Labor Force Participation, College Enrollment, and the Business Cycle

Zhifeng Cai & Rosemary Kaiser
Rutgers University

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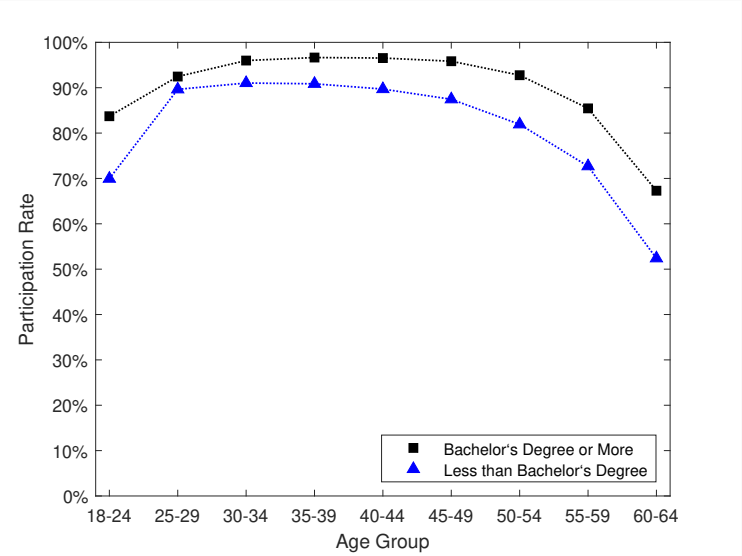
Introduction

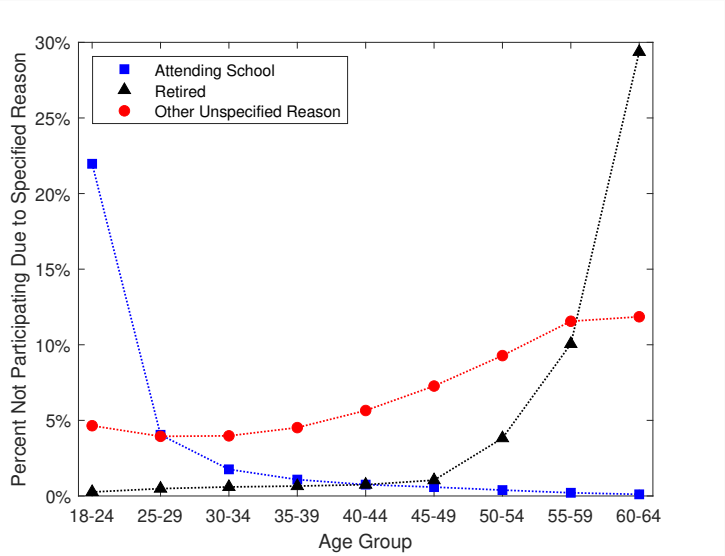
Two motivating empirical observations:

1. Participation displays an inverted U-shape over the life cycle

Participation Rate



Reported Reason for Non-Participation



Source: 2000-2022 average over monthly CPS data where non-participants due to disability, illness, or caring for house or family are discluded

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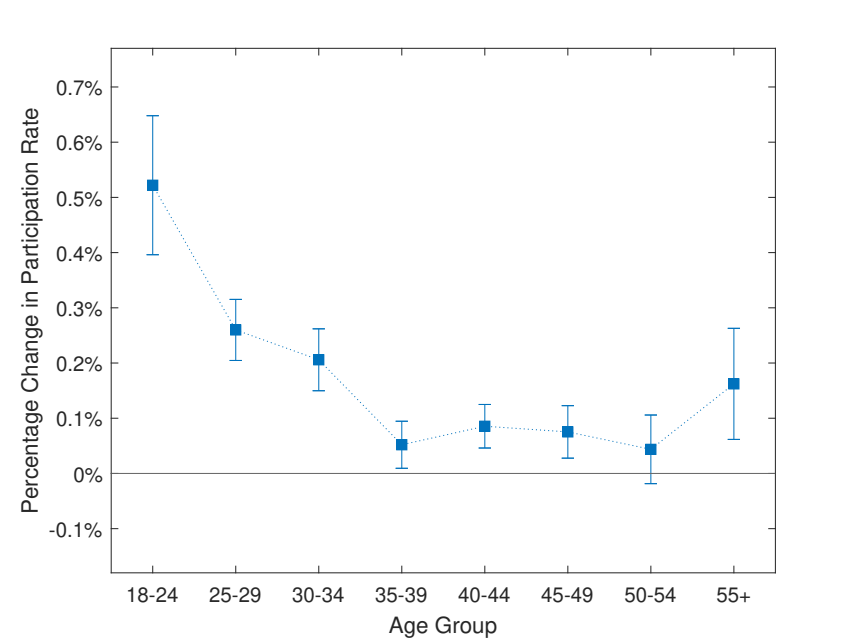
2. Participation responsiveness declines with age

Same-Quarter Change Associated w/ 1% Higher GDP Growth



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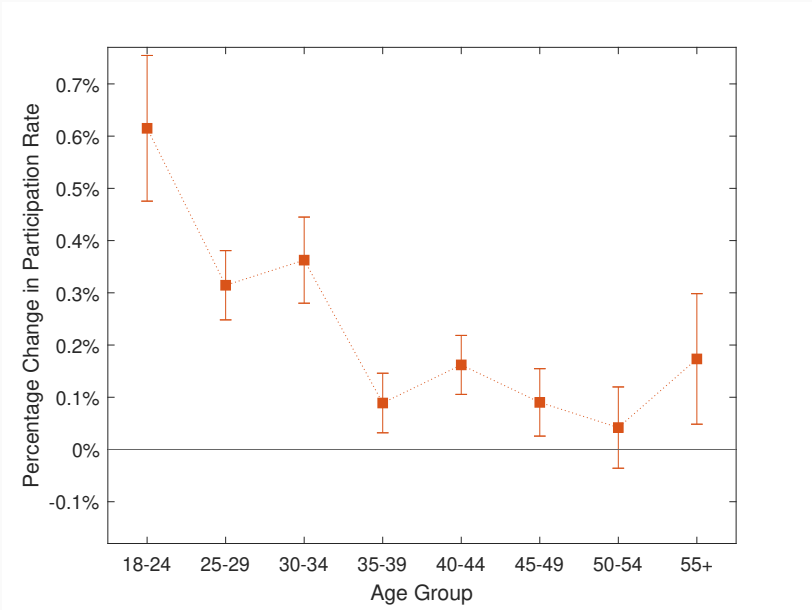
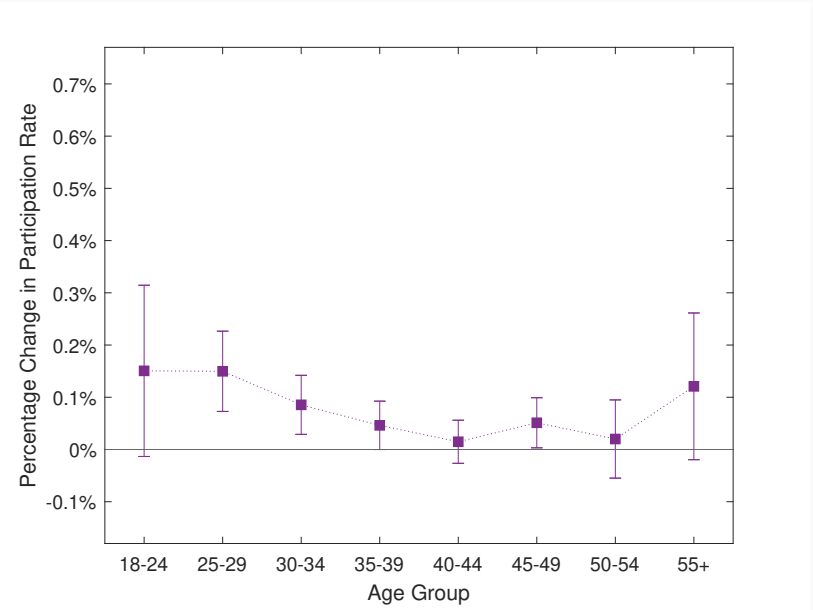
Less than Bachelor's Degree



Bachelor's Degree or More



Introduction

Research Questions:

1. What factors contribute to the age-related dynamics of labor participation? Why do certain age groups appear more susceptible to business cycle shocks?
2. Can government intervention, such as search subsidies, improve overall welfare?

Contribution and Overview

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   Contribution:

   - Participation choice w/ three states (employment, unemployment, non-participation): Tripier (2003), Veracierto (2008), Krusell et al. (2011) (2017) (2020), Christiano et al. (2021)
     - We include age heterogeneity & skill accumulation dynamics
     - Four states: employed, unemployed, college, no activity
     - Erosa et al. (2016): 25+ age dynamics, no college choice

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   Overview: Key Model Ingredients

   - Dynamics of age 18-24 only match the data well with endogenous college attendance choice (for all ages)
   - Dynamics of age 55-64 explained by horizon effect - benefit of search declines when approaching retirement age

Contribution and Overview

2. Can government intervention, such as search subsidies, improve overall welfare?

Contribution:

- Search subsidies smooth consumption but incentivize more time in unemployment: Pavoni and Violante (2007), Pavoni et al. (2016), Gervals et al. (2022), among others
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Overview

- In a model w/ risk aversion & imperfect insurance against job loss: search subsidies are beneficial if not interfering much with college choice

Model

Model Environment

Population

- Agents populate the model from age 18-65, each period is a quarter
- Agents differ by age (a), skill level (z), and education (τ)
- In any period, an agent is employed, unemployed, attending college, or out of the labor force and not attending college
- Non-employed draw random search cost: can search, pay fixed college cost, or do neither
- Endogenous mass of firms determined via free entry

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Productivity

- Aggregate productivity Z_t where $\ln Z_t = \rho \ln Z_{t-1} + \epsilon_t$, $\epsilon_t \sim \mathcal{N}(0, \sigma_\epsilon^2)$
- Output of employed is $f(Z_t, z_t)$
- Non-employed enjoy leisure benefit $b(z_t)$

Model Environment

Productivity (continued)

- Agents enter with $z = 0$ and no degree $\tau = 1$
- Skill growth on-the-job can depend on education (τ). When employed:

$$z_{t+1} = \begin{cases} z_t & \text{with probability } (1 - \pi_\tau) \\ z_t + \Delta_z & \text{with probability } \pi_\tau. \end{cases}$$

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Endogenous College Attendance and Participation

- Non-employed agents (of any age) can pay κ to attend college at the start of the next period
- Attendees graduate with probability g; upon graduation their education-level becomes $\tau = 2$ and they get one-time skill increase Δ_g

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- Attendees graduate with probability g; upon graduation their education-level becomes $\tau = 2$ and they get one-time skill increase Δ_g
- Agents may not simultaneously attend college and search for a job
- Non-employed agents can pay $c_w \sim \text{log-normal}(\mu_{cw}, \sigma^2_{cw})$ to search at the start of the next period

Model Environment

Search and Separations

- Agents direct their search for jobs offering fraction μ of production
- Jobs are destroyed with exogenous probabilities $\delta_a(\tau)$
- Job-to-job transitions: When a job is destroyed the worker can search and immediately match at the start of the next period

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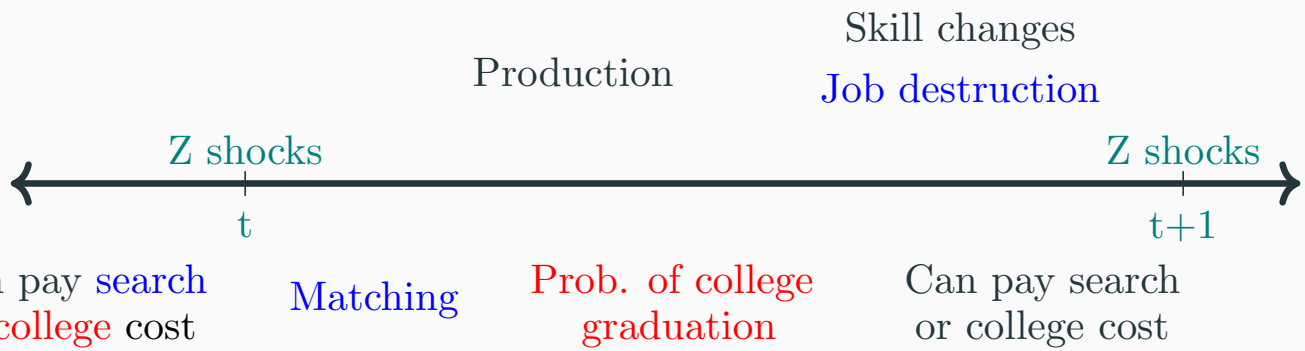
Matching Probabilities

- Vacancy posting cost c_f and CRTS matching function $M(u, v)$
- Submarket tightness: $\theta \equiv \frac{v}{u}$ determined by free entry
- Probability of meeting a firm: $\frac{M(u,v)}{u} \equiv p(\theta)$
- Probability of meeting a worker: $\frac{M(u,v)}{v} \equiv q(\theta)$

Model Environment

Model Timing

Employed



Non-employed

- College attendance and search choice made at the same time: if the agent does not search they decide to pay college cost or do nothing
- No on-the-job search: job-to-job transitions occur after job destruction as agents immediately search and can match at the next period's start
- On-the-job skill accumulation occurs after production and right before possible job destruction

Value Functions

Non-employed

$$N_a(\tau, Z, z) = \max\left\{N_a^N(\tau, Z, z), N_a^C(\tau, Z, z), N_a^S(\tau, Z, z)\right\}$$

Non-employed: Does Nothing

$$N_a^N(\tau, Z, z) = u(b(z)) + \beta\mathbb{E}[N_{a+1}(\tau, Z', z)]$$

Non-employed: Attends College

$$N_a^C(\tau, Z, z) = u(b(z) - \kappa) + \beta\mathbb{E}\left[(1-g)N_{a+1}(\tau, Z', z) + gN_{a+1}(2, Z', z + \Delta_g)\right]$$

Non-employed: Searches

$$N_a^S(\tau, Z, z) = u(b(z) - c_w) + \beta\mathbb{E}[\widehat{U}_{a+1}(\tau, Z', z)]$$

Value Functions

Value of Search

$$\widehat{U}_a(\tau, Z, z) = \max_{\mu} \{p\left(\theta_a(\tau, Z, z, \mu)\right) W_a(\tau, Z, z, \mu) + \left(1 - p\left(\theta_a(\tau, Z, z, \mu)\right)\right) N_a(\tau, Z, z)\}$$

Free Entry

$$c_f \geq q\left(\theta_a(\tau, Z, z, \mu)\right) J_a(\tau, Z, z, \mu) \qquad \forall \ a, \tau, Z, z, \mu$$

Workers' Value of Employment

$$W_a(\tau, Z, z, \mu) = u(\mu f(Z, z)) + (1 - \delta_a(\tau))\beta \mathbb{E}\left[W_{a+1}(\tau, Z', z', \mu)\right] + \delta_a(\tau)\beta \mathbb{E}\left[\widehat{U}_{a+1}(\tau, Z', z')\right]$$

Firms' Value of Employing a Worker

$$J_a(\tau, Z, z, \mu) = (1 - \mu) f(Z, z) + (1 - \delta_a(\tau))\beta \mathbb{E}\left[J_{a+1}(\tau, Z', z', \mu)\right]$$

Equilibrium

Recursive Equilibrium (RE) is given by:

1. *Value functions* $\left\{N_a^S(\tau, Z, z), N_a^C(\tau, Z, z), N_a^N(\tau, Z, z), N_a(\tau, Z, z), \widehat{U}_a(\tau, Z, z), W_a(\tau, Z, z, \mu), J_a(\tau, Z, z, \mu)\right\}$
2. *Equilibrium market tightness function* $\{\theta_a^U(\tau, Z, z)\}$ *solves the workers' search problem*
3. *Optimal search and college attendance rules* $G_a(\tau, Z, z)$ *and* $C_a(\tau, Z, z)$
4. *Aggregate transition probabilities consistent with policy functions and stochastic* Z *process.*

A Block Recursive Equilibrium (BRE) is a RE where value and policy functions depend on the aggregate state only through exogenous aggregate productivity Z.

A unique RE exists & is a BRE (follows from Menzio, Telyukova, & Visschers (2016))

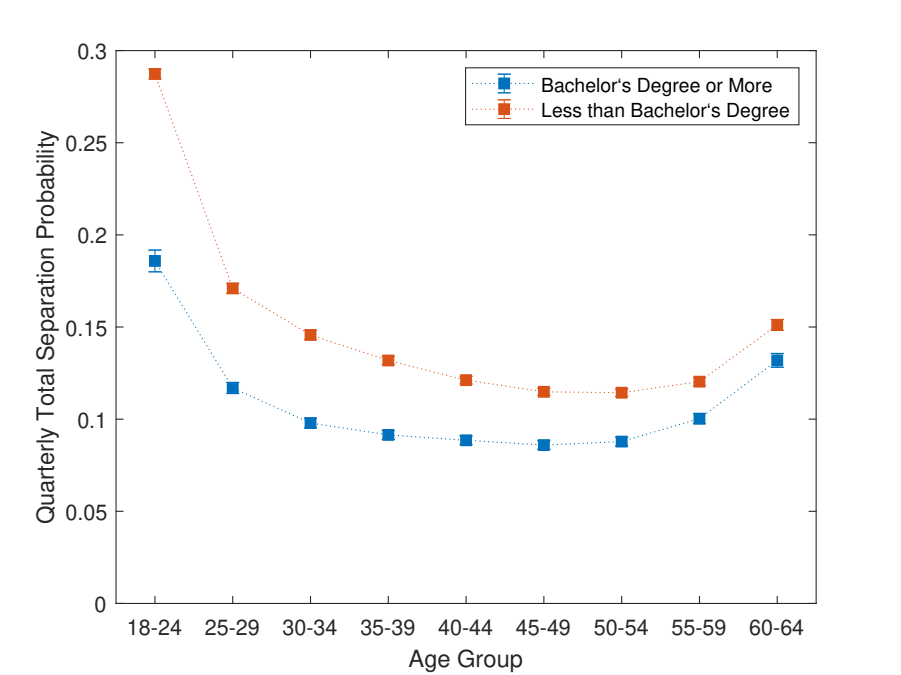
Calibration and Model Predictions

Calibration Overview

Assigned Parameter Values

Parameter	Description	Value
β	Discount factor	0.99
ρ	Autocorrelation of aggregate shocks	0.95
$\delta_a(\tau)$	Separation rates by age and education	CPS estimates (below)

Quarterly Total Separation Estimates by Age and Education



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Calibrated Parameter Values

Parameter	Estimate	Targeted Moment	Data	Model
ℓ	2.415631	Unemployment rate (%) for age 20+	4.035	4.066
κ	0.610879	Pop. age 25+ with Bachelor's degree (%)	31.920	30.962
Δ_g	0.240492	Wage ratio: prime age to 20-24	1.646	1.541
π_2	0.330988	College wage premium (age 25+)	1.814	1.775
π_1	0.112303	Wage ratio: 55-64 to prime age	1.086	1.334
c_f	0.811151	Vacancy posting rate	4.153	4.179
μ_{cw}	-0.144348	Age 20-64 participation rate (%)	87.140	88.364
σ_{cw}	0.828930	Prime age/60-64 participation rate	1.500	1.523
b_c	0.806085	College to non-college employment rate ratio	1.316	1.103
g	0.035700	College graduation rate over 4 yrs	0.441	0.441
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- Stochastic cost of participation calibrated to match the relative participation rate between the prime-aged and 55+
- Variance of this cost distribution has a long right tail

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- Model matches key statistics related to the endogenous college choice, including the wage premium, college share, and employment ratio

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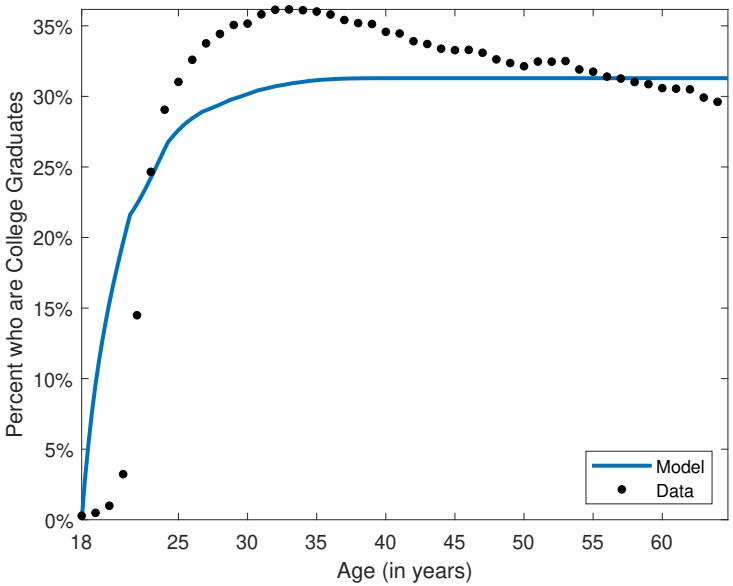
- Two key sources of risk: job loss ($\delta_a(\tau)$) and the risk of aggregate shocks affecting employment opportunities

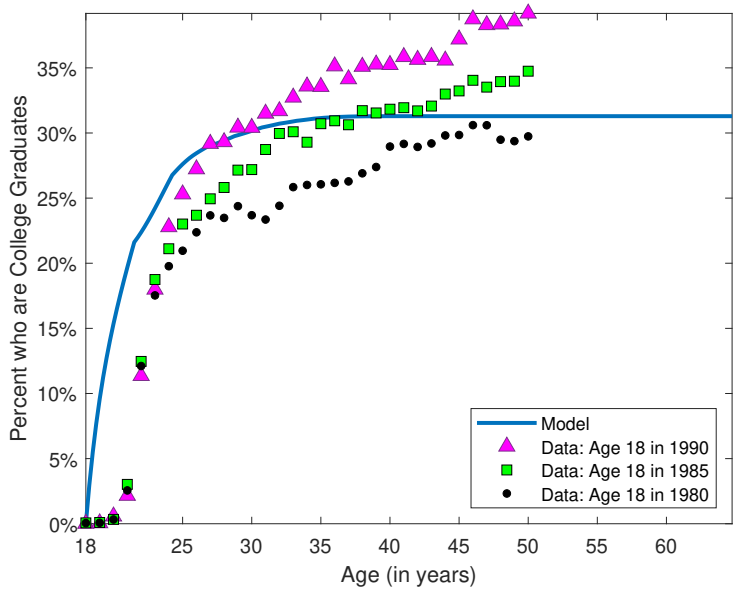
Model Predictions

Percent Who are College Graduates by Age (Untargeted)

2000-2022 Avg. over Cohorts



1980, 1985, and 1990 Cohorts



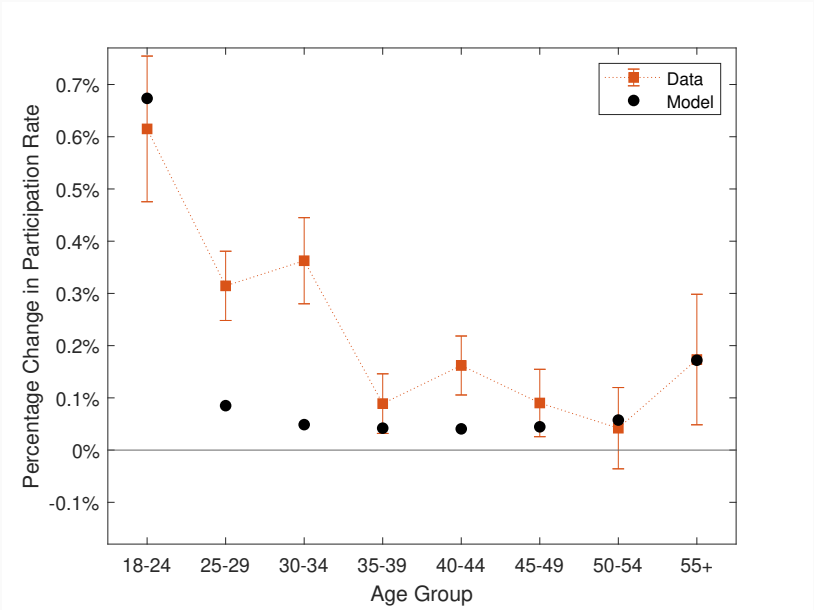
- Agents in the model can attend college at any age, but the benefit is greatest when young
- Responsiveness of 18-24 enrollment to positive 1% GDP shock: data -0.30%, model -0.28%

▸ Enrollment IRF

Model Predictions

Same-Quarter Change in Participation Rate Associated with 1% Higher GDP Growth (Untargeted)

Less than Bachelor's Degree



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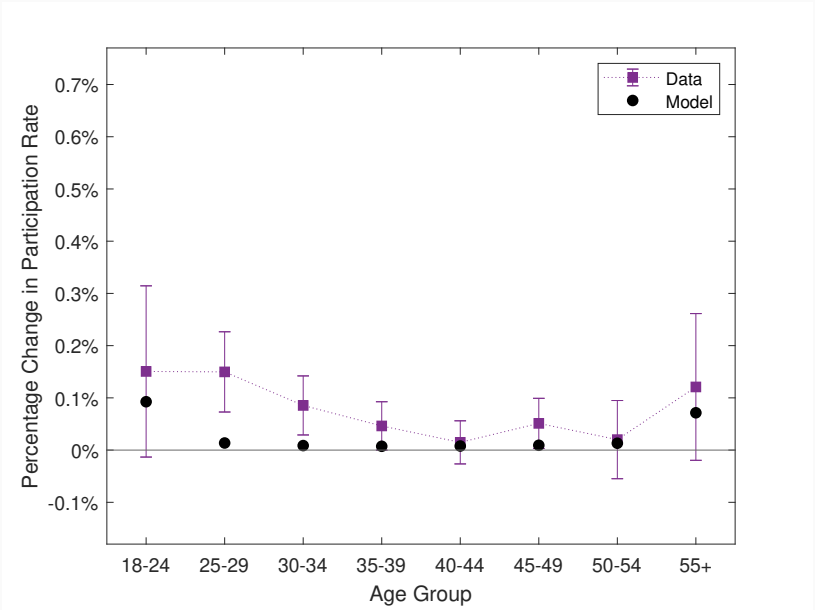

Counterfactual Results

Counterfactual: Subsidize Search

Introducing a subsidy for search:

- Smooths consumption as risk-averse agents move between employment states in an environment with no private insurance market

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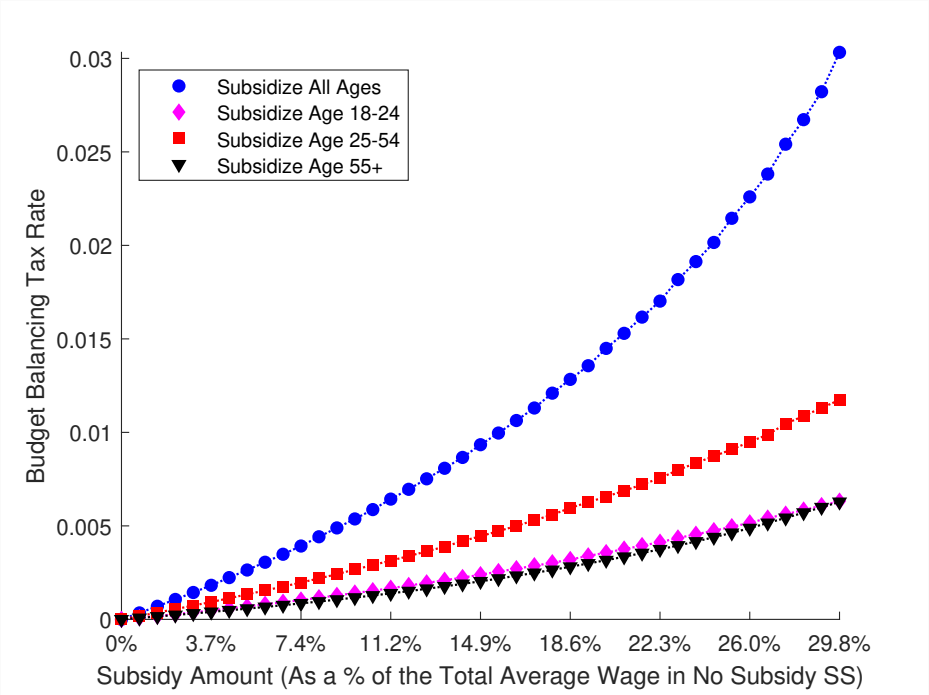
- Fiscal externality: agents do not fully internalize the benefit they create from finding employment (generated tax revenue)

Steady-State Effects of Search Subsidy

First, consider the effects of search subsidies in the risky steady-state

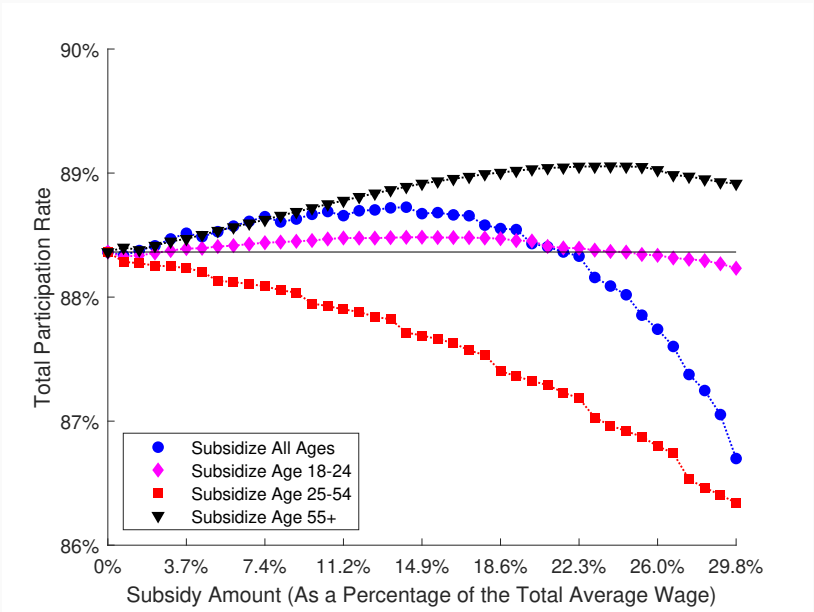
- Lump-sum subsidy s paid to the unemployed
- Financed by proportional income tax on wages of the employed

Budget Balancing Tax Rate

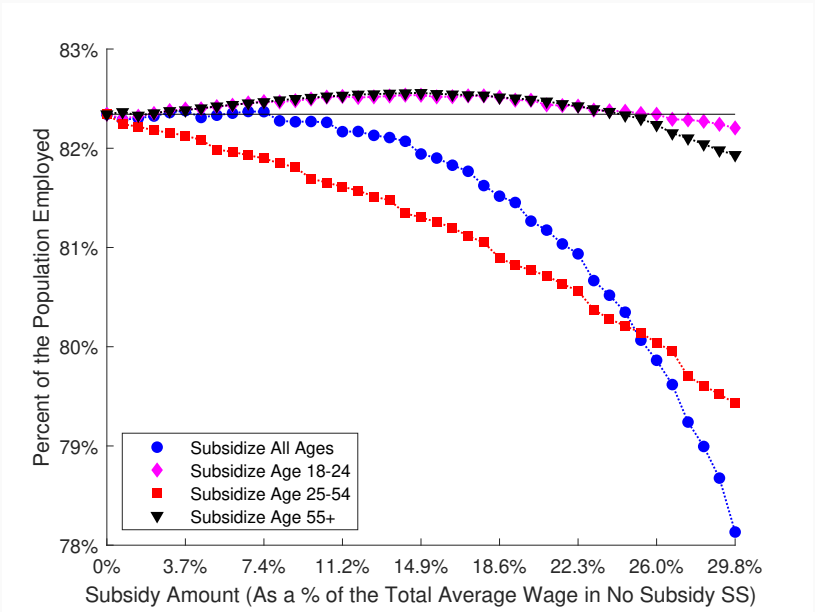


Steady-State Effects of Search Subsidy

Participation Rate

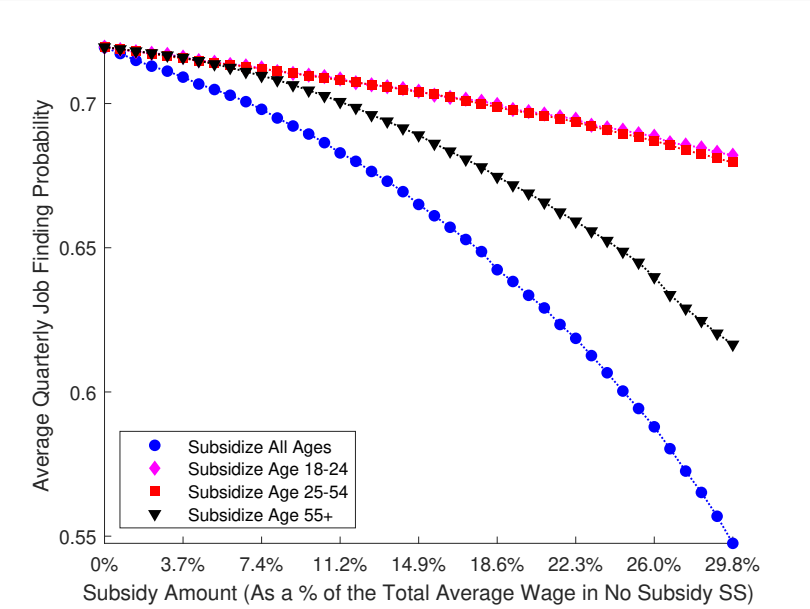


Employment Rate

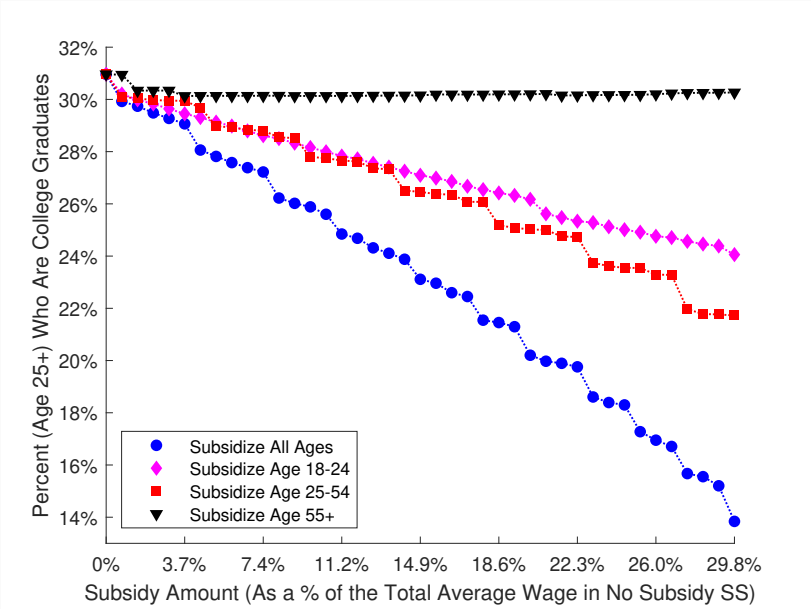


Steady-State Effects of Search Subsidy

Avg Qrtrly Job-Finding Rate



% College Graduates Among 25+

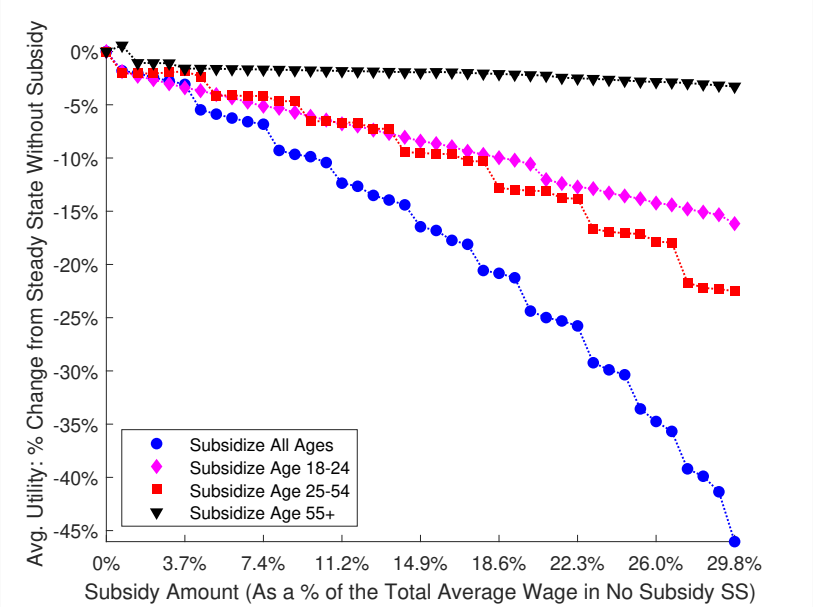


Incentive effects:

- Although participation increases, avg. time in unemployment increases
- Opportunity cost of college increases: this has sizeable effects when younger agents are given the search subsidy

Steady-State Effects of Search Subsidy

Average Utility



- Only offering very small subsidies to 55+ slightly increased utility
- Subsidies offered only to 55+ were most effective in increasing total utility (maximizing subsidy is 0.74% of avg. wage)
- Calibration suggests many 55+ are almost indifferent regarding participation, subsidy is cost-effective in encouraging participation

▸ Robustness ▸ CEV ▸ Transition

Search Subsidy: Decomposing Results

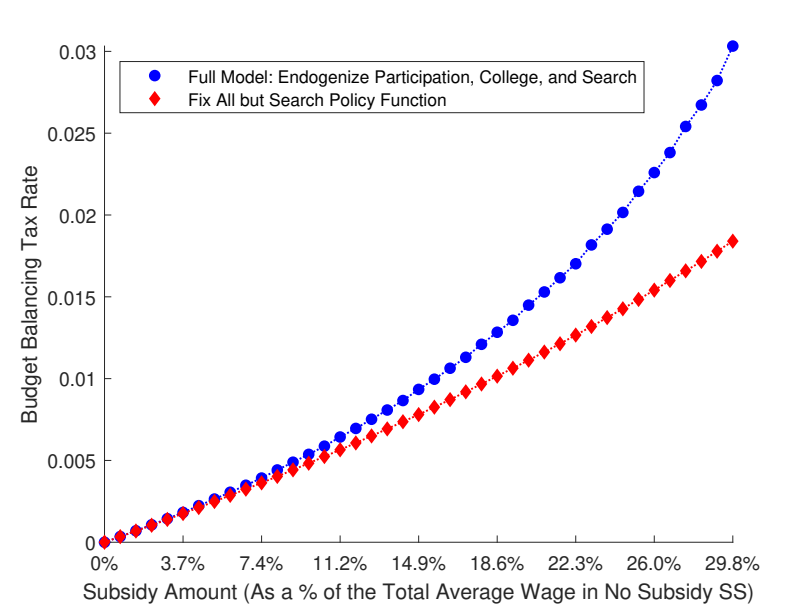
If only directed search decisions (and not participation and college attendance) were impacted by the subsidies:

Search Subsidy: Decomposing Results

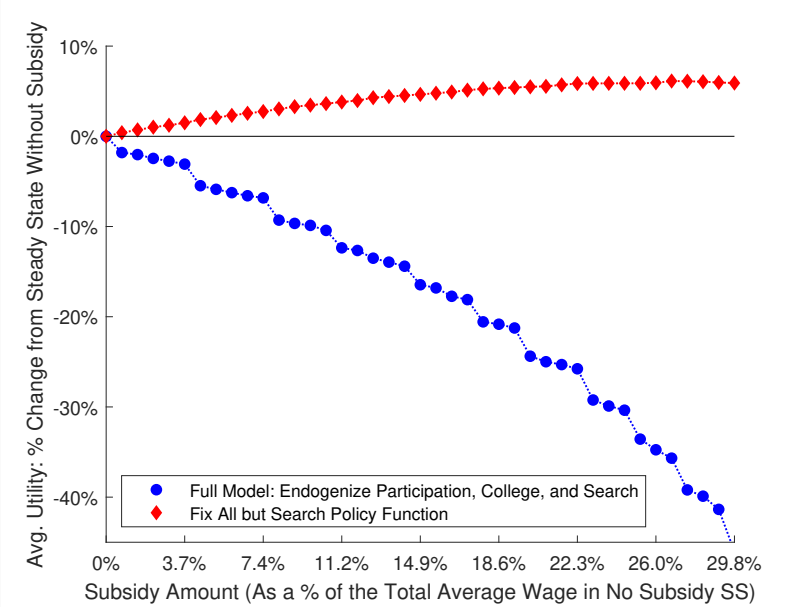
If only directed search decisions (and not participation and college attendance) were impacted by the subsidies:

- Would underestimate the budget-balancing tax rate
- Would get qualitatively different results regarding effect on avg. utility

Tax Rate: Subsidy to All Ages



Average Utility: Subsidy to All Ages



▸ Additional Decomposition Results

Conclusion

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  - Subsidizing only older agents results in higher total utility
  - A model with only a directed search margin would yield qualitatively different predictions

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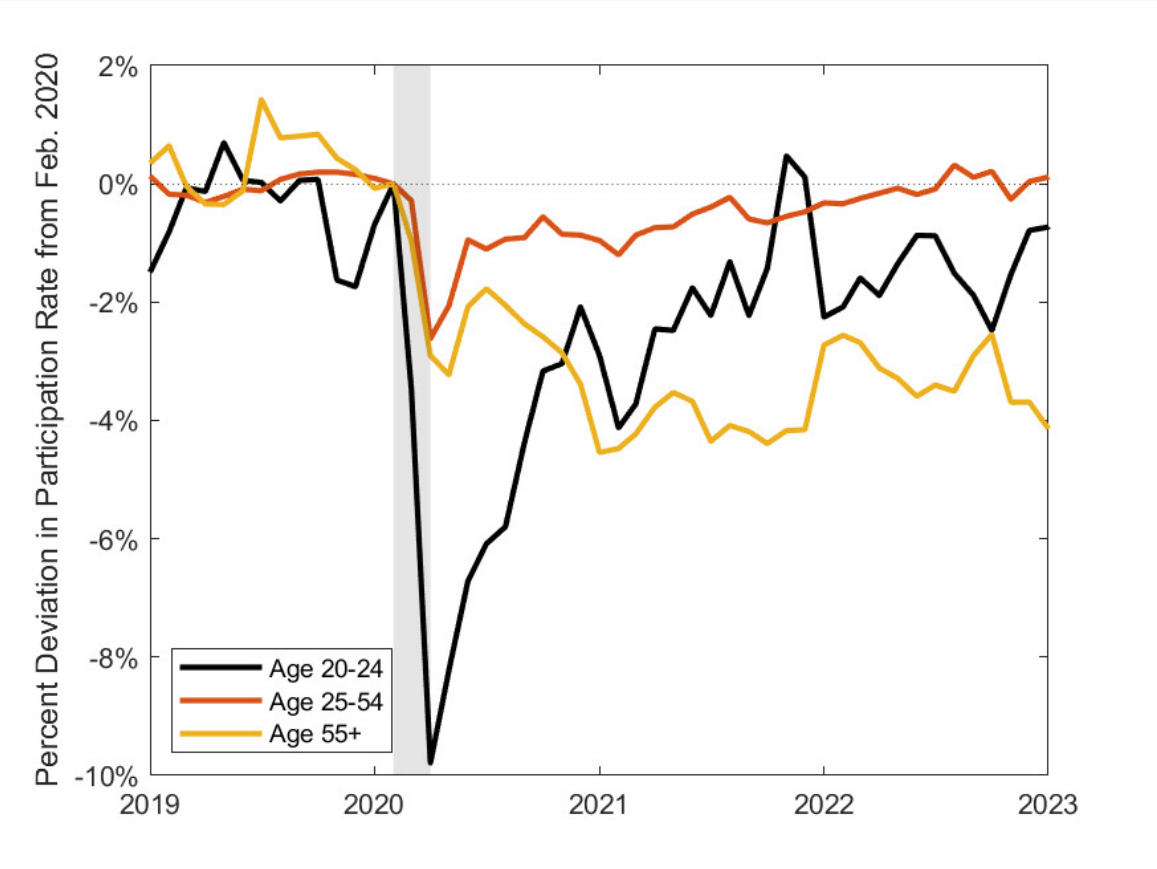
  - Including a college attendance option was necessary for capturing participation dynamics of younger individuals
- Subsidizing the search of all ages discourages college attendance
  - Subsidizing only older agents results in higher total utility
  - A model with only a directed search margin would yield qualitatively different predictions
- Increasing (decreasing) search subsidies during recessions (booms) promotes (discourages) search when it is least (most) productive

Thank You!

r.kaiser@rutgers.edu

Appendix: 2020 Participation Response

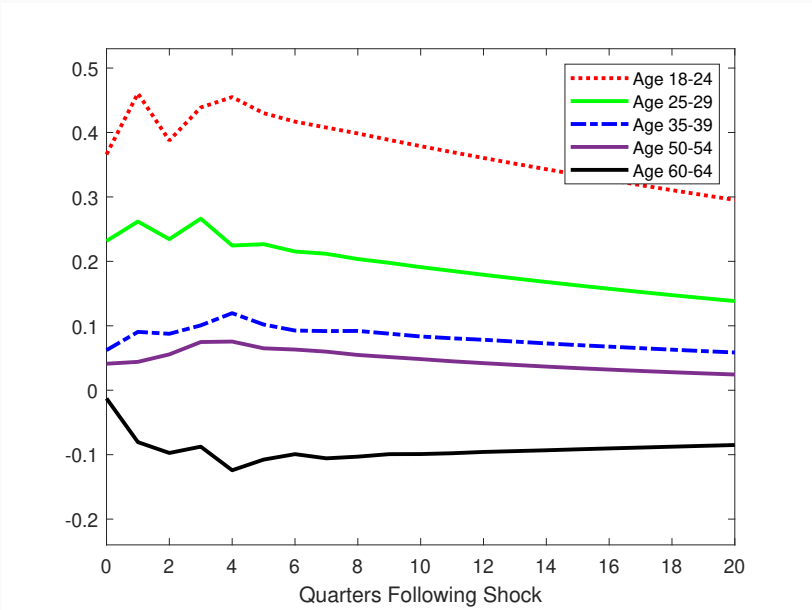


Source: U.S. Bureau of Labor Statistics, Labor Force Participation Rate (Seasonally Adjusted) - 25-54 Yrs, 20-24 Yrs, 55 Yrs and over, retrieved from FRED, Federal Reserve Bank of St. Louis

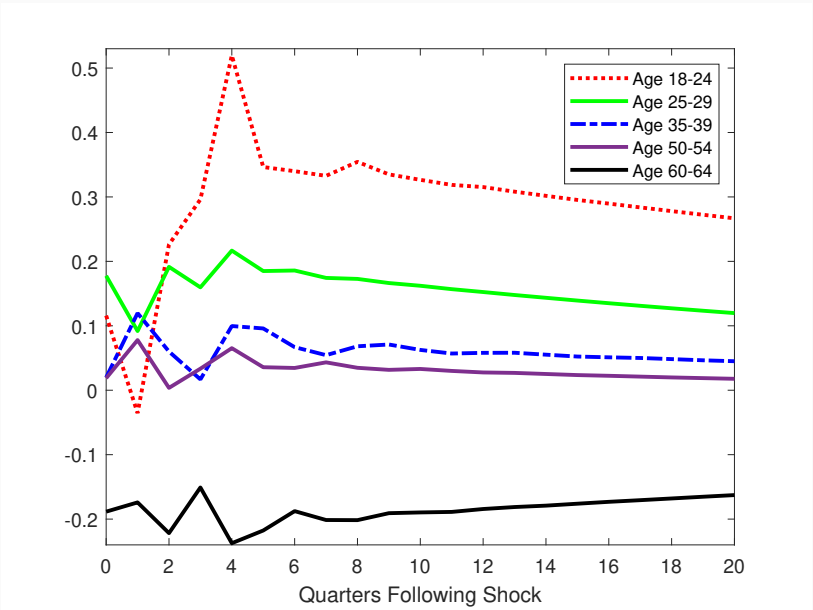
Return

Appendix: Response - Only Pre-Pandemic Data

IRFs Using 2000-2022 Data



IRFs Using 2000-2019 Data



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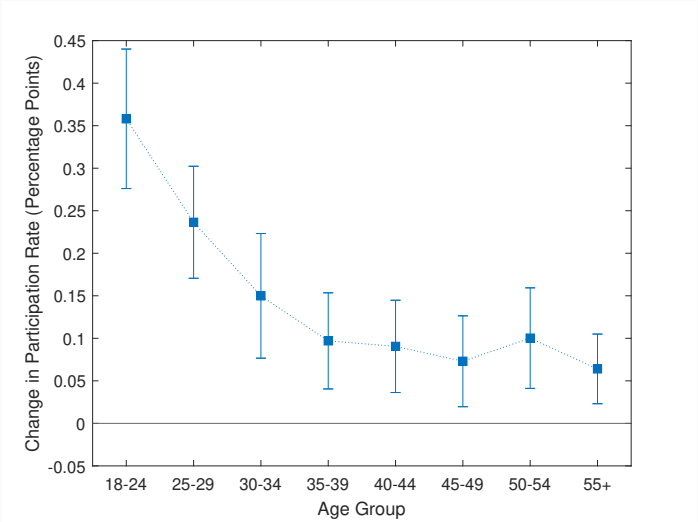
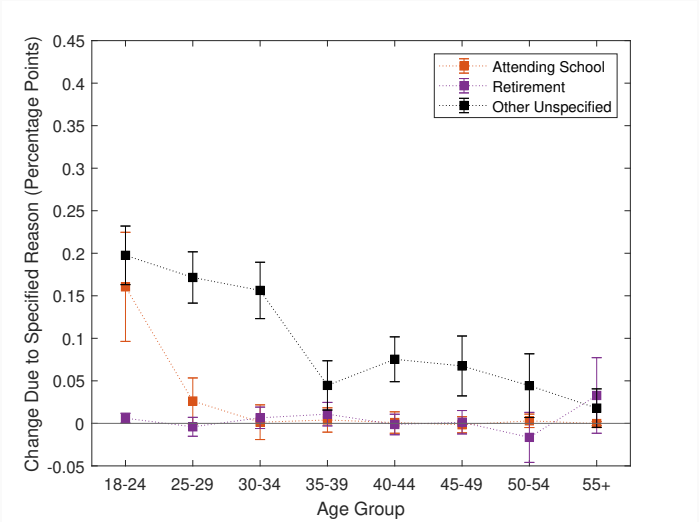
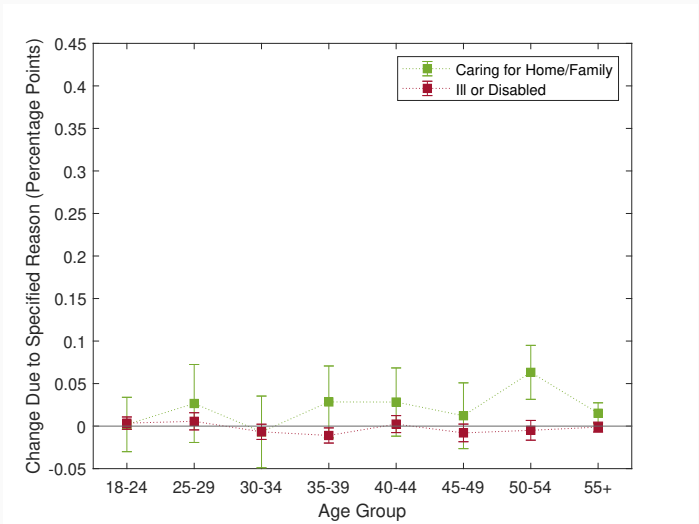
Appendix: Participation Response Decomposition

Decomposing Changes in Participation: Same-Quarter Percentage Point Responses Associated with 1% Higher GDP Growth

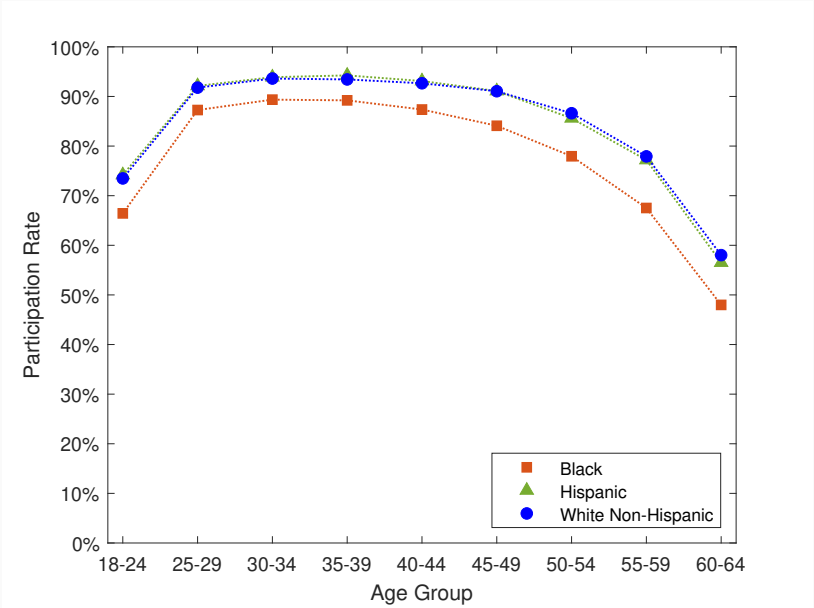




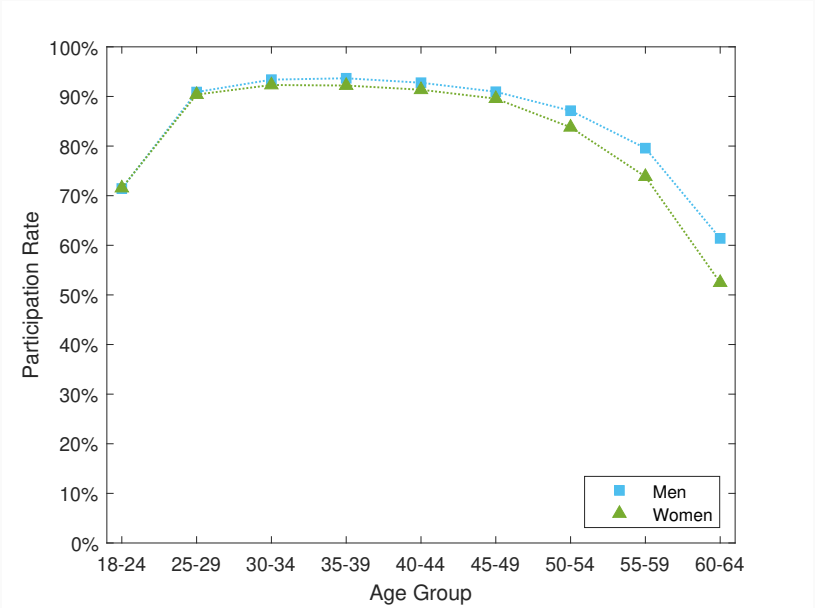


Appendix: Demographic

Participation by Race



Participation by Gender

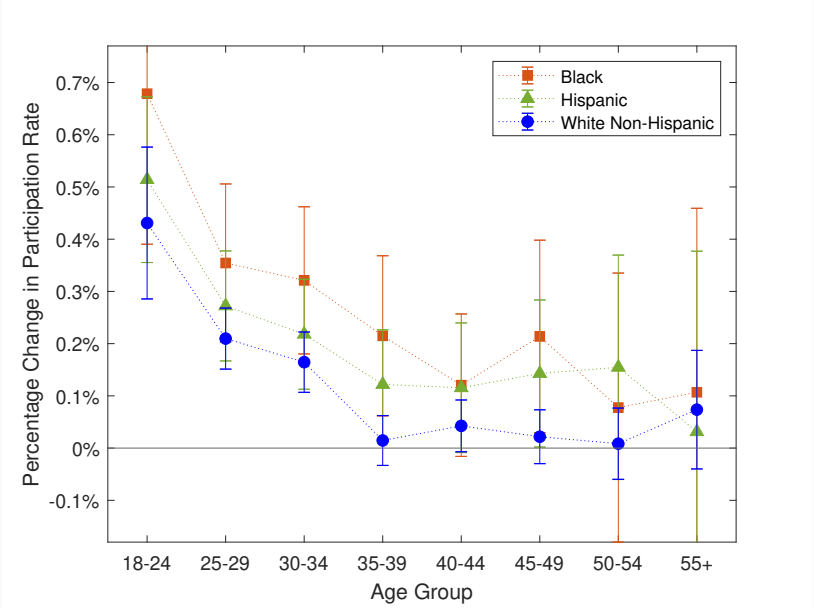


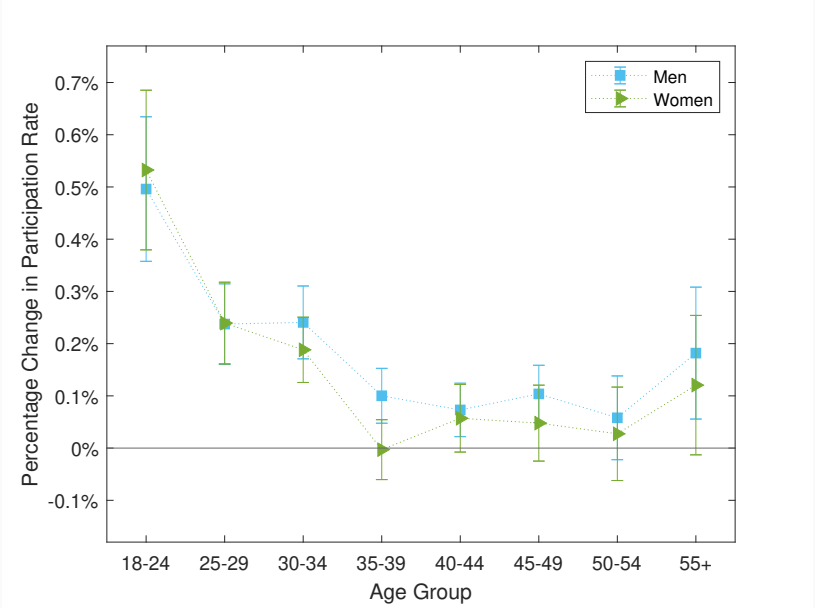
Source: 2000-2022 average over monthly CPS data where non-participants due to disability, illness, or caring for house or family are discluded

Return

Appendix: Demographic

Participation Responsiveness: Percentage Change in Participation Associated with 1% Higher GDP Growth in the Same Quarter



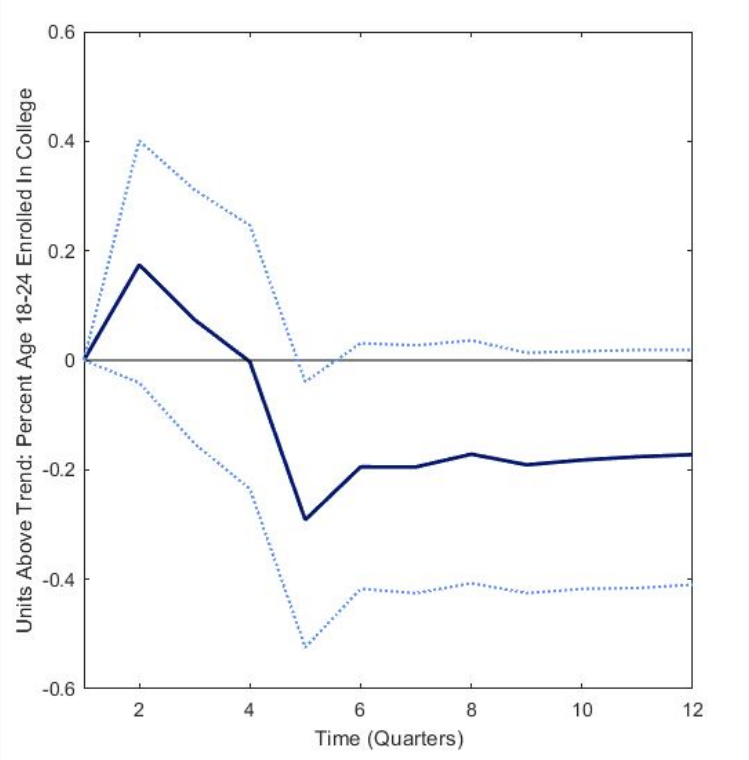


Return

Appendix: Enrollment Response to Positive Shock

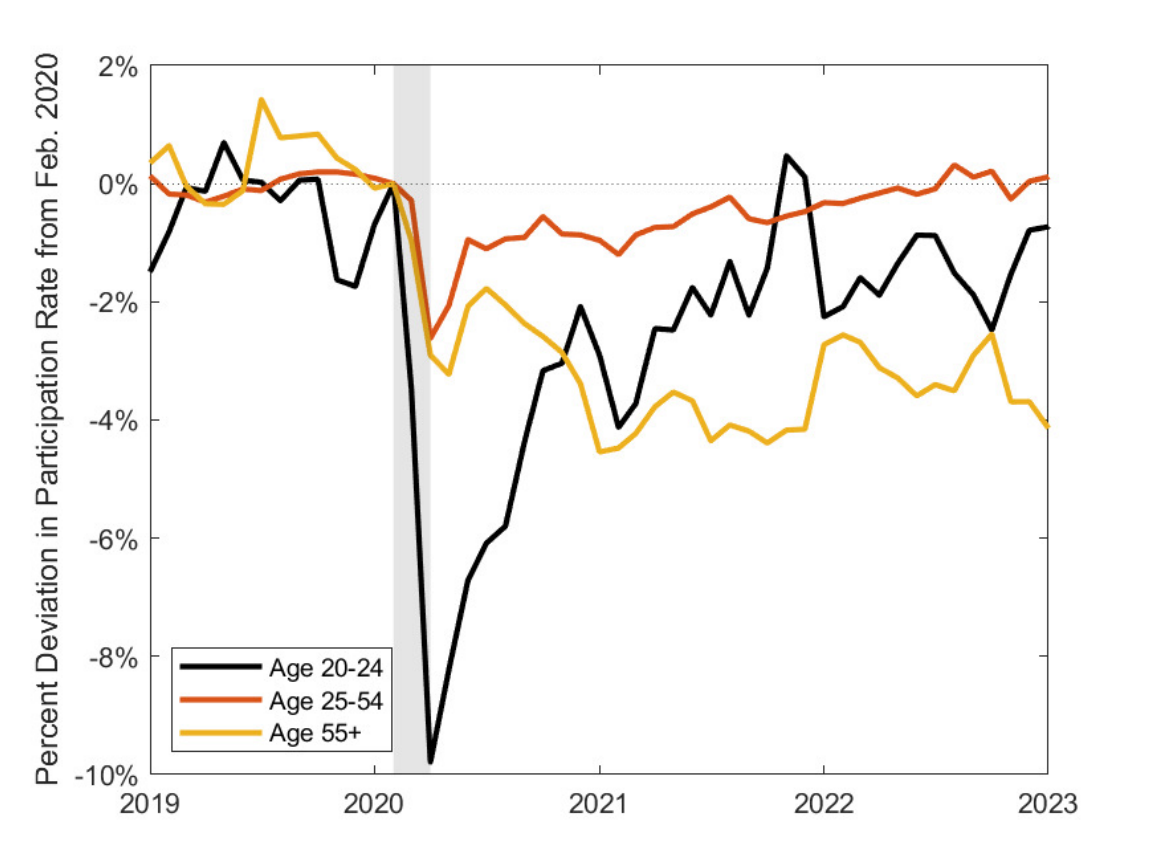
- Seasonally adjust age 18-24 enrollment rate data from the CPS
- Estimate VAR in GDP growth and enrollment rate with data from 1990-2019 and use Cholesky decomposition

College Enrollment Response to 1% Higher GDP Growth



Return

Model Predictions: 2020 Recession



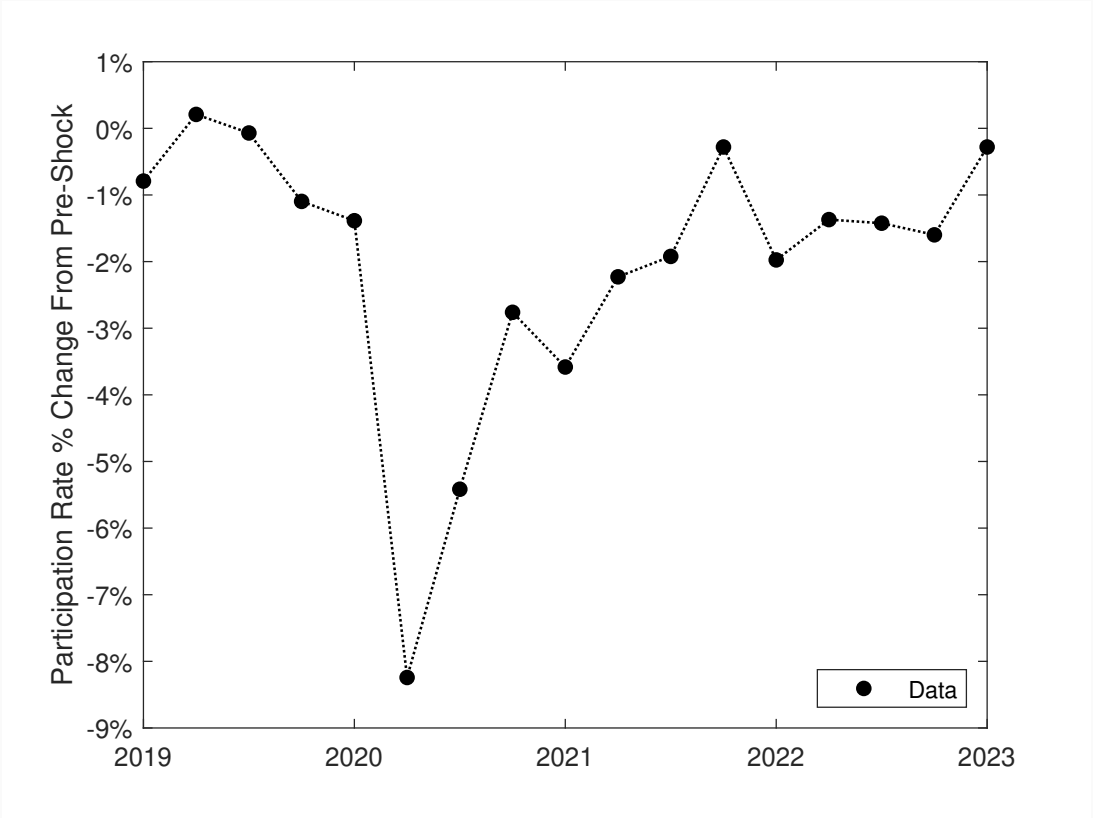
Notes: This data was obtained from the monthly Current Population Survey (CPS) and was seasonally adjusted. Individuals who reported not participating due to illness, disability, or because they were caring for their home/family were excluded from the sample

▸ Return

Model Predictions: 2020 Recession

- Take quarterly averages of data to compare with model response
- Simulate shock resulting in 8.48% drop in GDP

Age 20-24 Participation Response



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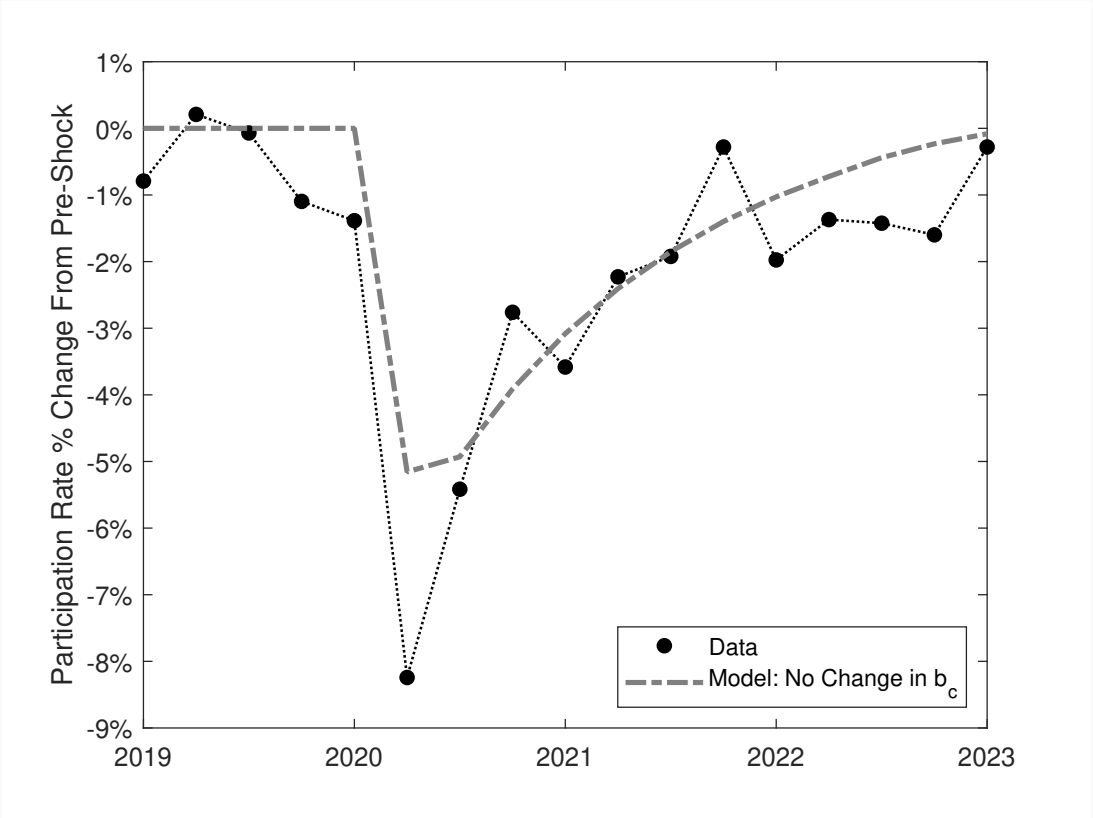
Model Predictions: 2020 Recession

- Take quarterly averages of data to compare with model response
- Simulate shock resulting in 8.48% drop in GDP

Age 20-24 Participation Response



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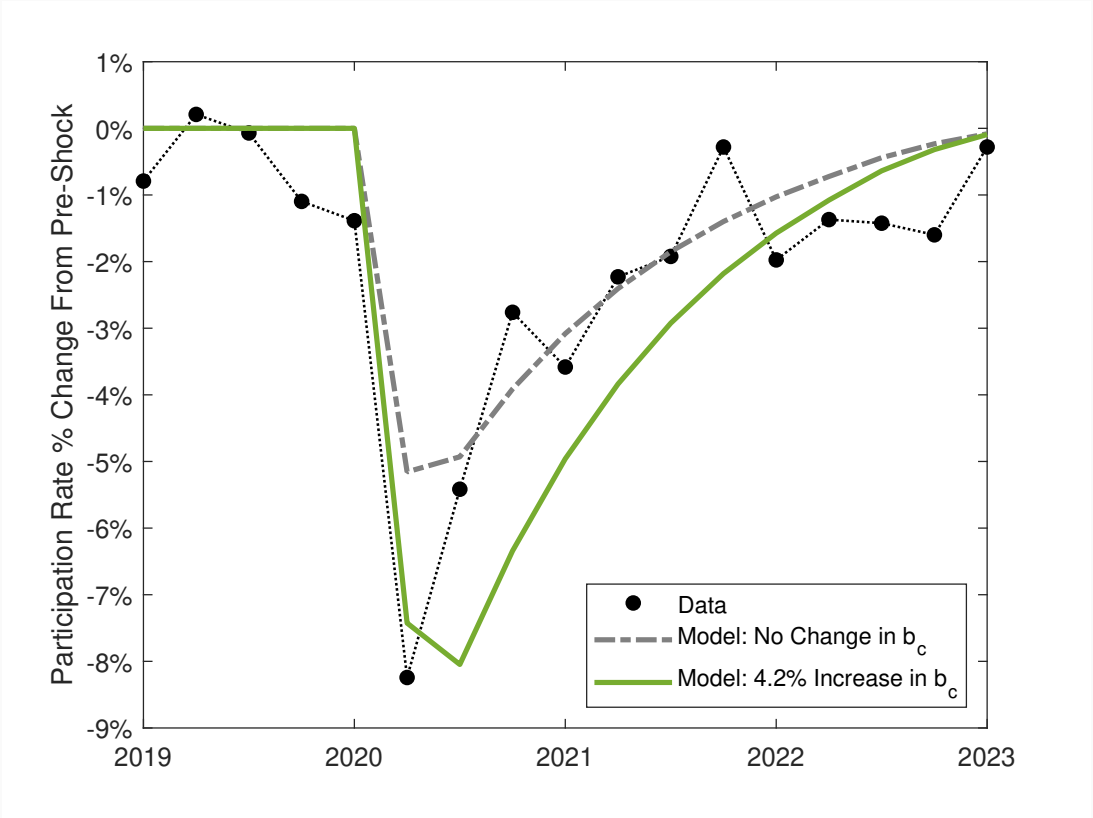
Model Predictions: 2020 Recession

- Take quarterly averages of data to compare with model response
- Simulate shock resulting in 8.48% drop in GDP

Age 20-24 Participation Response



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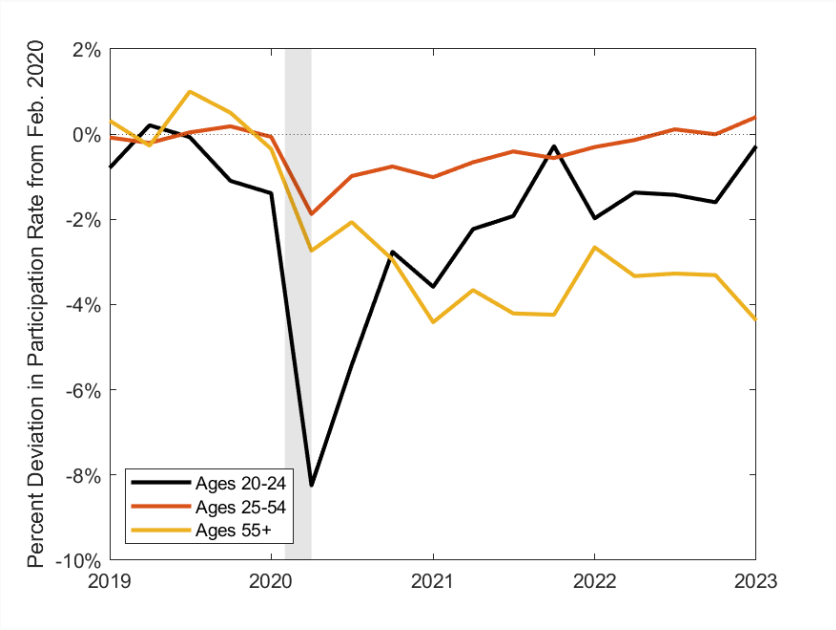
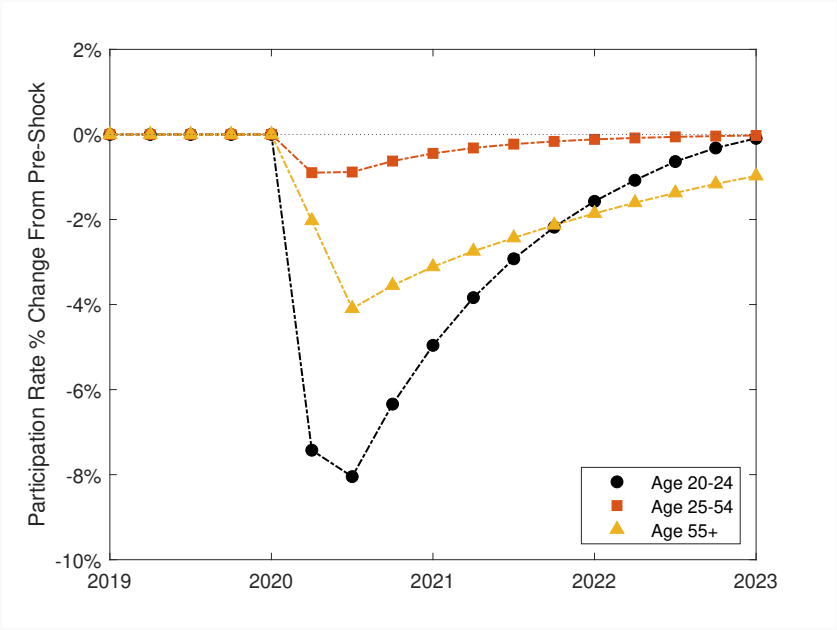
2020 Participation Dynamics

Data (Quarterly Averages)



Model



Subjecting all age groups to the same shock results in the same response pattern observed in the data

▸ Return

Appendix: Budget-Balancing Tax Rate

- Total cost of the subsidy is the subsidy amount multiplied by the mass of agents receiving the subsidy: $\left(s \sum_{a=\underline{a_s}}^{\overline{a_s}} u(a) \right)$
  - $\underline{a_s}$ and $\overline{a_s}$ are the lowest/highest age receiving the subsidy respectively, $u(a)$ is mass unemployed at age a

- For any subsidy, the corresponding tax rate τ must satisfy

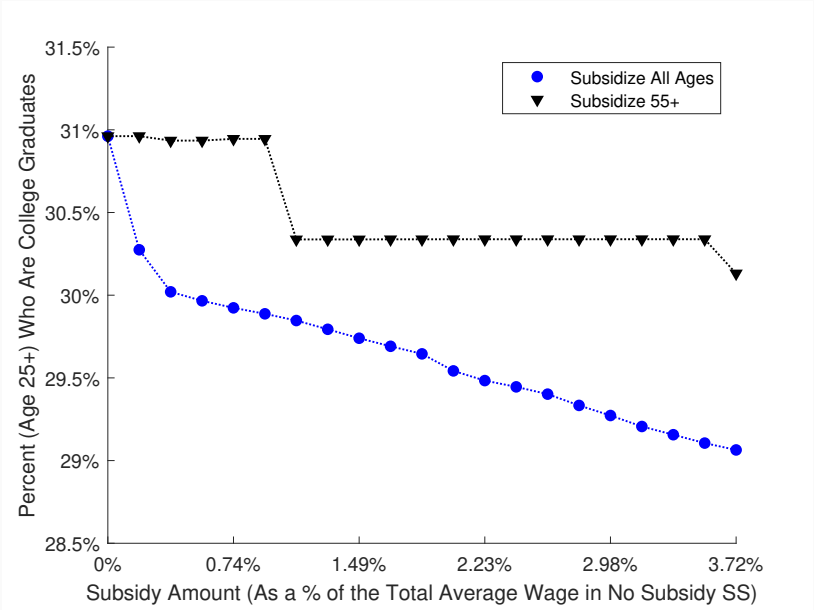
$$s \sum_{a=\underline{a_s}}^{\overline{a_s}} u(a) = \sum_{a} \sum_{w} \tau w e(a, w)$$

  - $e(a, w)$ is the mass employed at age a with wage w

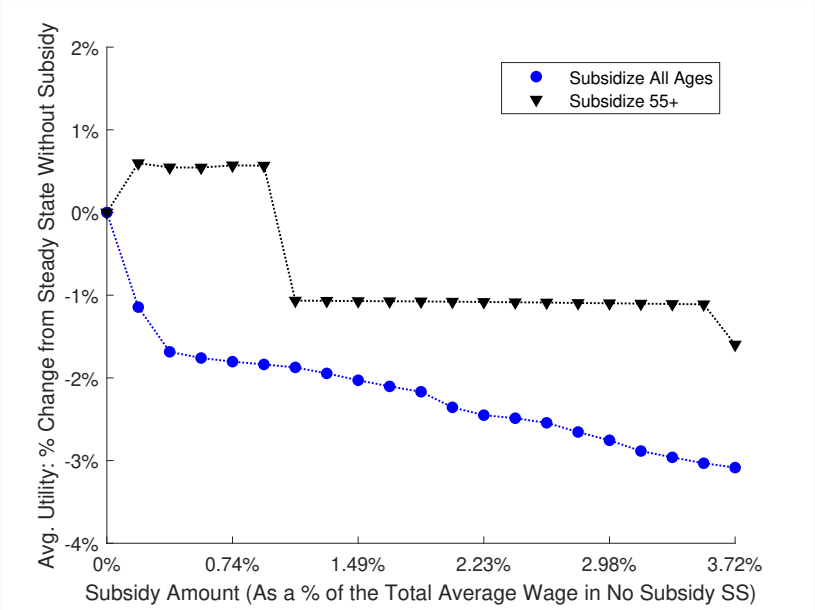
Return

Appendix: SS Subsidy Robustness

College Graduates



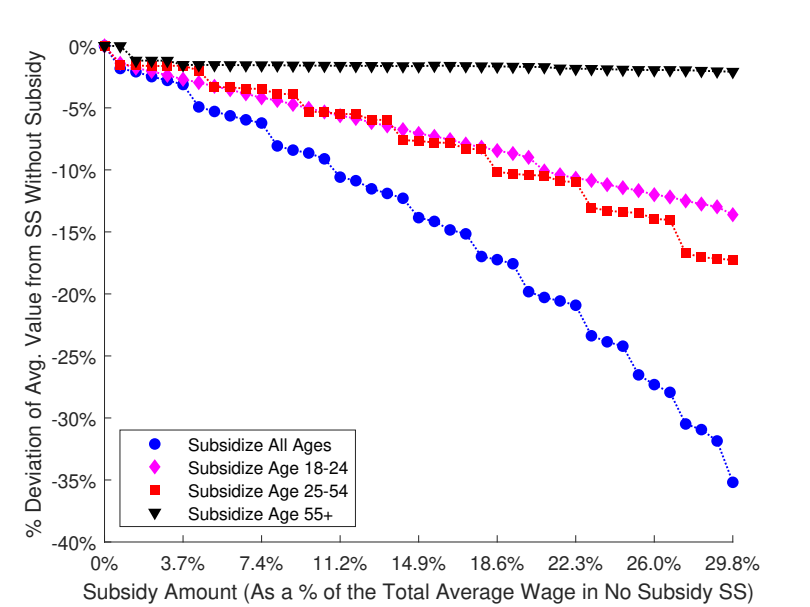
Average Utility



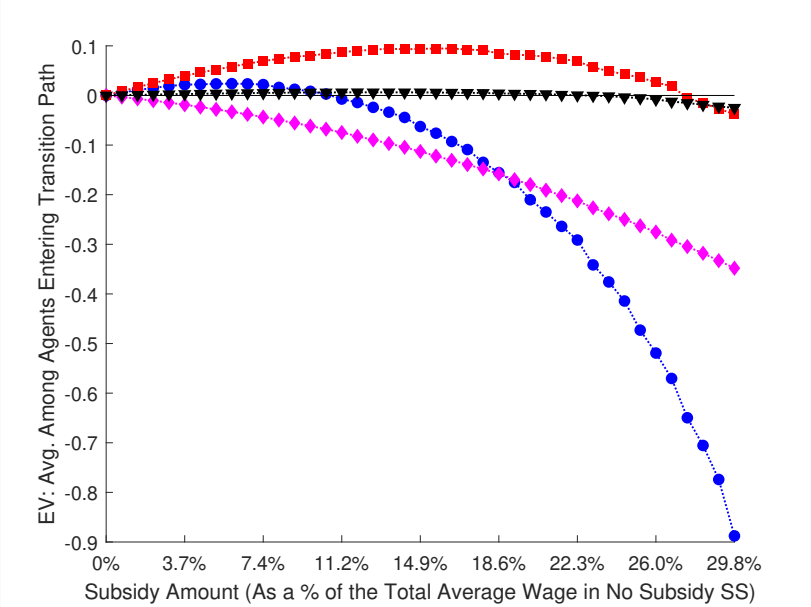
Return

Appendix: CEV and Related Calculations

% Change in Avg. VF At Change



Average CEV at Policy Change



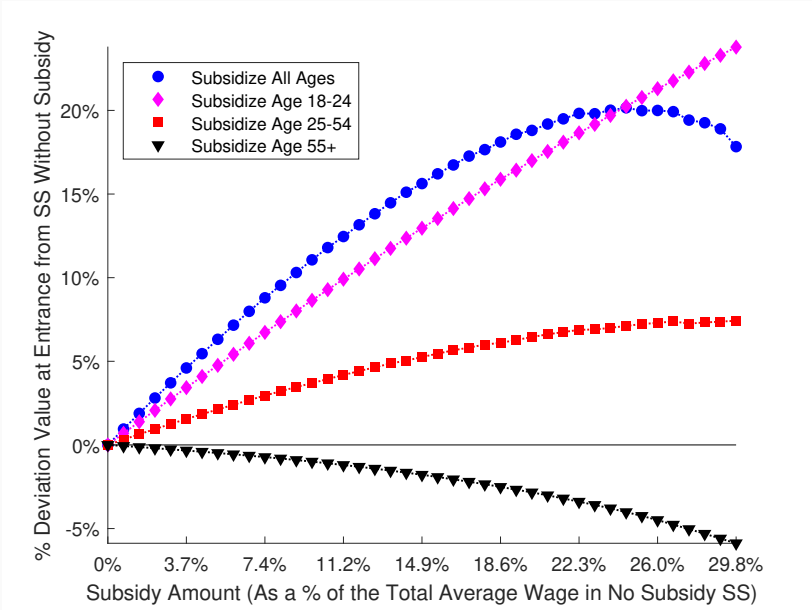
Consumption equivalent variation (CEV): share of remaining lifetime consumption each agent would be willing to forgo (or must receive) to experience the policy change

- Scale in percentages: 0.8 means would be willing to give up 0.8%

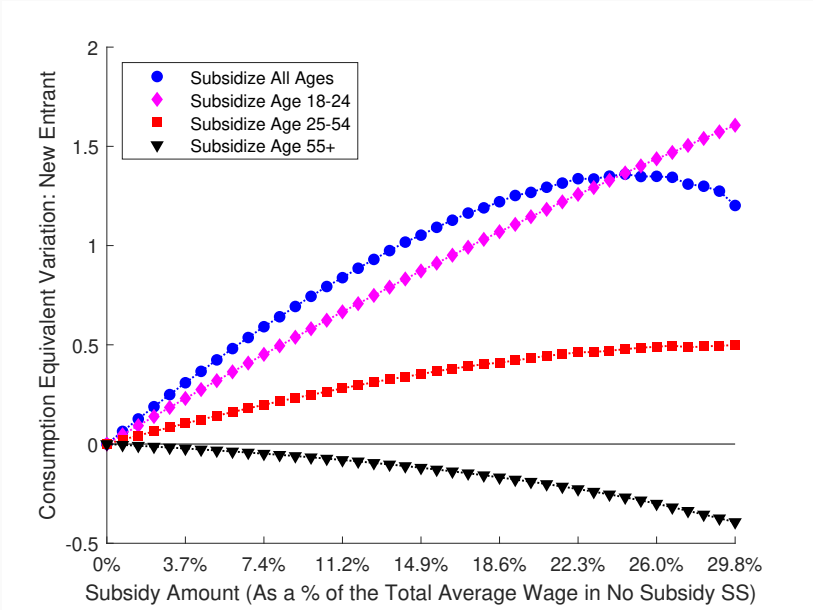
Return

Appendix: CEV and Related Calculations

% Change Value of New Entrant



CEV of New Entrant



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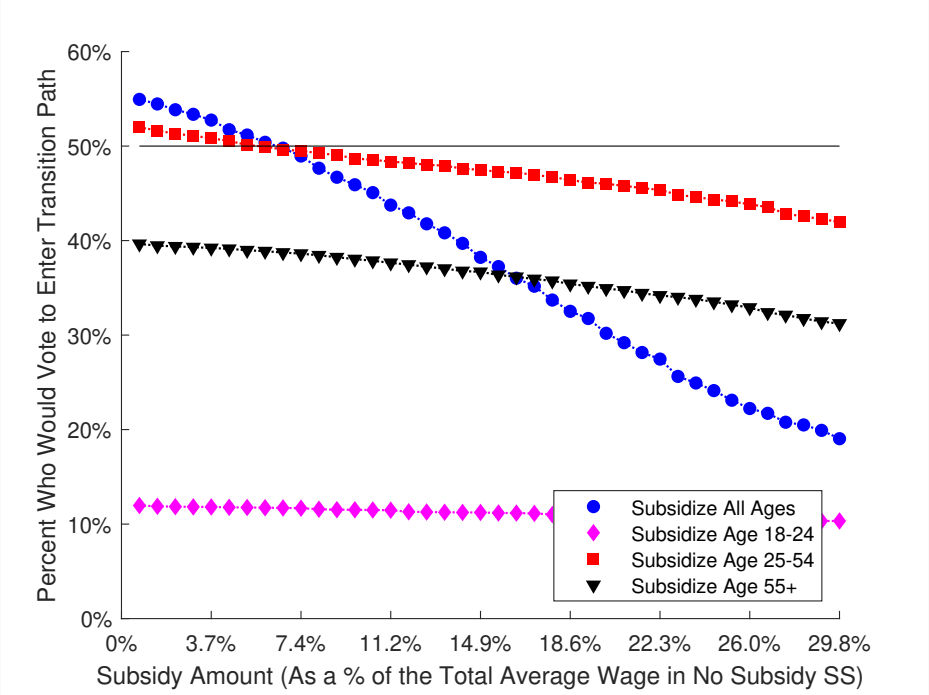
Appendix: CEV and Related Calculations

Percent Who Would Vote for Each Policy Change



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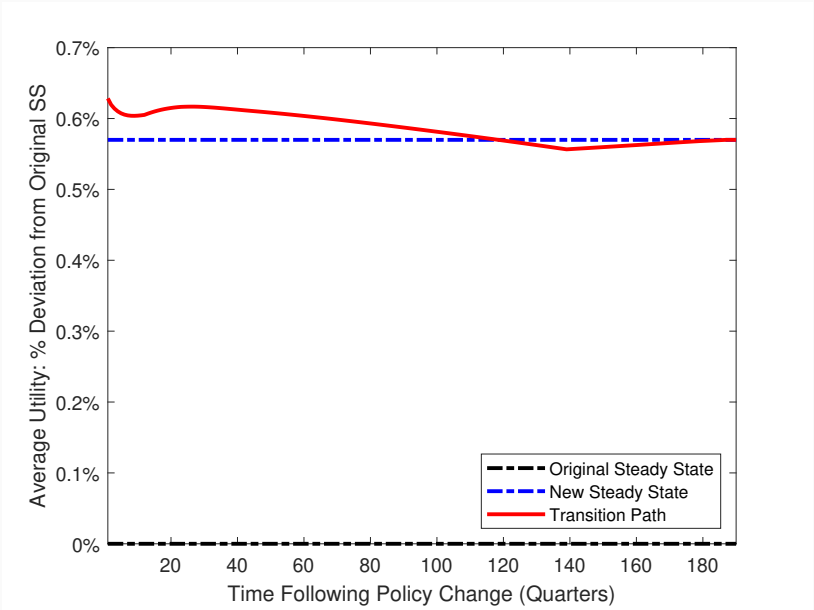
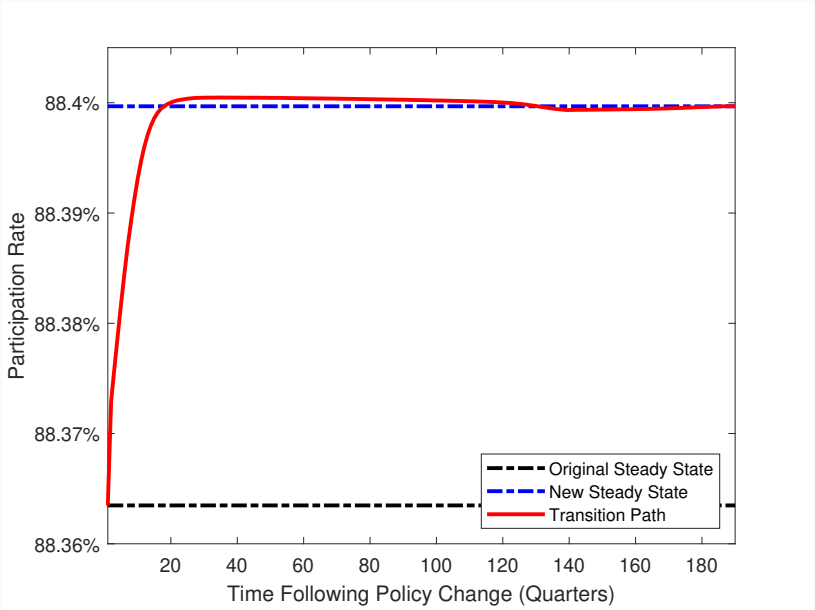
Appendix: Transition Paths

Average Utility



Participation Rate



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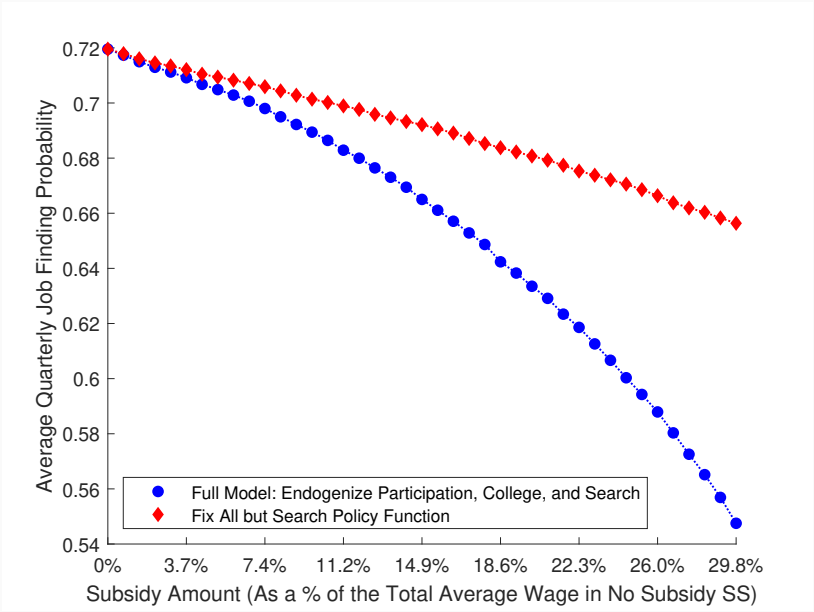
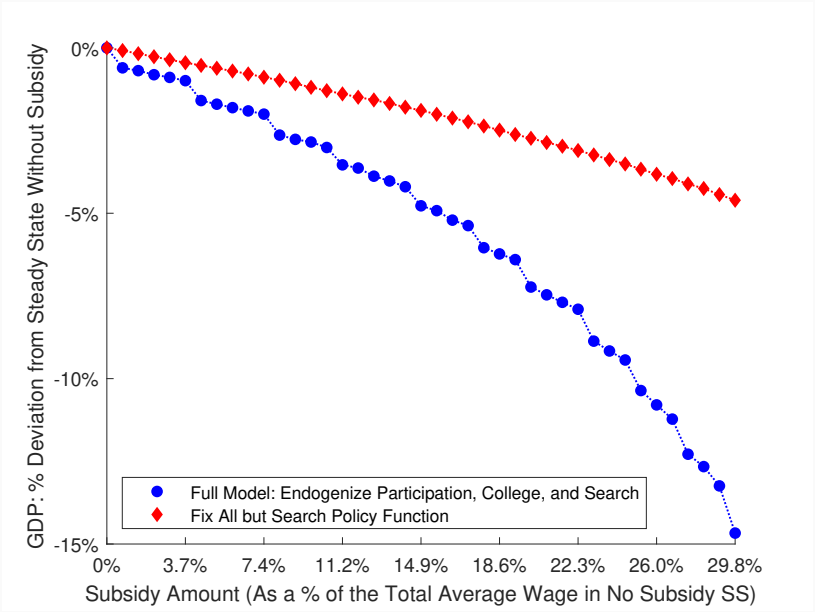
Appendix: Decomposing Search Subsidy Results

Avg. Qrterly Job-Finding Prob.



GDP: Production from Employment



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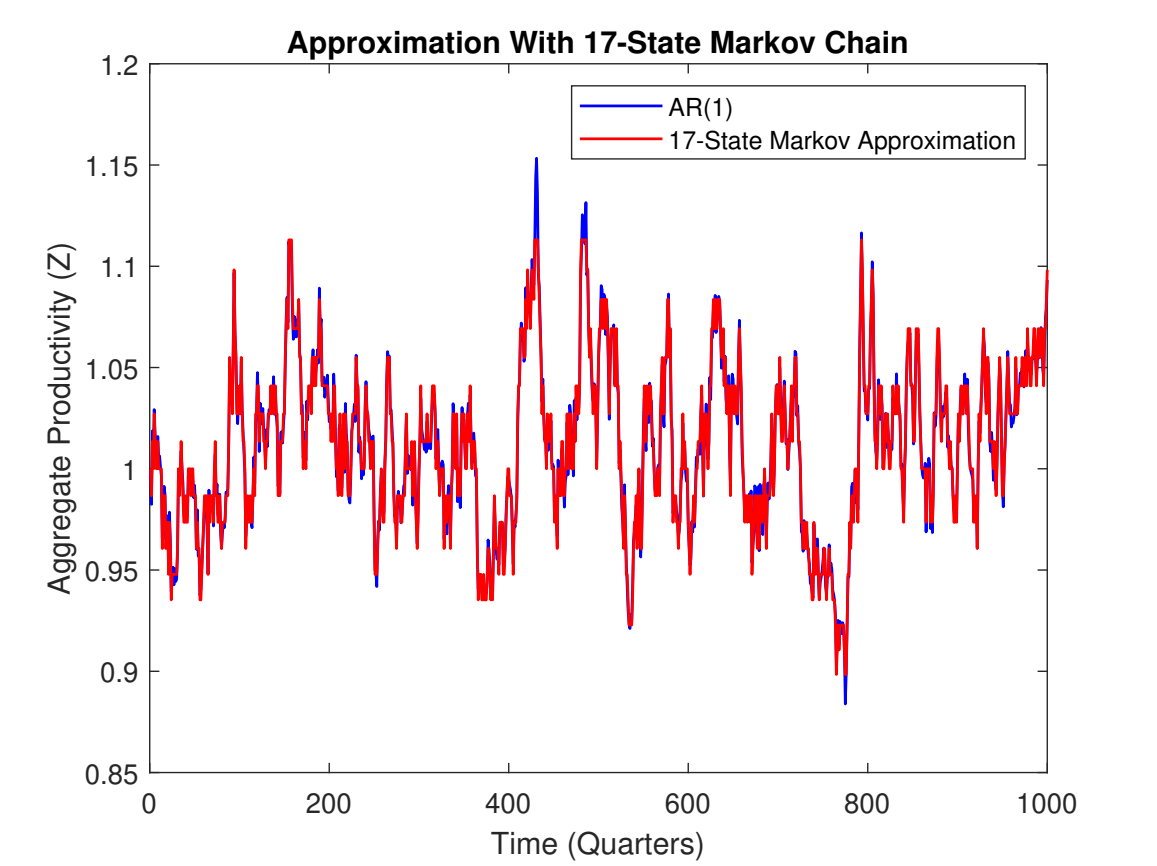
Appendix: Shock-Responsive Subsidy Simulation

Simulation of Aggregate Productivity AR(1) Process

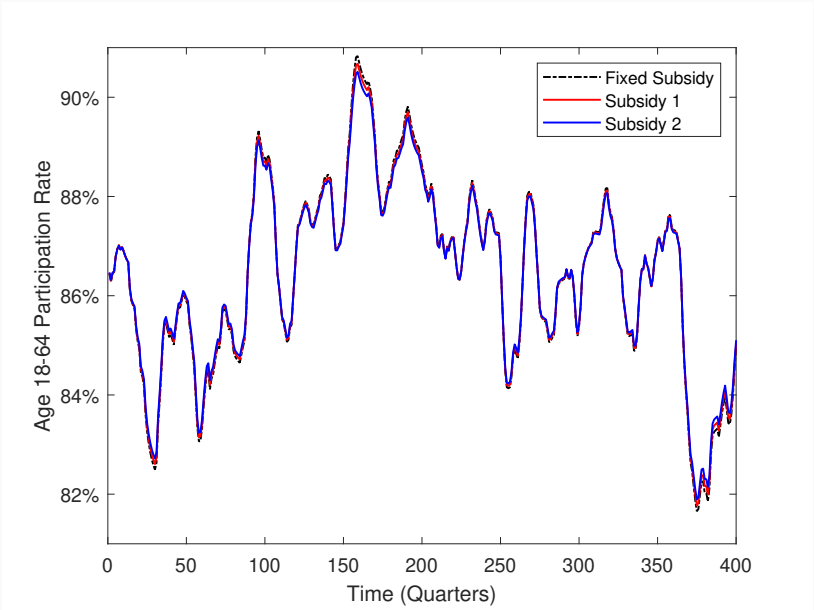


Approximate aggregate productivity AR(1) process as a 17-state Markov chain following Tauchen (1986)

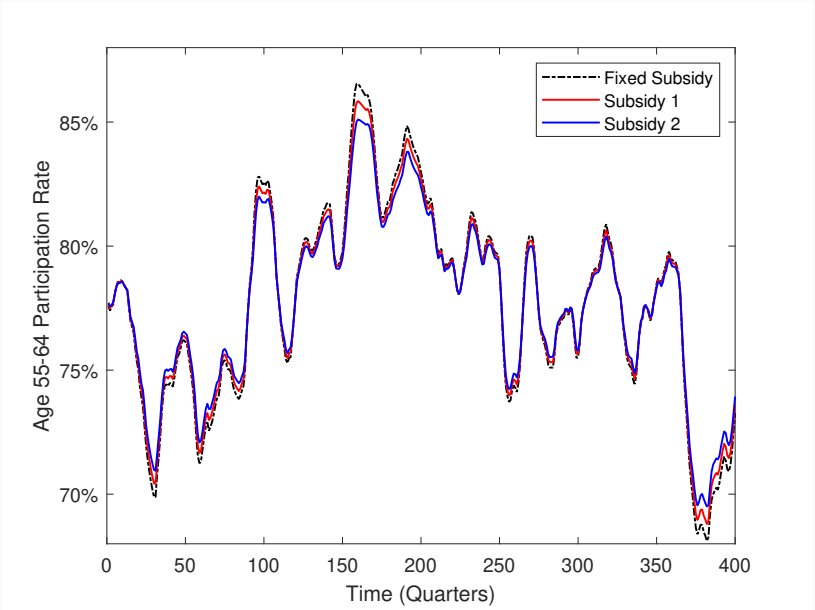
Return

Appendix: Shock-Responsive Subsidy Simulation

Age 18+ Participation



Age 55+ Participation



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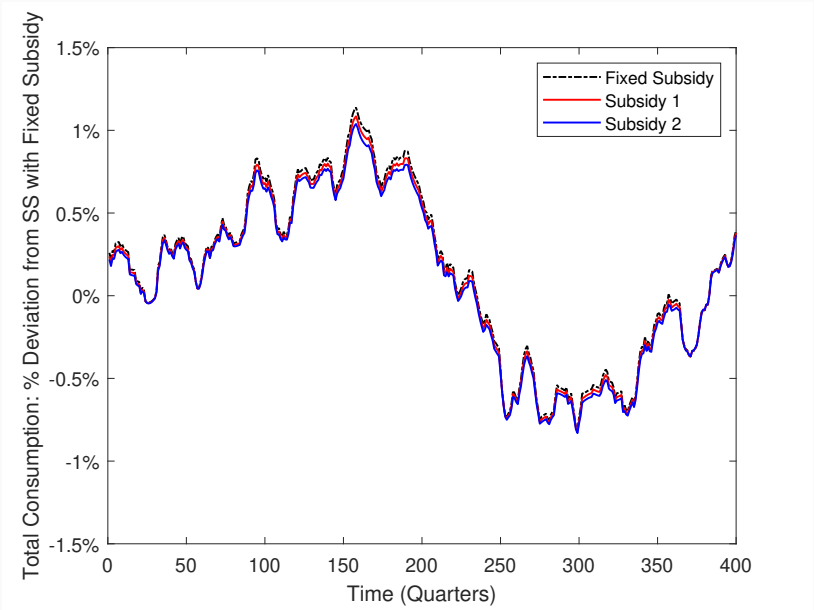
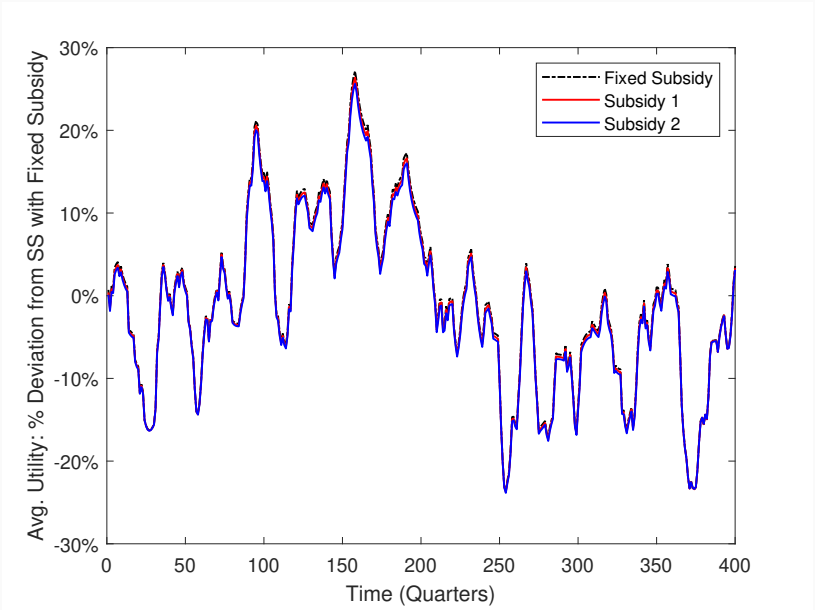
Appendix: Shock-Responsive Subsidy Simulation

Consumption



Average Utility



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Appendix: Shock-Responsive Subsidy Simulation Robustness

We check that our results are consistent when looking over ten total series each consisting of 1,000 simulated quarters in the model economy

Mean over Simulated Shocks: Robustness

	Fixed Subsidy to 55+	Subsidy 1	Subsidy 2
Avg. Utility: % Change	0.996%	0.653%	0.335%
Consumption: % Change	0.180%	0.156%	0.136%
GDP: % Change	0.030%	0.001%	-0.004%
18-64 Participation: Rate Change	0.032%	0.030%	0.026%
55+ Participation: Rate Change	0.163%	0.156%	0.140%

▸ Return