NATIONAL ACADEMIES Sciences Engineering Medicine

Incorporating Climate into Macroeconomic Modeling

Workshop | June 14–15, 2023

JUNE 2023

Opening Keynote

- **James Stock,** Committee Chair, Harvard University **3**

Keynote Session

Macroeconomic Assumptions and Considerations

Jim Stock
Harvard University

THE SALATA INSTITUTE
FOR CLIMATE AND SUSTAINABILITY
at Harvard University

Overview

Summary of Round Table charge:

- How do physical and transition climate change effects relate to macroeconomic performance?
- What are implications for fiscal, monetary, and financial stability policies?
- In particular, how should the U.S. budget process incorporate climate change?
- What are implications for the relevant macro models?

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- What are implications for the relevant macro models?

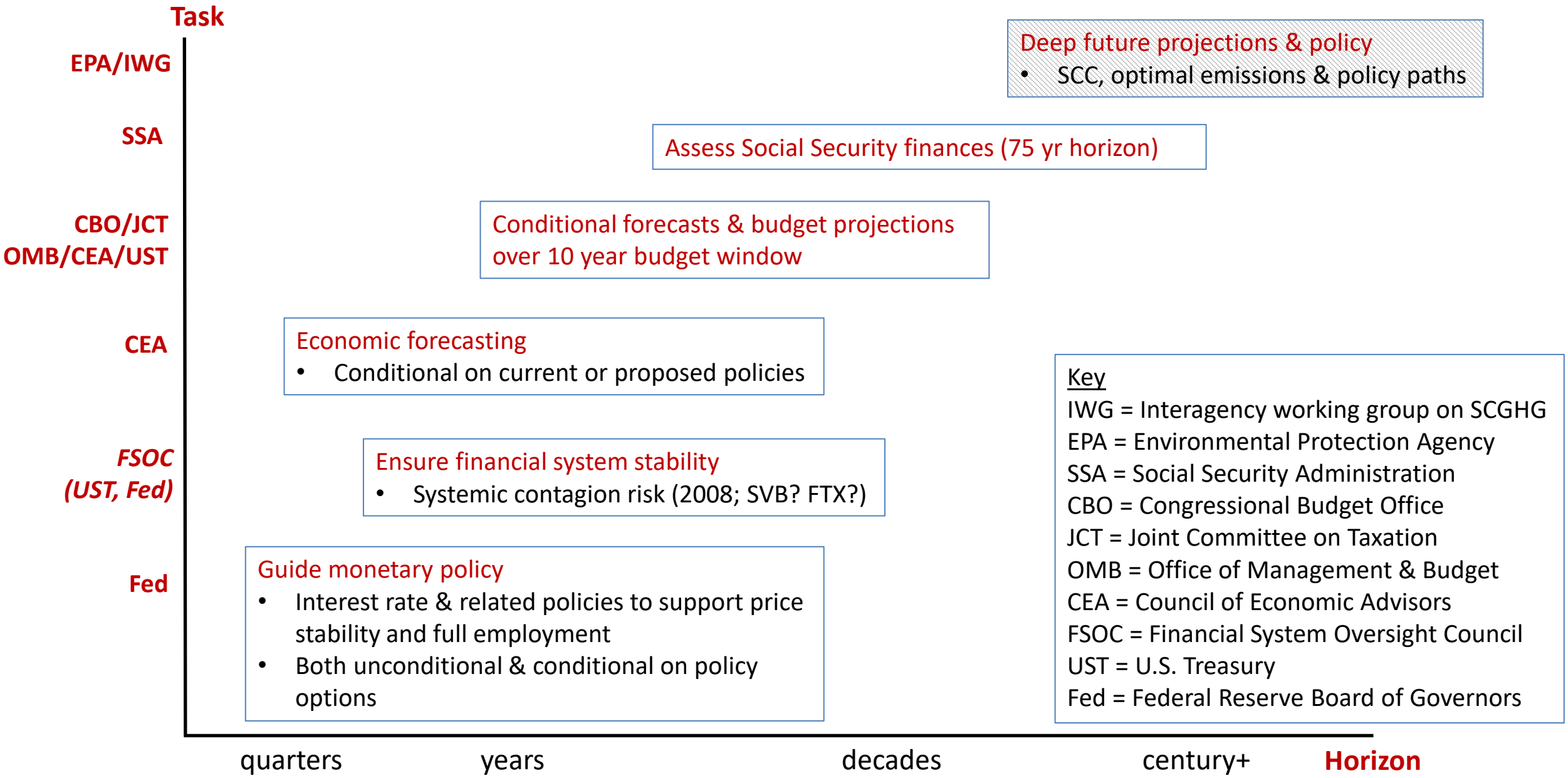
This talk:

1. Macroeconomic questions
    a) Tasks for macroeconomic policy analysis and forecasting (USG-focused)
    b) What are key metrics (GDP, tax receipts, storm damages,…)

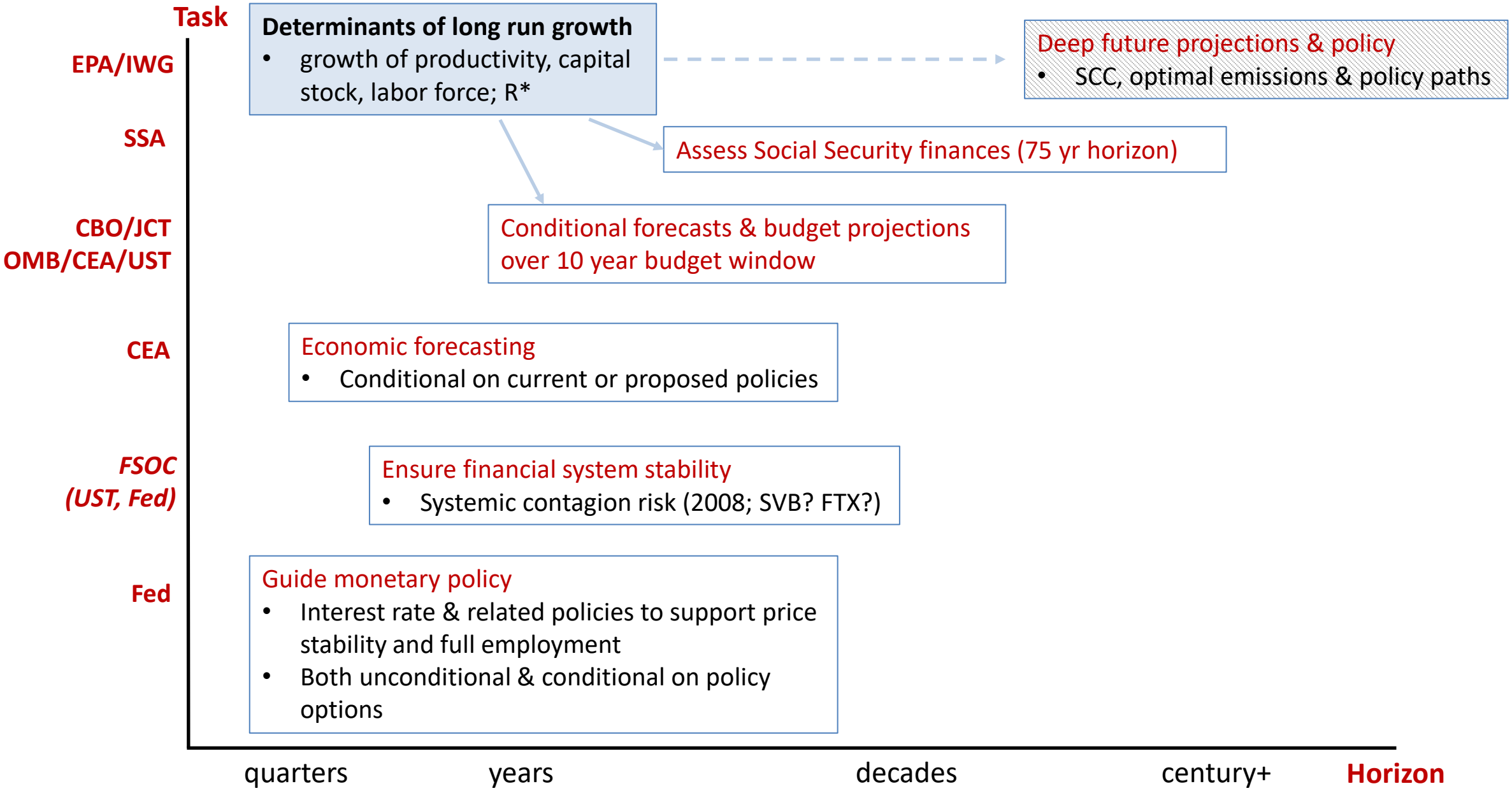
2. How might climate affect those questions
    a) "climate" = physical + human systems risks > physical + transition risks
    b) Catalog of risks and horizons
    c) Role of uncertainty across horizons

3. Implications for models (brief)
    a) There are many families of macro models, each family designed for a different purpose (question)
    b) Each family (and sometimes models within families!) necessarily have different assumptions
    c) We will see several of these families at this conference

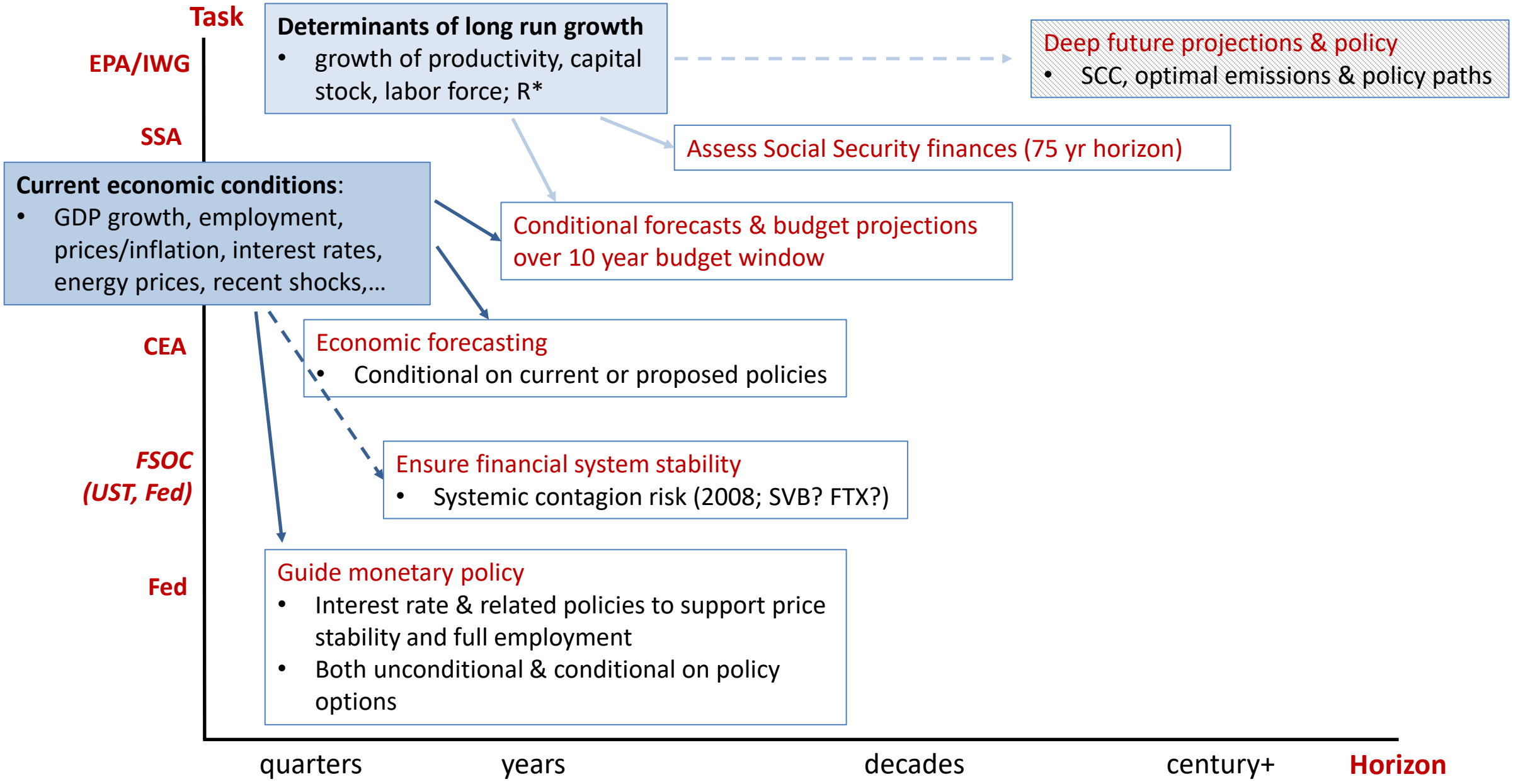
Examples of tasks of macroeconomists at federal agencies



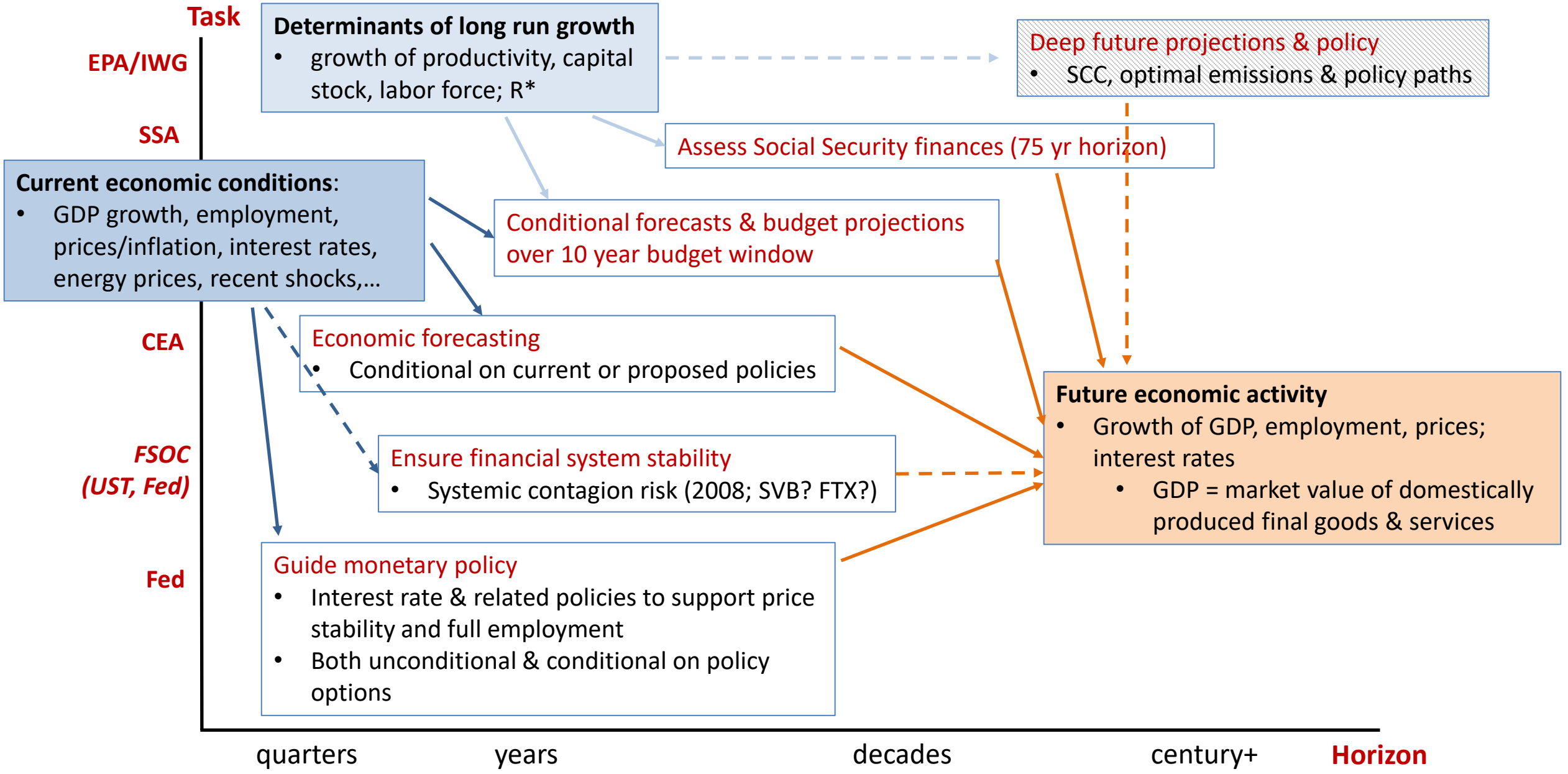
Economic inputs



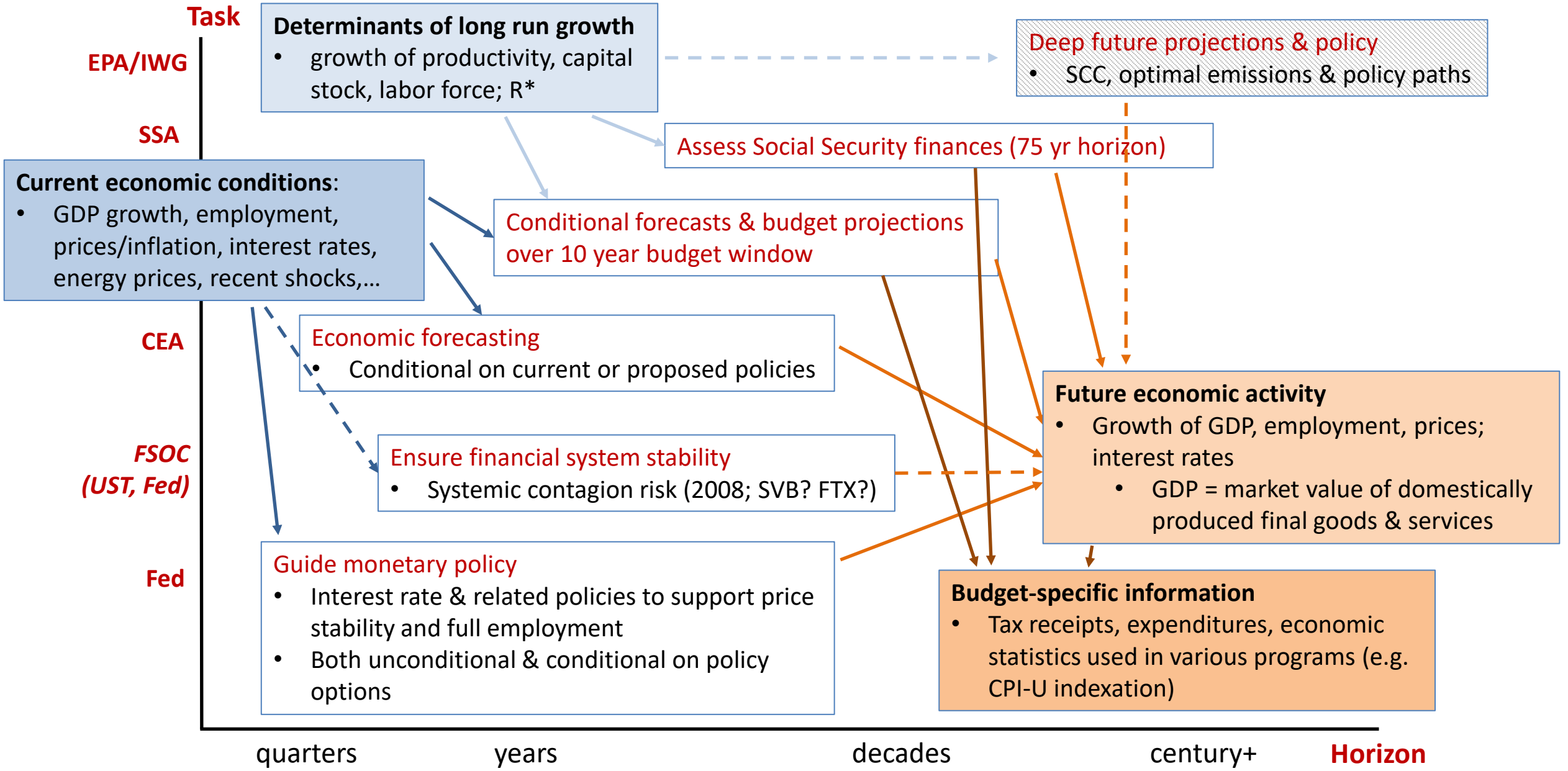
Economic inputs



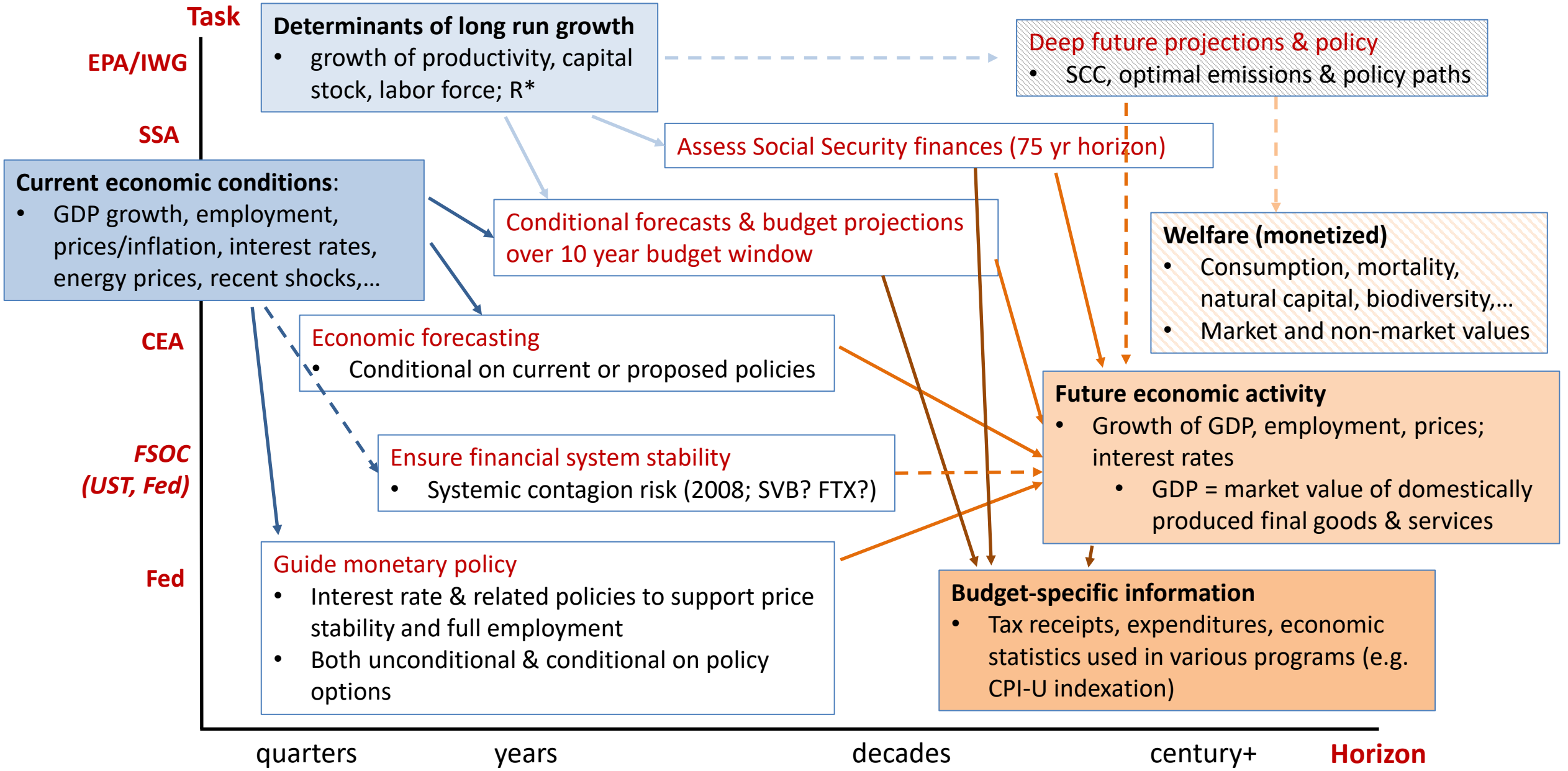
Economic inputs and outputs



Economic inputs and outputs

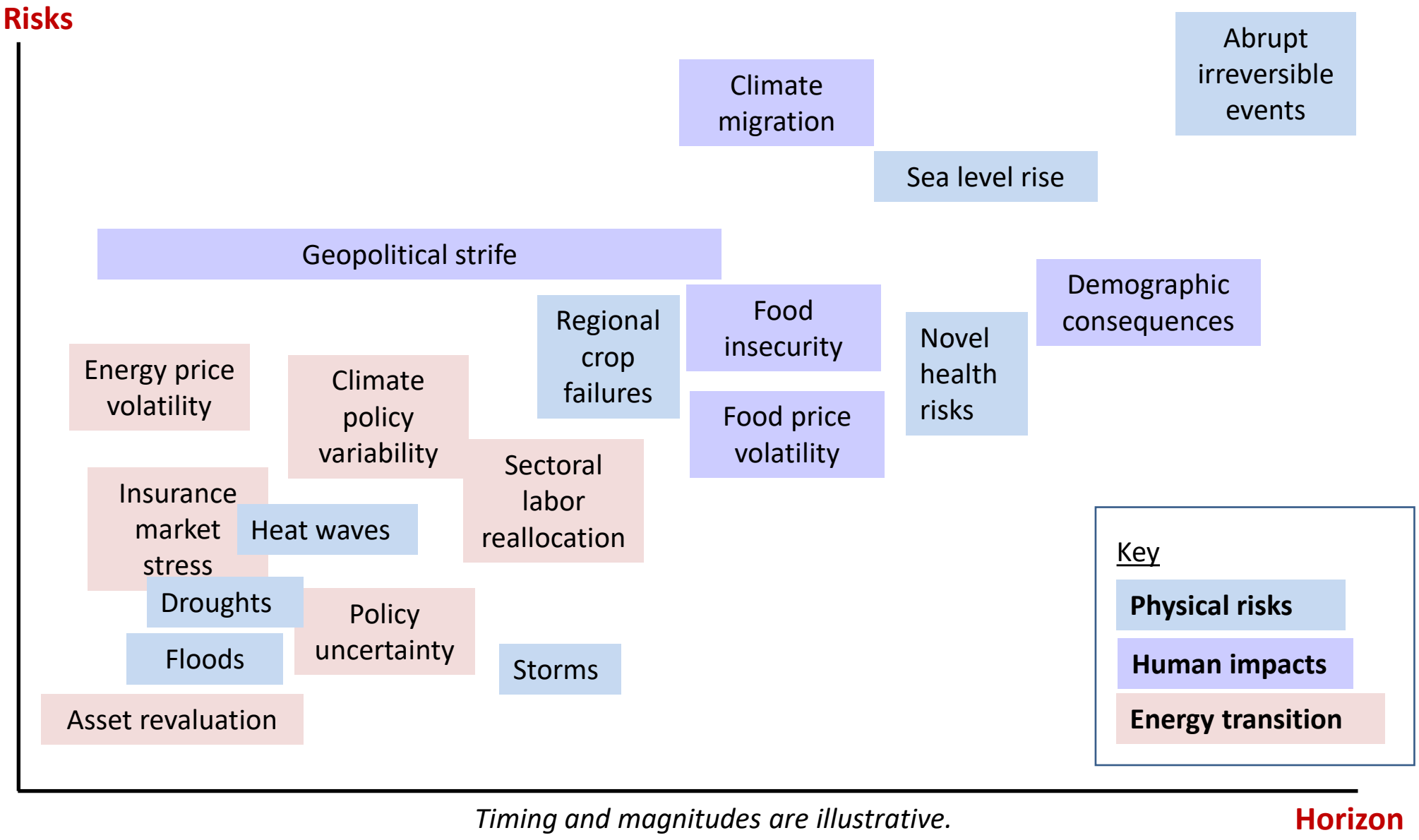


Economic inputs and outputs



Nearly all these tasks run through real economic activity (GDP, employment, etc.)

Which climate risks?



Each has considerable uncertainty – in some cases very considerable

Timeline of physical and transition risks

	Long run π*, R*, u*, μ	Short run π, u, shocks, business cycles
Physical	• Lower average crop yields • Lower productivity • sea level rise • adaptation costs,…	• Hurricanes • Floods & fires • droughts (food price shocks, famines) • heat waves (acute productivity shocks) • Grid failures/blackouts
Transition (Human systems)	• green investment demand • shifts in types of jobs/skills • monetary policy decision (no accommodation of smooth increase) • long run productivity growth	• Energy price shocks • Asset price shocks • Transitional unemployment • Policy transition shocks (implementation of carbon price,…) • Policy uncertainty shocks • Political risk (climate migration?) • Geopolitical risks (declining petro states? China & metals? SRM governance?) • **Unknown unknowns**

Tasks -> models: Different models for different tasks

Task

Misc.

SSA

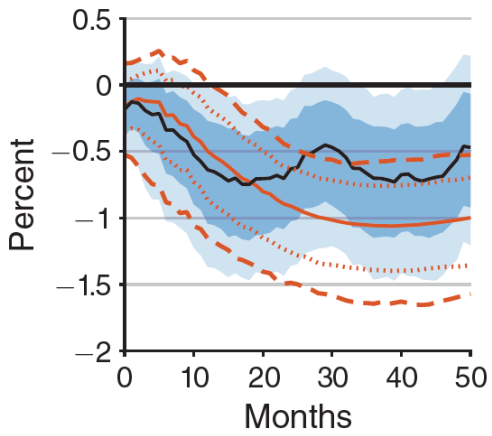
CBO/JCT
OMB
CEA

FSOC (UST)

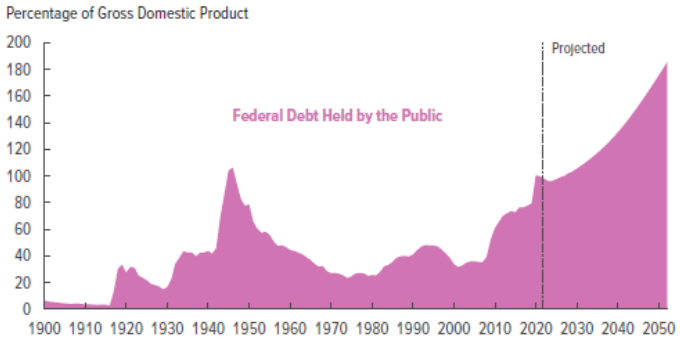
Fed

Horizon

Response of U.S. Industrial Production to an oil supply shock



Source: Känzig (*AER* 2021)



Source: CBO (*Budget & Economic Outlook, May 2022*)

Long term growth identity

$$\Delta \ln(GDP_t) = \Delta \ln\left(\frac{GDP_t}{Hour_t}\right) + \Delta \ln\left(\frac{Hour_t}{Emp_t}\right)$$
$$+\Delta \ln\left(\frac{Emp_t}{LF_t}\right) + \Delta \ln\left(\frac{LF_t}{Pop_t}\right) + \Delta \ln(Pop_t)$$

Tasks -> models: Different models for different tasks

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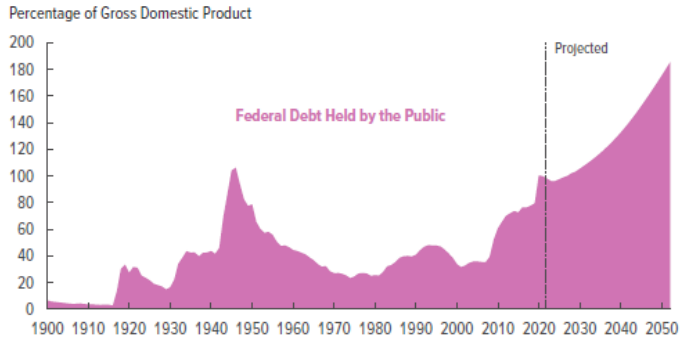
Hundreds (?) of linear simultaneous equations, estimated by OLS or IV



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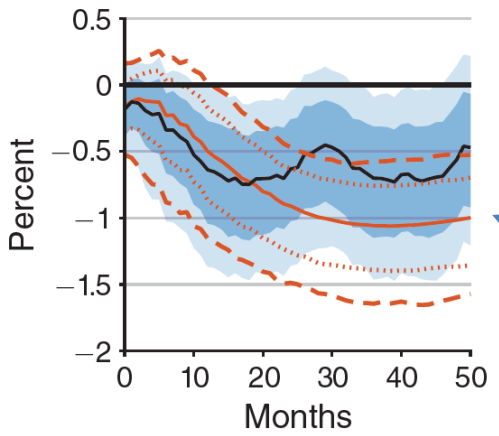
Response of U.S. Industrial Production to an oil supply shock



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8-variable vector autoregression with oil price shock identified using instrumental variables

Long term growth identity

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Assumptions or scenarios or stochastic modeling; demographic drivers

Where does climate change fit into these models?

Task

Misc.

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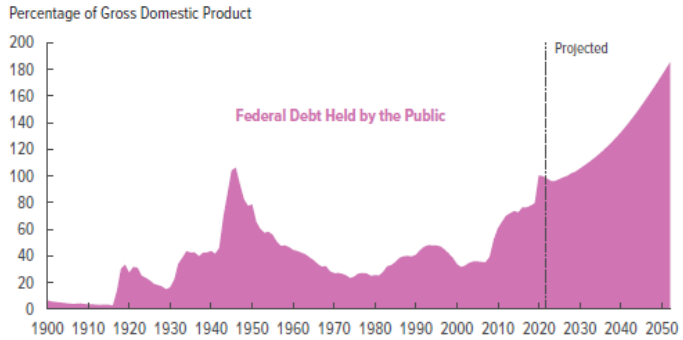
Horizon

Effect of physical & transition risks on:
- Baseline for 10-year budget projections



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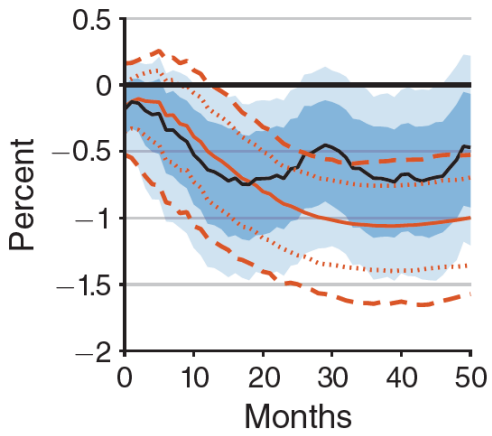
Effect of physical & transition risks on:
- Productivity growth
- u*, r*
- population growth
- fiscal situation

Response of U.S. Industrial Production to an oil supply shock



Source: Känzig (*AER* 2021)

Effect of physical & transition risks on:
- Energy prices, investment, employment, unemployment rate, inflation

Where does climate change fit into these models?

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Summary

- Different models for different tasks
- Climate affects (i) the growth baseline & (ii) the distribution of future shocks
- Transition risk is arguably more important than physical risk for horizons through 10 years
- For most macroeconomic purposes, the "bottom line" is real economic activity (GDP etc.) or something derived from it (tax receipts, automatic expenditures,…)

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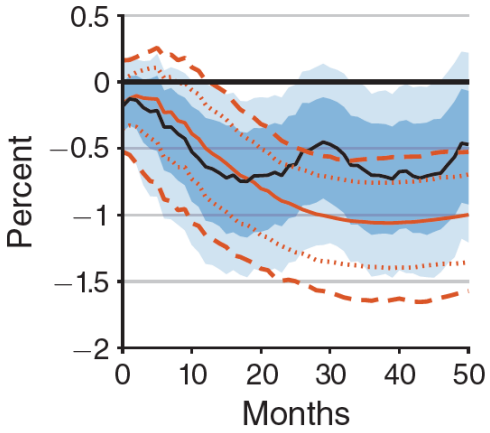
$$\Delta \ln(GDP_t) = \Delta \ln\left(\frac{GDP_t}{Hour_t}\right) + \Delta \ln\left(\frac{Hour_t}{Emp_t}\right) + \Delta \ln\left(\frac{Emp_t}{LF_t}\right) + \Delta \ln\left(\frac{LF_t}{Pop_t}\right) + \Delta \ln(Pop_t)$$

Pro



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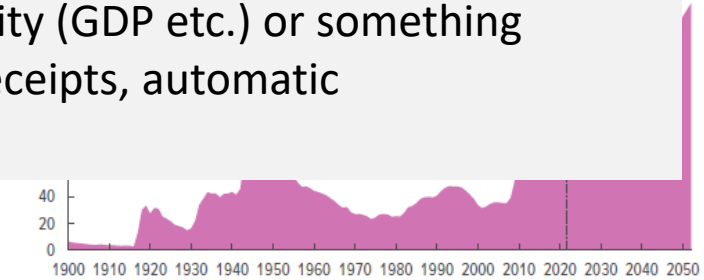

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Horizon

Additional Slides

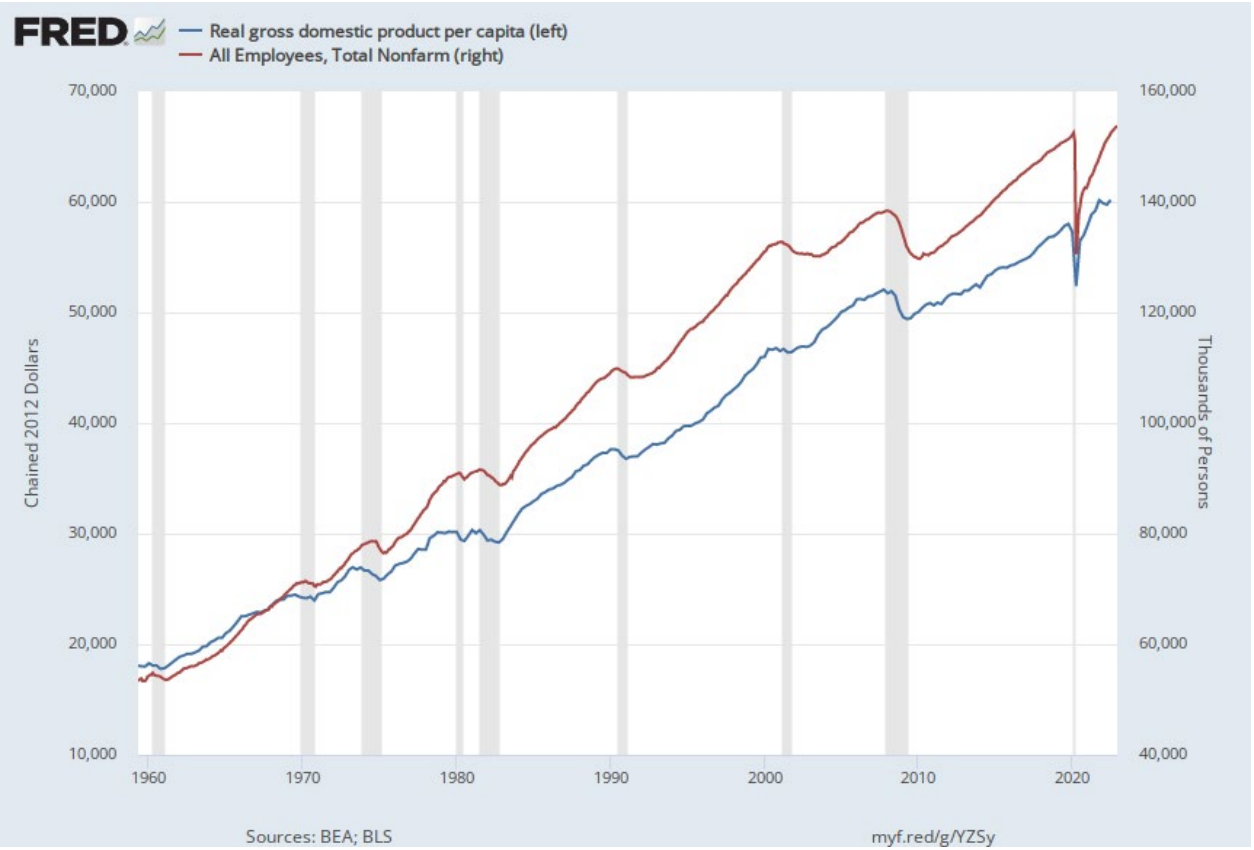
The National Academies of Sciences, Engineering, and Medicine will establishimproving understanding of how the physical and transition effects of climate change relate to and affect macroeconomic performance and the implications for fiscal, monetary, and financial stability policies. a Roundtable on Macroeconomics and Climate-related Risks and Opportunities, with a goal of

The Roundtable will be a venue for federal agencies and cross-disciplinary experts in academia, industry, and non-governmental organizations to discuss challenges associated with incorporating climate change risks and opportunities into macroeconomic analysis, including: (1) how to translate the uncertain impacts of climate change and the transition to net-zero carbon emissions economies into inputs to macroeconomic analyses; and (2) how to adjust macroeconomic models and analytic approaches to accommodate the unique characteristics of climate risks and opportunities.

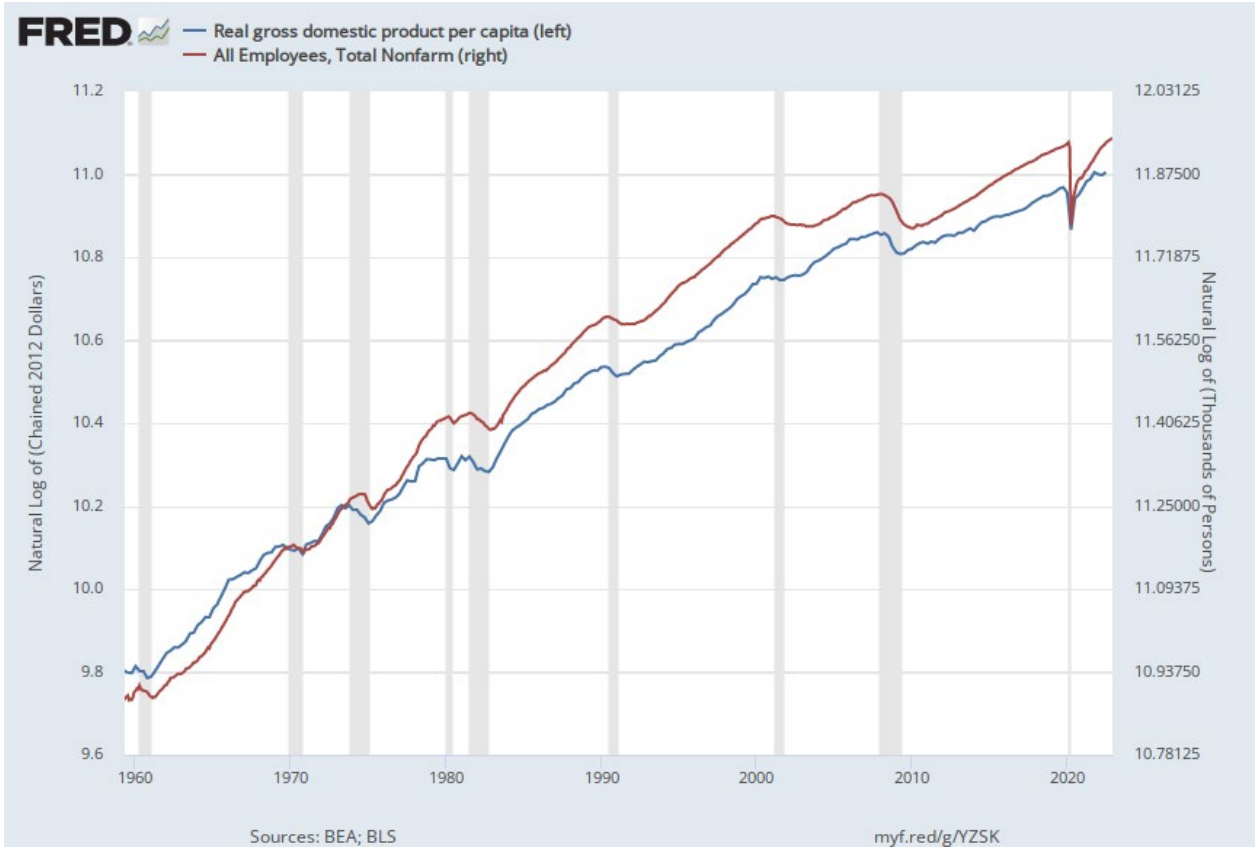
Activities of the Roundtable will help identify currently available data and analyses that can inform policy-making as the nation transitions to a net-zero carbon economy and prepares for anticipated impacts of climate change, highlight gaps in needed data and analyses, and provide a mechanism to expand relevant research efforts among both established and early career researchers. The Roundtable will focus on advancing data and methodologies that would support the development of macroeconomic analysis that inform the federal budget process in the United States, drawing upon international expertise and policies.

Real GDP and employment, 1960-present

Native units (real dollars, thou. people)



Natural log



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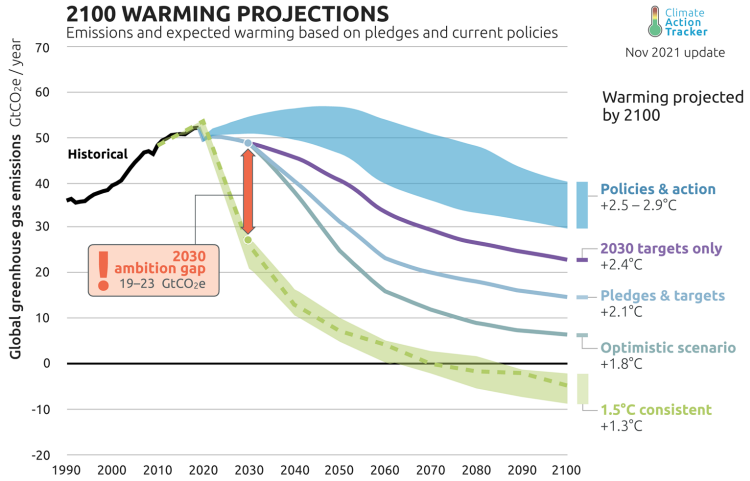

Physical

- Heat waves
- Storms
- Regional crop failures
- Sea level rise
- Climate migration

Transition (broad "human systems" interpretation)

- Asset revaluation
- Energy price volatility
- Sectoral reallocation
- Food price volatility
- Policy effects

Macro impacts

Examples of channels at different horizons

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