Modeling Tax Policy

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India Department of Revenue and World Bank
April 30, 2018

Website for the Training

GitHub repository

https://github.com/OpenRG/WB-India

- Tutorial, setup instructions
- Textbook chapters
- In-class code
- Optimized code

Schedule: Next two weeks

Date	Day	Topic	Notes
Apr 30	M	Intro session, office hours, computational setup	Slides
May 1	T	3-period-lived OG model	Ch. 2
May 2	W	S-period-lived OG model	Ch. 3
May 3	Th	Endogenous labor supply	Ch. 4
May 4	F	Heterogeneous ability, wealth inequality	Ch. 5
May 7	M	Demographic dynamics	Ch. 7
May 8	T	Productivity growth and stationarization	Ch. 7
May 9	W	Household and corporate taxation	Ch. 11
May 10	Th	Unbalanced government budget constraint	Ch. 12
May 11	F	Running a large-scale model	

Each day: 9am-noon, lunch, 1pm-4pm

Schedule: Today (Day 1)

9:00-9:30am	Introductions, meet the group
9:30-10:30am	Tax models overview, static models
10:45-11:45am	Dynamic models
1:00-2:30pm	Office hours, individual visits
2:30-4:00pm	Technical setup

What you should leave with

- Awareness of various tax modeling frameworks
- Access to microsimulation model resources
- Ability to write Python code for dynamic analysis model
- Ability to use Git and GitHub collaboration and version control platform
- Ability to run full dynamic analysis software suite
- Access to DeBacker and Evans for further development

What do we want from our models?

- Revenue estimates/Receipts forecasts
  - How much revenue do we raise with this policy?
- Distributional analysis
  - How does this policy affect the after-tax income of individuals?
- Macroeconomic impact
  - How does this policy affect the economy (GDP, employment, etc.)?

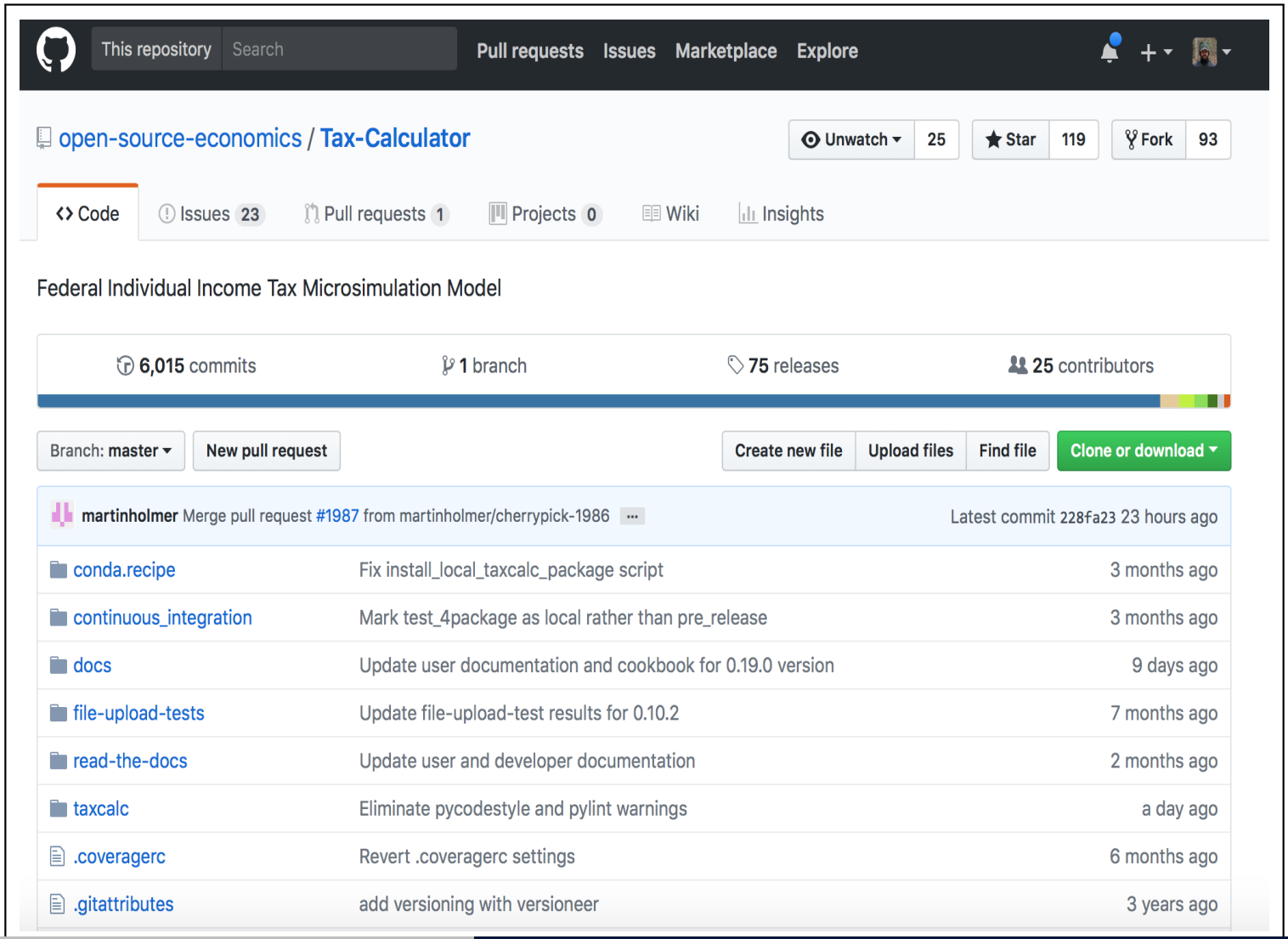
Who has models of tax policy in the U.S.?

- Legislative Branch
  - Joint Committee on Taxation (JCT)
    - Official "scorekeeper" for tax legislation
  - Congressional Budget Office (CBO)
- Executive Branch
  - Treasury's Office of Tax Analysis (OTA)
- Private Sector
  - Think tanks
  - Consulting firms

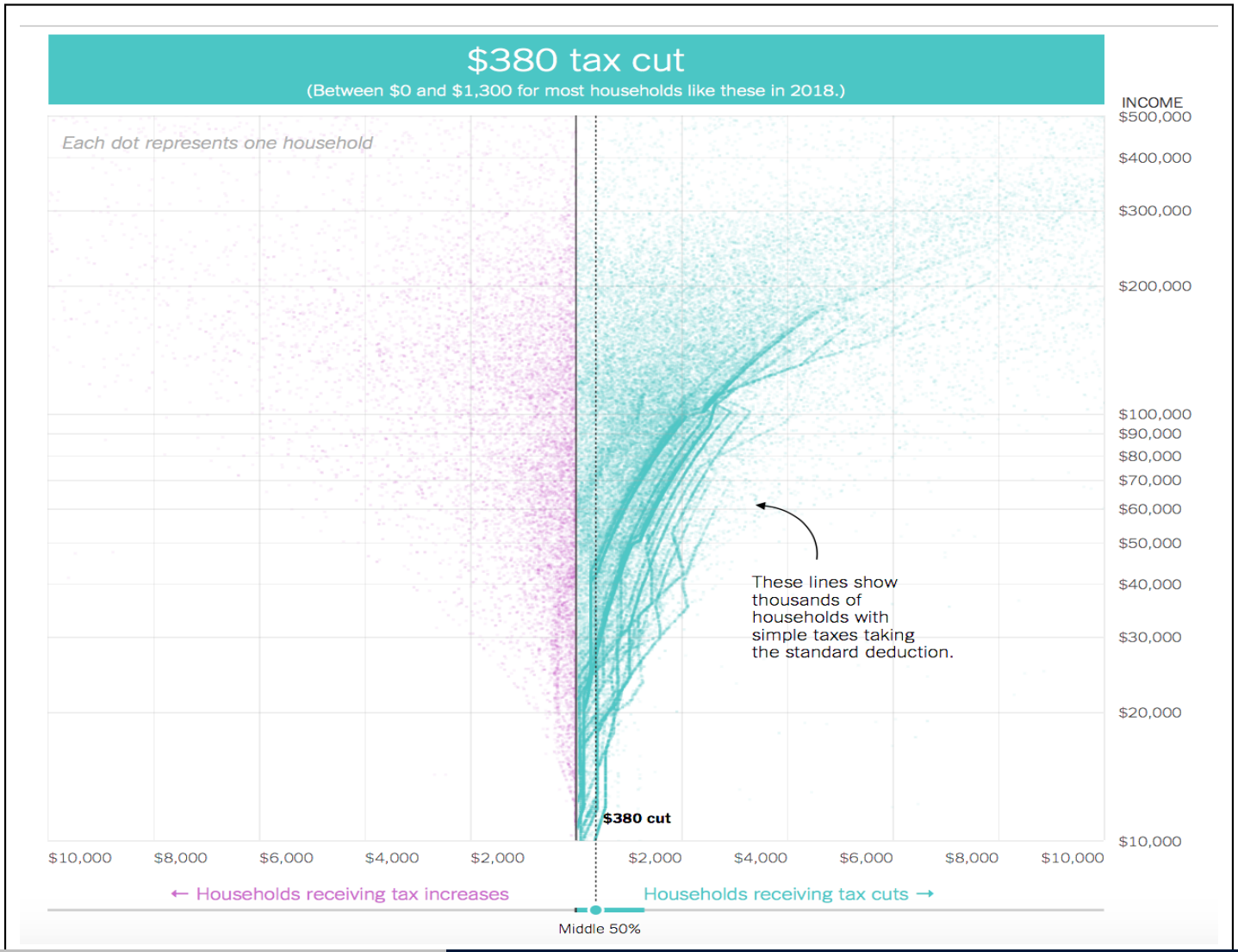
Types of Tax Models used in the U.S.

- Microsimulation
  - Individual income taxes
  - Corporate income taxes
- Macro-econometric
- Structural macro
  - e.g., CGE/OG models
- Cost of capital calculators
- Specialized:
  - Excise taxes
  - Healthcare taxes
  - Estate and gift taxes

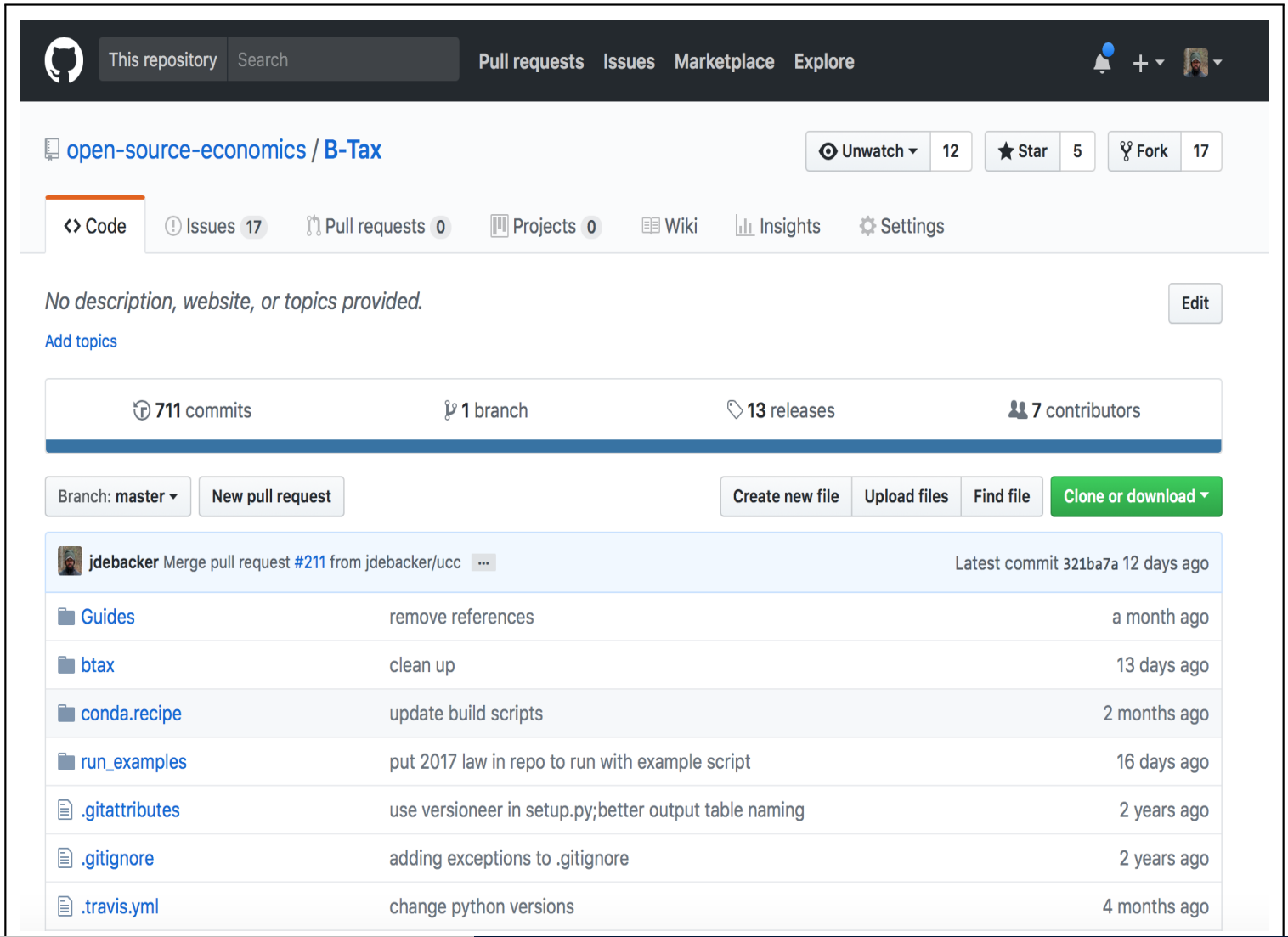
Tax-Calculator



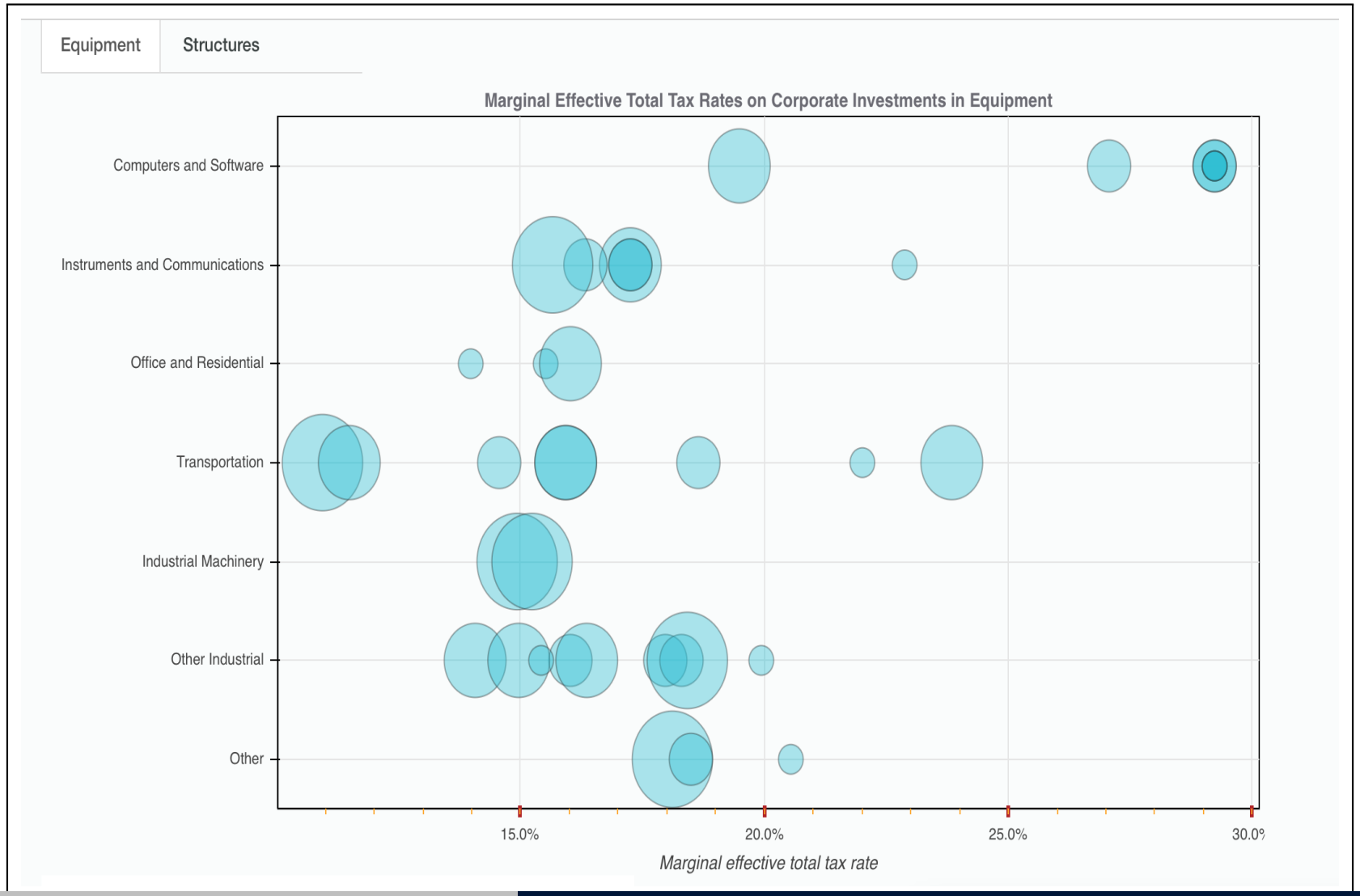
Tax-Calculator



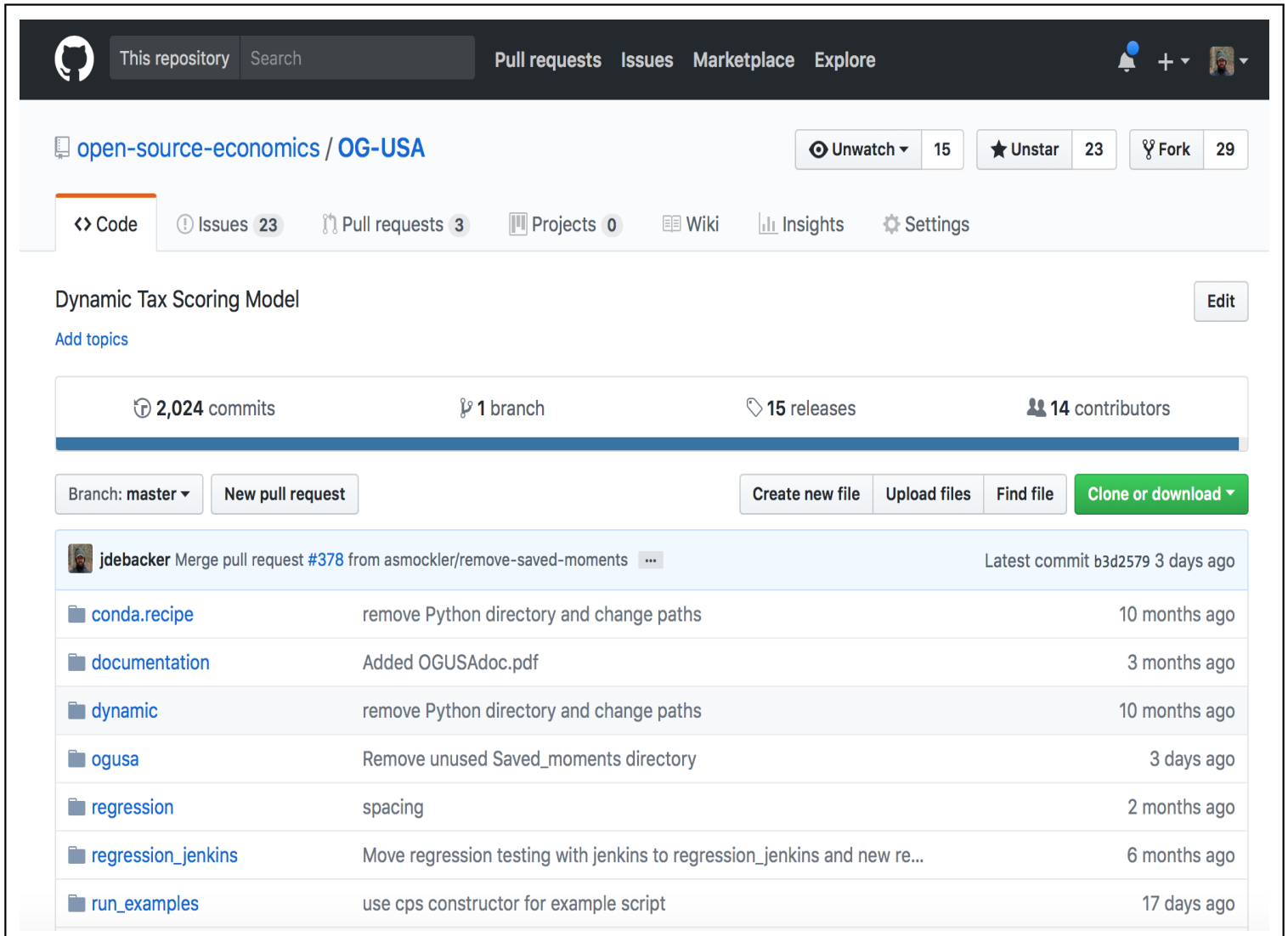
B-Tax: A Cost of Capital Model



B-Tax


Equipment
Structures
Marginal Effective Total Tax Rates on Corporate Investments in Equipment
Computers and Software
Instruments and Communications
Office and Residential
Transportation
Industrial Machinery
Other Industrial
Other
15.0%
20.0%
25.0%
30.0%
Marginal effective total tax rate

OG-USA


This repository Search
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Unwatch 15
Unstar 23
Fork 29
Code
Issues 23
Pull requests 3
Projects 0
Wiki
Insights
Settings
Dynamic Tax Scoring Model
Edit
Add topics
2,024 commits
1 branch
15 releases
14 contributors
Branch: master
New pull request
Create new file
Upload files
Find file
Clone or download
jdebacker Merge pull request #378 from asmockler/remove-saved-moments
Latest commit b3d2579 3 days ago
conda.recipe remove Python directory and change paths 10 months ago
documentation Added OGUSAdoc.pdf 3 months ago
dynamic remove Python directory and change paths 10 months ago
ogusa Remove unused Saved_moments directory 3 days ago
regression spacing 2 months ago
regression_jenkins Move regression testing with jenkins to regression_jenkins and new re... 6 months ago
run_examples use cps constructor for example script 17 days ago

A Revenue Estimate

- A revenue estimate is a forecast of the change in receipts over a period of time
- The forecast comes from a **model** of taxpayers and their responses
- As inputs, these models take data and assumptions
  - Data could be from tax returns, survey data, or other sources
  - Assumptions include assumptions about the path of the macroeconomy and about individuals behavioral responses to tax changes
- The forecast is over the "budget period" (or "budget window"), which, in the U.S., is typically 10 years.

A Revenue Estimate

JOINT COMMITTEE ON TAXATION
December 18, 2017
JCX-67-17

ESTIMATED BUDGET EFFECTS OF THE CONFERENCE AGREEMENT FOR H.R. 1, THE "TAX CUTS AND JOBS ACT"

Fiscal Years 2018 - 2027

[Billions of Dollars]

Provision	Effective	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2018-22	2018-27
I. Individual Tax Reform													
A. Simplification and Reform of Rates, Standard Deductions, and Exemptions													
1. 10%, 12%, 22%, 24%, 32%, 35%, and 37% income tax rate brackets (sunset 12/31/25) [1][2]	tyba 12/31/17	-94.1	-135.3	-140.9	-146.4	-152.0	-158.1	-164.3	-171.1	-52.0	[3]	-668.7	-1,214.2
2. Modify standard deduction ($12,000 for singles, $24,000 for married filing jointly, $18,000 for HoH) (sunset 12/31/25) [2]	tyba 12/31/17	-57.2	-82.6	-84.7	-87.5	-90.7	-92.9	-95.7	-99.1	-30.0	[3]	-402.6	-720.4
3. Repeal of deduction for personal exemptions (sunset 12/31/25) [2]	generally tyba 12/31/17	93.3	137.1	141.6	146.4	151.8	157.6	163.3	169.2	51.3	---	670.1	1,211.5
4. Alternative inflation measure [2]	tyba 12/31/17	0.8	2.1	5.5	8.2	10.4	12.8	16.6	20.0	25.6	31.5	27.0	133.5
B. Treatment of Business Income of Individuals, Trusts, and Estates													
1. Allow 20 percent deduction of qualified business income and certain dividends for individuals and for gross income of agricultural or horticultural cooperatives (sunset 12/31/25) [4]	generally tyba 12/31/17	-27.7	-47.1	-49.9	-51.8	-52.8	-52.2	-53.6	-53.2	-24.2	-1.9	-229.5	-414.5
2. Disallow active passthrough losses in excess of $500,000 for joint filers, $250,000 for all others (sunset 12/31/25)	tyba 12/31/17	9.5	16.2	17.2	18.0	18.8	19.6	20.4	19.4	9.3	1.3	79.7	149.7
C. Reform of the Child Tax Credit													
1. Modification of child tax credit: $2,000 not indexed; refundable up to $1,400 indexed down to nearest $100 base year 2018; $2,500 refundability threshold not indexed; $500 other dependents not indexed; phase outs $200K/$400K not indexed (sunset 12/31/25) [2]	tyba 12/31/17	-29.3	-67.7	-69.2	-70.4	-71.4	-73.8	-74.9	-76.0	-40.7	---	-308.1	-573.4
2. Require valid Social Security number of each child to claim refundable and non-refundable portions of child credit, non-child dependents and any child without a valid Social Security number still receives $500 non-refundable credit (sunset 12/31/25) [2]	tyba 12/31/17	---	3.9	3.8	3.8	3.7	3.8	3.7	3.7	3.0	0.5	15.2	29.8

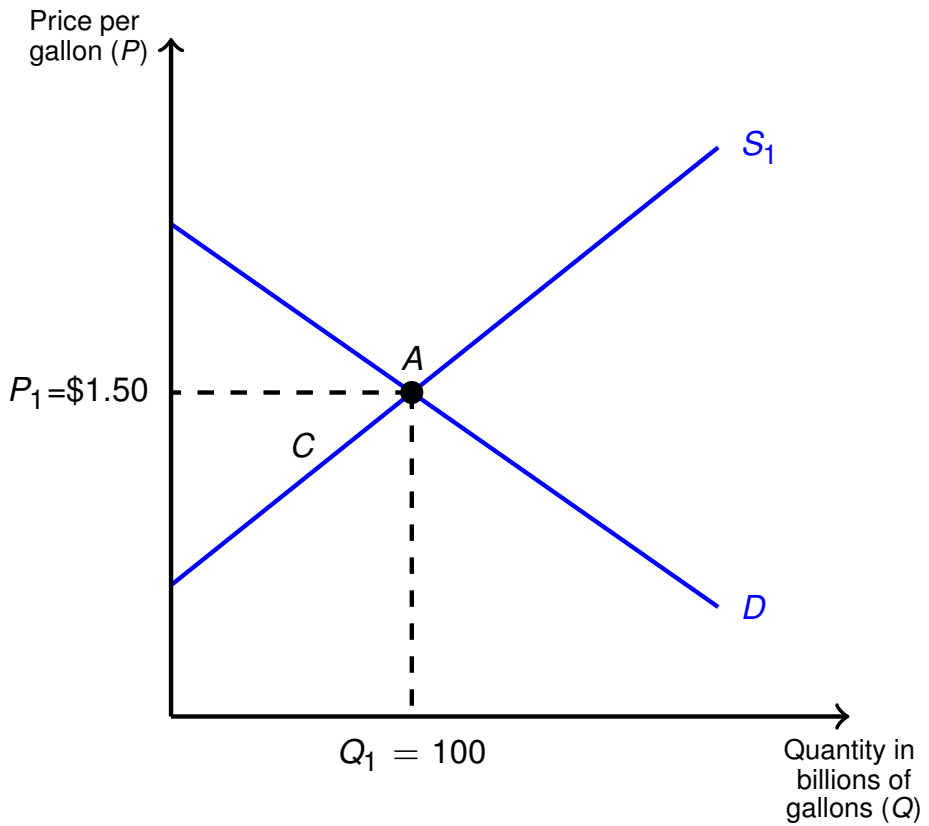
Types of Revenue Estimates

- "Truly static"
  - No behavioral changes in model
- Static
  - Behavioral responses are modeled, but no effects on prices or macroeconomic aggregates are modeled
  - Can have shifts in market incomes across individuals/sectors, but aggregate income is unchanged (need to be consistent with macroeconomic baseline forecast)
  - Sometimes called "micro-dynamic"
- Dynamic
  - Model the macroeconomic feedback effects that result from behavioral changes

An Illustration of Revenue Estimates

- Consider a the market for gasoline
- Let's look at the imposition of a quantity tax on this market
- With this example, we'll consider the revenue estimates from these different approaches.

The Market for Gasoline - Pre-taxes



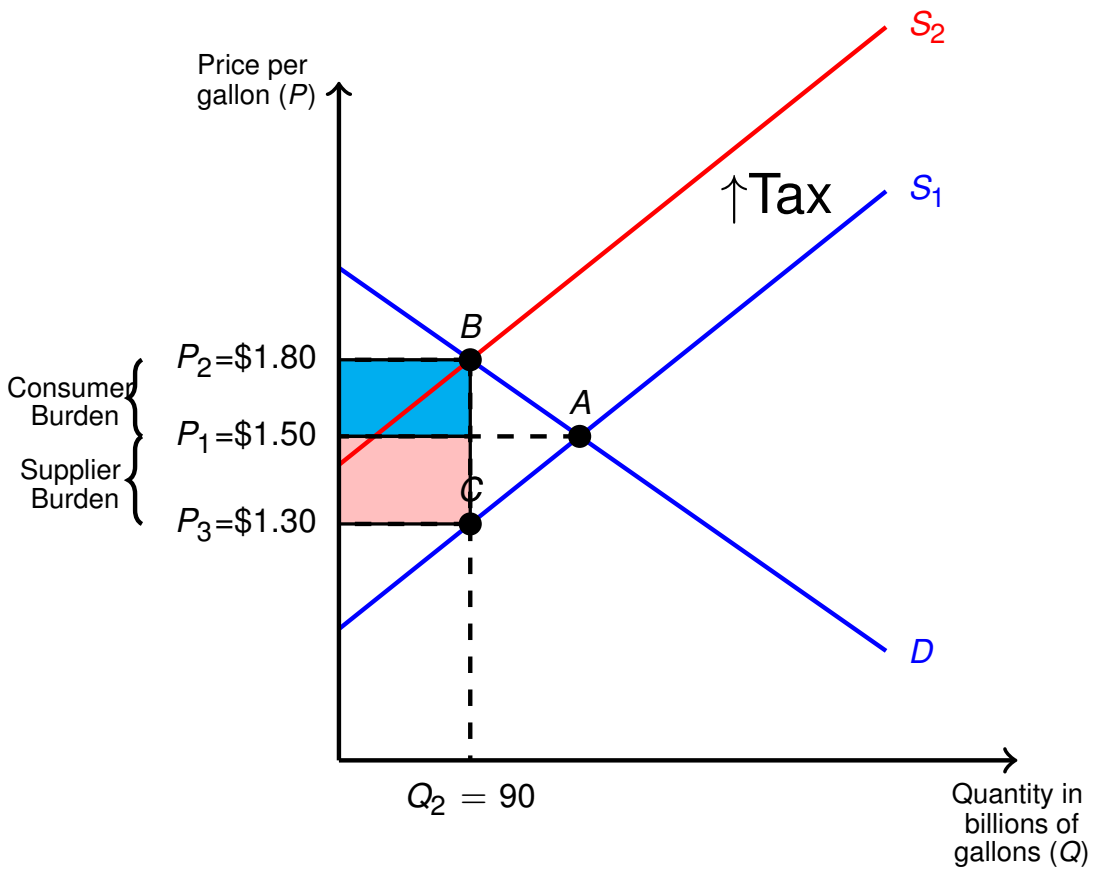
The "Truly Static" Revenue Estimate

- Consider a \$0.50 tax on each gallon of gasoline
- To find the truly static estimate, we simply do:

$$\text{Revenue} = \text{Tax Rate} * \text{Quantity}$$

$$\text{Revenue} = \$0.50 * 100 \text{ billion} = \$50 \text{ billion}$$

The Market for Gasoline – Post Taxes



The Static Revenue Estimate

- The \$0.50 tax changes the amount of gasoline sold
- To find the static estimate, we use the tax rate times this new tax base:

$$\text{Revenue} = \text{Tax Rate} * \text{Quantity}$$

$$\text{Revenue} = \$0.50 * 90 \text{ billion} = \$45 \text{ billion}$$

Dynamic Estimates

- We need to account for **general equilibrium** effects
- The tax on gasoline has effects beyond the market for gasoline
- Consider:
  - Gasoline is an input to production
    - The tax has output and substitution effects on production
  - Gasoline is a final consumption good
    - Income and substitution effects on consumption in other markets
  - Additional tax revenue affects public savings and thus interest rates

Recent Use of Dynamic Estimates

- In 2003 the House adopted a rule that requires JCT, upon request, to analyze the macroeconomic effects before consideration. This was done for May 2003 Jobs and Growth bill
- in 2015 The House adopted a rule to require the JCT to produce dynamic revenue estimates of bills where the budgetary impact exceeded 0.25 percent of GDP
- Now large pieces of legislation, such as the Tax Cuts and Jobs Act, are given dynamic revenue estimates.

Dynamic Scoring – Pros

- Most complete estimate, uses all information
- Lack of dynamic scoring introduces a systematic bias against certain types of policies
- Lack of dynamic scoring can create some anomalous results
- As technology and economics advance these estimate should become easier and more precise

Dynamic Scoring – Cons

- Much more reliant on assumptions which in turn are more likely to be subject to political pressure
- Cumbersome to integrate with the baseline, need to estimate for all legislation
- Need to account for the expenditure side to be consistent
- Different models give different answers
- Assumptions regarding fiscal and monetary policy very important and can be difficult to defend

Why are dynamic scores hard?

- Usually there is not an econometric literature measuring these types of effects
- Have to rely on theory which in turn is often very sensitive to assumptions
  - Partial equilibrium versus general equilibrium
  - Assumptions about uncertainty and the future

1997 Symposium Results

- In 1997 the Joint Committee on Taxation (JCT) asked a number of different forecasters to estimate the macro effects of tax reform
- Identical policies were used, both an income tax and a consumption tax
- Models differed and the resulting estimates differed dramatically
    - In some cases even the sign of the dynamic effect differed across models

Dynamic Estimates: Uncertainty and Future Policies

- If we are going to allow GDP to change we need to think more carefully about how decisions are made and the expectations that influence them
  - What is future fiscal policy? Tax increases, more borrowing, less spending?
  - What is the response of the central bank to changes in taxes? Do they offset or accommodate the macro effects of policy?
  - Generally what are individuals' expectations regarding the policy and future changes?

Types of dynamic analysis models

1. Econometric macro models
2. Solow growth models
3. Hybrid macro model (e.g., JCT MEG model)
4. Overlapping generations models

State of the art in Dynamic scoring

- Individual behavior and heterogeneity
- Careful demographics
- Bequest processes
- Multiple industries
- Closed economy, small open economy, large open economy
- Rich tax treatment in general equilibrium
- Government spending (deficit-surplus)

Complexity

All of these components must work together in a consistent, unified model.

Individuals and heterogeneity

- Households maximize consumption $c_{j,s,t}$, labor $n_{j,s,t}$
- Heterogeneous age s, lifetime income (ability) $e_{j,s}$

$$\max_{\{c_{j,s,t}, n_{j,s,t}\}} \sum_{s=E+1}^{E+S} \beta^{s-E-1} u\left(c_{j,s,t}, n_{j,s,t}, b_{j,s+1,t+1}\right) \quad \forall j, t$$

$$\text{s.t.} \quad c_{j,s,t} + b_{j,s+1,t+1} \leq (1 + r_t) b_{j,s,t} + w_t e_{j,s} n_{j,s,t} + \zeta_{j,s} \frac{BQ_t}{\lambda_j \tilde{N}_t} - T_{j,s,t}$$

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

Household characterizing equations

- S consumption/savings Euler equations.

$$(\hat{c}_{j,s,t})^{-\sigma} = \ldots$$

$$e^{-g_y\sigma}\left(\rho_s\chi^b_j\left(\hat{b}_{j,s+1,t+1}\right)^{-\sigma} + \beta(1-\rho_s)(\hat{c}_{j,s+1,t+1})^{-\sigma}\left[1 + r_{t+1} - \frac{\partial\hat{T}^I_{s+1,t+1}}{\partial\hat{b}_{j,s+1,t+1}}\right]\right)$$

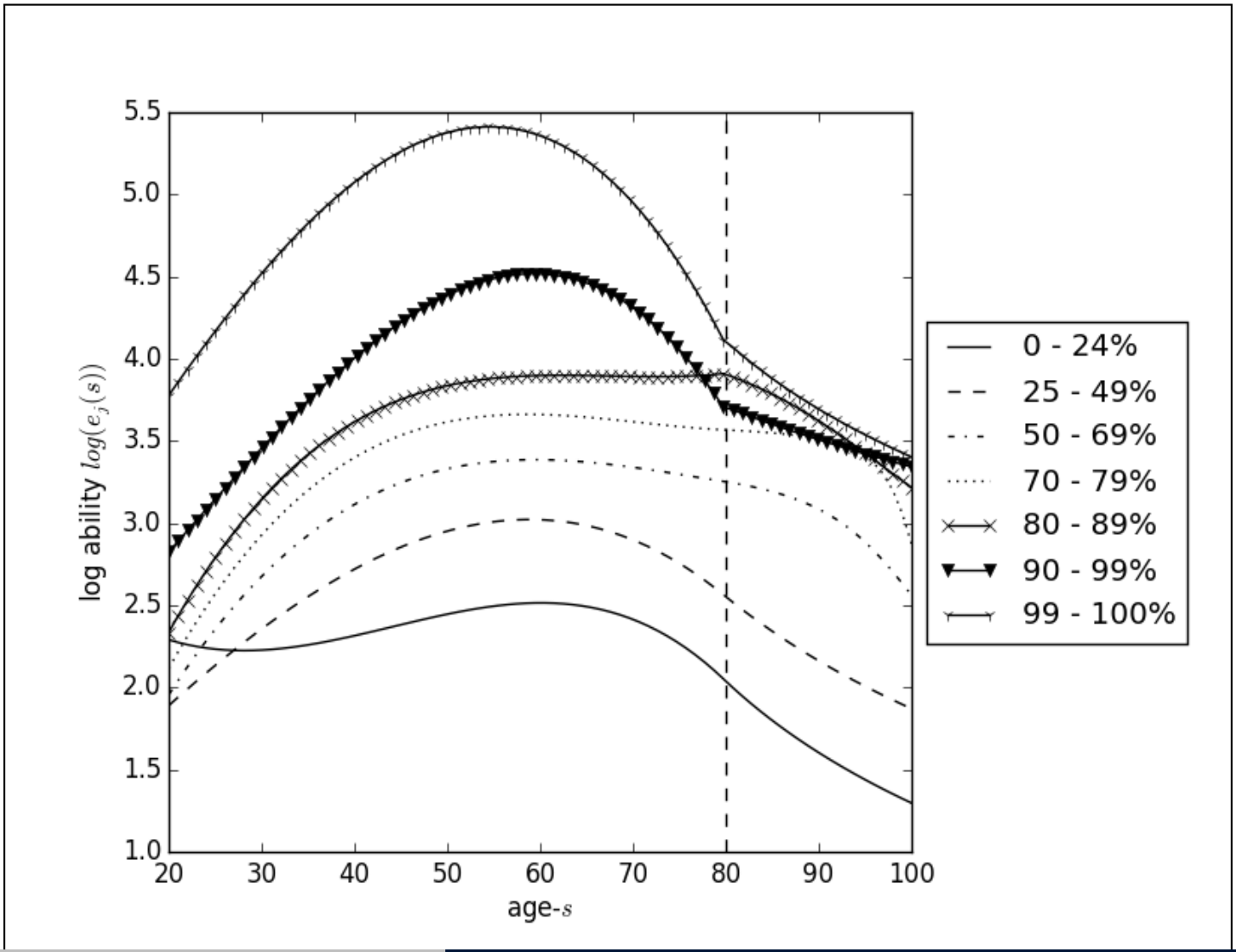
$$\forall j, t, \quad \text{and} \quad E+1 \leq s \leq E+S$$

- S labor leisure Euler equations.

$$(\hat{c}_{j,s,t})^{-\sigma}\left(\hat{w}_t e_{j,s} - \frac{\partial\hat{T}^I_{s,t}}{\partial n_{j,s,t}}\right) = \chi^n_s\left(\frac{b}{\tilde{l}}\right)\left(\frac{n_{j,s,t}}{\tilde{l}}\right)^{\upsilon-1}\left[1 - \left(\frac{n_{j,s,t}}{\tilde{l}}\right)^{\upsilon}\right]^{\frac{1-\upsilon}{\upsilon}}$$

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

Household lifetime income groups $e_{j,s}$



Household demographics

- Fertility rates f_s, mortality rates ρ_s, immigration rates i_s

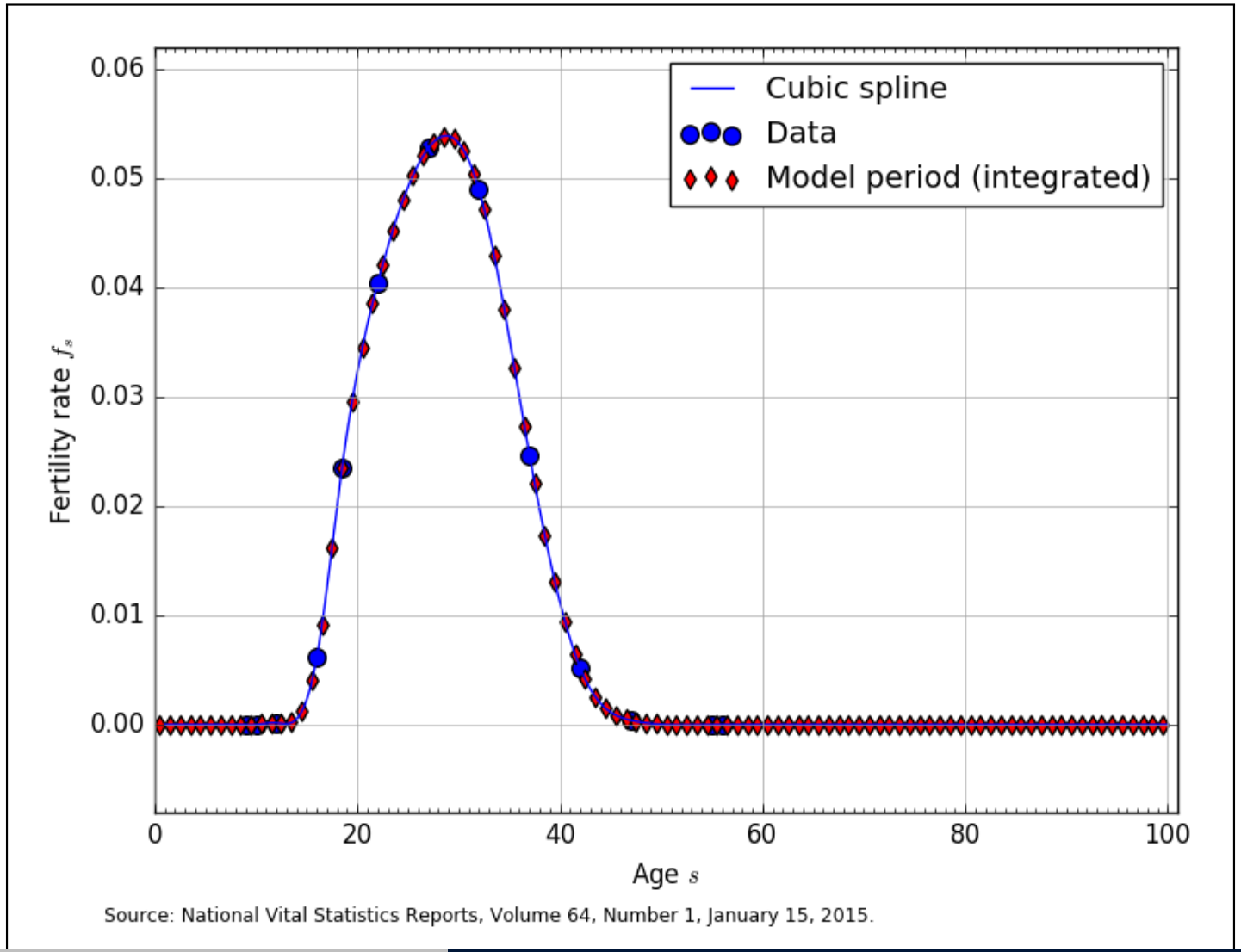
$$\omega_{1,t+1} = (1 - \rho_0) \sum_{s=1}^{E+S} f_s \omega_{s,t} + i_1 \omega_{1,t} \quad \forall t$$

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

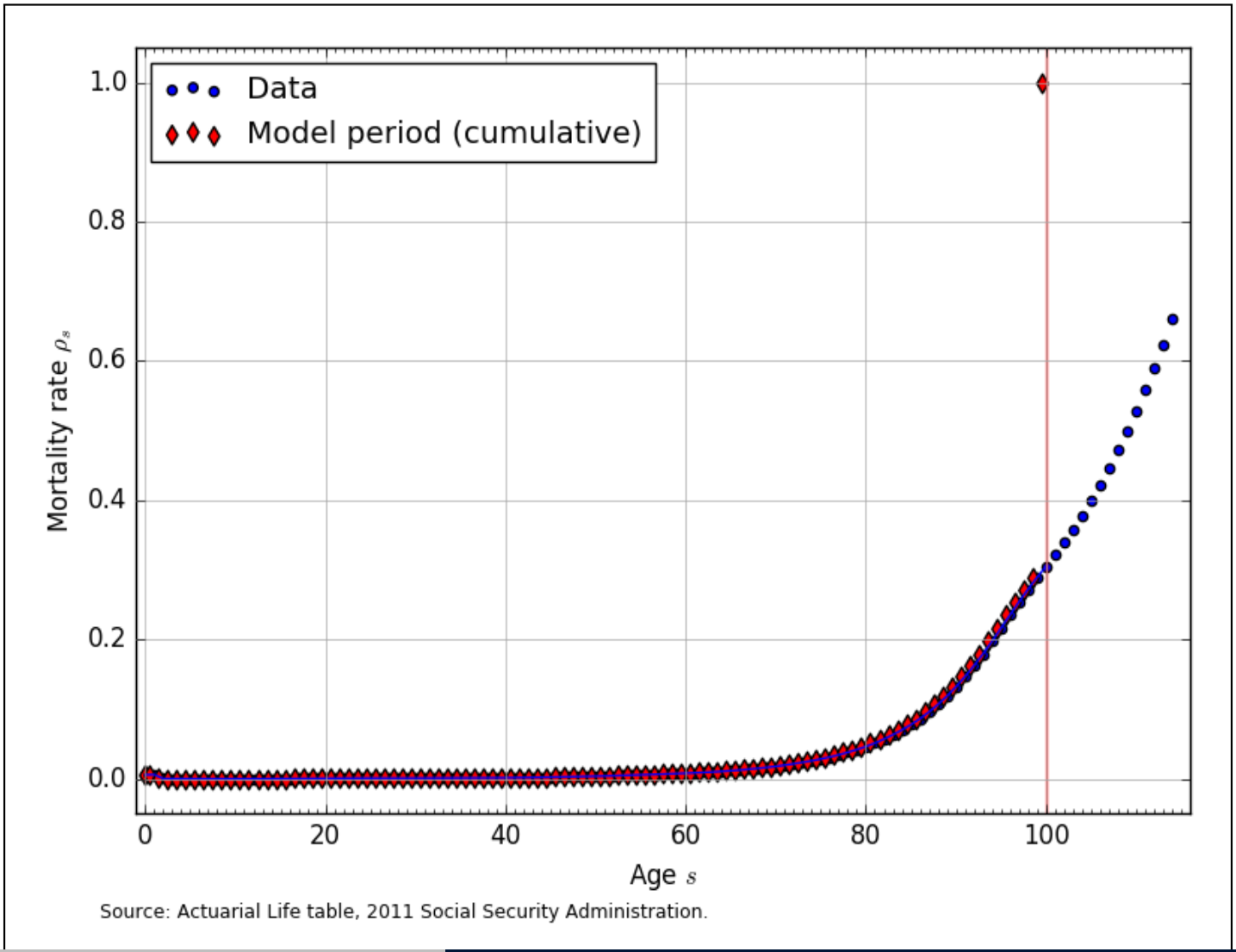
$$N_t \equiv \sum_{s=1}^{E+S} \omega_{s,t} \quad \forall t$$

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

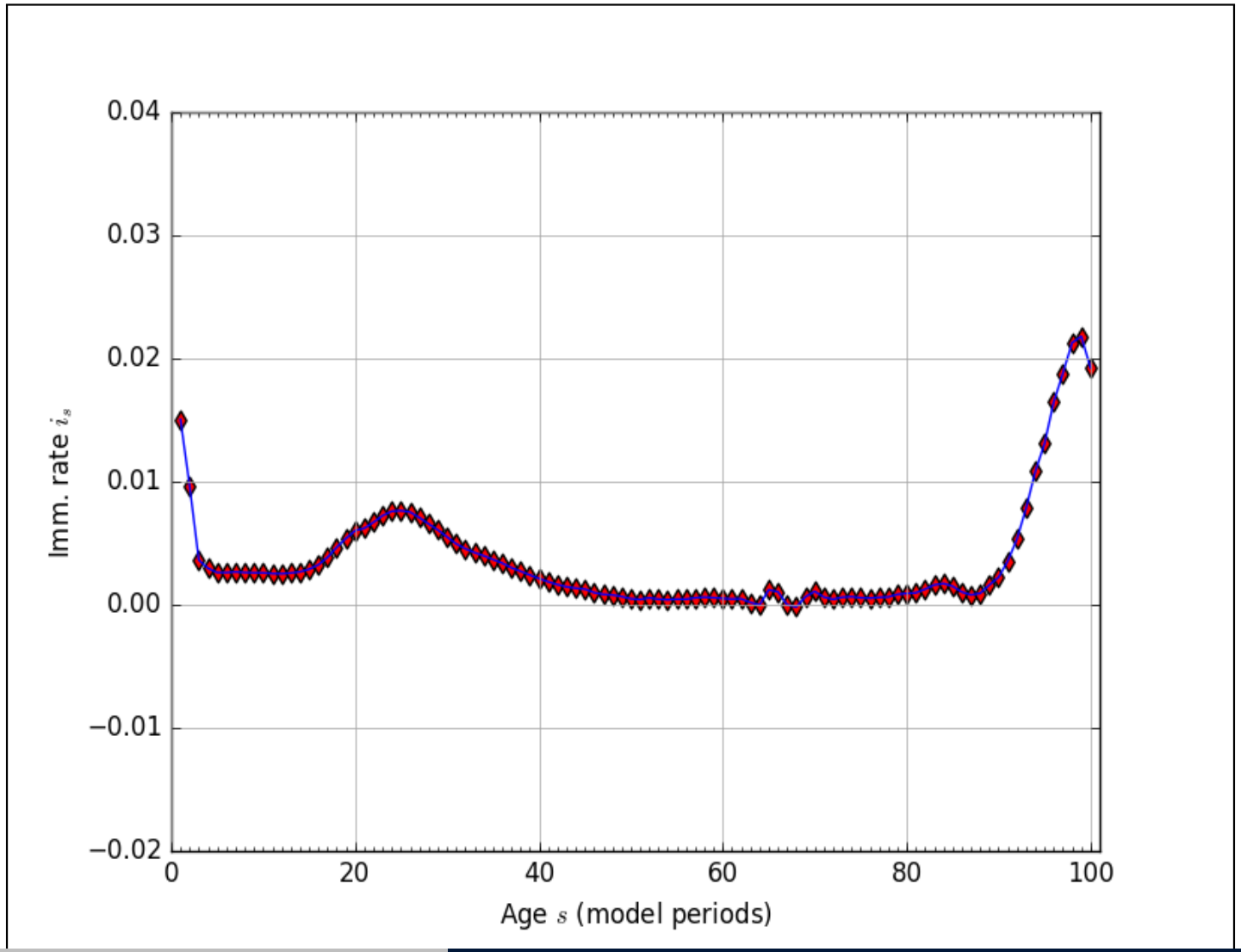
Demographics: fertility rates



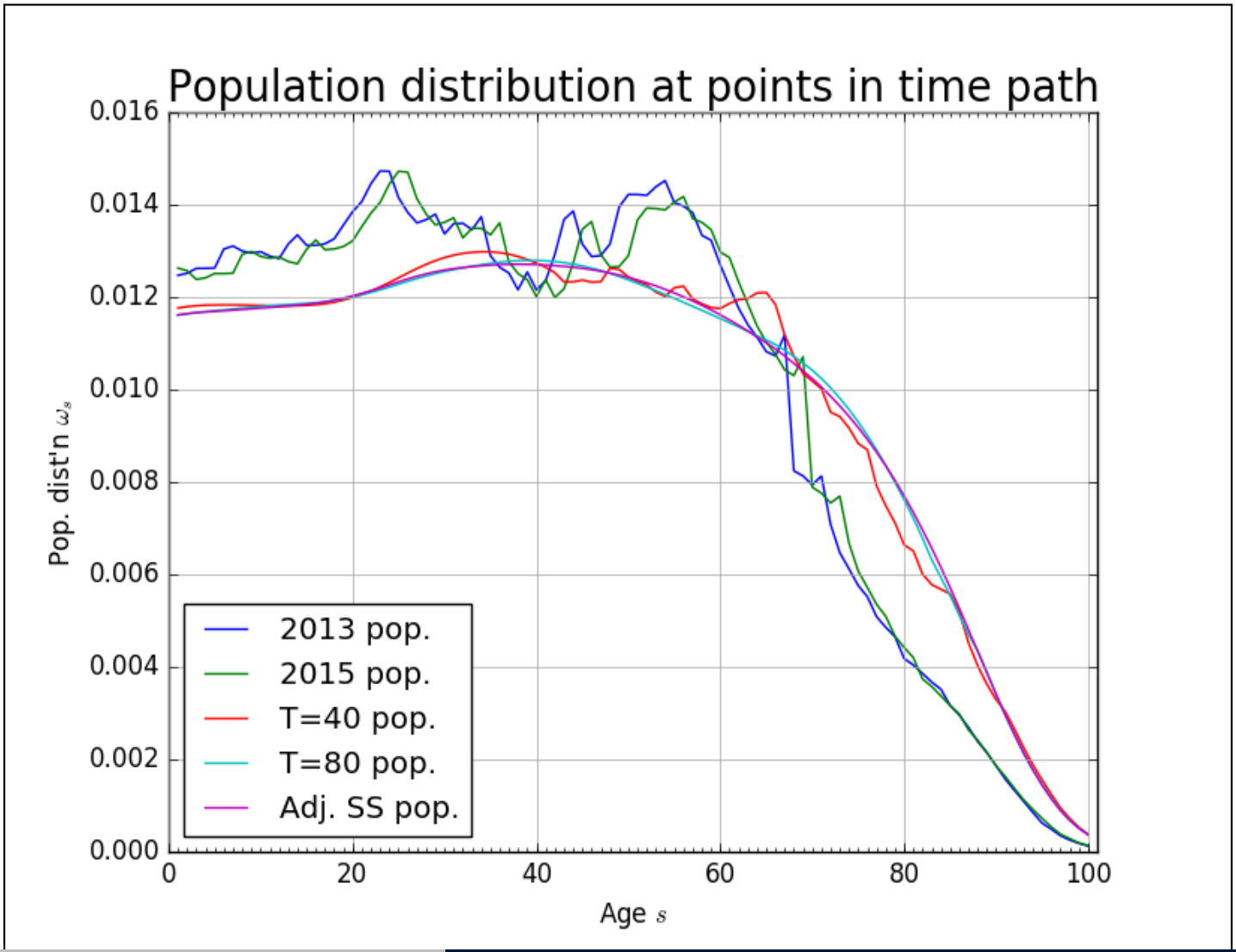
Demographics: mortality rates



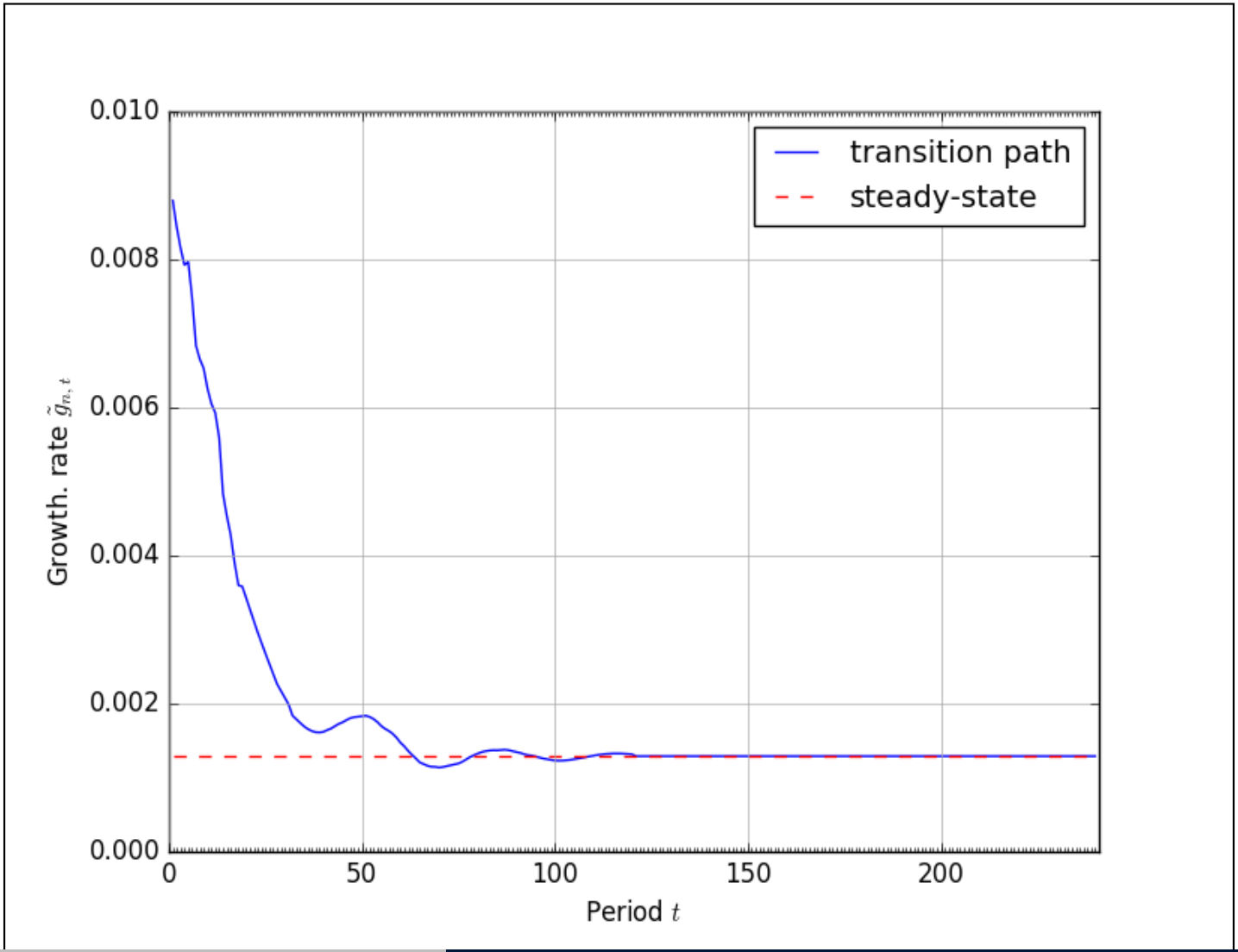
Demographics: immigration rates



Demographics: population distribution



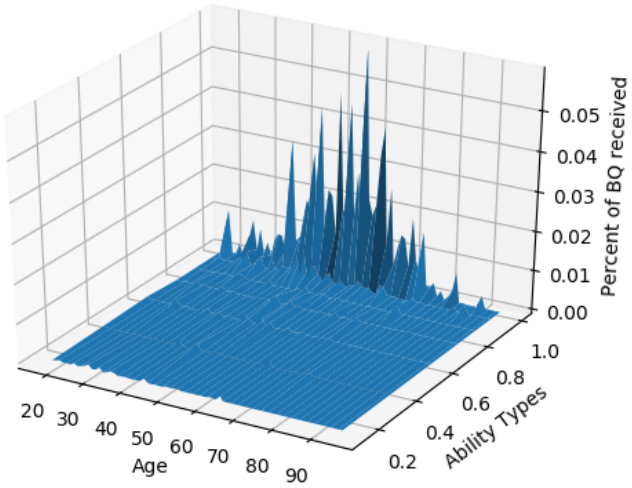
Demographics: population growth



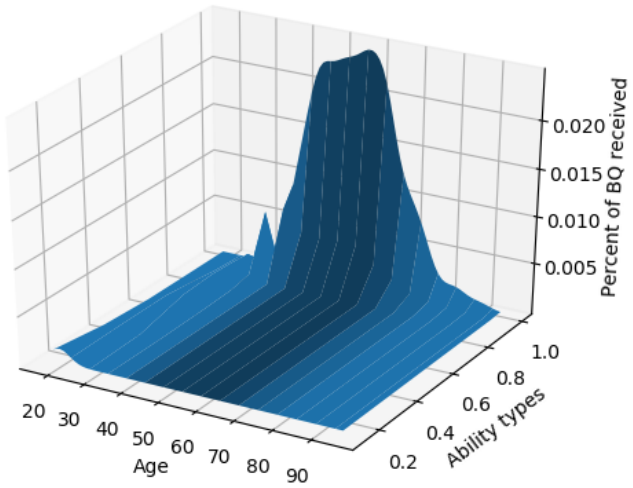
Bequests, inheritances

$$c_{j,s,t} + b_{j,s+1,t+1} \leq (1 + r_t)\, b_{j,s,t} + w_t e_{j,s} n_{j,s,t} + \zeta_{j,s} \frac{BQ_t}{\lambda_j \tilde{N}_t} - T_{j,s,t}$$

- It matters how bequests are distributed $\zeta_{j,s}$
- We take data and incorporate it into the model

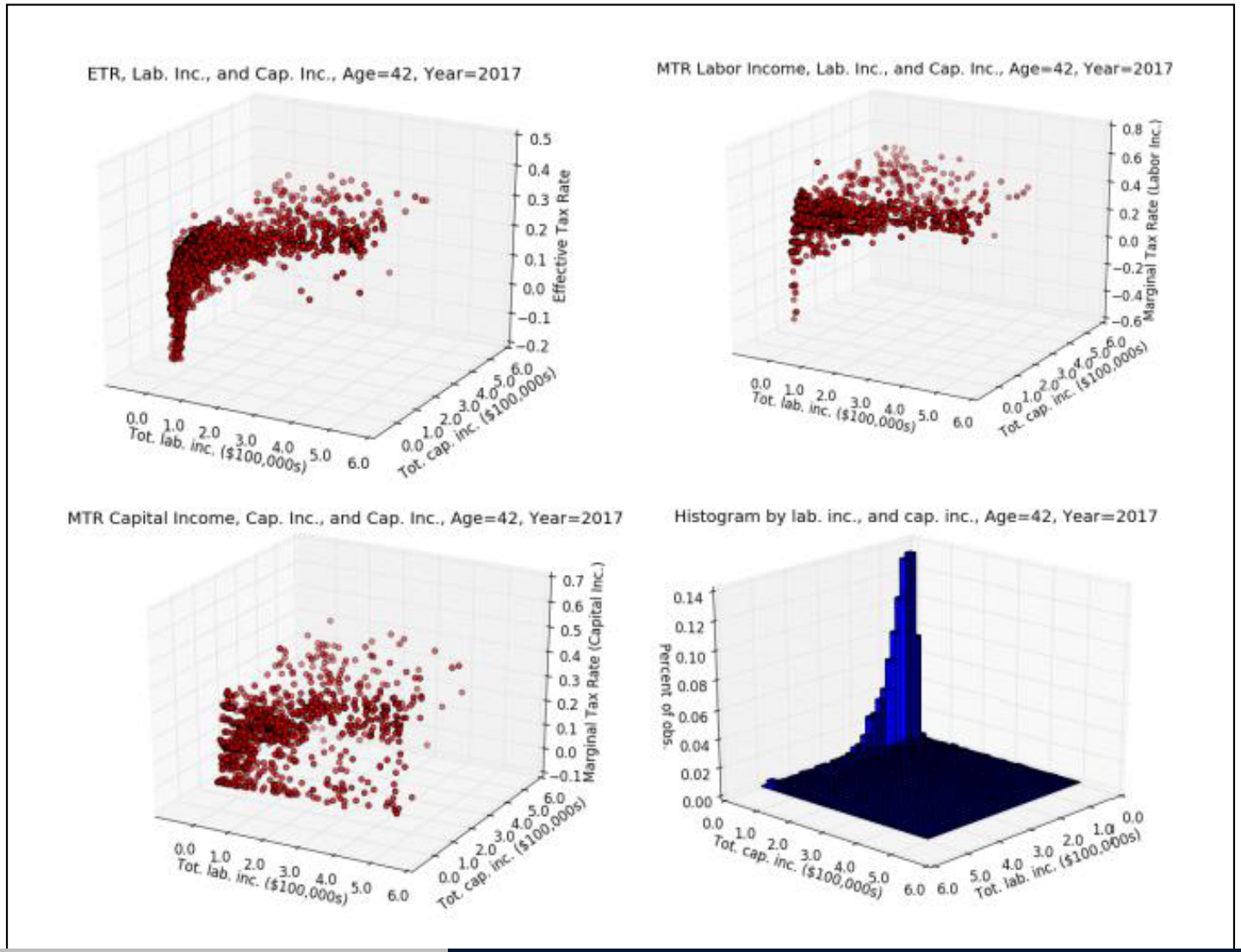


(a) Original data



(b) Kernel density estimate

Incorporating taxes



Incorporating taxes

We fit smooth monotonic functions to these data

- See DeBacker, Evans, and Phillips (2018)

$$\tau(x,y) = \left[\tau(x) + shift_x\right]^{\phi}\left[\tau(y) + shift_y\right]^{1-\phi} + shift$$

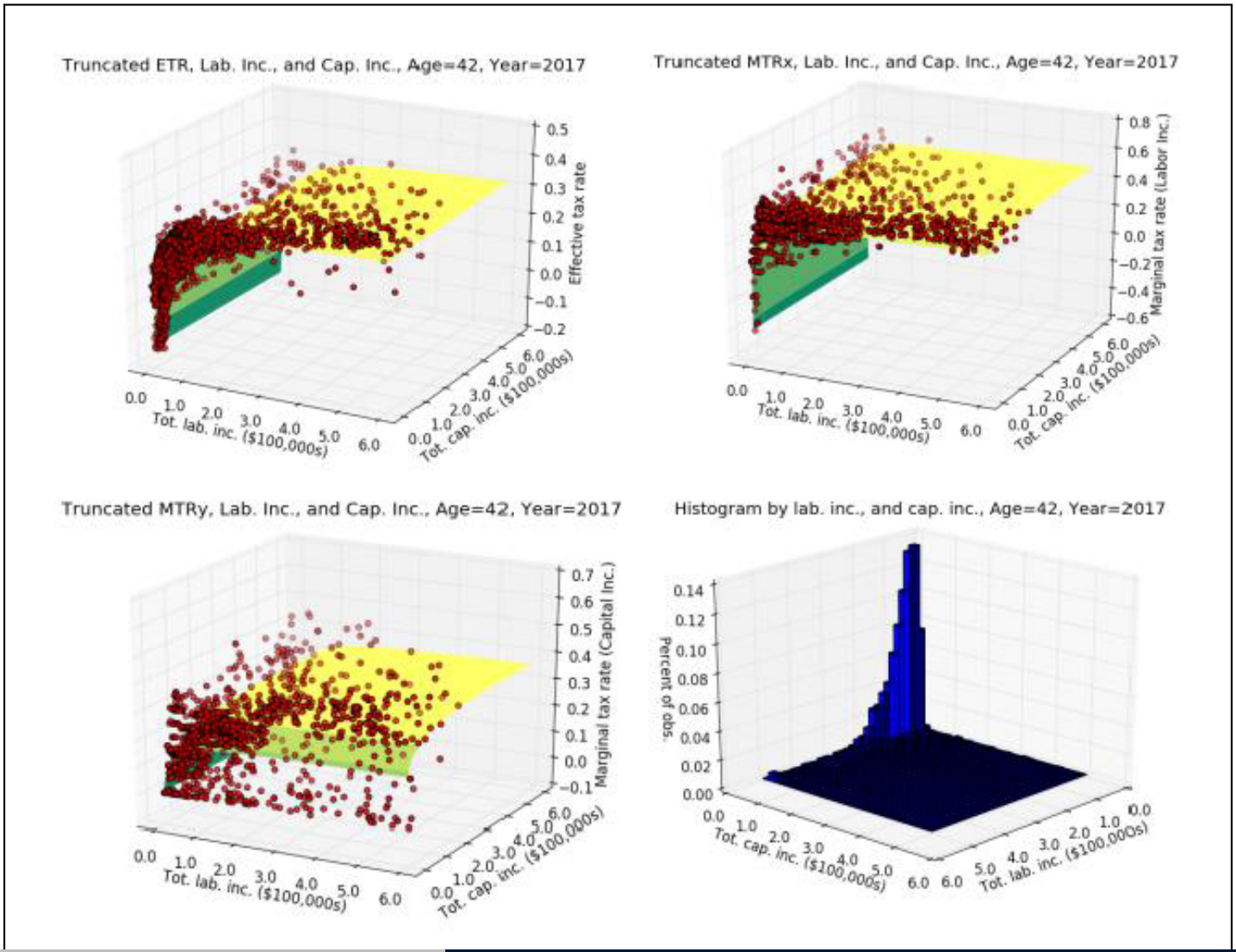
$$\text{where} \quad \tau(x) \equiv (max_x - min_x)\left(\frac{Ax^2 + Bx}{Ax^2 + Bx + 1}\right) + min_x$$

$$\text{and} \quad \tau(y) \equiv (max_y - min_y)\left(\frac{Cy^2 + Dy}{Cy^2 + Dy + 1}\right) + min_y$$

$$\text{where} \quad A, B, C, D, max_x, max_y, shift_x, shift_y > 0$$

$$\text{and} \quad \phi \in [0,1] \quad \text{and} \quad max_x > min_x \quad \text{and} \quad max_y > min_y$$

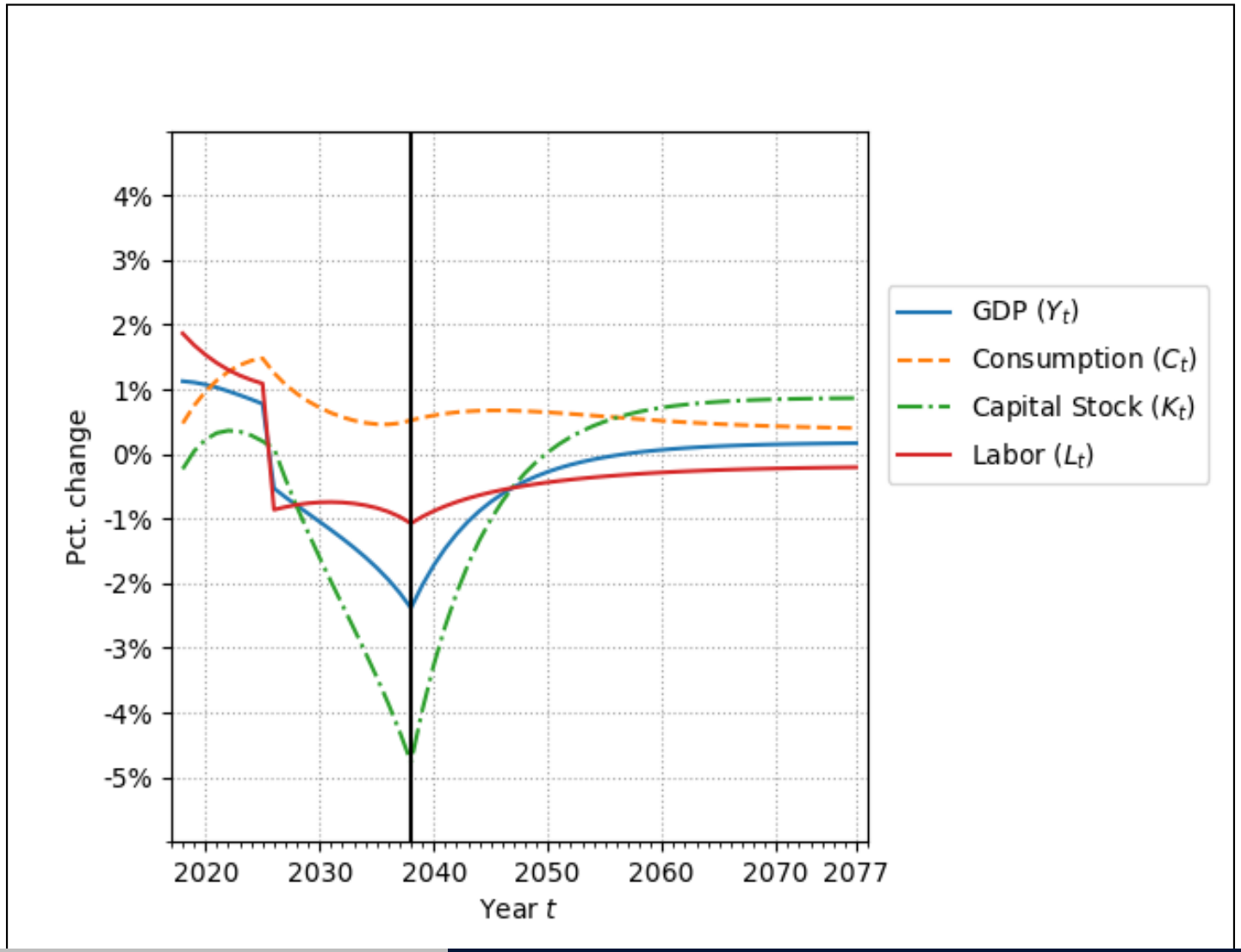
Incorporating taxes



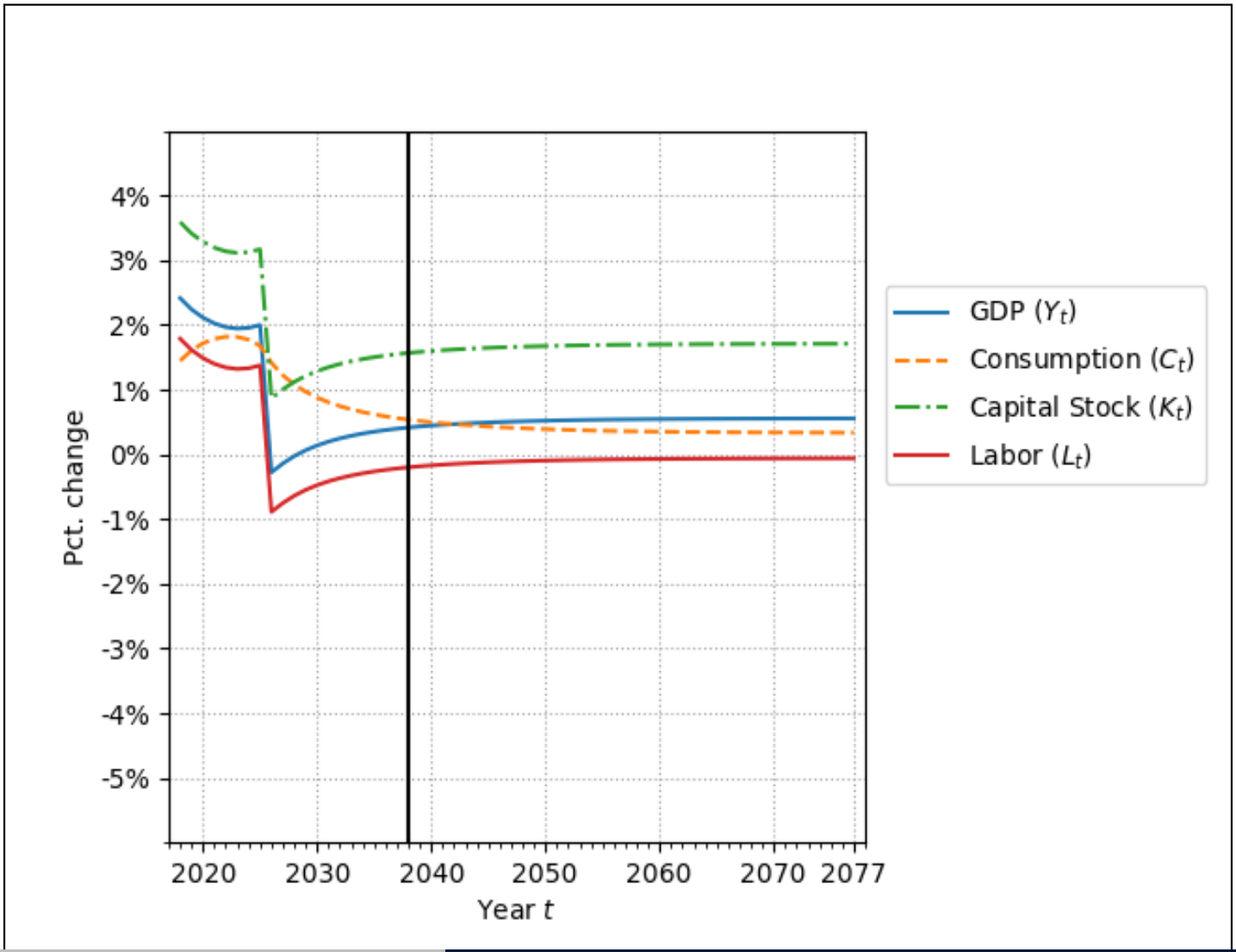
TCJA Dynamic Analysis: Summary

- Short-run growth (+1% to +2%) in GDP and employment in first 8 years
- Increasing debt quickly crowds out investment
- Wage growth is can range from -0.5% to +0.6% depending on international assumptions
- Revenue decrease is slightly bigger in small open economy case

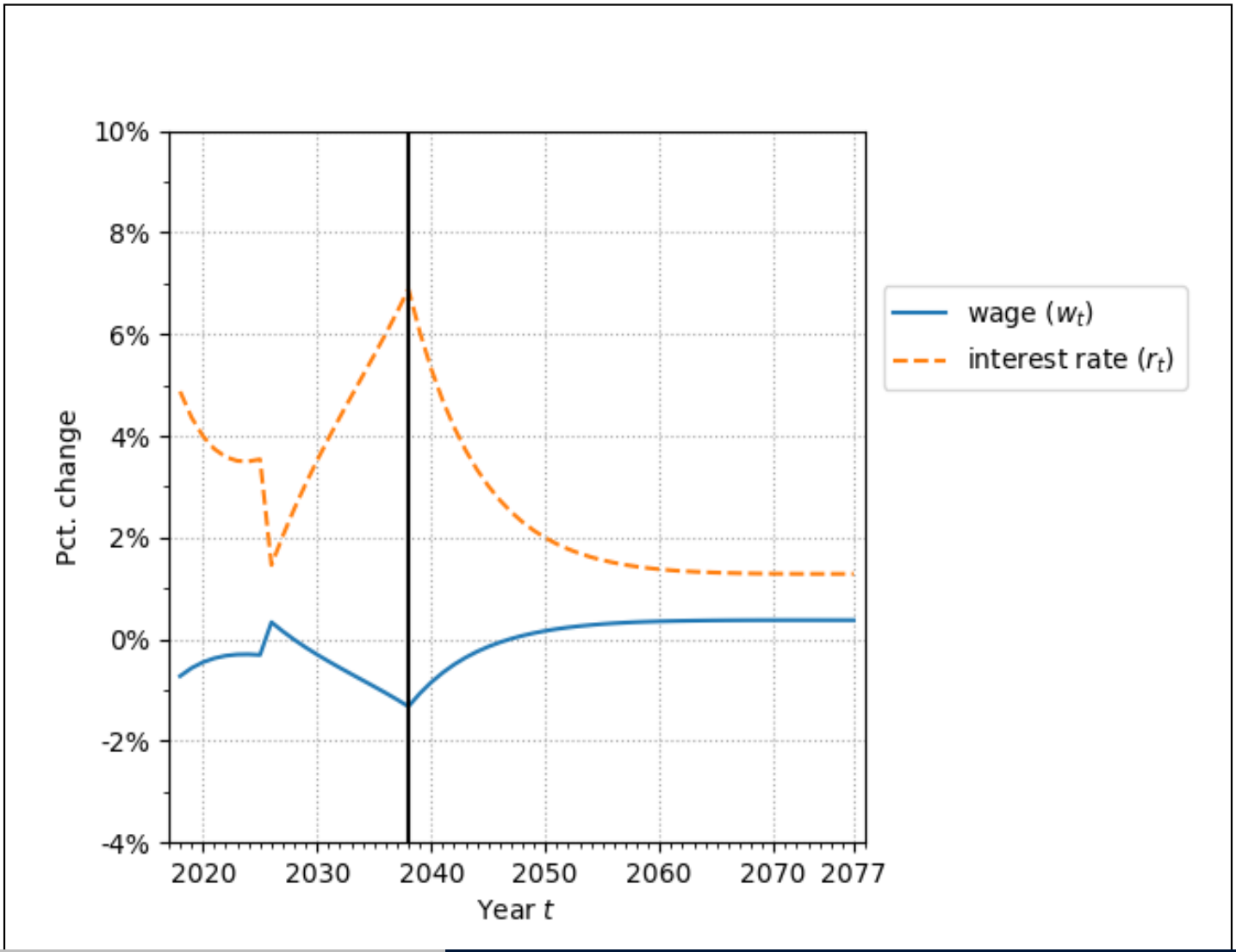
OG-USA: TCJA, macro vars., closed econ.



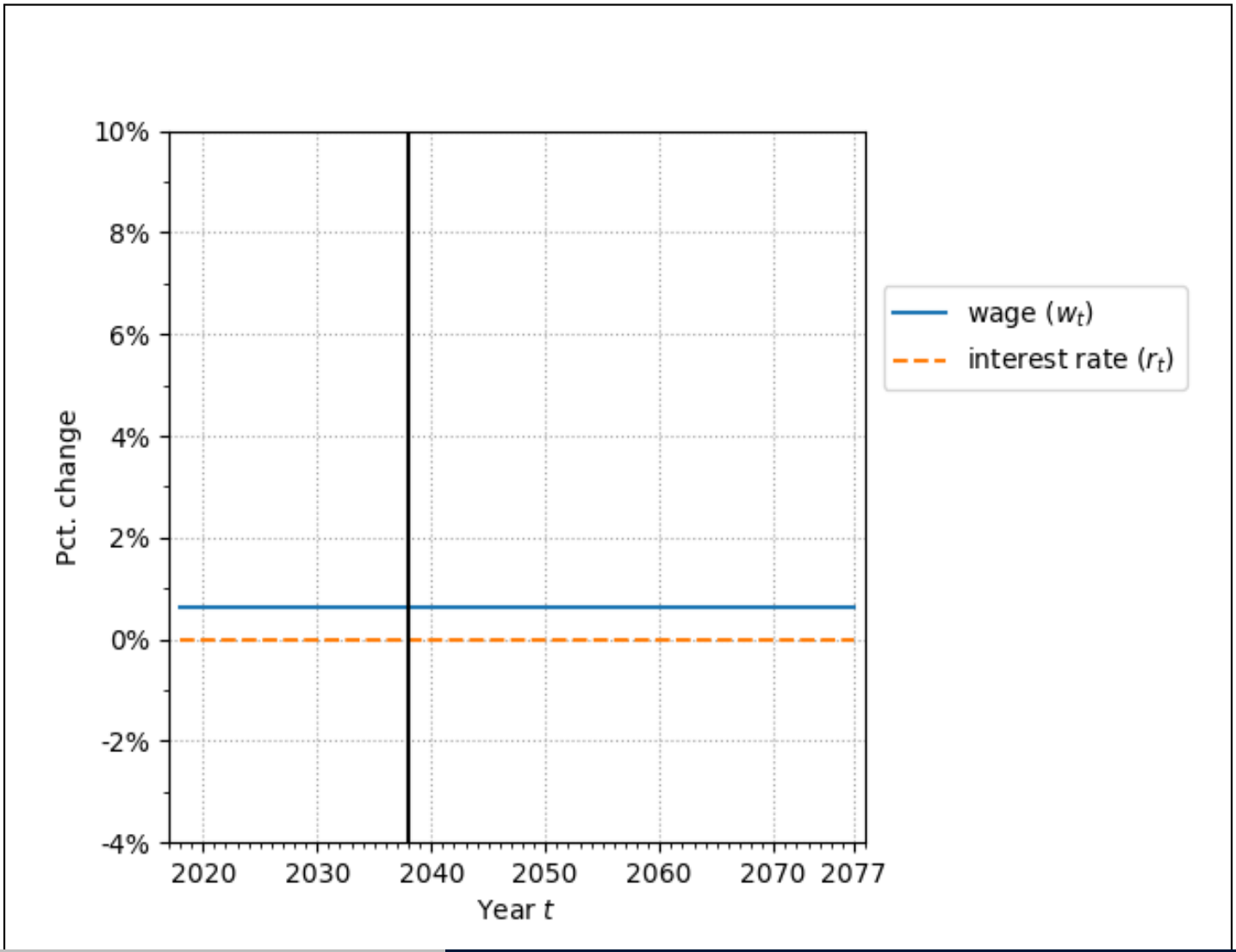
OG-USA: TCJA, macro vars., open econ.



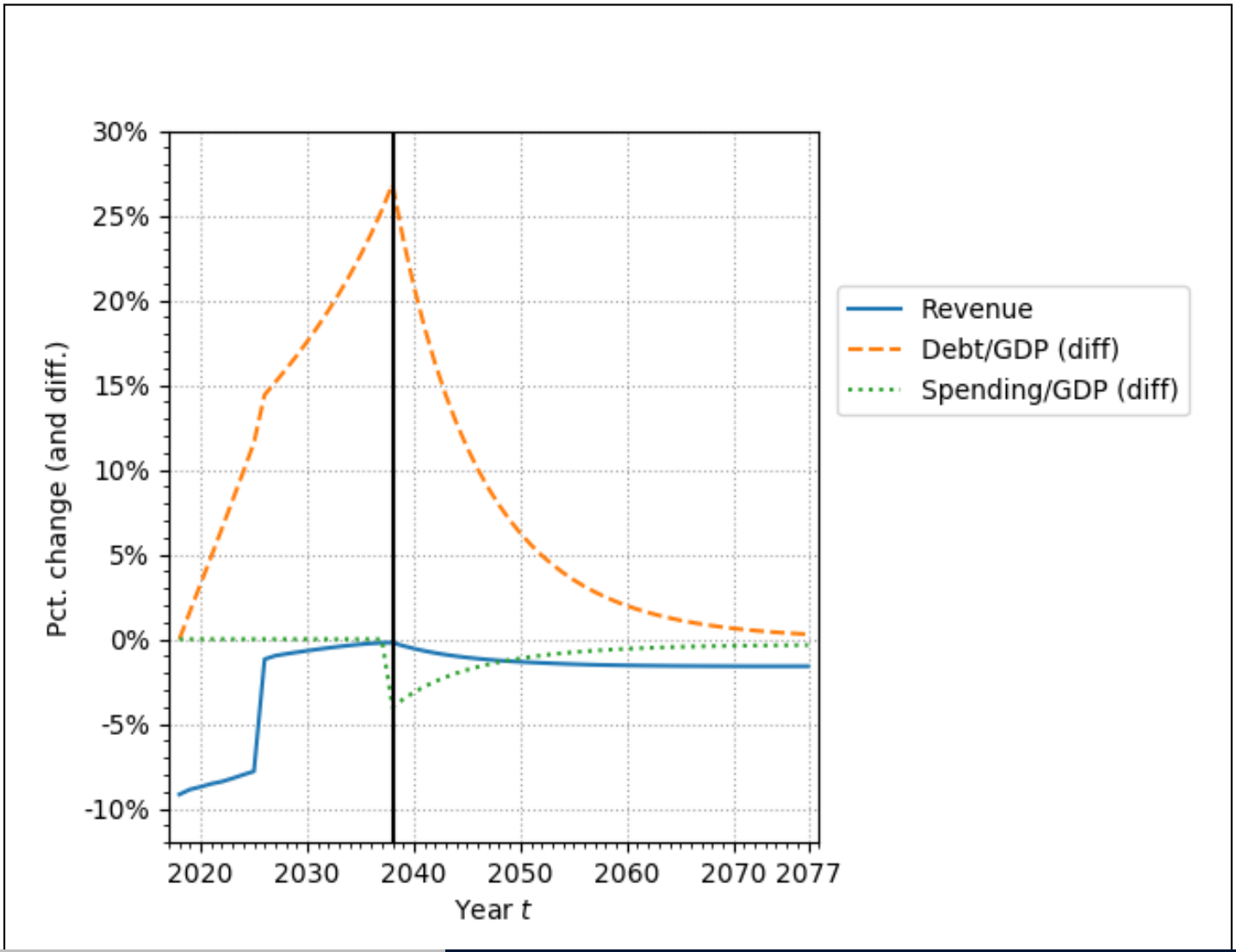
OG-USA: TCJA, price vars., closed econ.



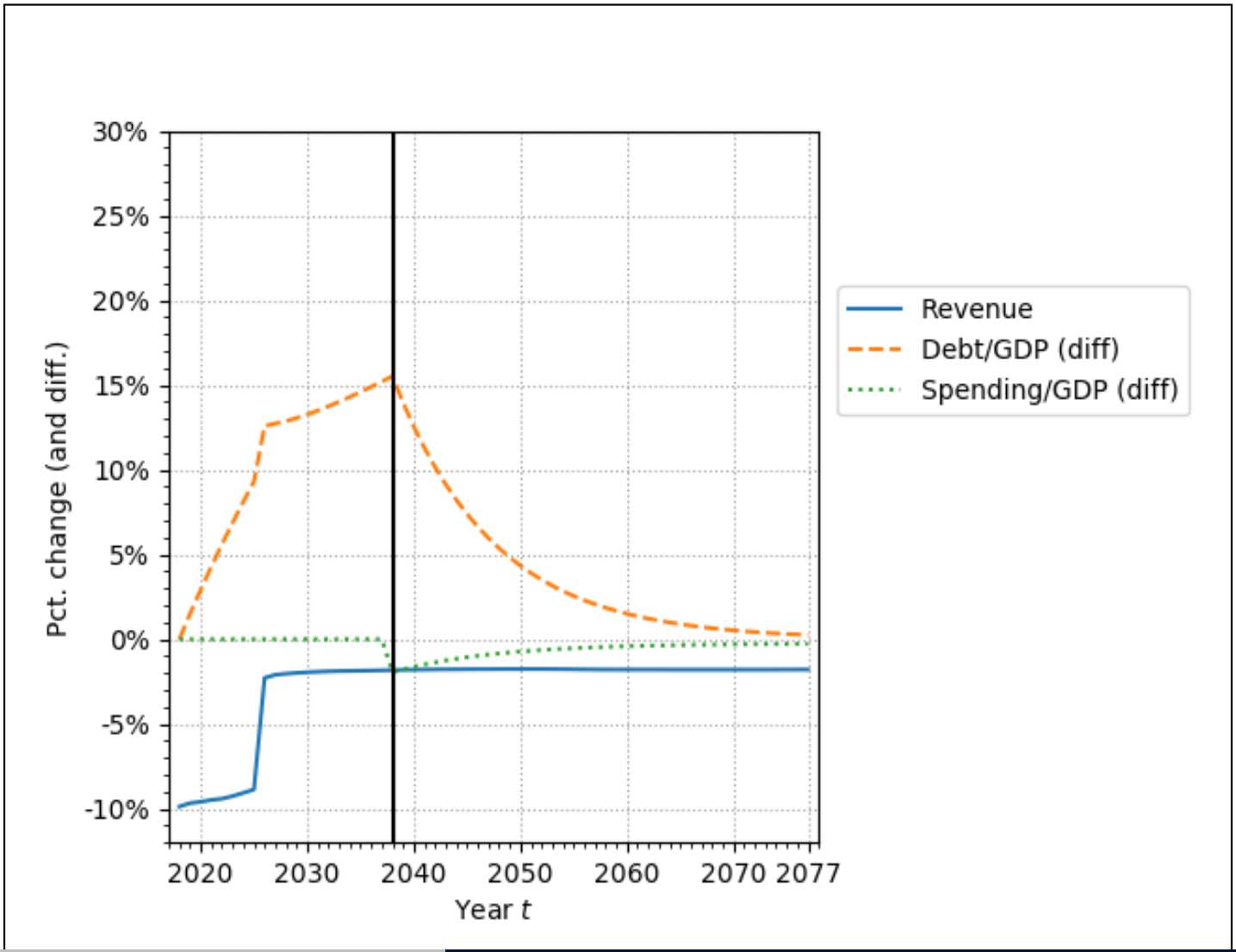
OG-USA: TCJA, price vars., open econ.



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



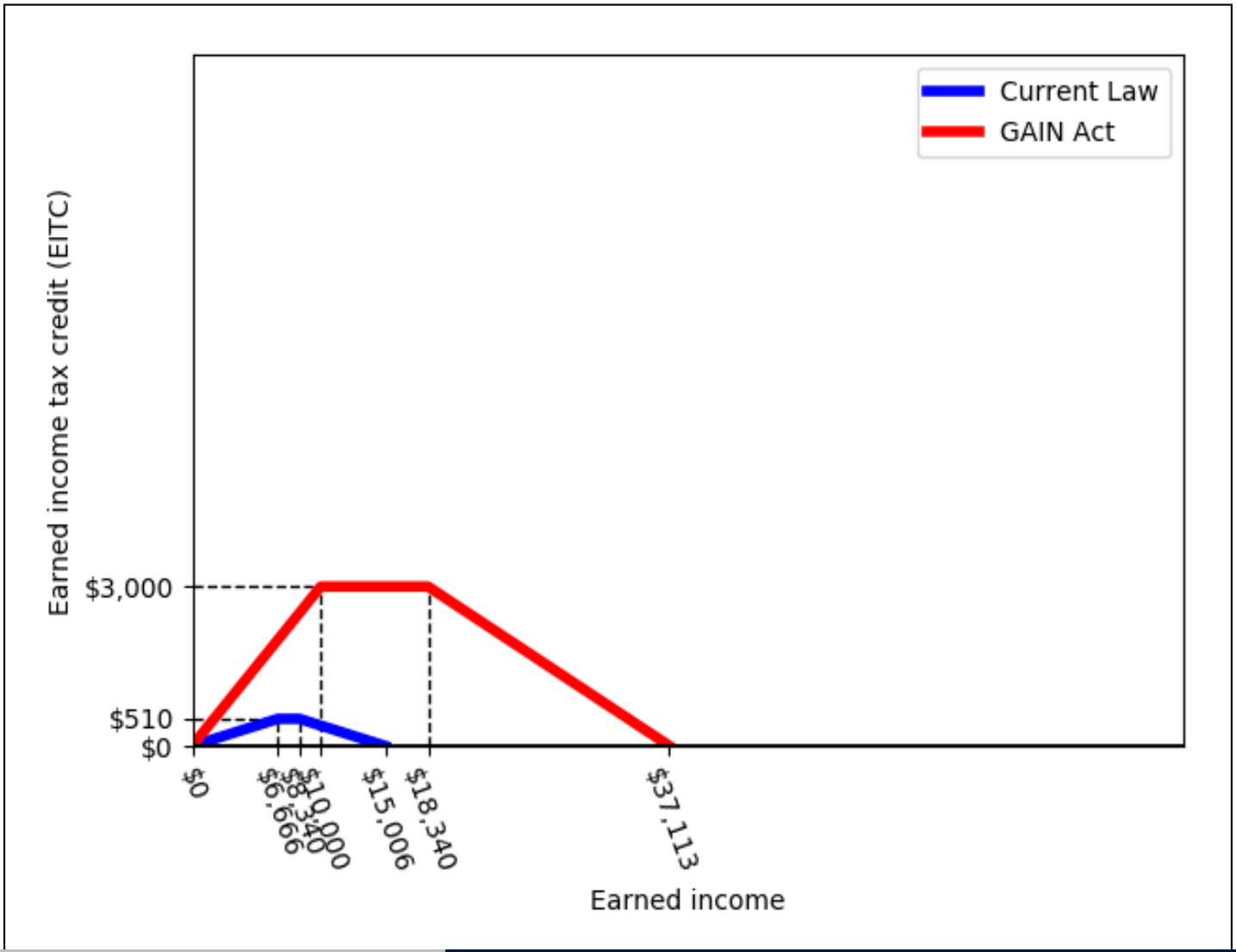
OG-USA: TCJA, fiscal vars., open econ.



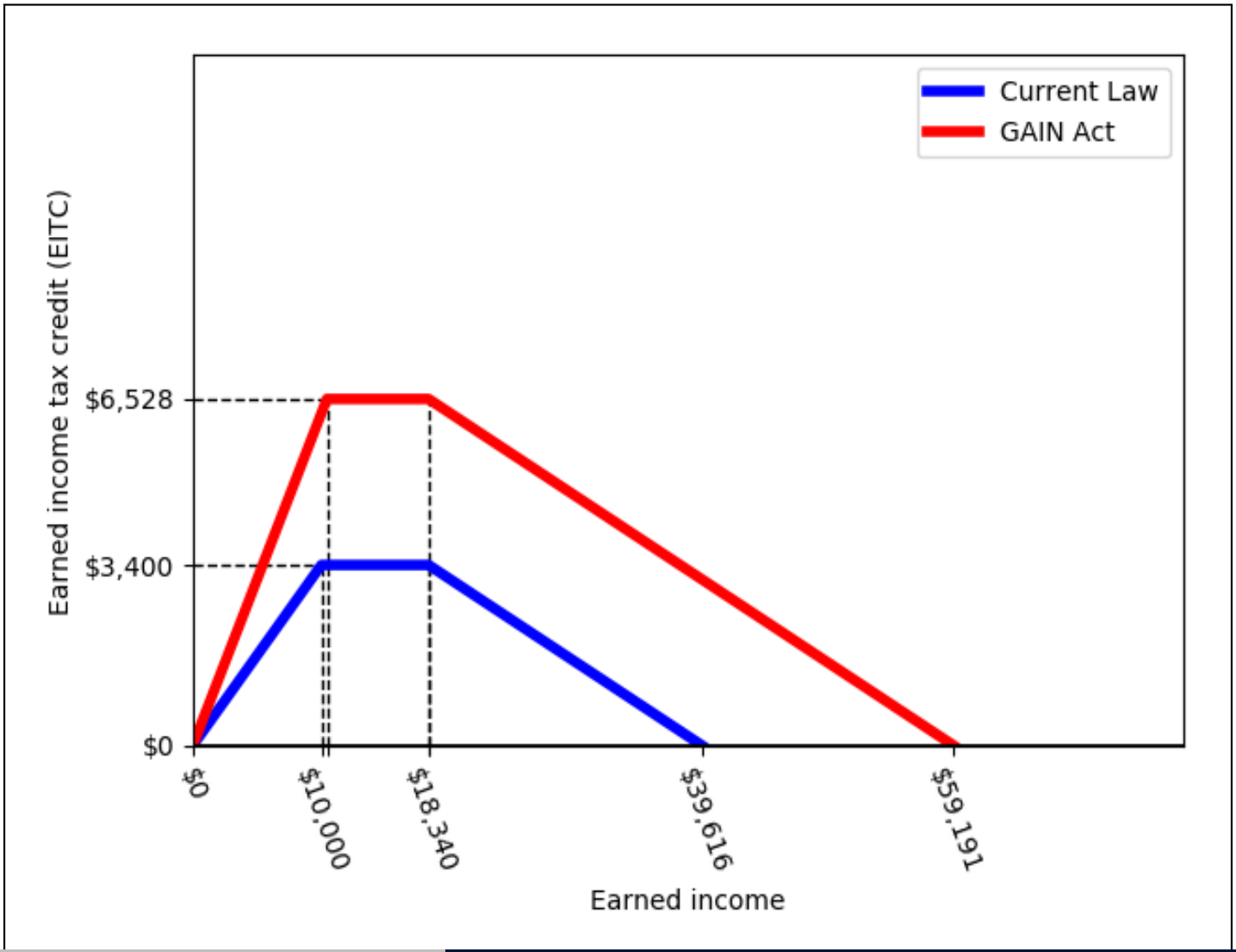
EITC Dynamic Analysis: Summary

- Brown-Khanna Grow American Incomes Now (GAIN) Act (9/2017)
  - Massive expansion of EITC
  - (Added revenue neutral case) Increase in top two tax brackets (35% and 37% to 59% and 63%)
- Results
  - GDP declines -0.5% per year or -1.5% per year
  - Average wages increase for eight years
  - GAIN alone (1st 5 yrs): hh labor supply $\downarrow$, savings $\uparrow$, consumption $\uparrow$
  - Rev neutr (1st 5 yrs): hh labor supply $\downarrow$, savings $\downarrow$, consumption $\downarrow$

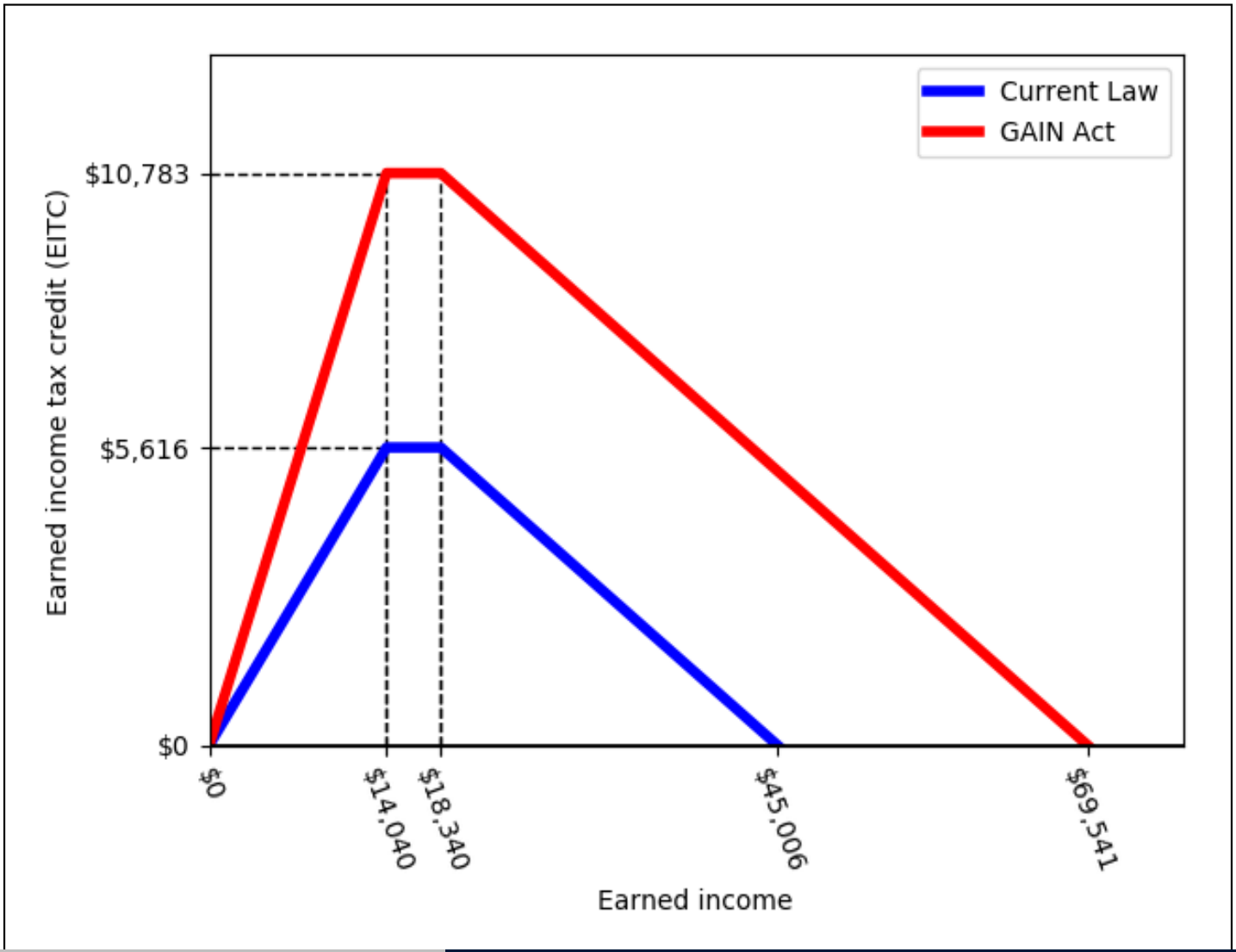
OG-USA: GAIN Act EITC expansion, Kids=0



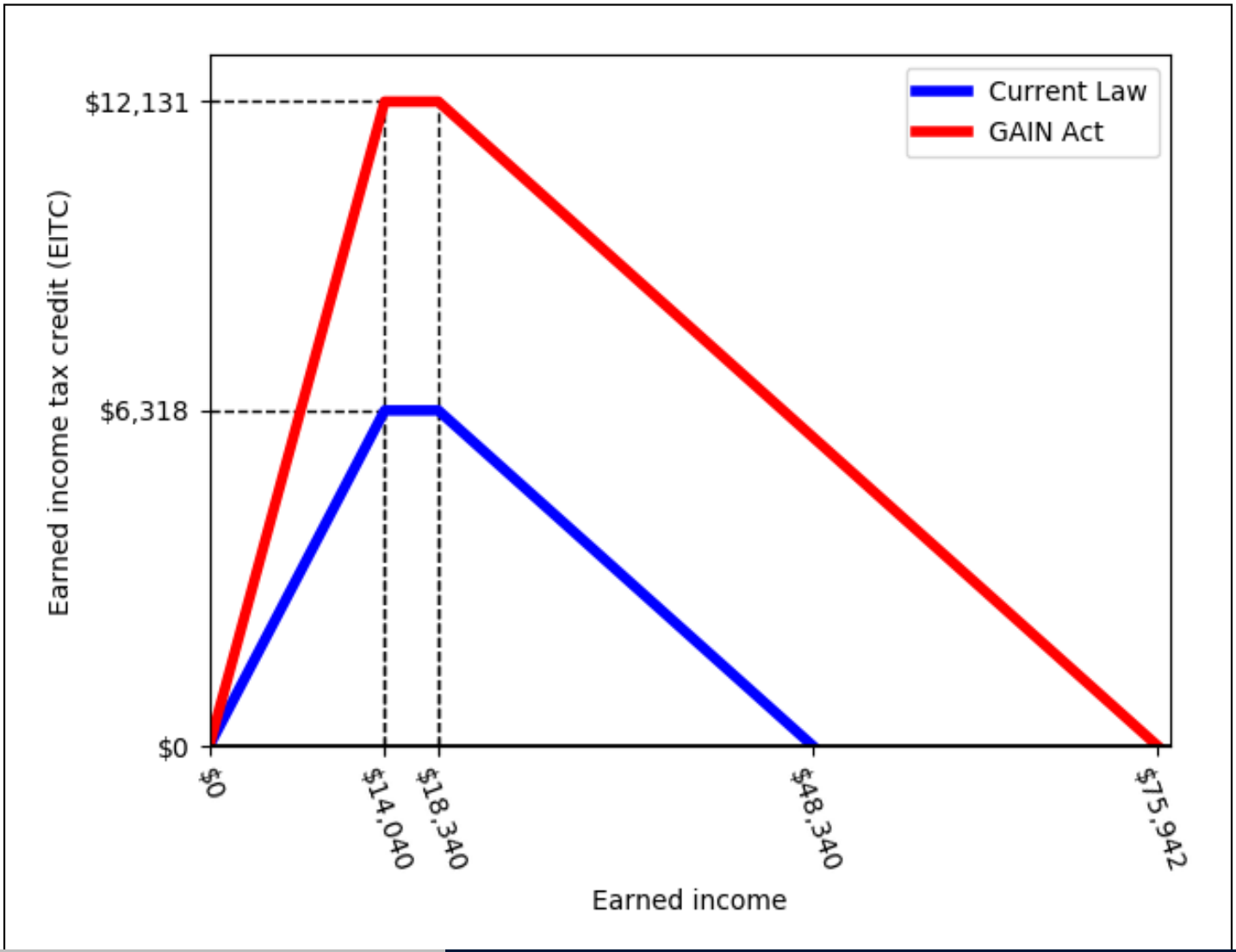
OG-USA: GAIN Act EITC expansion, Kids=1



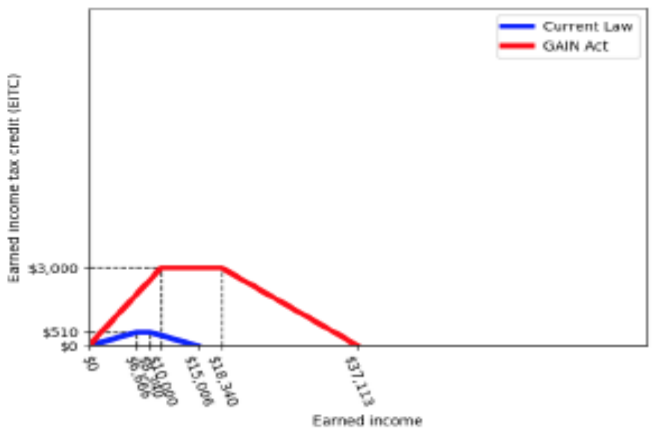
OG-USA: GAIN Act EITC expansion, Kids=2



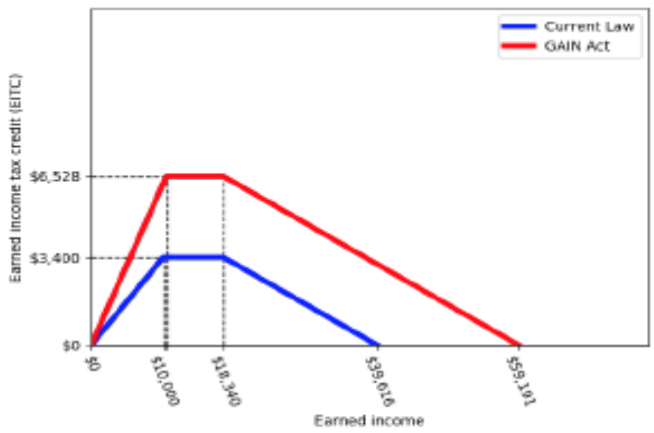
OG-USA: GAIN Act EITC expansion, Kids>=3



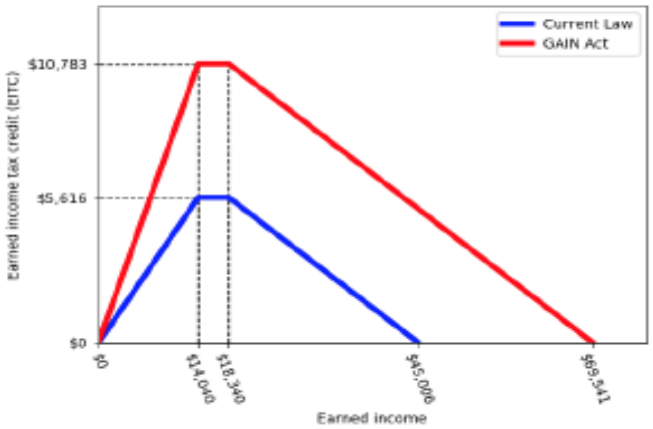
OG-USA: GAIN Act EITC expansion, All



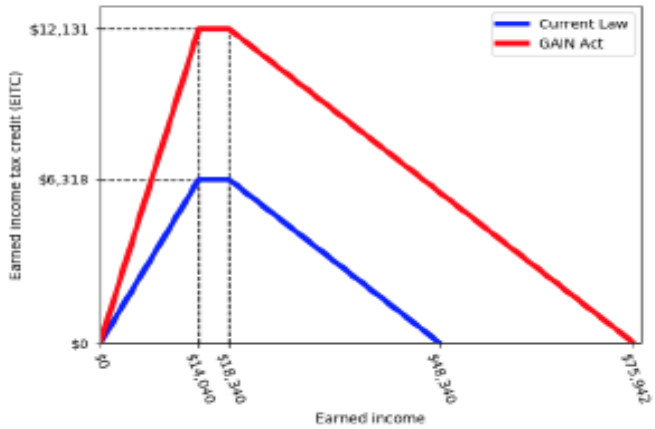
(a) Kids = 0



(b) Kids = 1



(c) Kids = 2



(d) Kids $\geq$ 3

GAIN Act alone: ETR MTR chgs

Table 3. Change in average effective and average marginal tax rates from GAIN Act alone

Tax rate	Year 2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
ETR baseline[b]	21.45%	20.15%	20.19%	20.19%	20.21%	20.23%	20.29%	20.34%	20.39%	21.72%
ETR reform	21.42%	19.10%	19.20%	19.25%	19.32%	19.40%	19.51%	19.62%	19.73%	21.16%
ETR diff.[a]	-0.03%	-1.05%	-0.99%	-0.94%	-0.89%	-0.83%	-0.78%	-0.72%	-0.66%	-0.55%
MTRx baseline[c]	31.97%	28.55%	28.54%	28.53%	28.51%	28.53%	28.54%	28.56%	28.60%	31.82%
MTRx reform	32.17%	29.18%	29.25%	29.30%	29.33%	29.41%	29.49%	29.55%	29.66%	33.08%
MTRx diff.[a]	0.20%	0.63%	0.71%	0.77%	0.82%	0.88%	0.94%	0.99%	1.06%	1.27%

[a] The tax rate difference row is the simple difference of the reform minus the baseline. These difference values are, therefore, percentage point differences and not percentage differences.

[b] *ETR* is the average effective tax rate in each year across all filers. For each filer, *ETR* total tax liability T divided by unadjusted gross income $T/(rb+wn)$

[c] *MTRx* is the average marginal tax rate on labor income in each year across all filers. For each filer, *MTRx* is the derivative of an filer's total tax liability T with respect to labor income $x \equiv w \times n$.

GAIN Act neutral: ETR MTR chgs

Table 6. Change in average effective and marginal tax rates from GAIN Act plus MTR increase

Tax rate	Year 2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
ETR baseline	21.45%	20.15%	20.19%	20.19%	20.21%	20.23%	20.29%	20.34%	20.39%	21.72%
ETR reform	21.18%	20.27%	20.38%	20.44%	20.52%	20.61%	20.73%	20.85%	20.97%	22.03%
ETR diff.[a]	-0.27%	0.12%	0.19%	0.25%	0.31%	0.38%	0.45%	0.51%	0.58%	0.31%
MTRx baseline	31.97%	28.55%	28.54%	28.53%	28.51%	28.53%	28.54%	28.56%	28.60%	31.82%
MTRx reform	34.87%	31.98%	32.08%	32.14%	32.21%	32.30%	32.41%	32.51%	32.64%	35.53%
MTRx diff.[a]	2.91%	3.43%	3.54%	3.61%	3.70%	3.78%	3.86%	3.95%	4.05%	3.71%
MTRy baseline	34.16%	29.48%	29.50%	29.47%	29.44%	29.52%	29.61%	29.70%	29.87%	34.33%
MTRy reform	36.28%	32.25%	32.33%	32.33%	32.36%	32.47%	32.59%	32.73%	32.93%	36.86%
MTRy diff.[a]	2.12%	2.77%	2.83%	2.86%	2.91%	2.95%	2.98%	3.02%	3.06%	2.53%

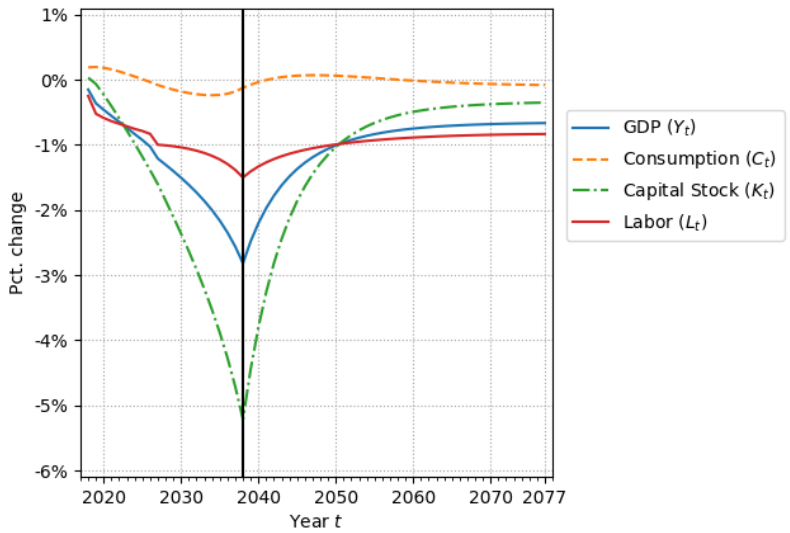
[a] The tax rate difference row is the simple difference of the reform minus the baseline. These difference values are, therefore, percentage point differences and not percentage differences.

[b] *ETR* is the average effective tax rate in each year across all filers. For each filer, *ETR* total tax liability T divided by unadjusted gross income $T/(rb+wn)$

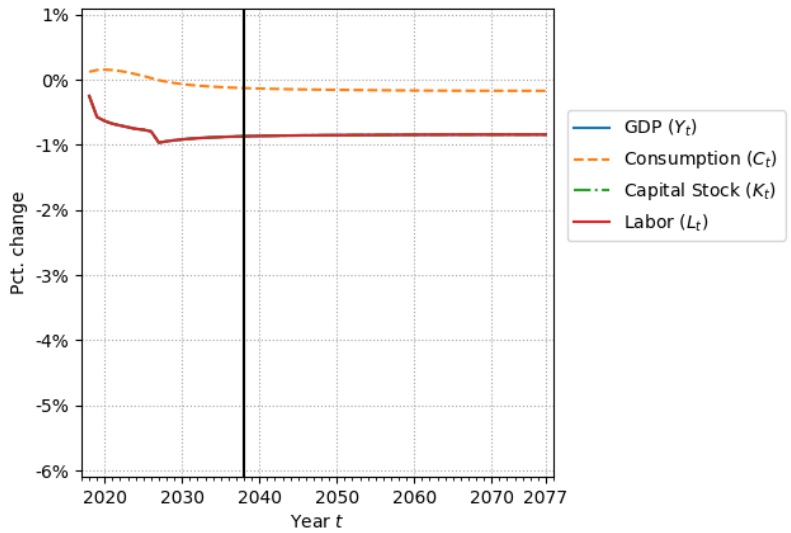
[c] *MTRx* is the average marginal tax rate on labor income in each year across all filers. For each filer, *MTRx* is the derivative of an filer's total tax liability T with respect to labor income $x \equiv w \times n$.

[d] *MTRy* is the average marginal tax rate on capital income in each year across all filers. For each filer, *MTRy* is the derivative of an filer's

GAIN Act alone: macro vars

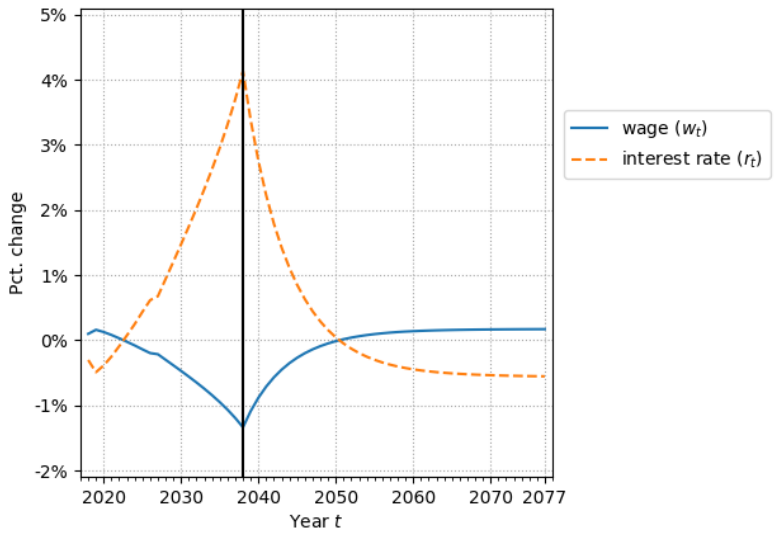


(a) Macro aggregates, closed economy

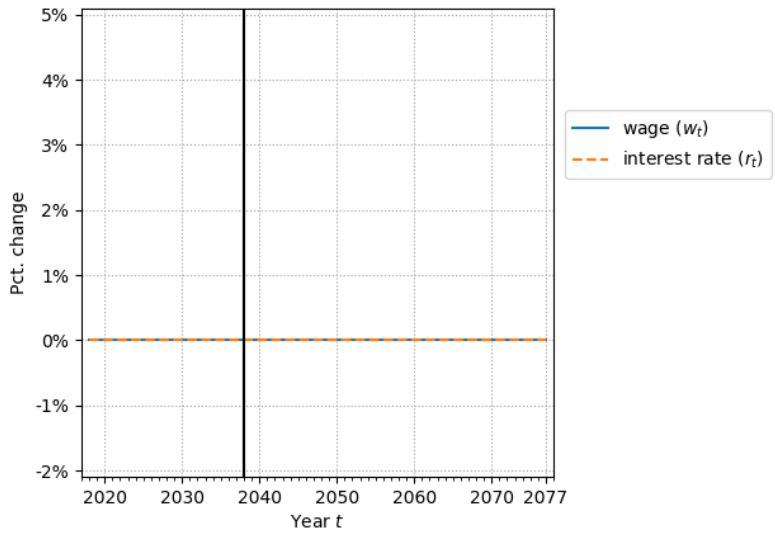


(b) Macro aggregates, small open economy

GAIN Act alone: prices

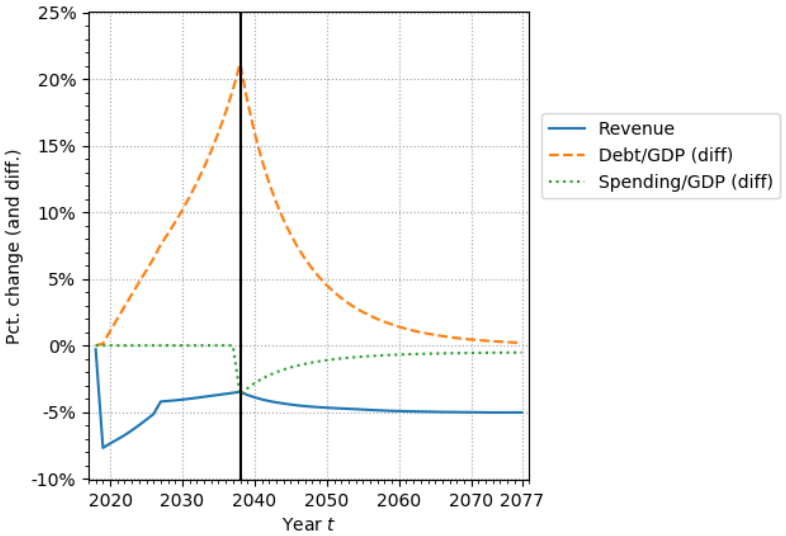


(a) Prices, closed economy

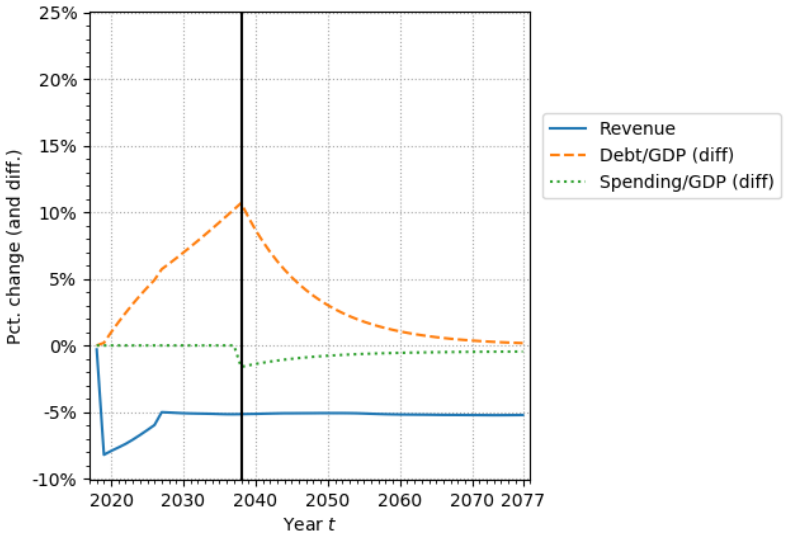


(b) Prices, small open economy

GAIN Act alone: fiscal

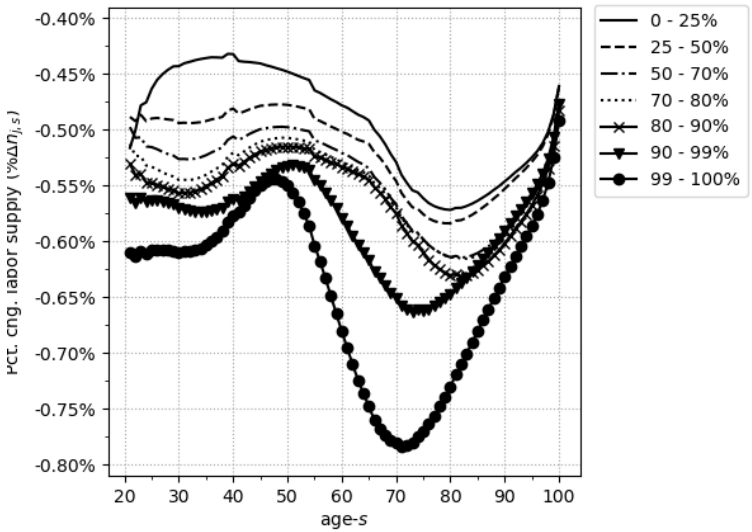


(a) Fiscal variables, closed economy

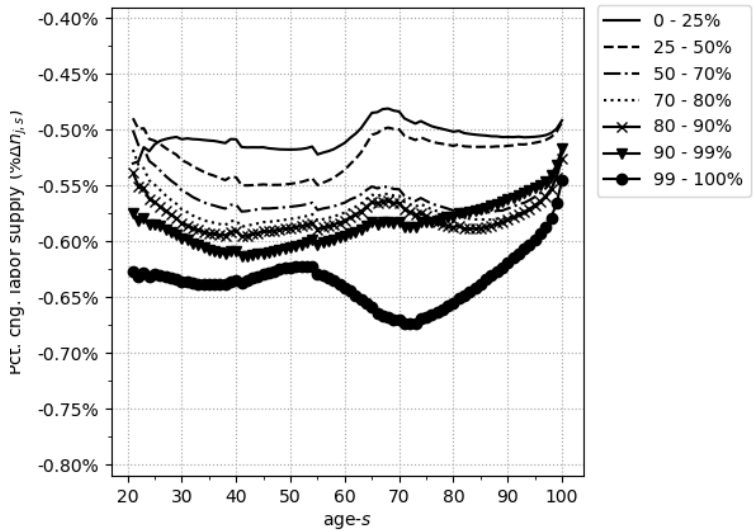


(b) Fiscal variables, small open economy

GAIN Act alone: hh labor supply

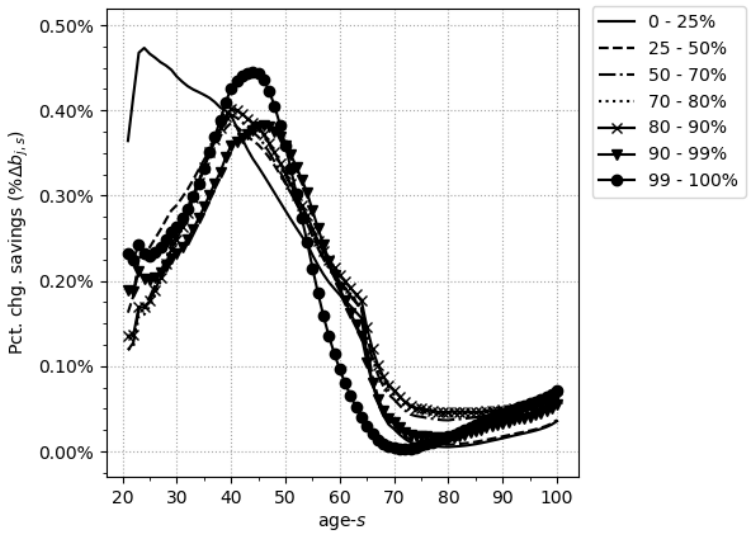


(a) Labor supply, closed economy

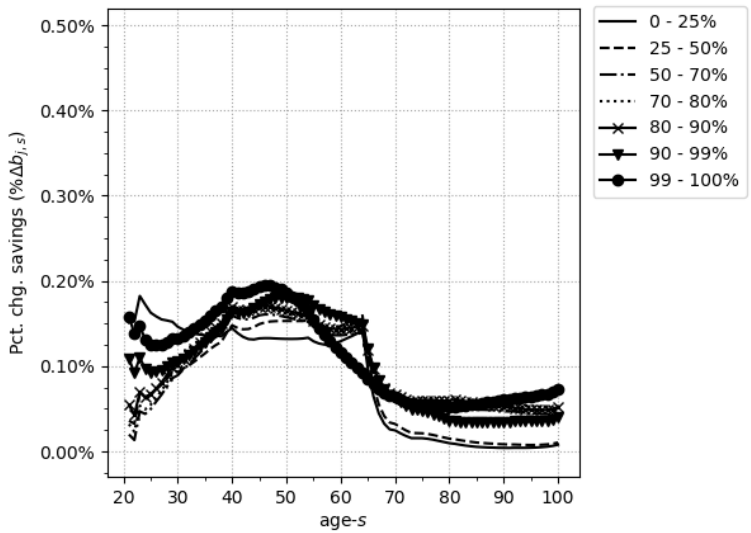


(b) Labor supply, small open economy

GAIN Act alone: hh savings

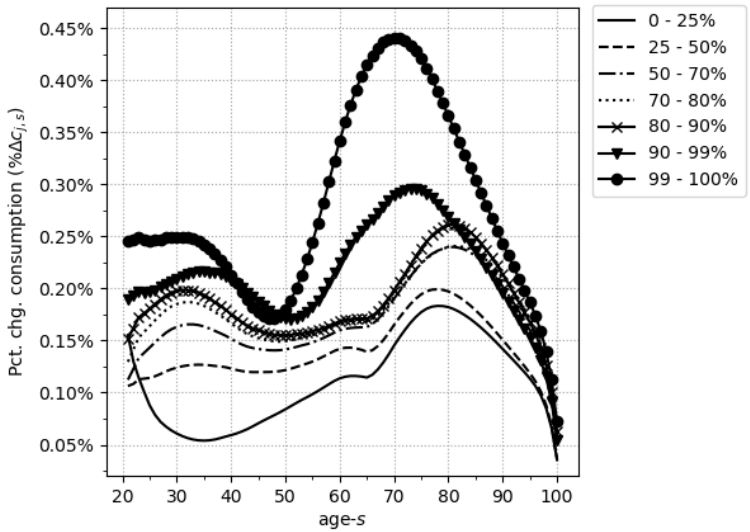


(a) Savings, closed economy

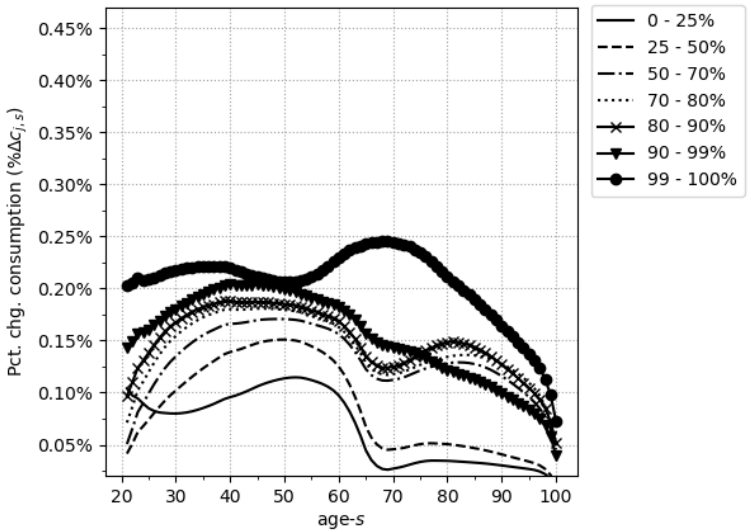


(b) Savings, small open economy

GAIN Act alone: hh consumption

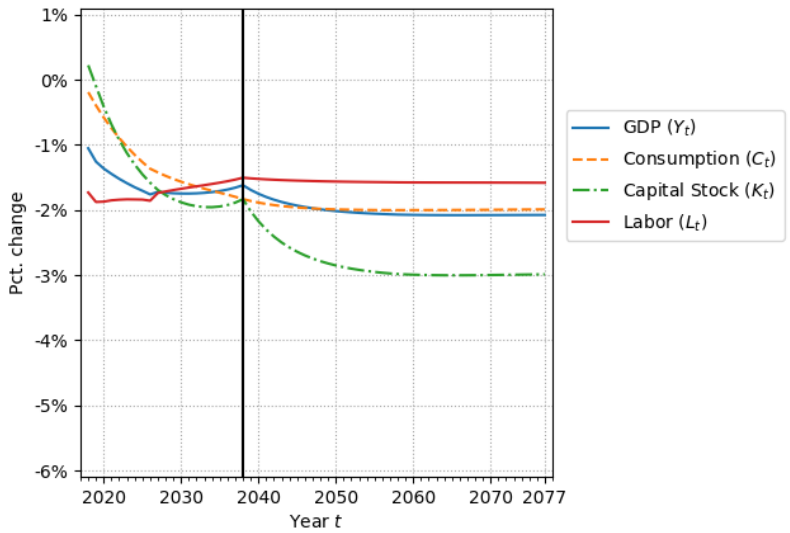


(a) Consumption, closed economy

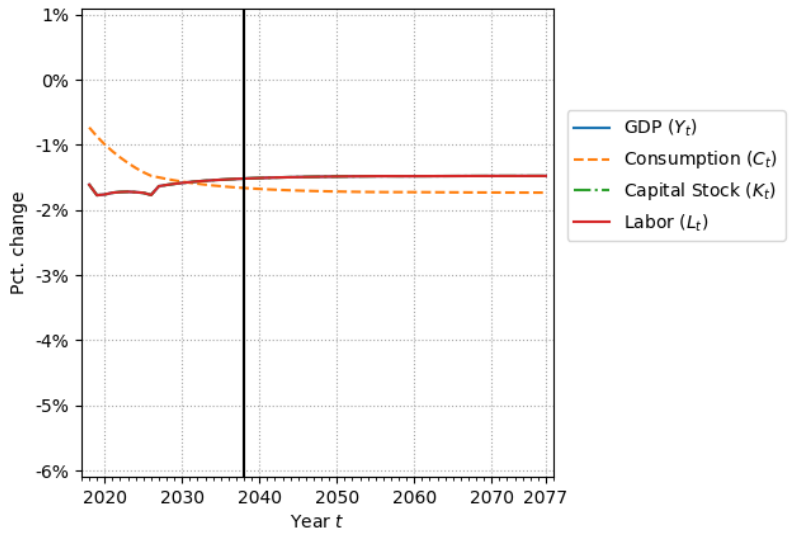


(b) Consumption, small open economy

GAIN Act neutral: macro vars

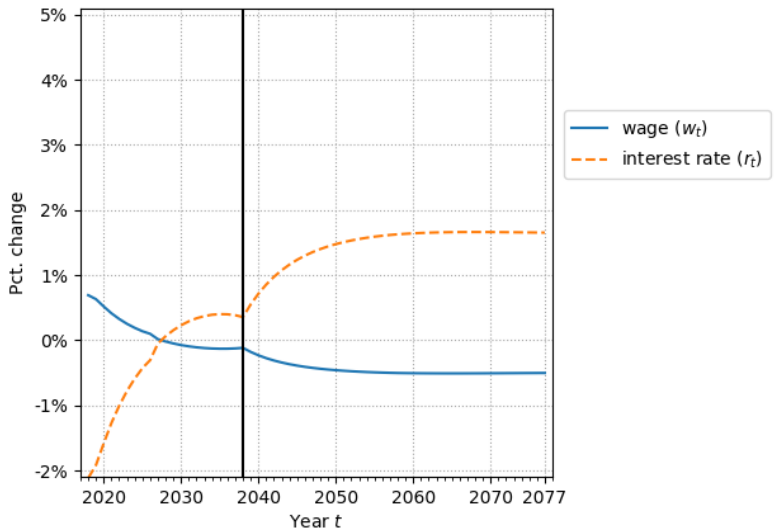


(a) Macro aggregates, closed economy

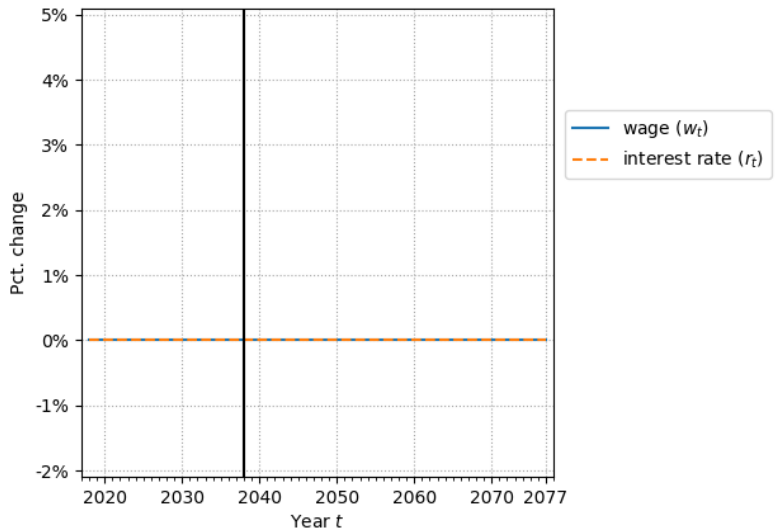


(b) Macro aggregates, small open economy

GAIN Act neutral: prices

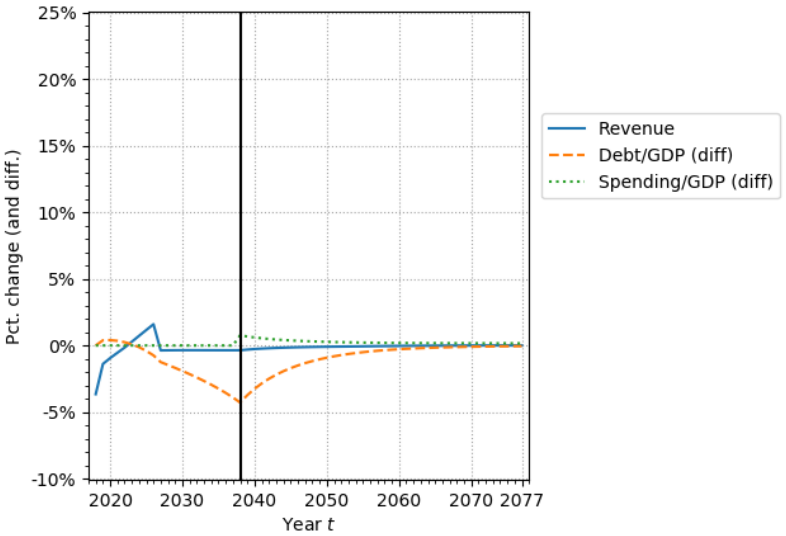


(a) Prices, closed economy

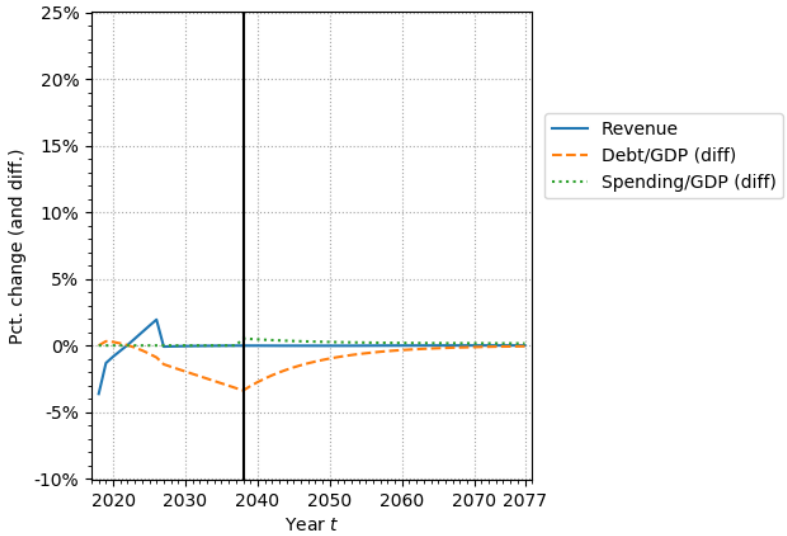


(b) Prices, small open economy

GAIN Act neutral: fiscal

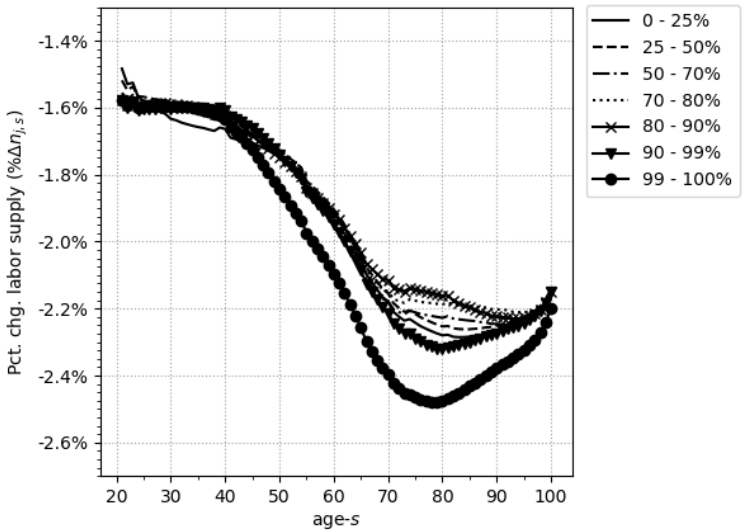


(a) Fiscal variables, closed economy

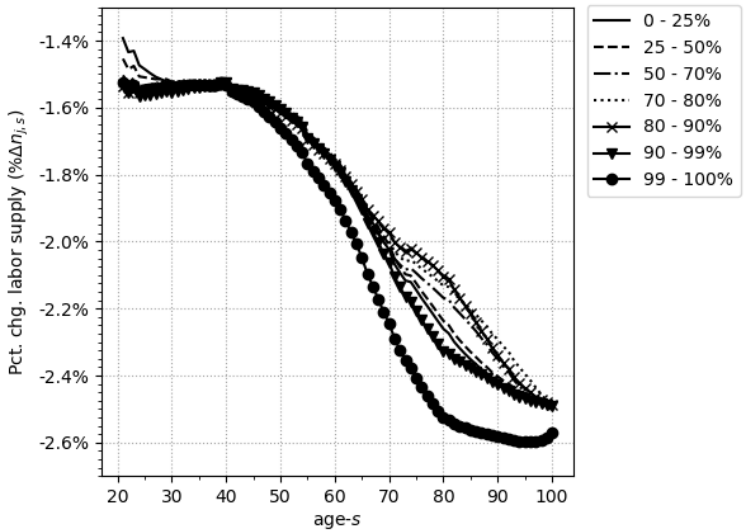


(b) Fiscal variables, small open economy

GAIN Act neutral: hh labor supply

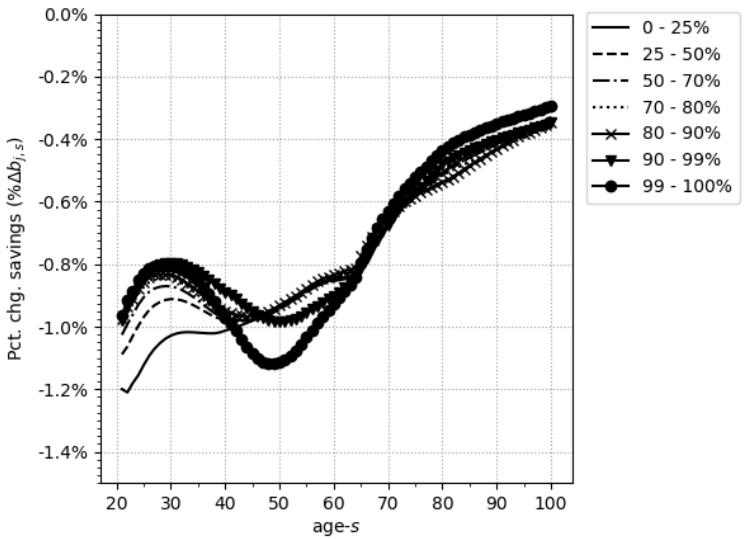


(a) Labor supply, closed economy

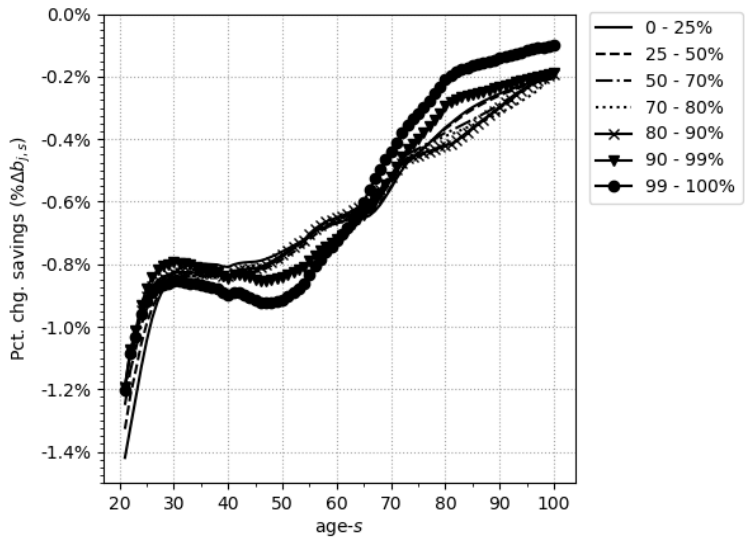


(b) Labor supply, small open economy

GAIN Act neutral: hh savings

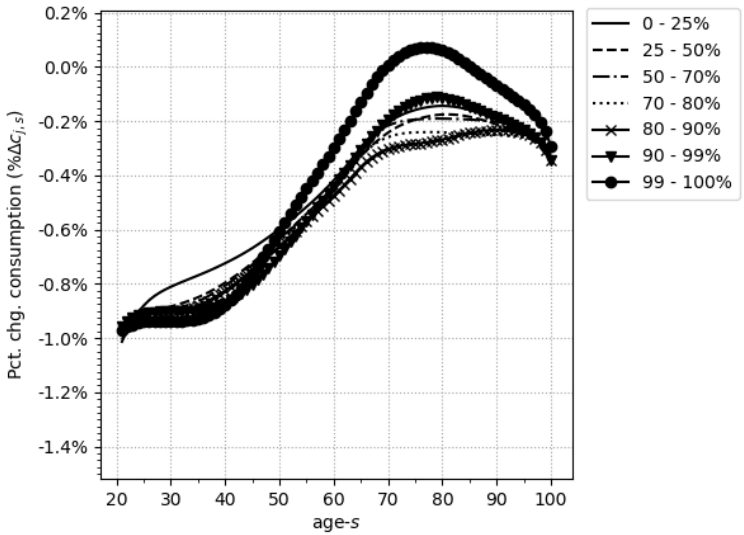


(a) Savings, closed economy

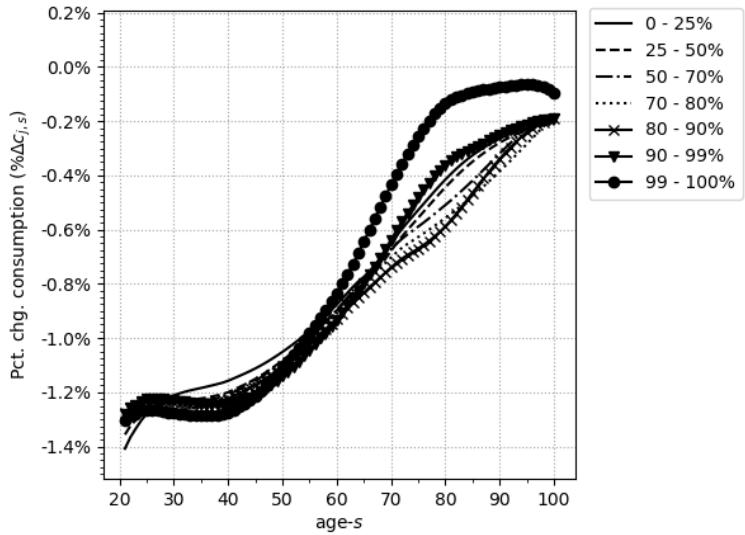


(b) Savings, small open economy

GAIN Act neutral: hh consumption



(a) Consumption, closed economy



(b) Consumption, small open economy

Summary

Goals for fiscal modeling

- Revenue estimates/Receipts forecasts
- Distributional analysis
- Macroeconomic impact

Dynamic modeling captures all

Overlapping generations address all these areas