Open Source Modeling for Policy Analysis, Research, and Teaching

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What I do

- Senior Lecturer, M.A. Program in Computational Social Science
  - Teach core compute classes (Perspectives) in MACSS
  - Teach structural estimation and overlapping generations
- Director, Open Source Macroeconomics Laboratory
  - Run summer boot camp
  - Supervise research assistants
  - Direct related research
- Fellow, Becker Friedman Institute
- Economist, Open Source Policy Center
- Steering Committee Member, QuantEcon

Takeaways

1. Open source modeling is a philosophical imperative for official models.
2. Open source workflow and platforms facilitate collaboration, dissemination, attribution, replication, sensitivity analysis, and transparency
3. Open source curriculum is a powerful teaching tool and marketing tool

And if time permits...

Some other applications: open source drafting of legislation

The Policy Scoring Landscape

- Any time legislation is introduced (tax and/or spending change) the effect must be estimated.
  - Officially done by JCT, CBO, Treasury, OMB
- Other groups wanting scores: state legislators, lobbyists, corporations, think tanks,
- Types of scoring models
  - microsimulation models (static scoring)
  - econometric models
  - general equilibrium (dynamic scoring)

Open source policy

- Most models used for policy are proprietary/closed source
  - Joint Committee on Taxation (JCT)
  - Congressional Budget Office (CBO)
  - Internal Revenue Service (IRS)
  - Tax Policy Center (TPC)
  - Penn Wharton Budget Model (PWBM)
  - Tax Foundation
  - Climate models
- Models have hundreds of assumptions and parameters
  - One could get the model to say anything
  - How test sensitivity, robustness?

Philosophical statement

Models used to evaluate public policy should be open source

Example: Tax Cuts and Jobs Act (12/22/2017)

- Reduce marginal income tax rate schedule for most filers through 2025 (increase in 2026)
- Use a chain-weighted CPI as an inflation index
- Increase the standard deduction through 2025 (reduce in 2026)
- Increase the child tax credit (CTC), but phase out by 2026
- Cut the top corporate income tax rate from 35% to 21%
- Allow 100% expensing on new investments in assets with less than 20-year depreciable life through 2022 (reduced by 20 percentage points per year starting in 2023)
- Limit intereste deduction to 30% of business income
- Move to a territorial system for taxing foreign earnings, with one-time tax on unrepatriated foreign earnings of 8%
- Repeal the corporate alternative minimum tax
- Provide a 20% deduction for pass-through entity income through 2025 (increase in 2026, some limitations for high income filers)
- Limit state and local income and sales tax deduction to $10,000 through 2025 (eliminate limitation in 2026)
- Increase exemption amount and phaseout range of alternative minimum tax (AMT) through 2025 (revert to 2017 law in 2026)
- Repeal the individual insurance mandate of the Affordable Care Act (ACA)
- Double the exemption amount for the estate tax through 2025 (return in 2026)

Example: Tax Cuts and Jobs Act (12/22/2017)

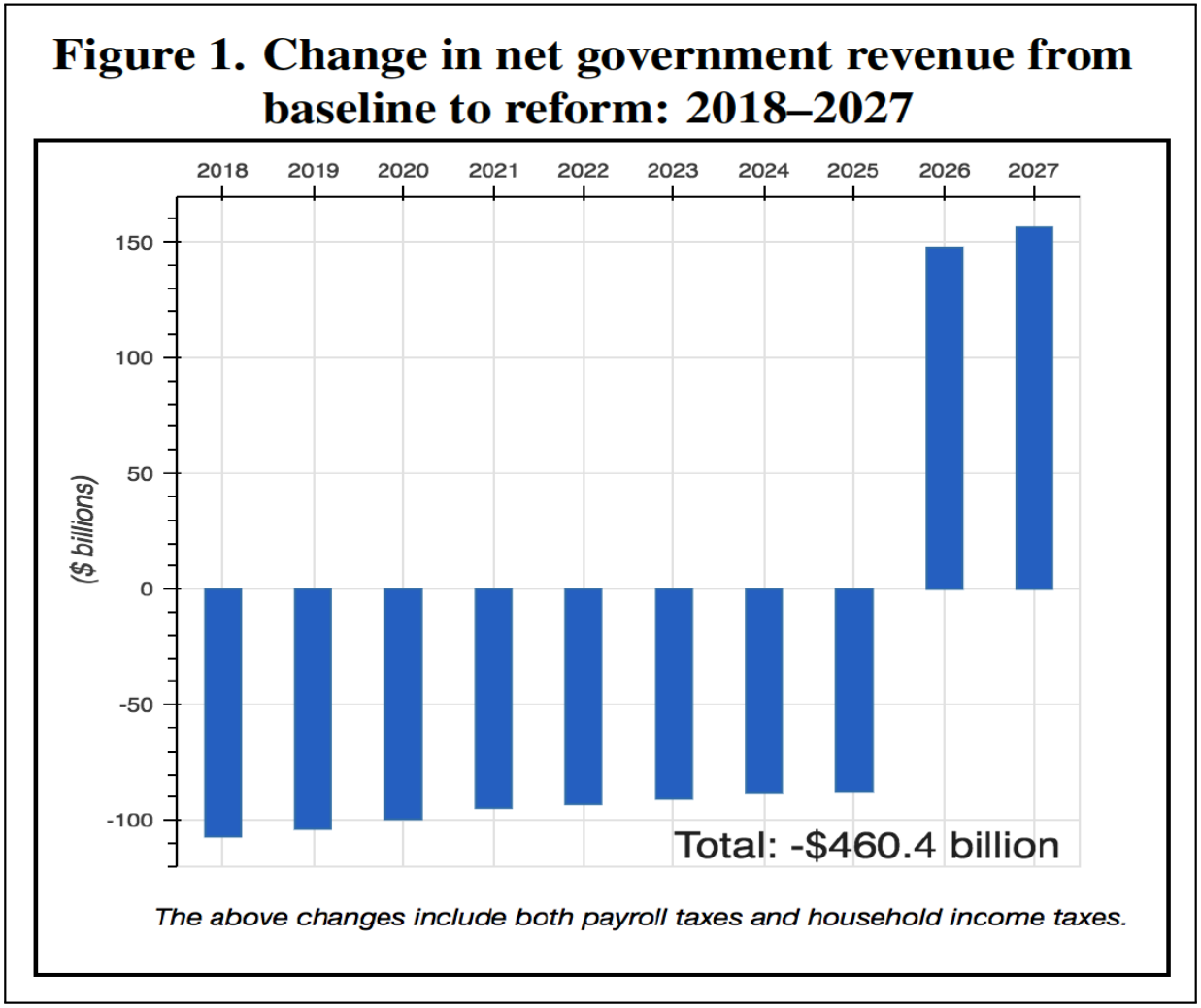
- How does one infer effects?
  - Past data, estimation
  - Simulation, model
- What questions do you care about?
  - underlying population, inequality
  - household savings, labor supply, consumption, income, wealth
  - demographics
  - prices: wages and interest rates
  - macro variables: GDP, employment, capital
  - fiscal variables: gov't revenues, gov't spending, debt-to-GDP

Open Source Policy Center (OSPC)

- Multiple models, decentralized maintainers:
  - Open source code base (here)
  - Web apps for easier access (TaxBrain, CCC)
- Tax-Calculator static simulation (Evans and Ham)
- OG-USA dynamic simulation (DeBacker and Evans)
- Influencing current debate (articles, NYT and CNN datavis)
- Good projects for young researchers

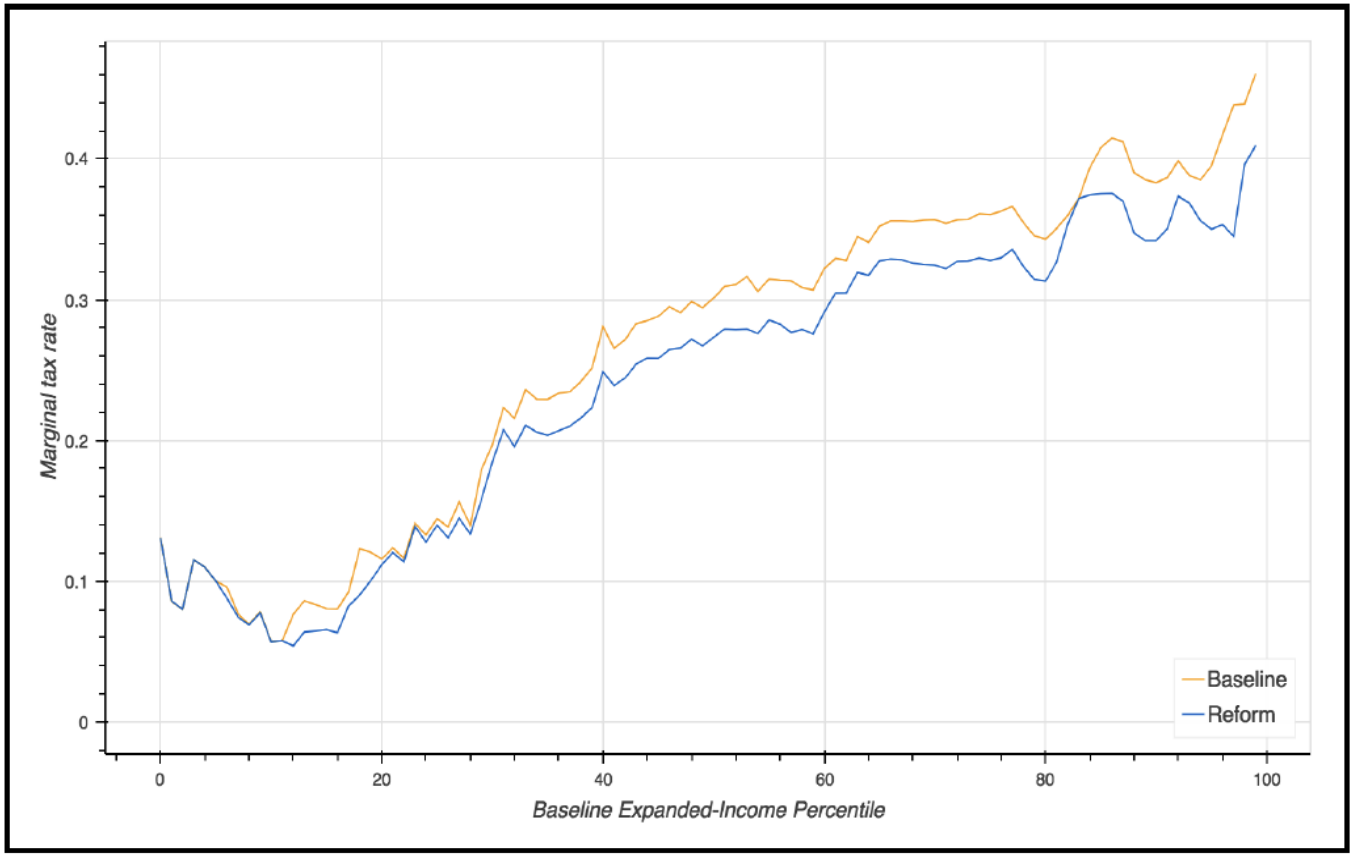
TCJA microsim with Tax-Calculator (Evans and Ham)

- Late November, Senate Finance Chairman's Mark



TCJA microsim with Tax-Calculator (Evans and Ham)

Figure 2. Mean marginal tax rate for primary earner wage income by income percentile: 2018



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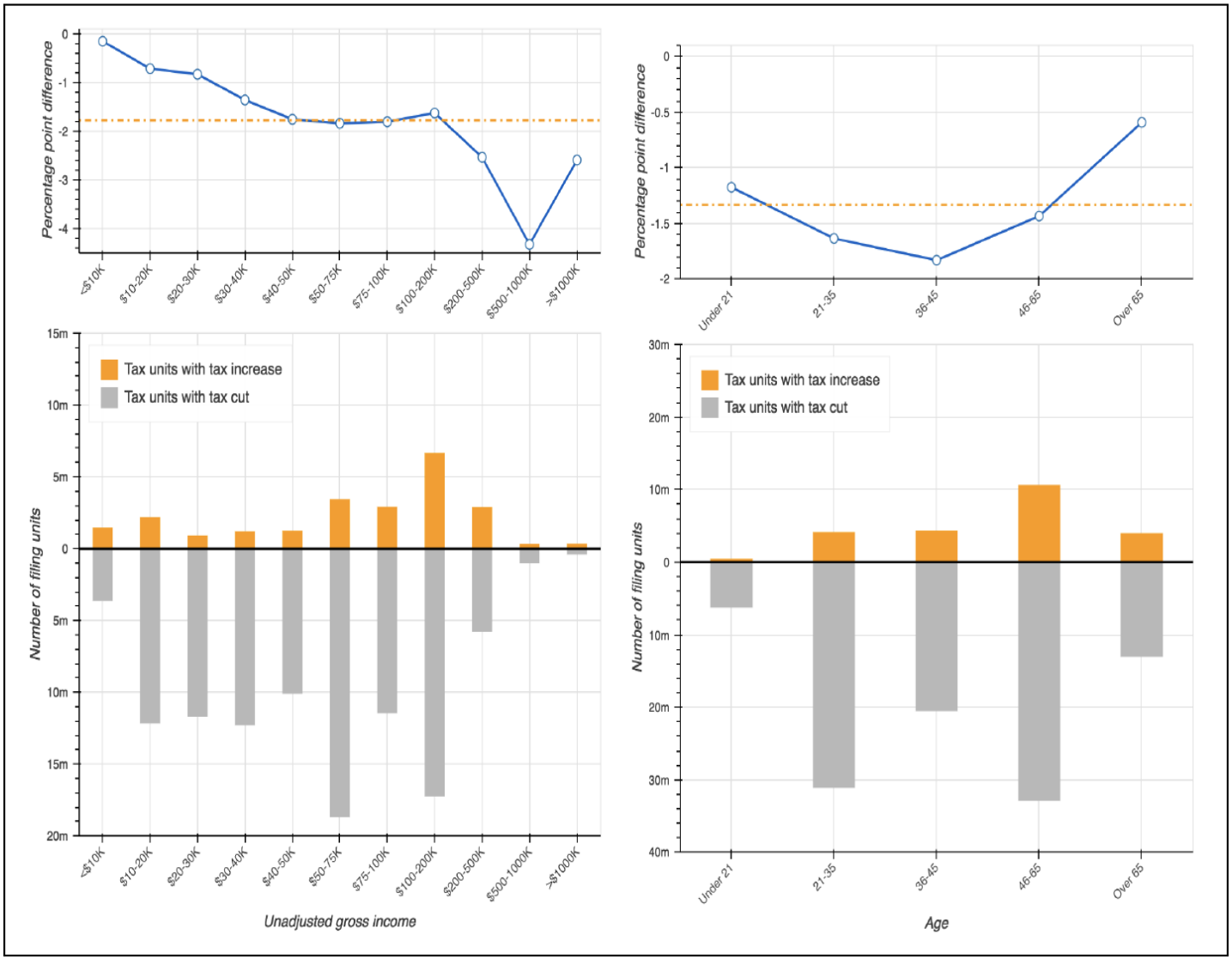

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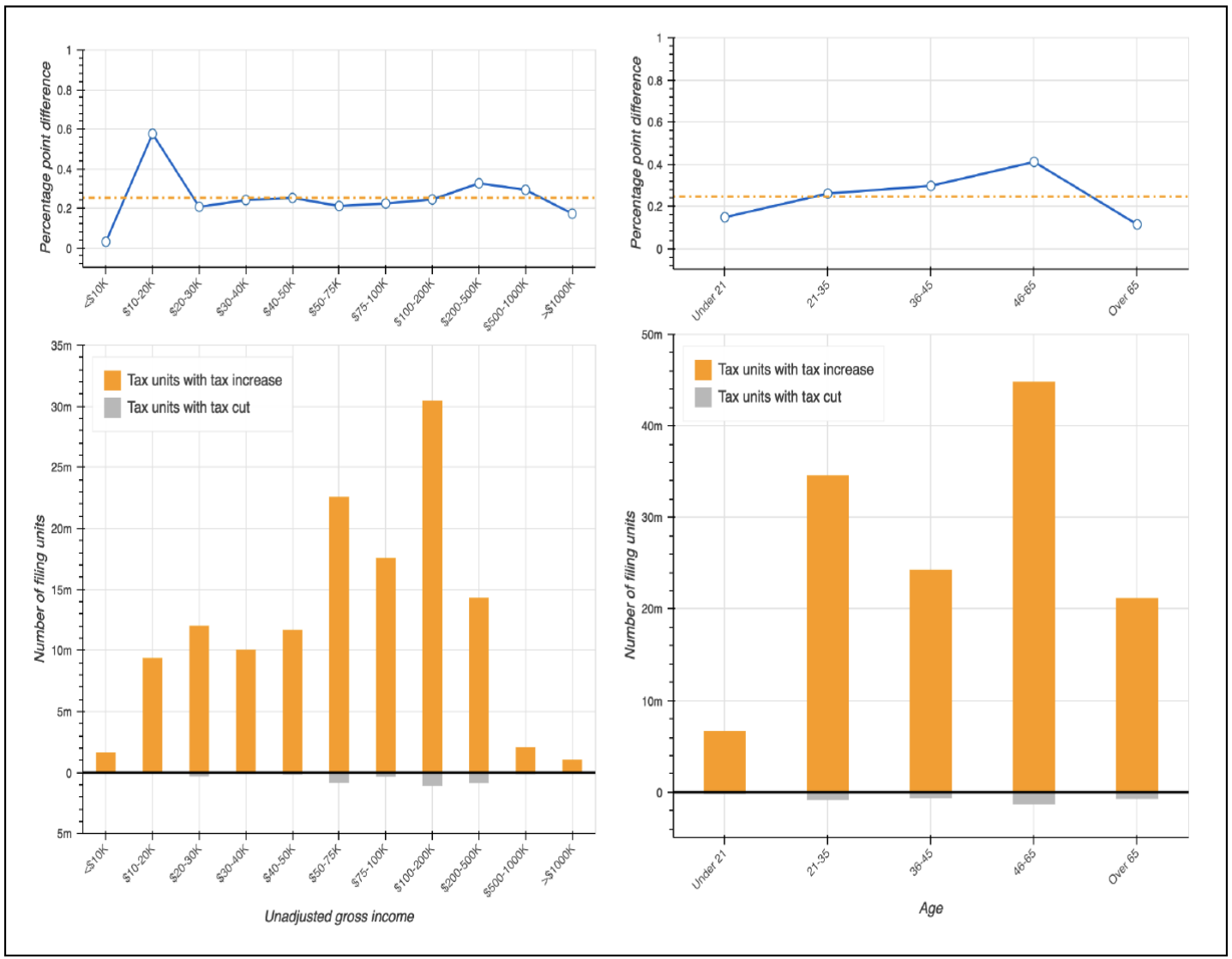


Web app, articles, and NYT and CNN

- TaxBrain web application allows non-economists to play
- large number of articles by NYT, Washington Post, Wall Street Journal
- Dynamic visualizations: NYT and CNN

The Power of Web Apps

- Make specialized models available to nonexperts
- Front-end Django code is also open source
- Leverage cheap computing: AWS, Google Cloud, Azure
- Crowd source policy making

Imagine Illinois

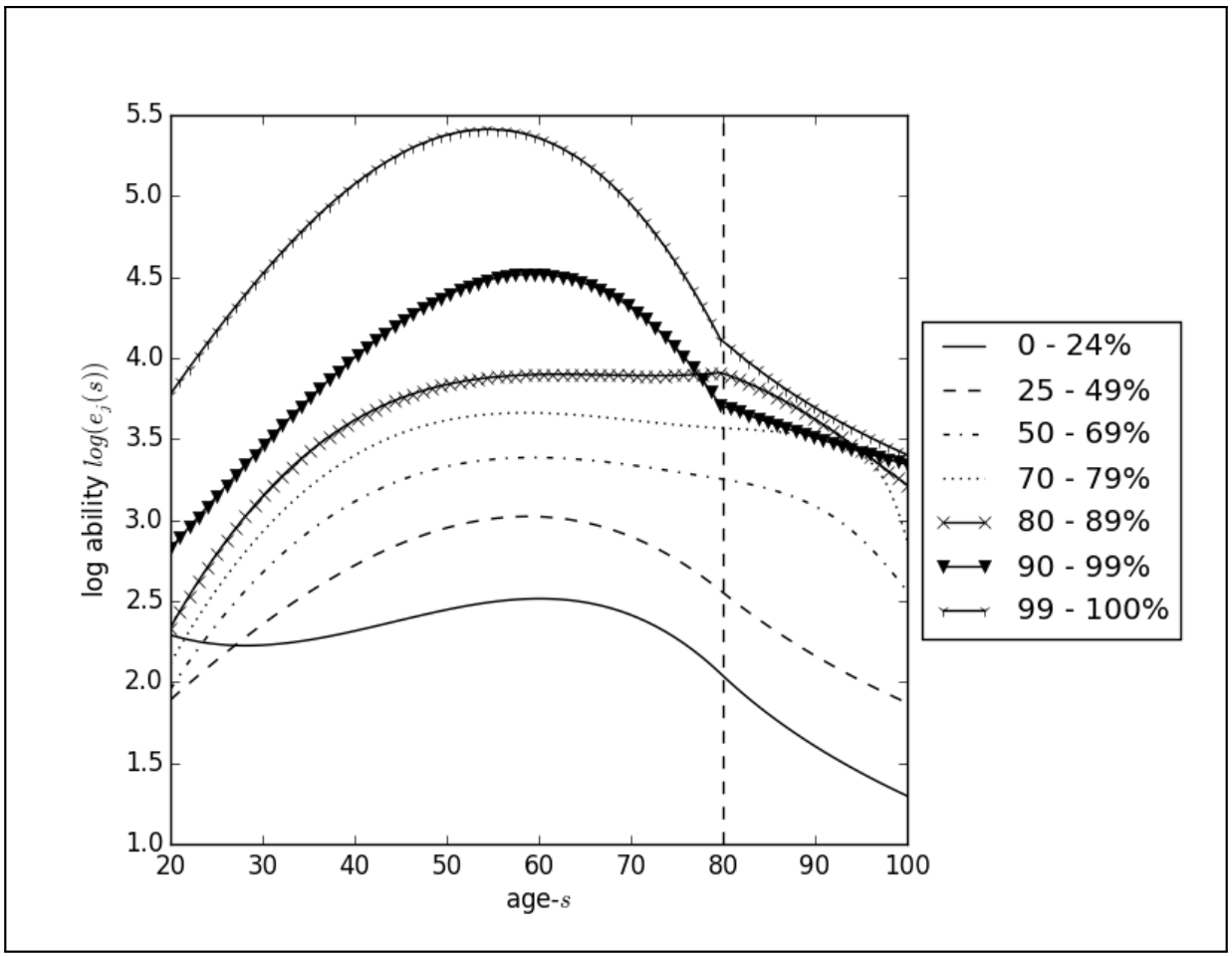
"Fiscal dumpster fire" states (IL, CT, NJ, AZ) could have large numbers of interested individuals coming up with proposals of how to solve fiscal issues.

OG-USA: Summary

- Dynamic general equilibrium
- Age heterogeneity
- Earning heterogeneity
- Demographic dynamics
- Integration of microsimulation taxes
- Bequests
- Corporate taxes
- Productivity growth
- Unbalanced government budget constraint
- Open economy option
- Extensive documentation here

OG-USA: Household earnings ability

$$c_{j,s,t} + b_{j,s+1,t+1} = (1 + r_t)b_{j,s,t} + w_t e_{j,s} n_{j,s,t} + ...$$



OG-USA: Demographics

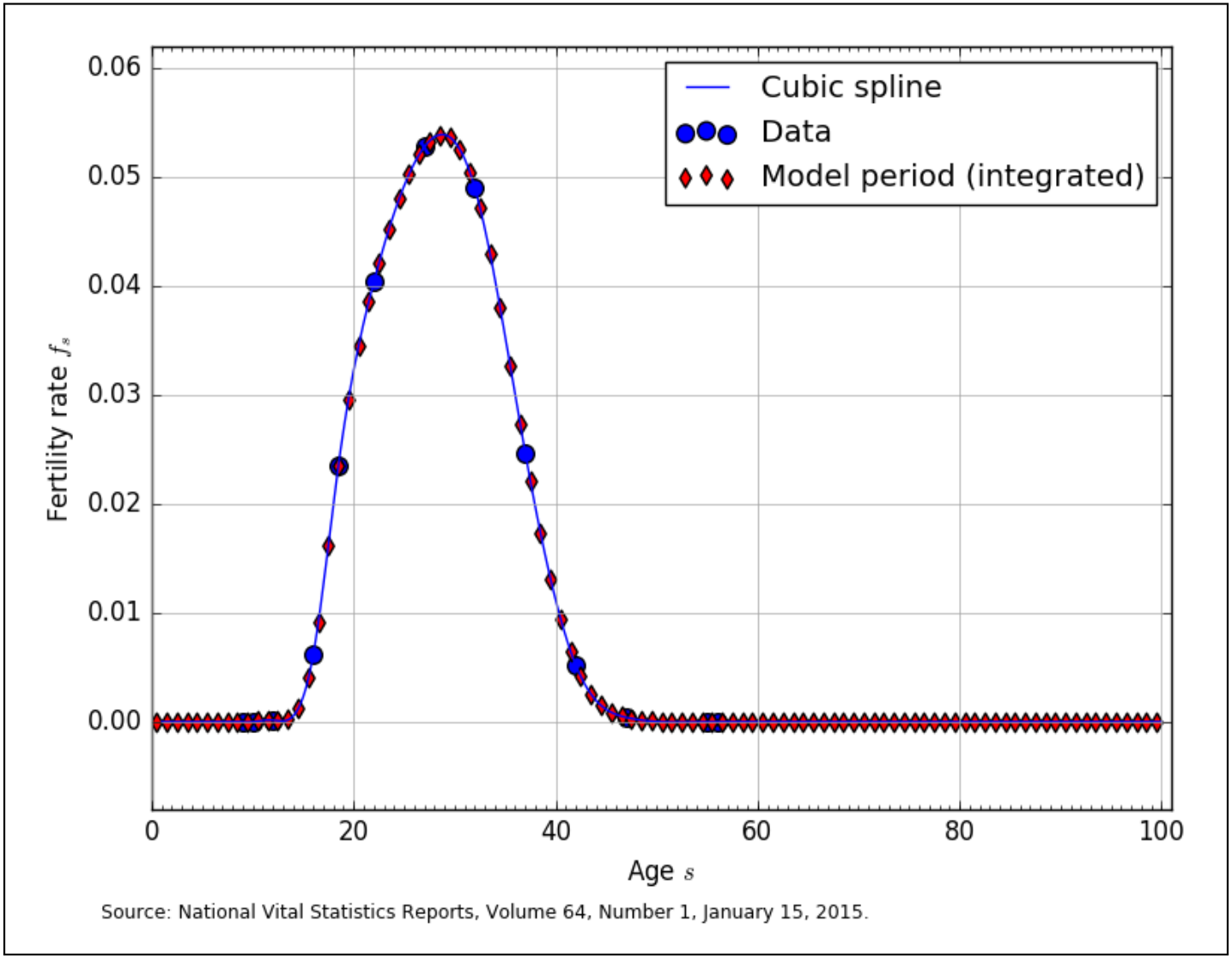
$$\omega_{1,t+1} = (1 - \rho_0) \sum_{s=1}^{E+S} f_s \omega_{s,t} + i_1 \omega_{1,t} \quad \forall t$$

$$\omega_{s+1,t+1} = (1 - \rho_s)\omega_{s,t} + i_{s+1}\omega_{s+1,t} \quad \forall t \quad \text{and} \quad 1 \leq s \leq E + S - 1$$

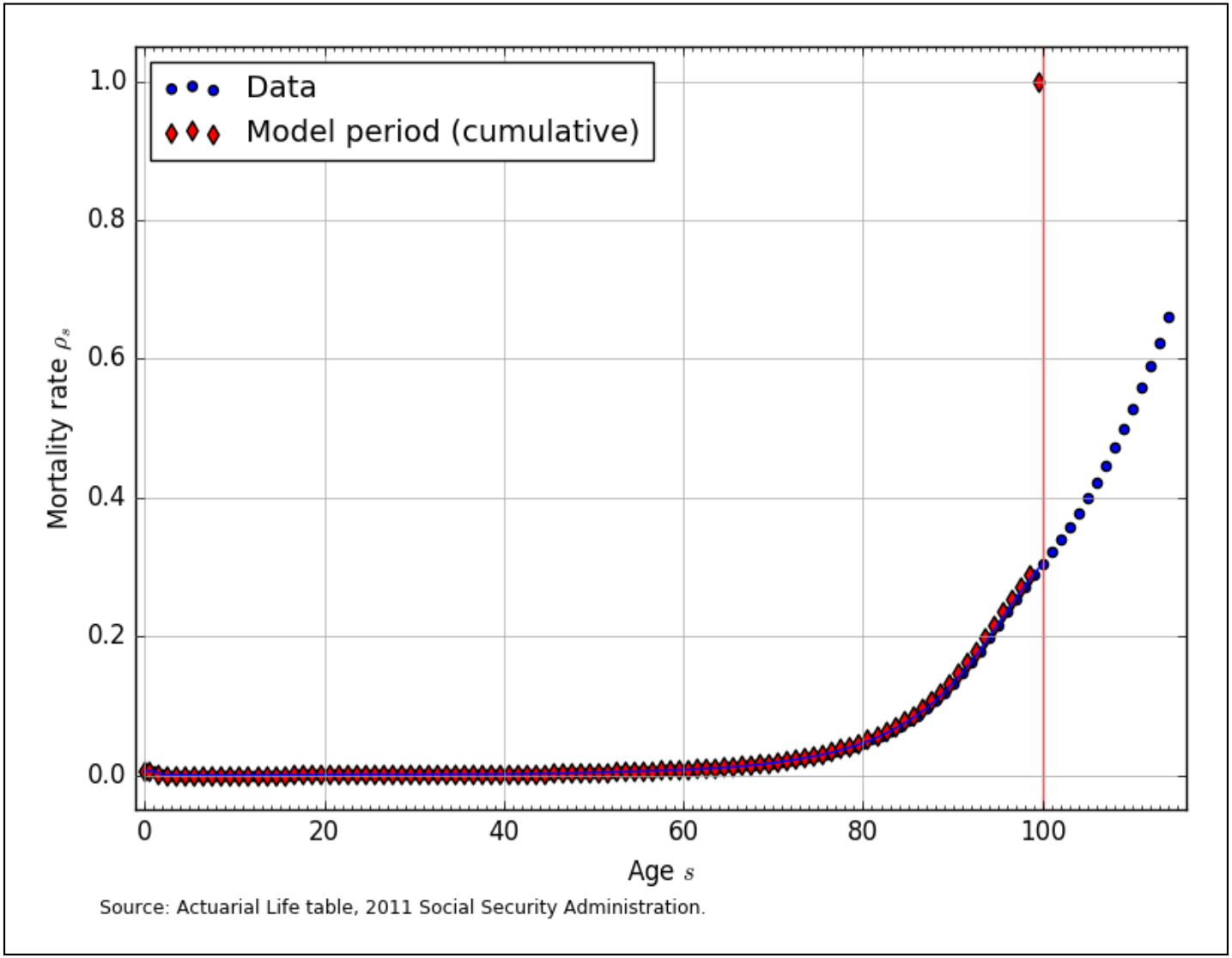
$$N_t \equiv \sum_{s=1}^{E+S} \omega_{s,t} \quad \forall t$$

$$g_{n,t+1} \equiv \frac{N_{t+1}}{N_t} - 1 \quad \forall t$$

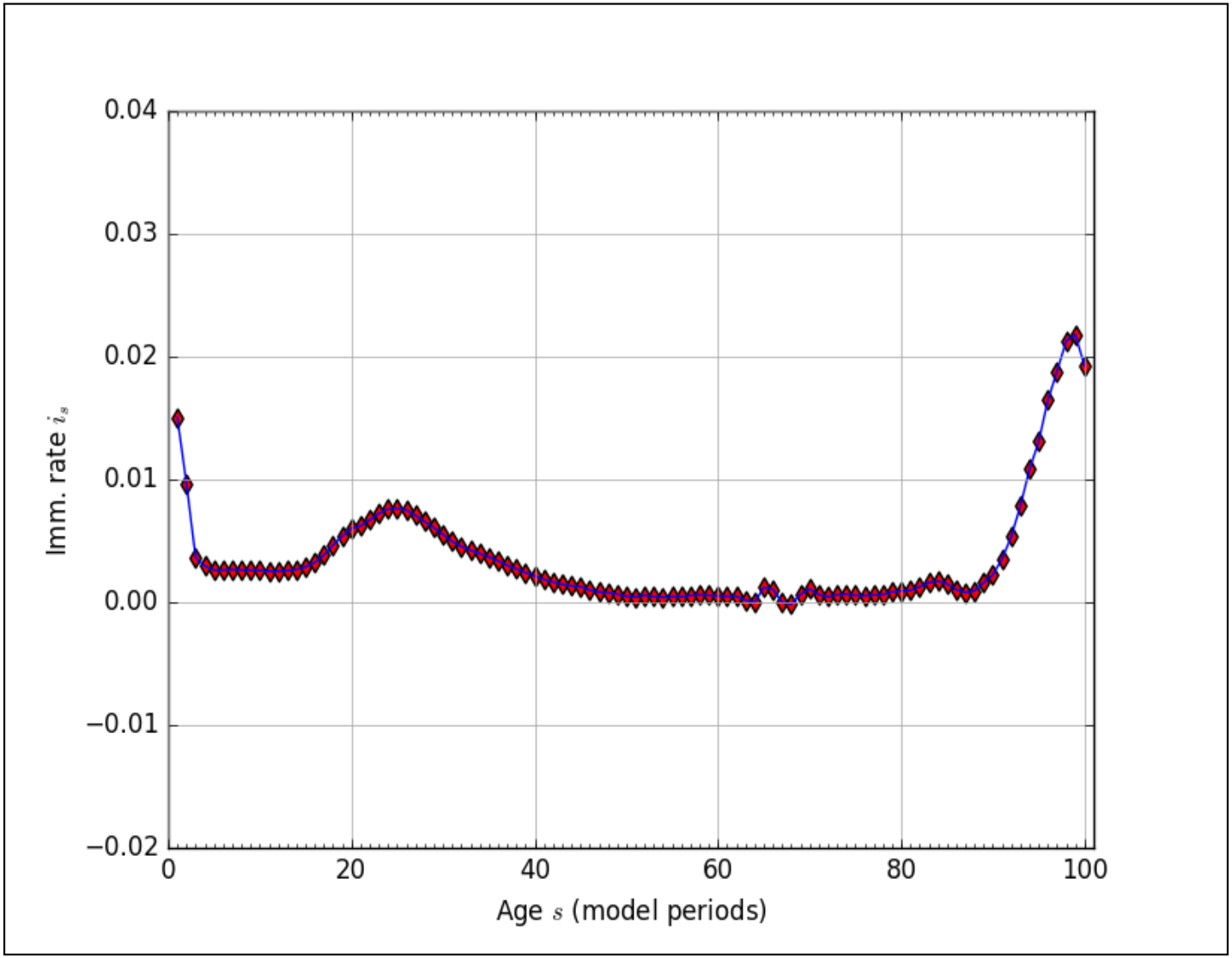
OG-USA: Demographics, fertility rates



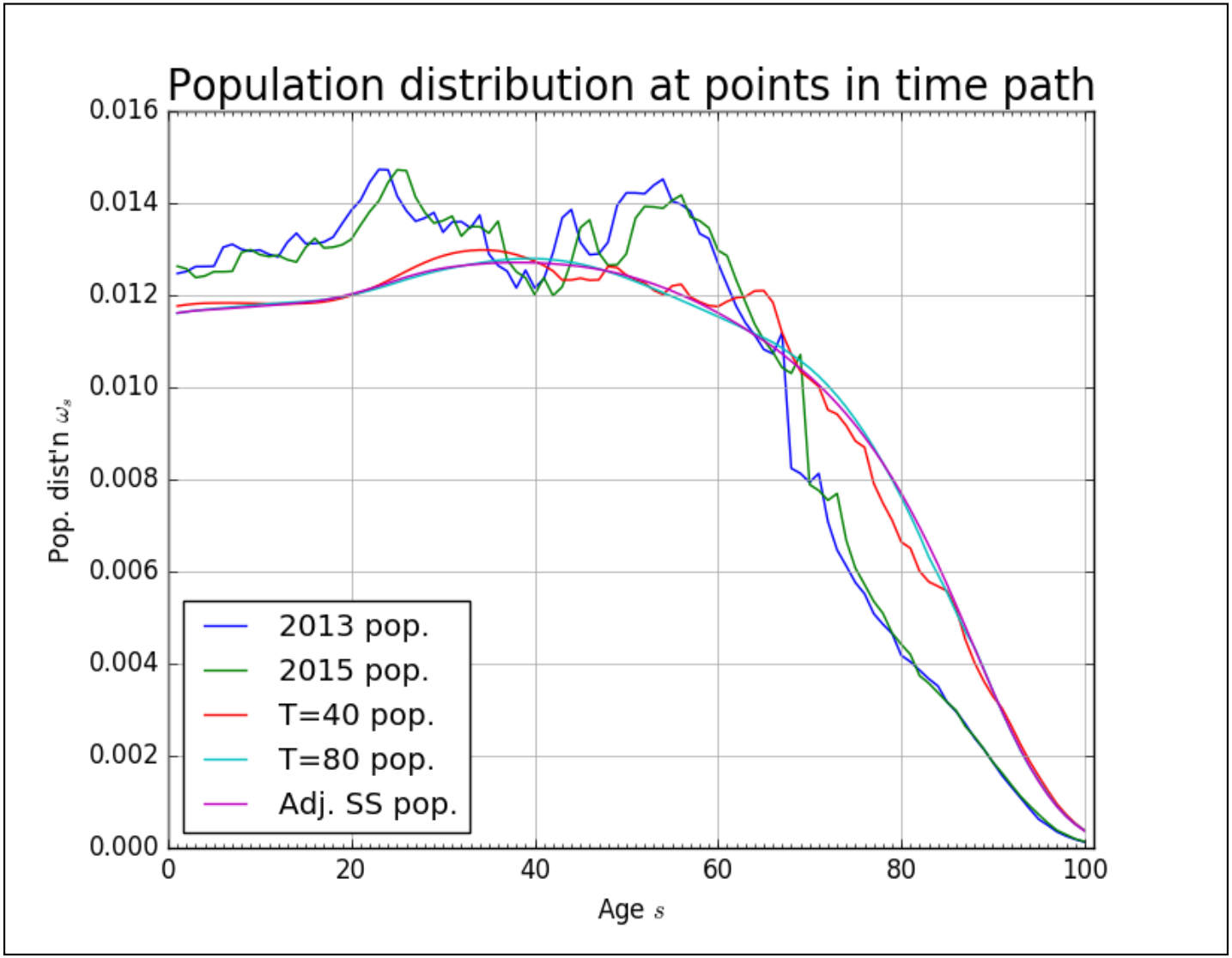
OG-USA: Demographics, mortality rates



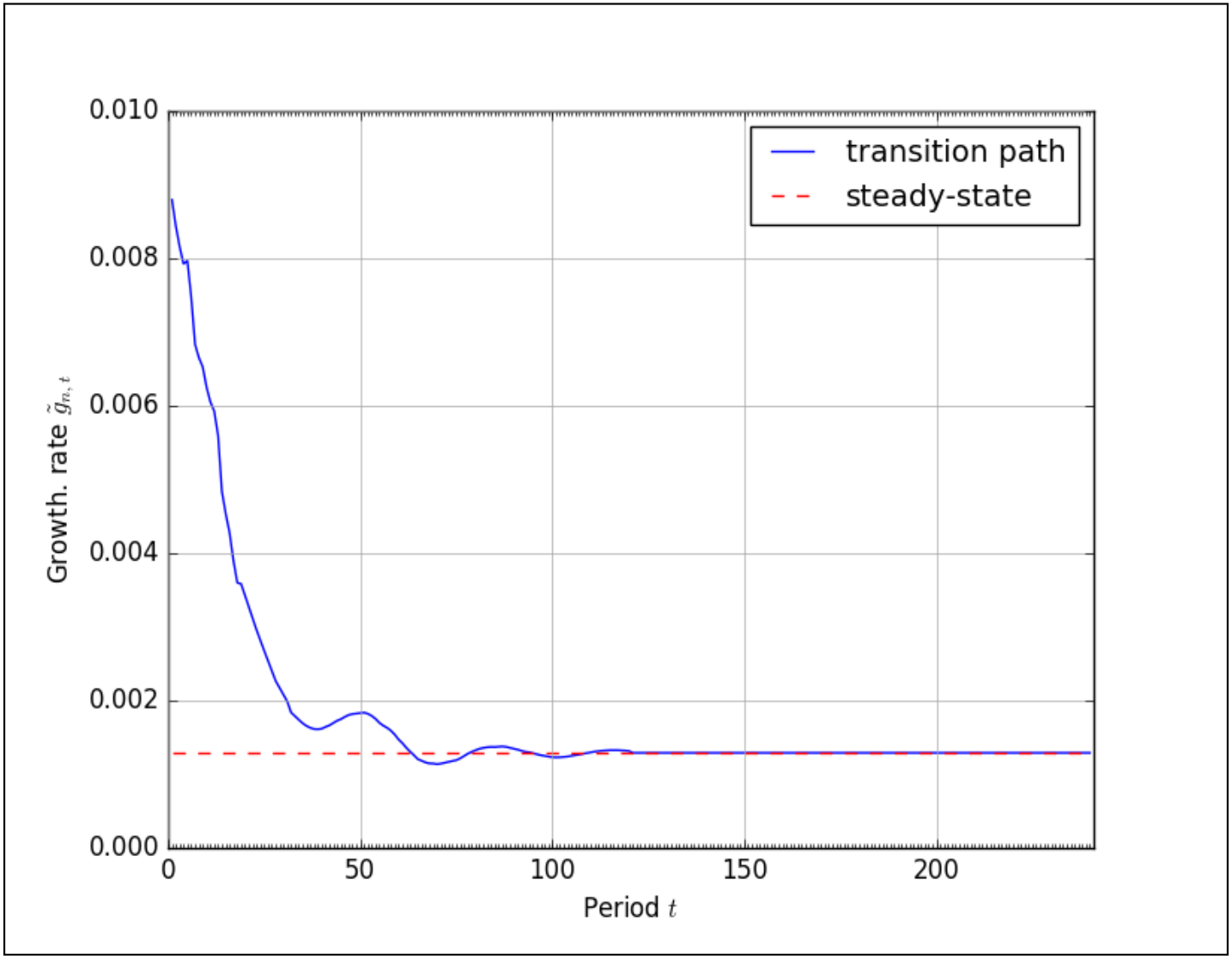
OG-USA: Demographics, immigration rates



OG-USA: Demographics, pop. distribution



OG-USA: Demographics, pop. growth



OG-USA: Tax integration (DeBacker and Evans, 2017)

$$c_{j,s,t} + b_{j,s+1,t+1} = (1 + r_t)b_{j,s,t} + w_t e_{j,s} n_{j,s,t} + \zeta_{j,s}\frac{BQ_t}{\lambda_j \omega_{s,t}} + \eta_{j,s,t}\frac{TR_t}{\lambda_j \omega_{s,t}} - T_{s,t}$$

$$\forall j, t \quad \text{and} \quad s \geq E + 1 \quad \text{where} \quad b_{j,E+1,t} = 0 \quad \forall j, t$$

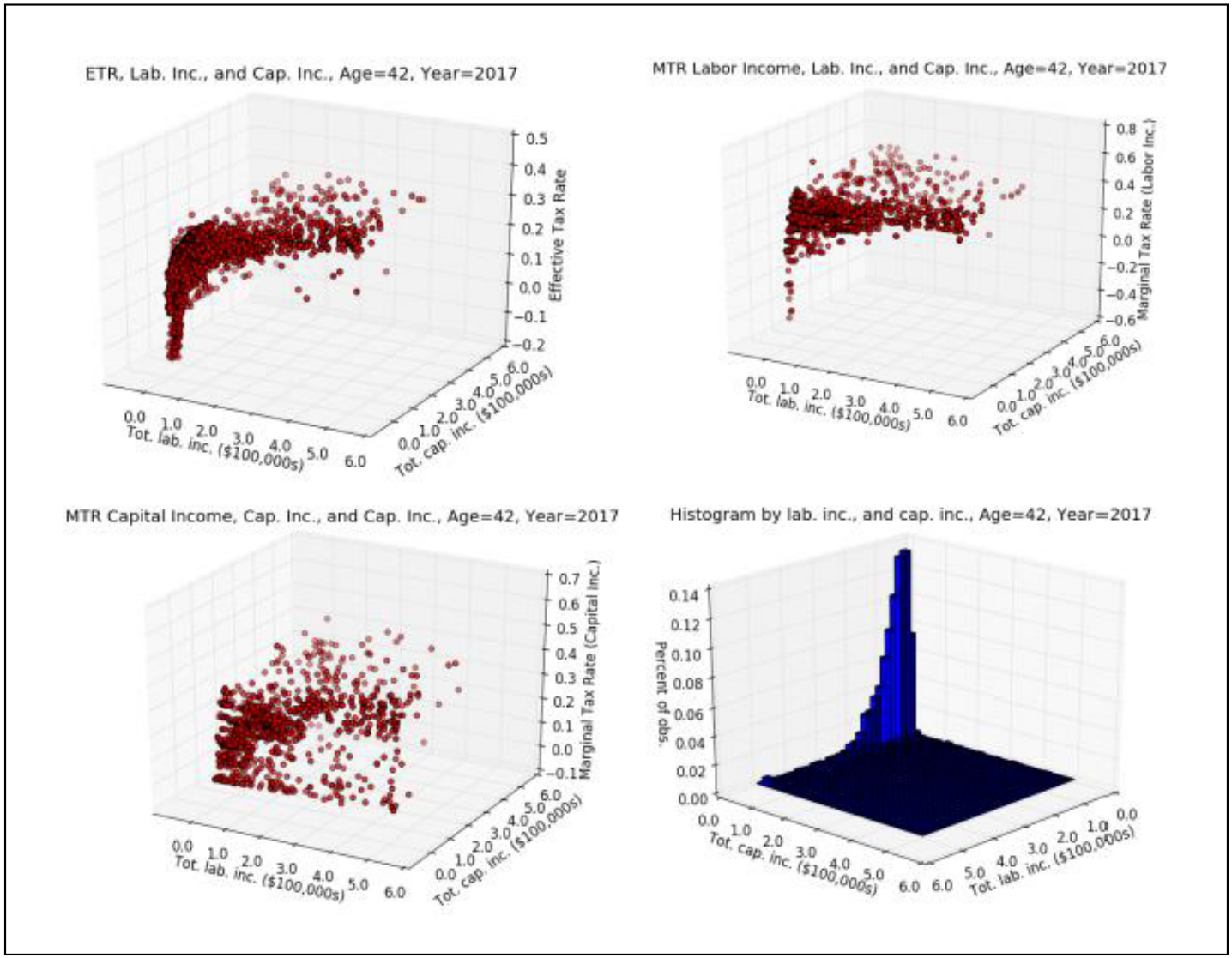
$$w_t e_{j,s}\left(1 - \tau_{s,t}^{mtrx}\right)\left(c_{j,s,t}\right)^{-\sigma} = e^{g_y(1-\sigma)}\chi_s^n\left(\frac{b}{\tilde{l}}\right)\left(\frac{n_{j,s,t}}{\tilde{l}}\right)^{\upsilon-1}\left[1 - \left(\frac{n_{j,s,t}}{\tilde{l}}\right)^{\upsilon}\right]^{\frac{1-\upsilon}{\upsilon}}$$

$$\forall j, t, \quad \text{and} \quad E + 1 \leq s \leq E + S$$

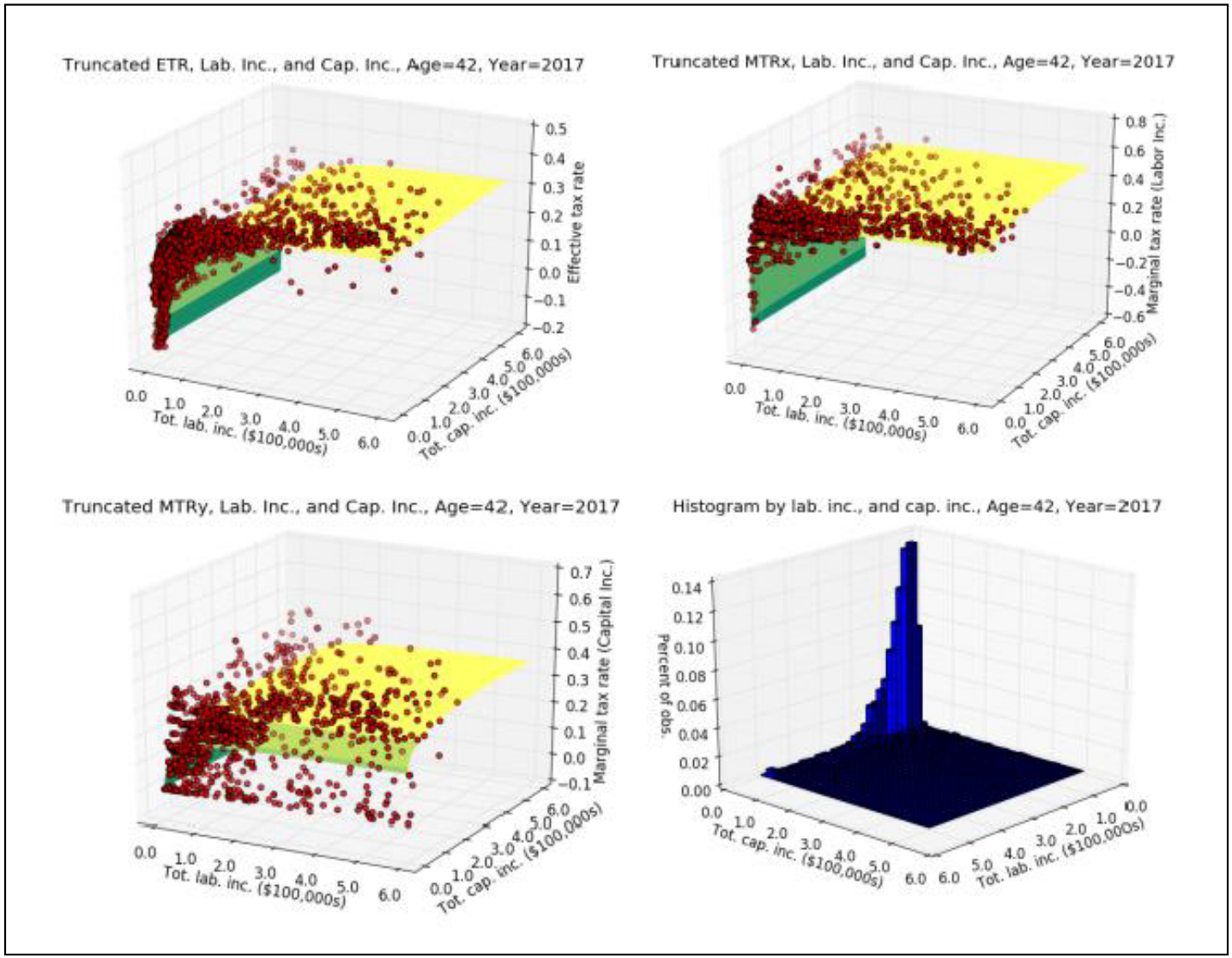
$$\left(c_{j,s,t}\right)^{-\sigma} = \chi_j^b \rho_s \left(b_{j,s+1,t+1}\right)^{-\sigma} + \beta\left(1 - \rho_s\right)\left(1 + r_{t+1}\left[1 - \tau_{s+1,t+1}^{mtry}\right]\right)\left(c_{j,s+1,t+1}\right)^{-\sigma}$$

$$\forall j, t, \quad \text{and} \quad E + 1 \leq s \leq E + S - 1$$

OG-USA: Tax integration, 42-yr-old, 2017



OG-USA: Tax integration, 42-yr-old, 2017



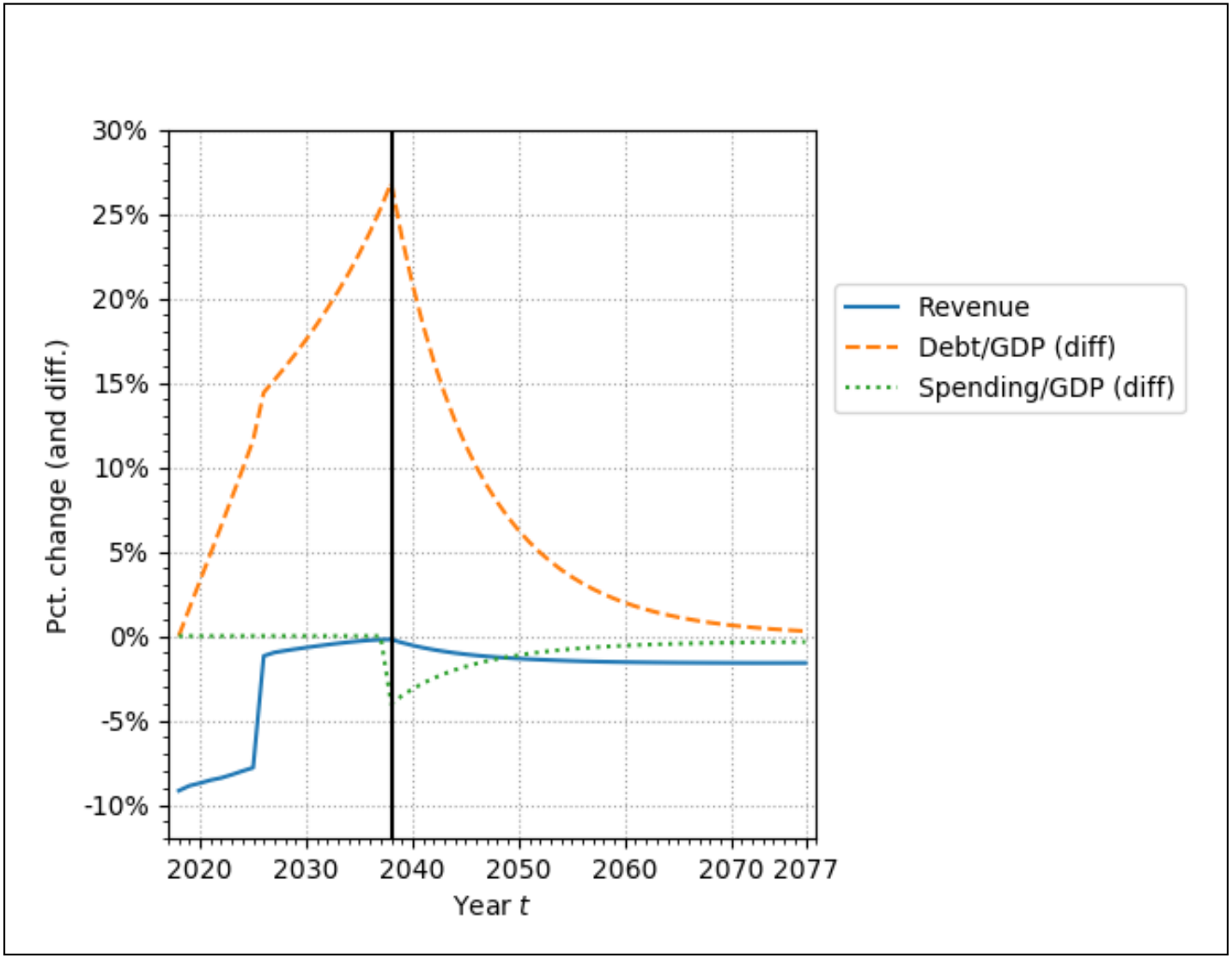
OG-USA: Dynamic analysis of TCJA

- Simulate effects of TCJA in DGE model
  - Includes effects on w_t, r_t, Y_t, D_t

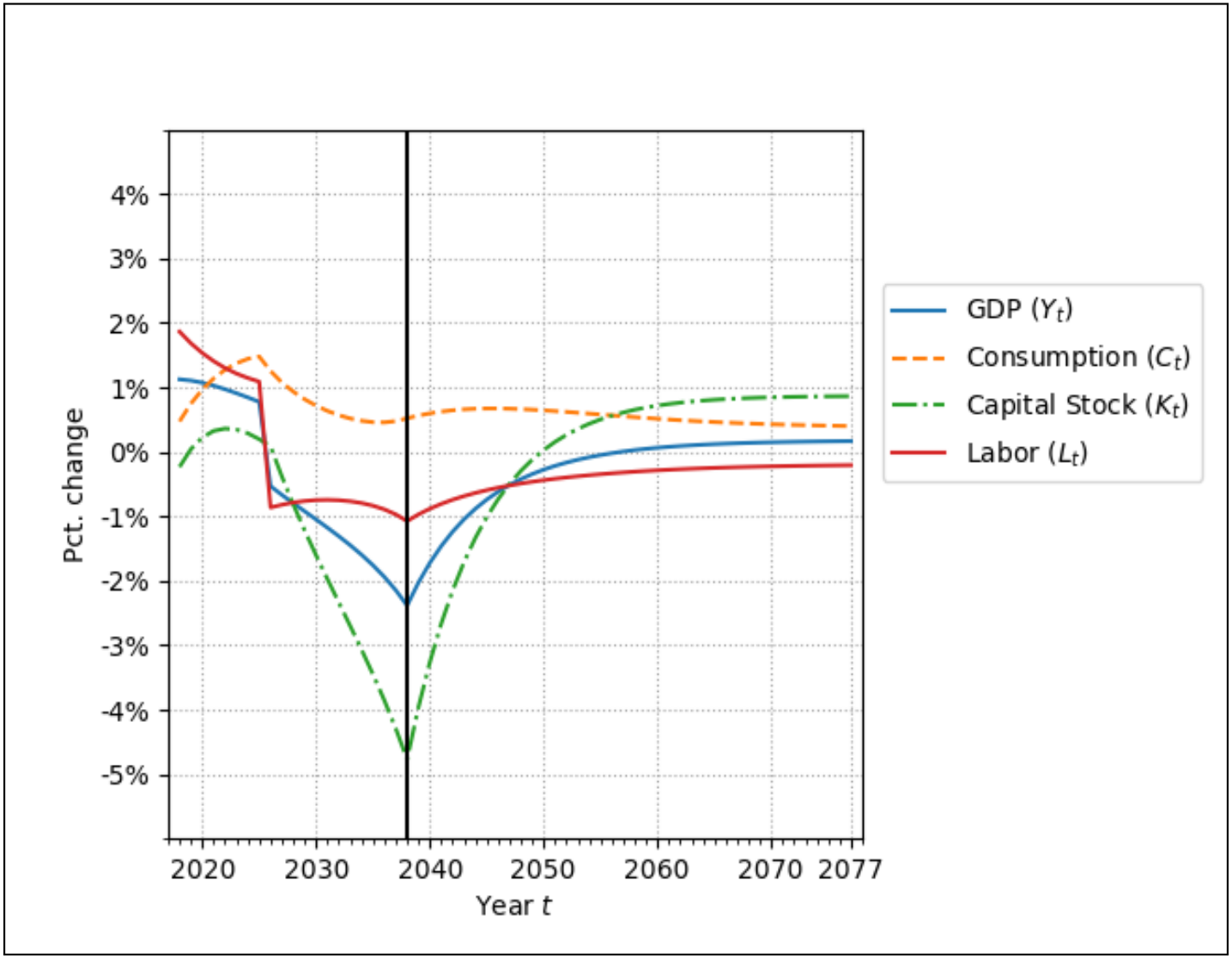
Findings

- GDP growth between 1% and 2% in first 8 years
  - Growth mainly from increased labor supply
- Increasing debt-to-GDP quickly crowds out investment and capital accumulation
- wage growth ranges from negative to small
- international capital flow assumption is critical

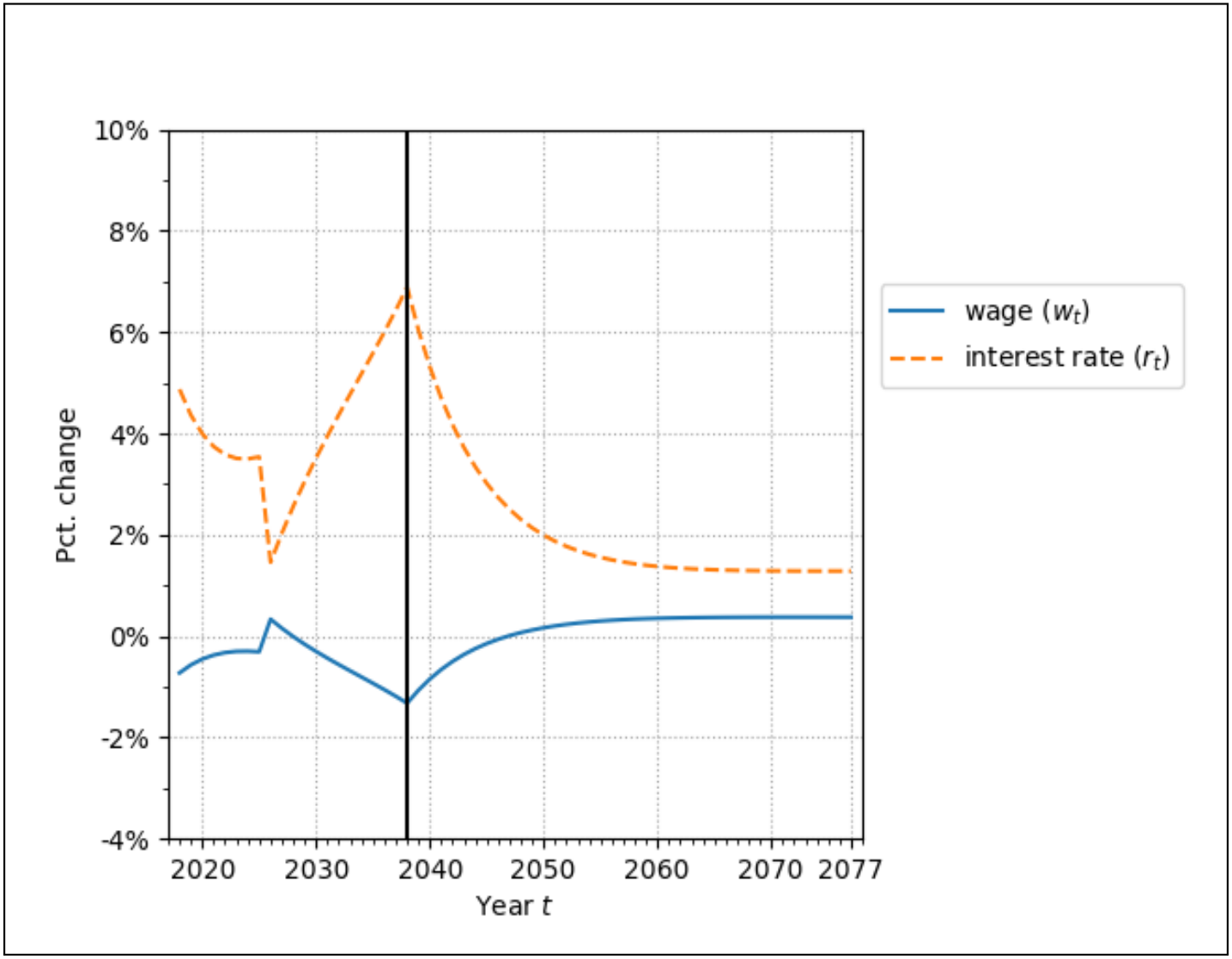
OG-USA: TCJA, fiscal vars., closed econ.



OG-USA: TCJA, macro vars., closed econ.



OG-USA: TCJA, price vars., closed econ.



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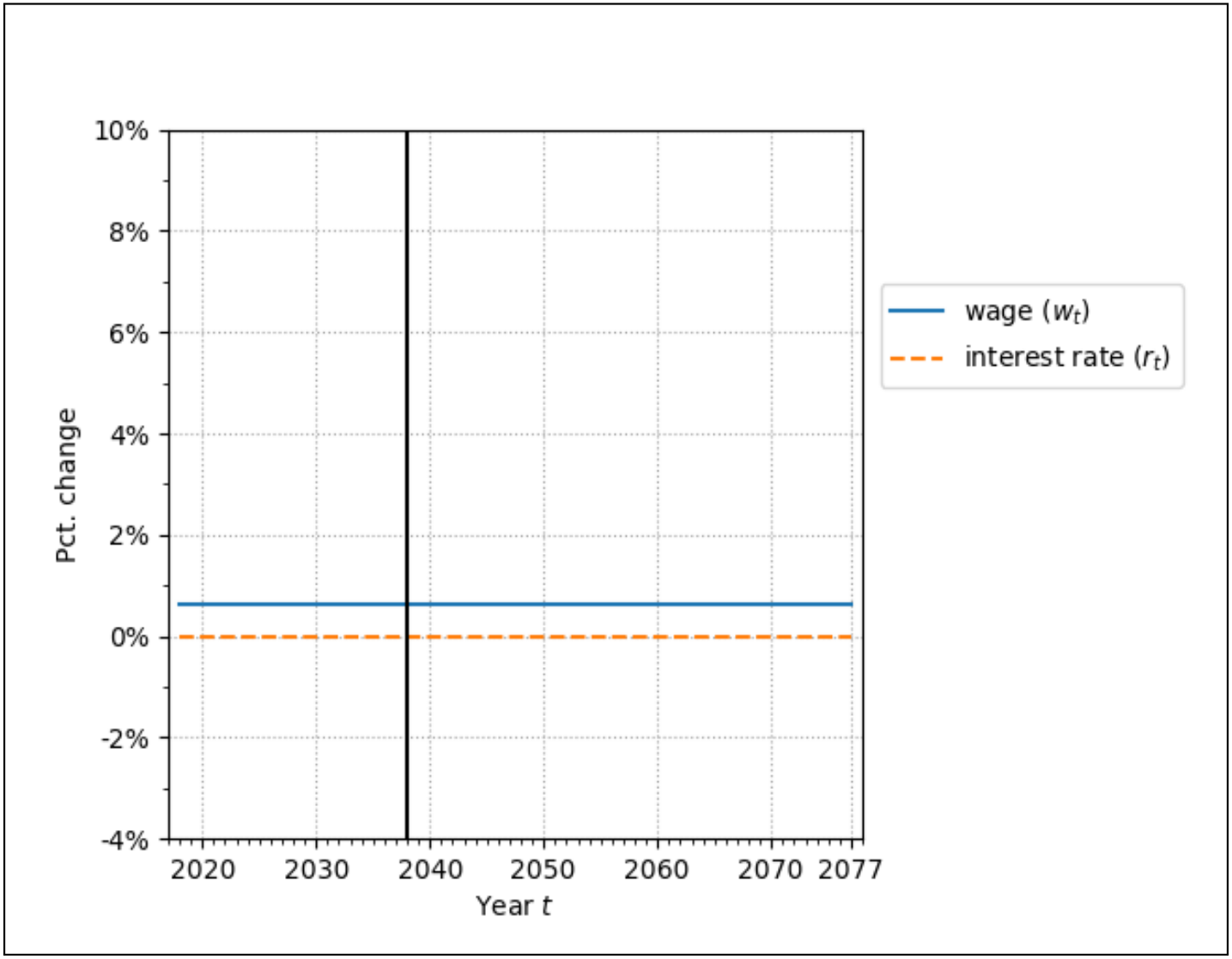

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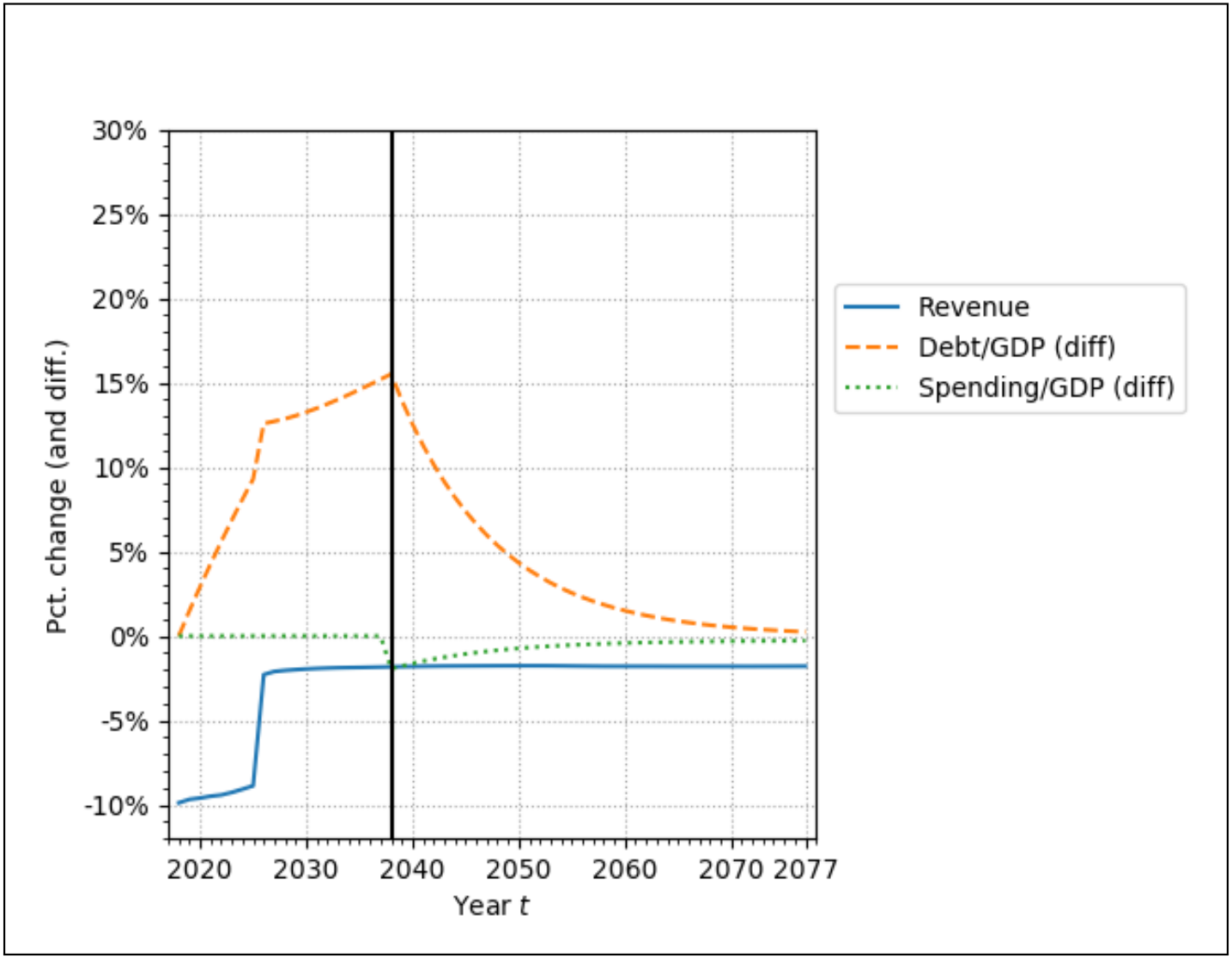

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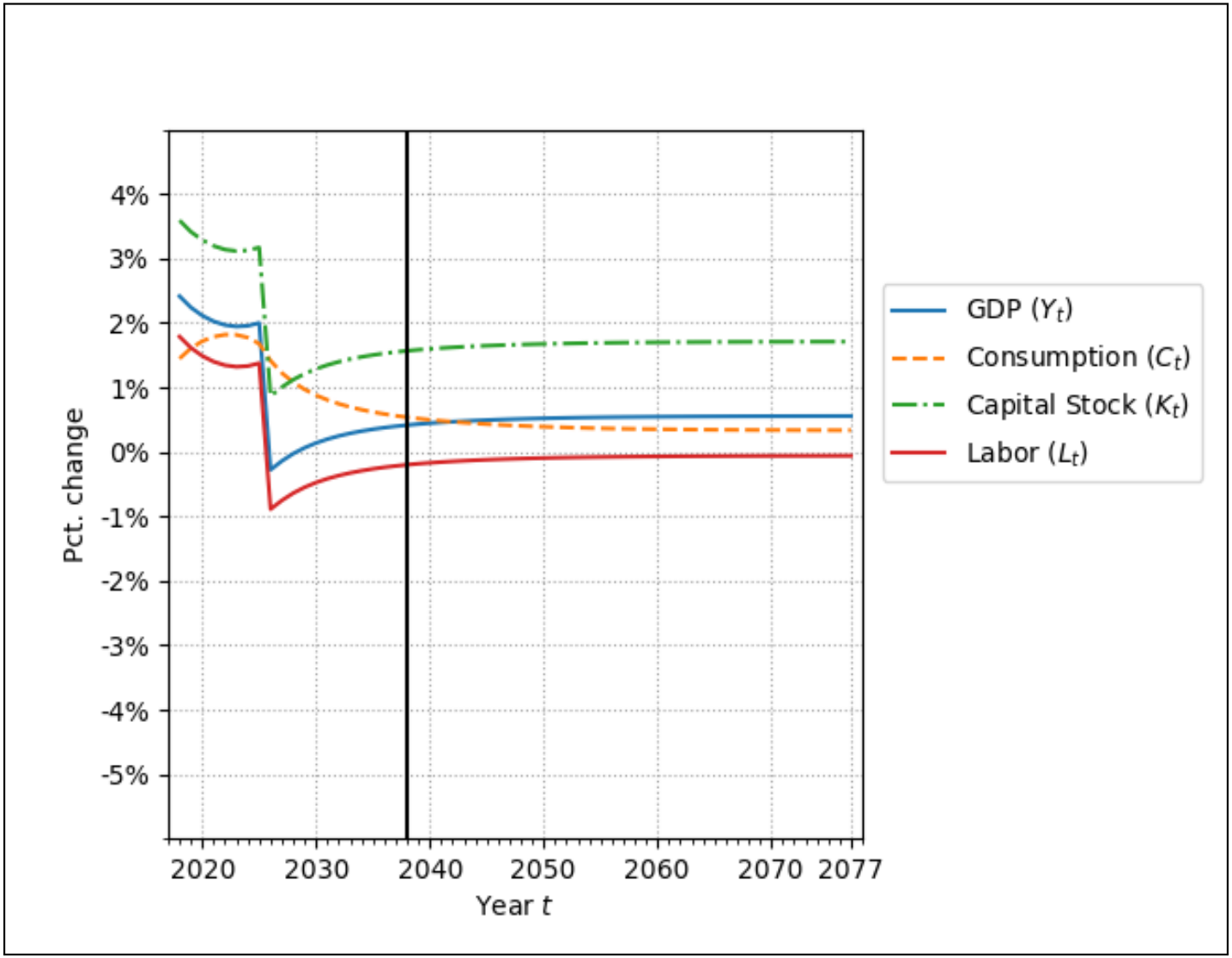

Open Source benefits researchResearch

- collaboration
  - Hierarchical permission structure of git
  - Look at OG-USA issue #234
  - Look at OG-USA closed PR #337
- dissemination
- attribution
  - `git blame`: Show what revision and author last modified each line of a file
  - Contributor pages as resume
  - Contributor list
- replication
- sensitivity analysis
- transparency
- You're always backed up

Open curriculum

Key principles

- Open access
- Open to collaborative input/improvement
- Use open language (Python, Julia, R)

Key resources and tools

- Open Source Macroeconomics Laboratory (OSM Lab)
- QuantEcon
- Jupyter notebooks
  - QuantEcon notebook library
- SphinxContrib-Jupyter

Summary

- Open source modeling is a philosophical imperative for official models.
- Open source workflow and platforms facilitate collaboration, dissemination, attribution, replication, sensitivity analysis, and transparency
- Open source curriculum is a powerful teaching tool and marketing tool

Questions and arguments

- If I make my code open source, someone will steal my research idea.
- How can open source projects move forward if data is proprietary or protected?
- I can't make money off my software if I make it open source.

Open source legislation

- Congressman proposes general framework of bill and designates who has merge rights
- Anyone who wants to add anything submits a PR.
  - Congressional staff, lobbyists, corporations, think tanks, yeoman citizen activists
- How sweet would `git blame` be!