political decision-making and strategic orientation.*”

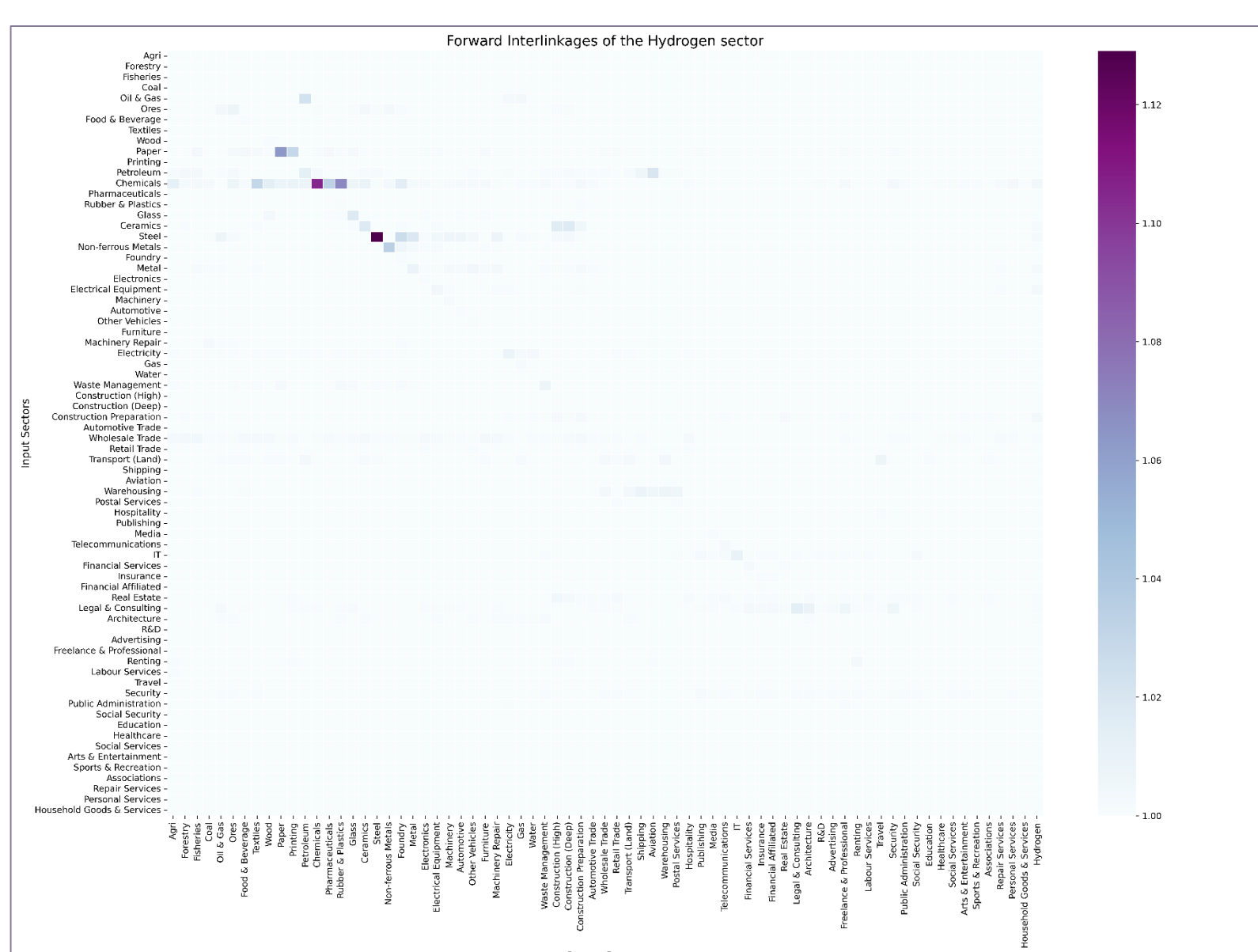
Link to **sfctools**:  
An open-source macroeconomic stock-flow-consistent modelling framework developed at DLR



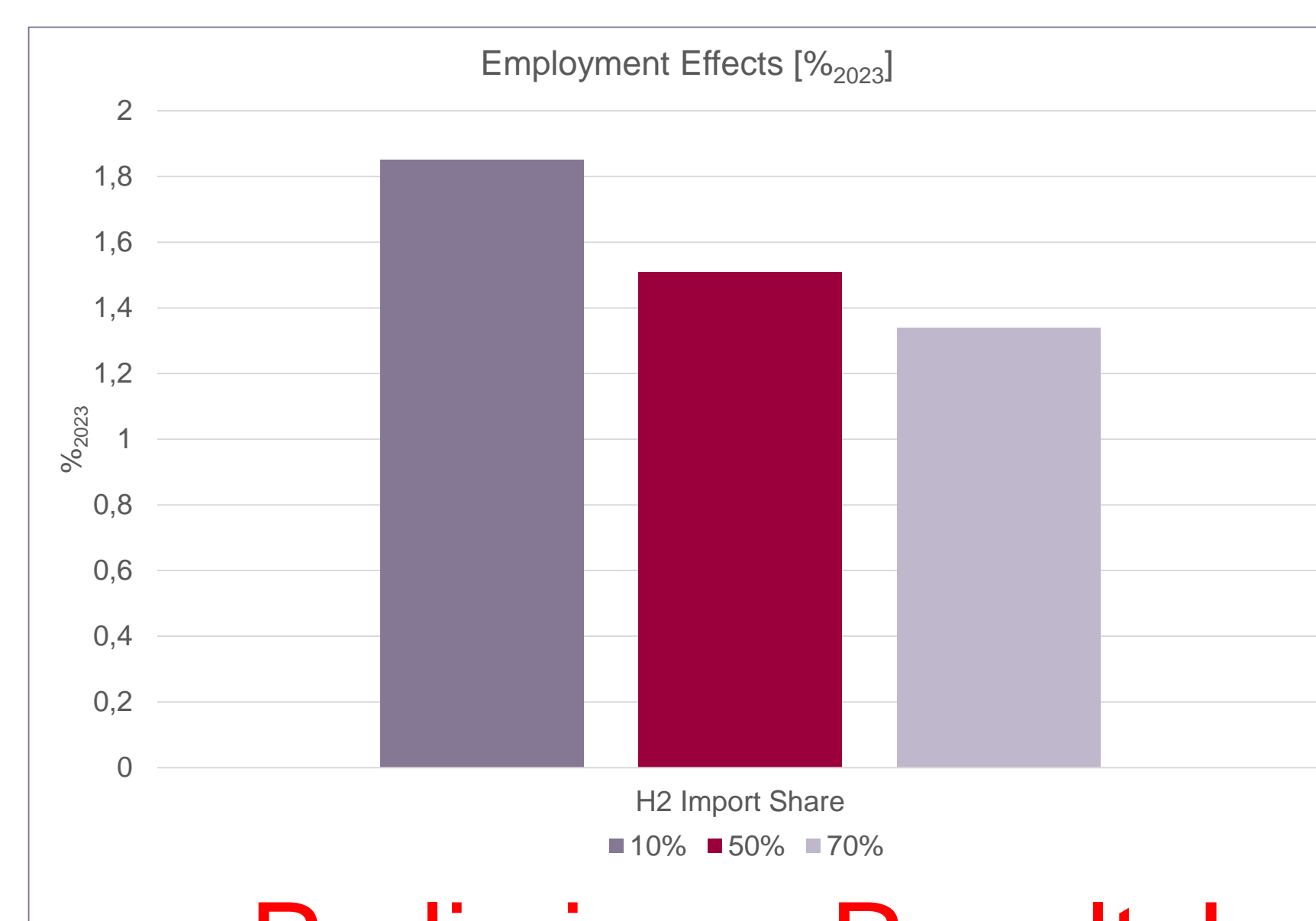
Backward



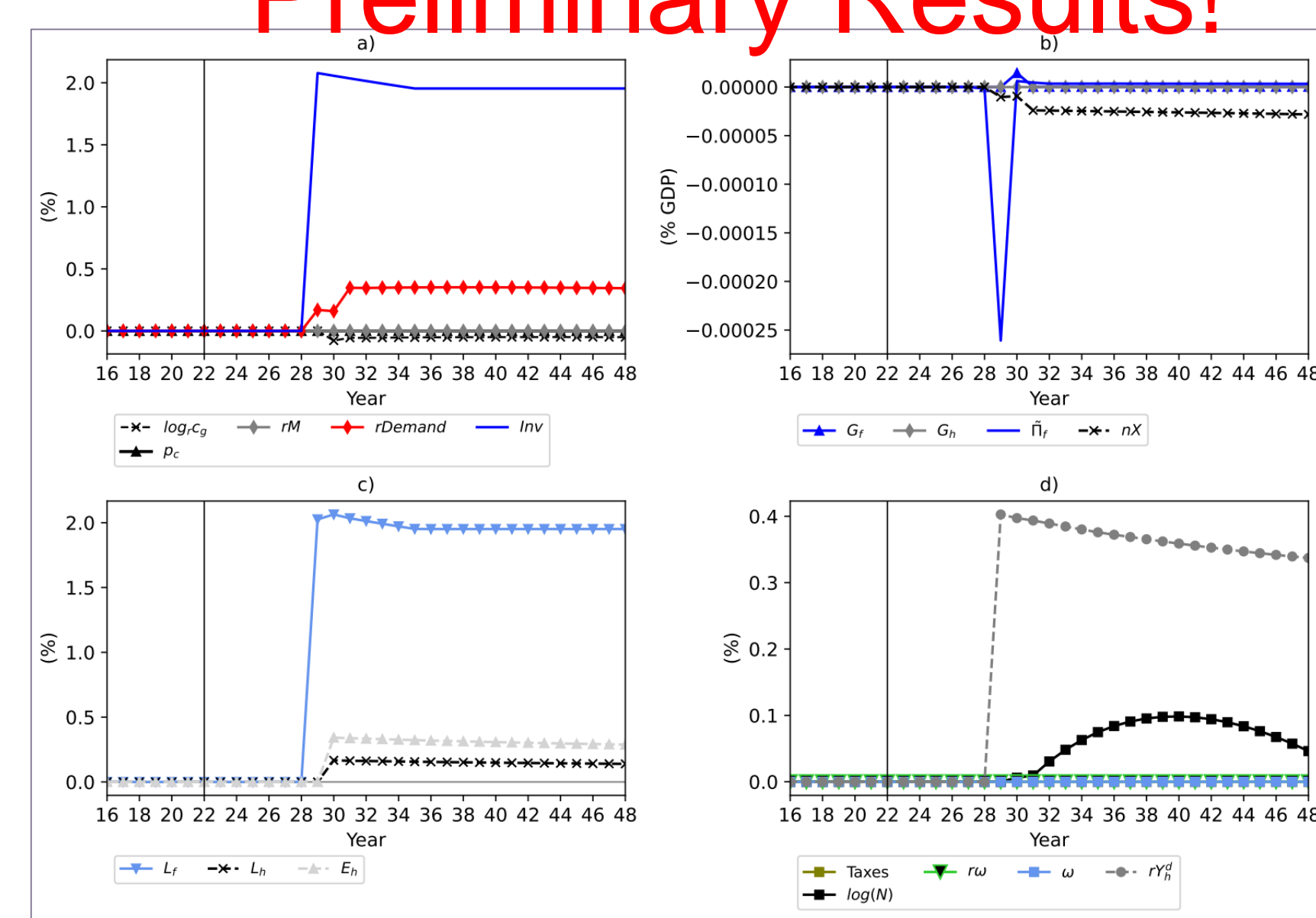
Forward



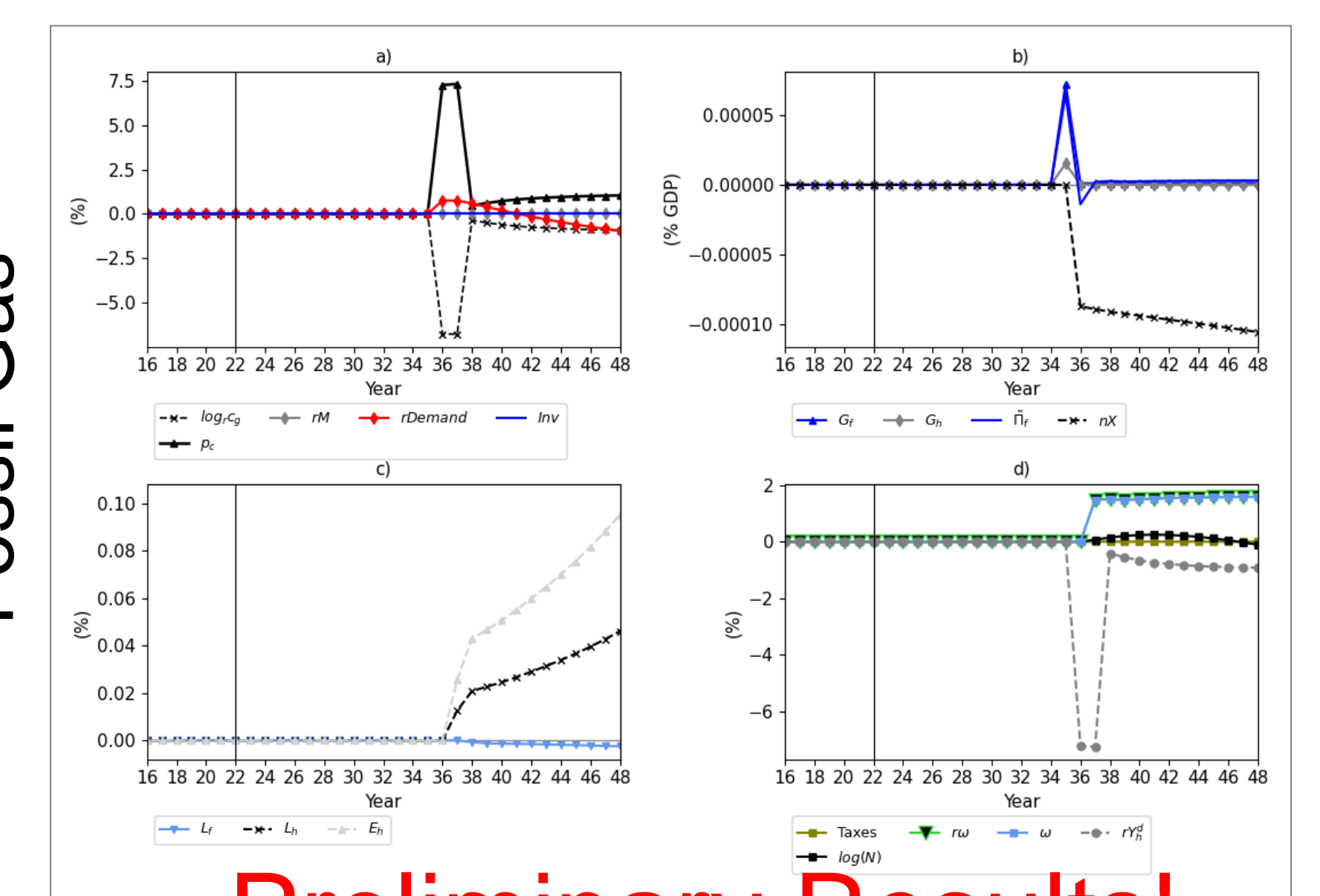
Static IO



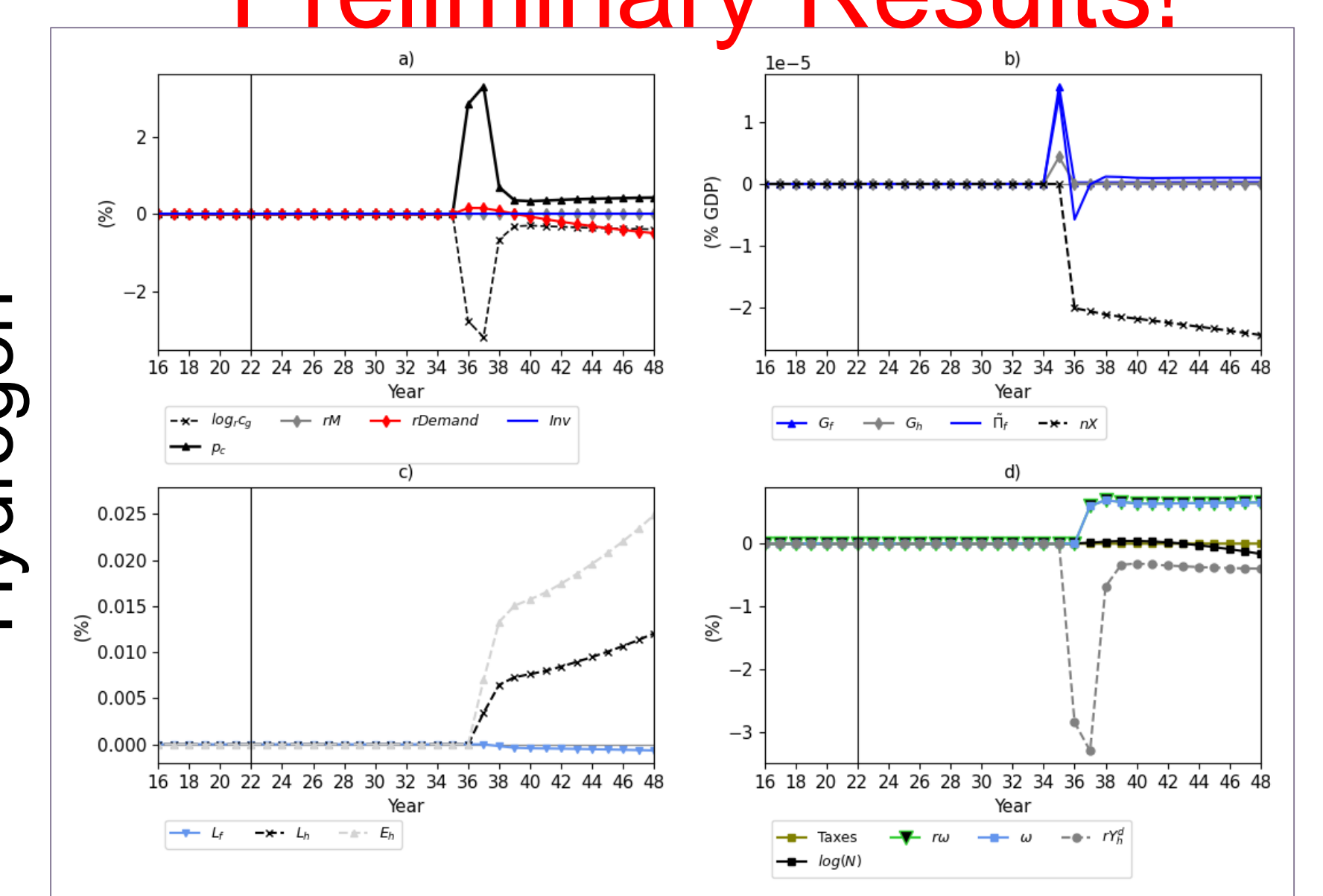
Dynamic IO-SFC



Fossil Gas



Hydrogen



Preliminary Results!

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