

MACROECONOMICS AND HOUSEHOLD HETEROGENEITY

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THE QUESTION

- ▶ **Broad Question:** Is Microeconomic Heterogeneity Important for Macroeconomic Outcomes
- ▶ **Narrower Version of this Question** (and the one addressed in talk):
 1. Is **household income and wealth inequality** quantitatively important for **aggregate consumption, investment and output** response to an exogenous **Great Recession** shock?
 2. How do **social insurance policies** impact these **aggregates**?
 3. How are consumption, welfare losses of aggregate shock **distributed** across population? How does **social insurance** affect that **distribution**?
- ▶ **What I won't be talking about:**
 - ▶ **Firm heterogeneity** and business cycles (see e.g. Khan & Thomas 2008, Bachmann, Caballero & Engel 2013)
 - ▶ Interaction of inequality and **long run growth** (see e.g. Kuznets 1952, Benabou 2002, Piketty 2014)
 - ▶ **Computation** of heterogeneous agent models. See 2010 JEDC Special Issue)

THE BASIC ARGUMENT: WHY MAY INEQUALITY MATTER FOR DYNAMICS OF RECESSION?

- ▶ Earnings fall in recessions (unemployment rises, real wages fall)
- ▶ If low wealth households have higher MPC out of current earnings changes....
- ▶ ...then the degree of **wealth inequality** impacts **aggregate C dynamics** over the cycle.
- ▶ If, in addition, **aggregate C matters for output** (if Y is partially demand-determined b/c of endogenous TFP, nominal rigidities), then **wealth distribution influences aggregate Y dynamics**...
- ▶ ...and **social insurance policies** are potentially **output-stabilizing**.

PLAN FOR TALK: DATA MEETS QUANTITATIVE THEORY

- ▶ *Empirical* analysis using US household (PSID) y, c, a data:
 - ▶ How did y, c, a distribution look prior to Great Recession?
 - ▶ How did y, c, a change for individual households in the Great Recession?

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 - ▶ How did y, c, a change for individual households in the Great Recession?
- ▶ *Quantitative analysis* using versions of heterogeneous household business cycle (Krusell & Smith 1998) model:
 - ▶ Does the model match the inequality facts?
 - ▶ Does wealth distribution matter (quantitatively) for response of C, I to Great Recession shock?
 - ▶ What about Y response if Y is partially (aggregate consumption C) demand-determined?

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 - ▶ Does wealth distribution matter (quantitatively) for response of C, I to Great Recession shock?
 - ▶ What about Y response if Y is partially (aggregate consumption C) demand-determined?
- ▶ *Policy analysis using* stylized unemployment insurance (UI) system:
 - ▶ How does UI impact $\Delta C, \Delta Y$ for given wealth distribution?
 - ▶ How does size of UI impact the wealth distribution itself?
 - ▶ How is distribution of welfare losses from Great Recession shaped by UI?

EMPRIRICAL ANALYSIS

THE DATA

- ▶ PSID waves of 2004-2006-2008-2010. Detailed US household-level information about y, c, a .
 - ▶ Panel dimension: can assess how individual households changed actions (c expenditures) during the Great Recession
 - ▶ Coarse time series dimension (biannual surveys for data between 2004 and 2010)
- ▶ Complements literature on measuring inequality trends, e.g. Piketty & Saez (2003), RED Special Issue (2010), Kuhn & Rios-Rull (2015), Atkinson & Bourguignon (2015), Krueger & Perri (2006), Aguiar & Bilal (2015).
- ▶ Here: specific focus on joint dynamics of y, c, a . See also
 - ▶ Italian Survey of Household and Wealth (SHIW): Krueger & Perri (2009)
 - ▶ For the U.S.: Fisher, Johnson, Smeeding & Thompson (2015): *Inequality in 3D*.
 - ▶ Data constraint is panel data on c . Alternatively impute c , Skinner (1987), Blundell, Pistaferri & Preston (2008).

THE DATA

- ▶ Variables of Interest
 - ▶ Net Worth = a = Value of all assets (including real estate) minus liabilities
 - ▶ Disposable Income = y = Total money income net of taxes (computed using TAXSIM)
 - ▶ Consumption Expenditures = c = Expenditures on durables, nondurables and services (excluding health)
- ▶ Sample
 - ▶ All households in PSID waves 2004-2006-2008-2010, with at least one member of age 22-60

DATA: MARGINAL DISTRIBUTIONS

	y	c	a	SCF 07 a
Mean (2006\$)	62,549	43,980	291,616	497,747
<i>%Share : Q1</i>	4.5	5.6	-0.9	-0.2
Q2	9.9	10.7	0.8	1.2
Q3	15.3	15.6	4.4	4.6
Q4	22.8	22.4	13.0	11.9
Q5	47.5	45.6	82.7	82.5
90 – 95	10.8	10.3	13.7	11.1
95 – 99	12.8	11.3	22.8	25.3
Top 1%	8.0	8.2	30.9	33.5
Sample Size	6442		2910	

- ▶ *a*: Bottom 40% holds basically no wealth
- ▶ *y, c*: less concentrated
- ▶ *a* distribution in PSID \simeq SCF except at very top

HETEROGENEITY (INEQUALITY) IN 2006: JOINT DISTRIBUTIONS

Q.a	% Share of:		Exp.Rate
	y	c	c/y (%)
Q1	8.6	11.3	92.2
Q2	10.7	12.4	81.3
Q3	16.6	16.8	70.9
Q4	22.6	22.4	69.6
Q5	41.4	37.2	63.1

- ▶ a correlated with y and saving
- ▶ Wealth-rich earn more and save at a higher rate
- ▶ Bottom 40% hold no wealth, still account for almost 25% of spending

MOVING TO THE THEORY

- ▶ Empirical evidence shows:
 - ▶ Bottom 40% have no wealth...
 - ▶ ...but account for almost 25% of consumption

MOVING TO THE THEORY

- ▶ Empirical evidence shows:
 - ▶ Bottom 40% have no wealth...
 - ▶ ...but account for almost 25% of consumption
- ▶ Is a standard macro model with heterogeneous agents a la Krusell & Smith (1998) consistent with these facts?
- ▶ We then use the model as a laboratory for *quantifying*:
 - ▶ how **wealth distribution** affects C, I, Y responses to Great Recession shock
 - ▶ how this impact is shaped by **social insurance policies**
 - ▶ how welfare losses from Great Recession are distributed across **wealth distribution**

THE MODEL AND CALIBRATION

AGGREGATE TECHNOLOGY

- ▶ Standard production function as in RBC literature [Kydland & Prescott 1982, Long & Plosser 1983]

$$Y = Z^* K^\alpha N^{1-\alpha}$$

- ▶ Total factor productivity Z^* in turn is given by

$$Z^* = ZC^\omega$$

- ▶ C is aggregate consumption
 - ▶ $\omega \geq 0$: aggregate demand externality
 - ▶ Benchmark model $\omega = 0$
- ▶ Focus on $Z \in \{Z_l, Z_h\}$: recession and expansion.

$$\pi(Z'|Z) = \begin{pmatrix} \rho_l & 1 - \rho_l \\ 1 - \rho_h & \rho_h \end{pmatrix}.$$

- ▶ Capital depreciates at a constant rate $\delta = 0.025$ quarterly.
- ▶ Capital share: $\alpha = 36\%$

HOUSEHOLD PREFERENCES

- ▶ Continuum of households with **idiosyncratic y risk** [Bewley 1986, Imrohorglu 1989, Huggett 1993, Aiyagari 1994]
- ▶ Period utility function $u(c) = \log(c)$
- ▶ To generate sufficient **wealth dispersion** follow Carroll, Slacalek & Tokuoka (2015):
 - ▶ Households draw **discount factor β** at birth from $U[\bar{\beta} - \epsilon, \bar{\beta} + \epsilon]$
 - ▶ Choose $\bar{\beta}, \epsilon$ to match quarterly $K/Y = 10.26$, Wealth Gini of working pop.=0.77. Yields annual $\beta \in [0.9265, 0.9672]$
- ▶ In working life, constant retirement prob. $1 - \theta = 1/160$.
- ▶ In retirement constant death probability $1 - \nu = 1/60$.

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- ▶ In working life, constant retirement prob. $1 - \theta = 1/160$.
- ▶ In retirement constant death probability $1 - \nu = 1/60$.
- ▶ Other mechanisms to generate large **wealth dispersion**
 - ▶ **Entrepreneurs** [Quadrini 1997, Cagetti & De Nardi 2006]
 - ▶ **Bequest motives** [De Nardi 2004]
 - ▶ **Health expenditure shocks in old age** [De Nardi, French, Jones 2010, Ameriks, Briggs, Caplin, Shapiro, Tonetti 2015]
 - ▶ **Extreme income realizations** [Castaneda, Diaz-Gimenez, Rios-Rull 2003]
 - ▶ **Heterogeneous investm. returns** [Benhabib, Bisin, Zhu 2011]

HOUSEHOLD ENDOWMENTS

- ▶ Time endowment normalized to 1
- ▶ Idiosyncratic unemployment risk, $s \in S = \{u, e\}$
 - ▶ $\pi(s'|s, Z', Z)$
- ▶ Idiosyncratic labor productivity risk, $y \in Y$
 - ▶ Estimate stochastic process from annual PSID (1967-1996) data (only employed households):

$$\begin{aligned}\log(y') &= p + \epsilon \\ p' &= \phi p + \eta\end{aligned}$$

with persistence ϕ , innovations (η, ϵ) . Find estimates of $(\hat{\phi}, \hat{\sigma}_\eta^2, \hat{\sigma}_\epsilon^2) = (0.9695, 0.0384, 0.0522)$

- ▶ Turn into quarterly process, discretize into Markov chain
- ▶ Follows large literature on estimation of stochastic earnings processes [Meghir & Pistaferri 2001, Storesletten, Telmer, Yaron, 2004]
- ▶ Alternative: Estimate earnings process with administrative data [e.g. Guvenen, Karahan, Ozkan, Song 2015]

FINANCIAL MARKETS AND AGGREGATE STATE VARIABLES

- ▶ $a \in A$ asset (capital) holdings
- ▶ Incomplete insurance markets.
- ▶ No borrowing, perfect annuity markets
- ▶ Households born with $a = 0$. Mimics life cycle.
- ▶ Cross-sectional distribution: $\Phi(y, s, a, \beta)$
- ▶ Aggregate state of economy summarized by (Z, Φ) . Source of the computational complexity.

GOVERNMENT POLICY

- ▶ Balanced budget unemployment insurance system
 - ▶ Replacement rate $\rho = \frac{b(y, Z, \Phi)}{w(Z, \Phi)y}$ if $s = u$
 - ▶ Thus benefits given by $b(y, Z, \Phi) = \rho w(Z, \Phi)y$
 - ▶ Baseline $\rho = 0.5$. Compare to $\rho = 0.1$.
 - ▶ Proportional labor income tax $\tau(Z; \rho)$ to balance budget:
- ▶ Balanced PAYGO social security system
 - ▶ Payroll tax rate $\tau_{SS} = 15.3\%$
 - ▶ Lump-sum benefits that balance the budget

RECURSIVE FORMULATION OF HH PROBLEM

- ▶ Individual state variables $x = (y, s, a, \beta)$
- ▶ Aggregate state variables (Z, Φ)
- ▶ Aggregate law of motion $\Phi' = H(Z, \Phi', Z')$
- ▶ Household dynamic program problem of worker reads as

$$v_W(s, y, a, \beta; Z, \Phi) =$$

$$\begin{aligned} & \left\{ \max_{c, a' \geq 0} u(c) \right. + \beta \sum_{(Z', s', y') \in (Z, S, Y)} \pi(Z'|Z) \pi(s'|s, Z', Z) \pi(y'|y) \\ & \quad \left. * [\theta v_W(s', y', a', \beta; Z', \Phi') + (1 - \theta)v_R(a', \beta; Z', \Phi')] \right\} \end{aligned}$$

subject to

$$\begin{aligned} c + a' &= (1 - \tau(Z; \rho) - \tau_{SS})w(Z, \Phi)y [1 - (1 - \rho)1_u] + (1 + r(Z, \Phi) - \delta)a \\ \Phi' &= H(Z, \Phi', Z') \end{aligned}$$

Equilibrium concept: ▶ Recursive Competitive Equilibrium

CALIBRATION OF AGGREGATE PRODUCTIVITY RISK

- ▶ Recall that $Z \in \{Z_l, Z_h\}$ and

$$\pi(Z'|Z) = \begin{pmatrix} \rho_l & 1 - \rho_l \\ 1 - \rho_h & \rho_h \end{pmatrix}$$

- ▶ Expected *duration* of a recession is $EL_l = \frac{1}{1-\rho_l}$. Fraction of time economy is in recession is $\Pi_l = \frac{1-\rho_h}{2-\rho_l-\rho_h}$
- ▶ Choose $\rho_l, \rho_h, \frac{Z_l}{Z_h}$ to match:
 1. the average length of a severe recession EL_l
 2. the fraction of time economy is in severe recession, Π_l .
 3. the decline in GDP per capita in *severe* recessions relative to normal times

WHAT IS A SEVERE RECESSION?

- ▶ Define start of severe recession when $u \geq 9\%$. Lasts as long as $u \geq 7\%$.
- ▶ From 1948 to 2014.III two severe recessions, 1980.II-1986.II and 2009.I-2013.III.
- ▶ Frequency of severe recessions: $\Pi_l = 16.48\%$, expected length of 22 quarters.
- ▶ Average unemployment rate $u(Z_l) = 8.39\%$, $u(Z_h) = 5.33\%$
- ▶ Implied transition matrix:

$$\pi = \begin{pmatrix} 0.9545 & 0.0455 \\ 0.0090 & 0.9910 \end{pmatrix}$$

- ▶ Average output drop in severe recessions measured as $\frac{Y_l}{Y_h} = 0.9298$. Matching this in model requires $\frac{Z_l}{Z_h} = 0.9614$.
- ▶ Severe recession similar in spirit to rare disasters [Rietz 1988, Barro 2006, Gourio 2015]

IDIOSYNCRATIC EMPLOYMENT STATUS TRANSITIONS

Transition matrices $\pi(s'|s, Z', Z)$ for $s, s' \in \{u, e\}$ calibrated to quarterly job finding rates (computed from CPS). For example

- ▶ Economy is and remains in a recession: $Z = Z_l, Z' = Z_l$

$$\begin{pmatrix} 0.34 & 0.66 \\ 0.06 & 0.94 \end{pmatrix}$$

- ▶ Economy is and remains in normal times: $Z = Z_h, Z' = Z_h$

$$\begin{pmatrix} 0.19 & 0.81 \\ 0.05 & 0.95 \end{pmatrix}$$

- ▶ In recessions more likely to lose job and less likely to find one.
- ▶ Thus as economy falls into recession, UE *risk* up (and more persistent) even for those not yet having lost job. **Strong precautionary savings motive for wealth-poor!**

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- ▶ Role of unemployment risk in heterogenous agent models:
Krusell, Mukoyama & Sahin (2010), Herkenhoff (2013), Ravn & Sterk (2015), den Haan, Rendahl & Riegler (2015)

MODEL: SUMMARY OF KEY ELEMENTS

- ▶ Exogenous **aggregate shock** Z moves aggregate wages w and unemployment rate $\Pi_Z(u)$. Rare but severe recessions.
- ▶ Potentially: **aggregate consumption** C demand externality $\omega > 0$.
- ▶ Exogenous **individual income risk**
 - ▶ (Un-)employment risk $s \in \{u, e\}$. Increases in recessions
 - ▶ Income risk y , conditional on being employed
- ▶ Exogenous **individual preference heterogeneity** $\beta \sim U[\bar{\beta} - \epsilon, \bar{\beta} + \epsilon]$. Constant survival risk θ .
- ▶ Basic life cycle elements and thus **age heterogeneity**
- ▶ **Unemployment insurance system** with size ρ .

RESULTS

VERSIONS OF MODEL STUDIED TODAY

1. Original Krusell & Smith (1998) [KS] economy (single discount factor + income risk + low ρ)
2. Economy 1. but with heterogenous β 's, survival risk $\theta < 1$ and high $\rho = 50\%$ [Benchmark]
3. (Later in the Talk, hopefully...): Economy 2. but with aggregate demand externality $\omega > 0$

INEQUALITY IN THE BENCHMARK ECONOMY

New Worth % Share held by:	Data		Models	
	PSID, 06	SCF, 07	Bench	KS
Q1	-0.9	-0.2	0.3	6.9
Q2	0.8	1.2	1.2	11.7
Q3	4.4	4.6	4.7	16.0
Q4	13.0	11.9	16.0	22.3
Q5	82.7	82.5	77.8	43.0
90 – 95	13.7	11.1	17.9	10.5
95 – 99	22.8	25.3	26.0	11.8
T1%	30.9	33.5	14.2	5.0
Gini	0.77	0.78	0.77	0.35

- ▶ Benchmark economy does a good job matching bottom and top of wealth distribution, but still **misses very top**.
- ▶ Original KS economy does not produce enough inequality.

JOINT DISTRIBUTIONS (2006): DATA V/S MODEL

a Quintile	% Share of:				%c/y	
	y		c		Data	Model
	Data	Model	Data	Model		
Q1	8.6	6.0	11.3	6.6	92.2	90.4
Q2	10.7	10.5	12.4	11.3	81.3	86.9
Q3	16.6	16.6	16.8	16.6	70.9	81.1
Q4	22.6	24.6	22.4	23.6	69.6	78.5
Q5	41.4	42.7	37.2	42.0	63.1	79.6

- ▶ Model captures well that bottom 40% has almost no wealth but significant consumption share
- ▶ But **overstates consumption shares and rates of the rich.**
- ▶ Rudimentary life cycle is crucial for level of consumption rates and their decline with wealth.

DYNAMICS OF $a, y, c/y$ DURING RECESSION (2006-2010) ACROSS WEALTH QUINTILES: DATA V/S MODEL

a Q.	$\Delta a(\%)$		$\Delta y(\%)$		$\Delta c/y(\text{pp})$	
	Data	Model	Data	Model	Data	Model
Q1	NA	24	7.4	4.9	-4.4	-0.4
Q2	4	15	5.2	0.3	-2.1	0.8
Q3	6	8	2.1	-2.4	-0.7	2.2
Q4	2	4	1.7	-4.0	-2.1	3.2
Q5	-5	-1	-1.1	-6.4	-1.6	4.6

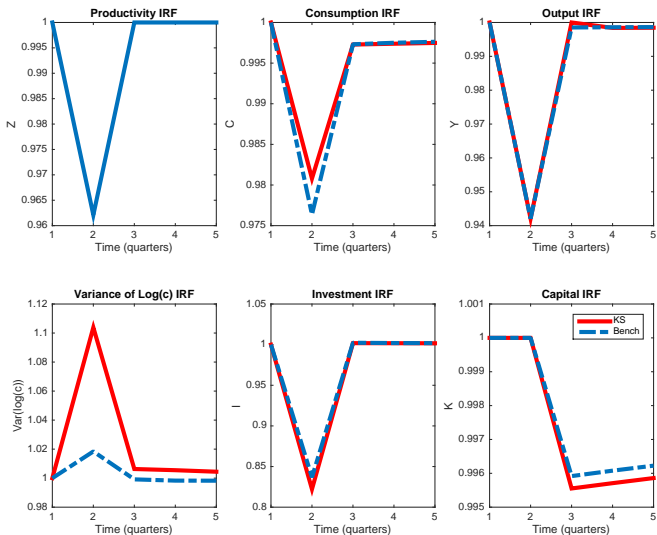
- ▶ Model's issues:
 - ▶ Model captures well that wealth-poor cut consumption rates the most.
 - ▶ Too much y fall for rich (too much mean reversion).
 - ▶ Too small decline in a at the top of wealth distribution in model (no price movements).
- ▶ Now: use the model to understand how wealth inequality matters for C, I, Y dynamics.

INEQUALITY AND THE AGGREGATE DYNAMICS OF A SEVERE CRISIS

In order to understand how wealth inequality matters for C, I, Y dynamics, we compare:

- ▶ **KS economy**, with low wealth inequality (behaves \approx as RA economy)
- ▶ The calibrated **heterogenous β** (baseline) economy
- ▶ Note: calibration insures both economies have same average K/Y ratio.
- ▶ Focus on household heterogeneity and consumption dynamics in recessions shared with Guerrieri & Lorenzoni (2011), Berger & Vavra (2014), Glover, Heathcote, Krueger & Rios-Rull (2014), Heathcote & Perri (2014)

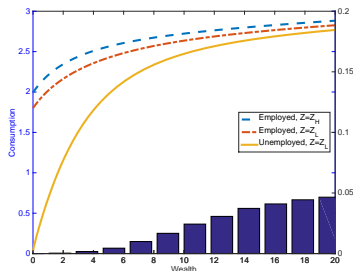
IRF, 2 ECONOMIES: ONE PERIOD RECESSION



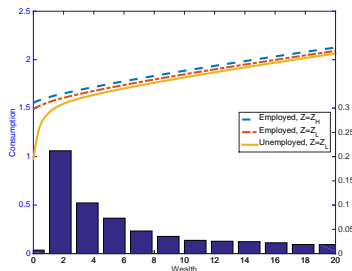
Consumption drop: **KS -1.9%** vs **Baseline -2.4%** Larger wealth inequality leads to $\approx 26\%$ bigger consumption recession. WHY?

CONSUMPTION FUNCTIONS & WEALTH DISTRIBUTION

KS



Het β



- ▶ **KS**: more concave consumption function (mainly because of $\rho = 0.01$), but little mass close to $a \approx 0$
- ▶ **Benchmark** puts significant mass where consumption falls the most in recessions
- ▶ Note: households with $a \approx 0$ do not all act as hand-to-mouth (HtM) consumers. Those without job losses cut c more than y .
- ▶ Alternatives for generating high MPC households: **Wealthy HtM** [Kaplan & Violante 2014], **Durables** [Berger & Vavra 2015]

DYNAMICS OF $a, y, c/y$ DURING RECESSION (2006-2010) ACROSS WEALTH QUINTILES: DATA V/S MODEL

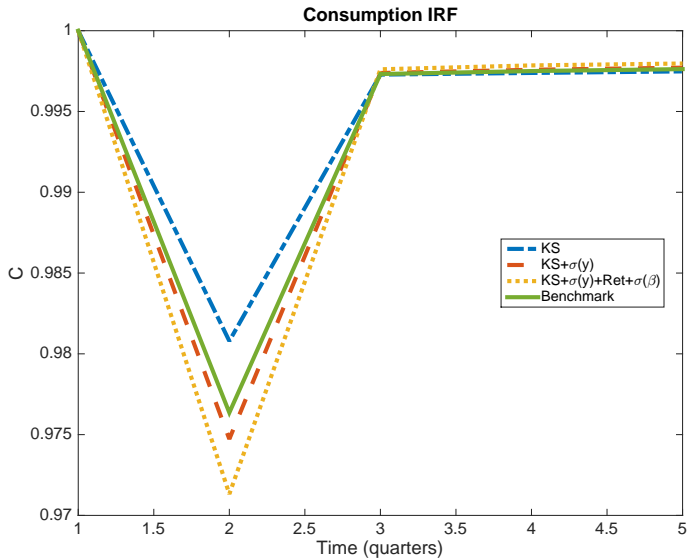
a Q.	$\Delta a(\%)$		$\Delta y(\%)$		$\Delta c/y(pp)$	
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Q4	2	4	1.7	-4.0	-2.1	3.2
Q5	-5	-1	-1.1	-6.4	-1.6	4.6

- Model captures well that wealth-poor cut consumption rates the most.

NET WORTH DISTRIBUTIONS AND CONSUMPTION DECLINE: DIFFERENT VERSIONS OF THE MODEL

% Share:	Models*					KS+Top 1%
	KS	$+\sigma(y)$	+Ret.	$+\sigma(\beta)$	+UI	
<i>Q1</i>	6.9	0.7	0.7	0.7	0.3	5.0
<i>Q2</i>	11.7	2.2	2.4	2.0	1.2	8.6
<i>Q3</i>	16.0	6.1	6.7	5.3	4.7	11.9
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<i>Q5</i>	43.0	73.3	71.1	76.1	77.8	57.9
90 – 95	10.5	17.5	17.1	17.5	17.9	7.4
95 – 99	11.8	23.7	22.6	25.4	26.0	8.8
<i>T1%</i>	5.0	11.2	10.7	13.9	14.2	30.4
Wealth Gini	0.350	0.699	0.703	0.745	0.767	0.525
ΔC	-1.9%	-2.5%	-2.6%	-2.9%	-2.4%	-2.0%

CONSUMPTION RECESSIONS IN VARIOUS VERSIONS OF THE MODEL



THE IMPACT OF SOCIAL INSURANCE POLICIES

- ▶ How does presence of **unemployment insurance (UI)** affect the response of **macro economy to aggregate shock**?
- ▶ Two effects:
 - ▶ UI moderates individual consumption decline for given wealth
 - ▶ UI changes precautionary savings incentives and thus modifies the wealth distribution
- ▶ Two experiments:
 - ▶ (I) Run $\rho = 0.5$ v/s $\rho = 0.1$ in benchmark economy. Both effects present.
 - ▶ (II) Hit both $\rho = 0.5$ v/s $\rho = 0.1$ economies with recession, starting with *same* wealth distribution. Isolates the first effect.

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 - ▶ (II) Hit both $\rho = 0.5$ v/s $\rho = 0.1$ economies with recession, starting with *same* wealth distribution. Isolates the first effect.
- ▶ Important caveat: **UI does not impact individual/firm incentives to seek/create jobs [Hagedorn, Karahan, Manovskii and Mitman 2015]**

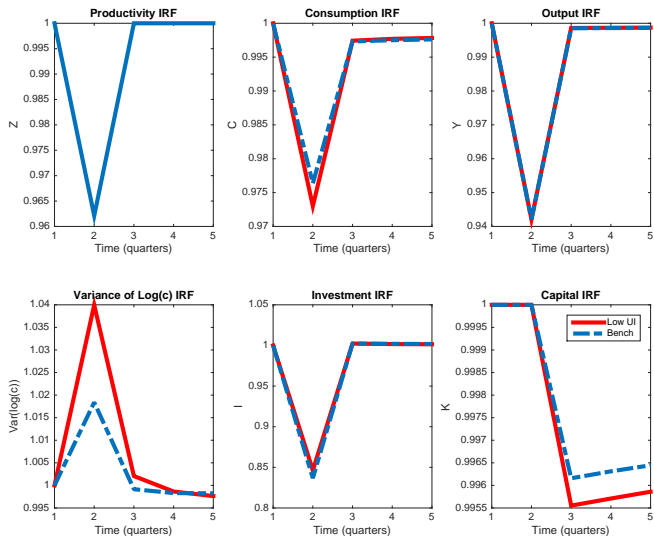
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 - ▶ (II) Hit both $\rho = 0.5$ v/s $\rho = 0.1$ economies with recession, starting with *same* wealth distribution. Isolates the first effect.
- ▶ Analysis complements **literature on impact of social insurance/tax policy on aggregate consumption dynamics in heterogeneous household models** [Heathcote 2005, Krusell & Smith 2006, McKay & Reis 2014, Kaplan & Violante 2014, Carroll, Slacalek & Tokuoka 2014, Jappelli & Pistaferri 2014, Brinca, Holter, Krusell & Malafry 2015]

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- ▶ Two experiments:
 - ▶ (I) Run $\rho = 0.5$ v/s $\rho = 0.1$ in benchmark economy. Both effects present.
 - ▶ (II) Hit both $\rho = 0.5$ v/s $\rho = 0.1$ economies with recession, starting with *same* wealth distribution. Isolates the first effect.
- ▶ Next step would be **optimal social insurance policy analyses** in quantitative incomplete markets models [e.g. Domeij & Heathcote 2005, Conesa, Kitao & Krueger 2009, Peterman 2013, Storesletten, Heathcote & Violante 2014, Karababounis 2015, Bakis, Kaymak & Poschke 2015, Krueger & Ludwig 2015, Mitman & Rabinovich 2015]

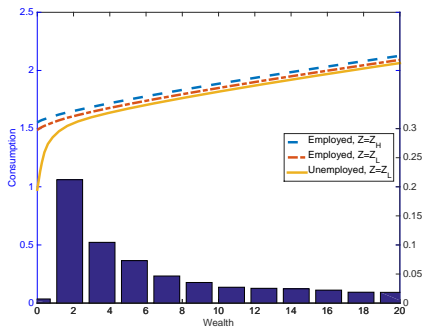
EXPERIMENT I: ONE TIME SHOCK, TWO LEVELS OF UI



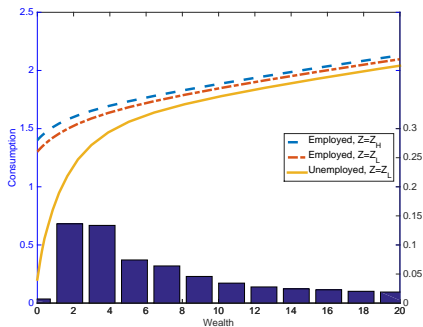
Consumption drop: **Low UI -2.9%** vs **Baseline -2.4%**. Difference moderated by adjustment of wealth distribution.

CONSUMPTION FUNCTIONS & WEALTH DISTRIBUTION

High UI

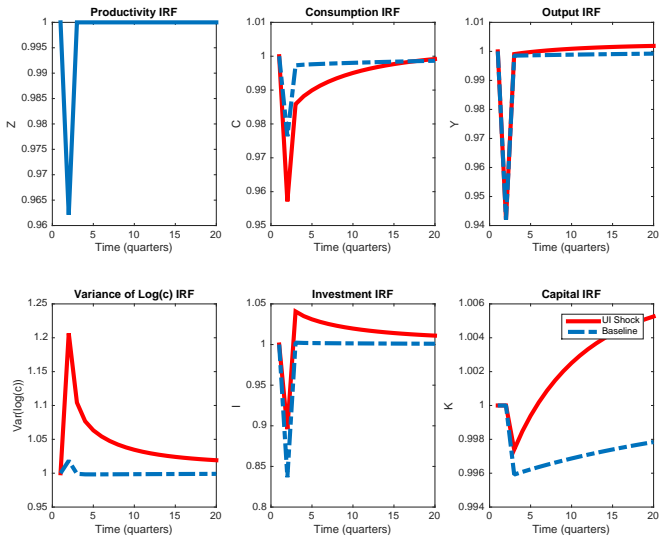


Low UI



- ▶ Benchmark: 25% with close to zero NW, compared to 15% with low UI
- ▶ Impact of UI on aggregate consumption response is muted because low UI shifts wealth distribution to right.
- ▶ How important is this effect? Suppose wealth distribution would *NOT* respond: Consumption disaster!

IRF, FIXED DISTRIBUTION: ONE TIME SHOCK



Consumption drop: **Low UI -4.4%** vs **Baseline -2.4%**. Note: consumption would drop almost as much as output! But faster

INEQUALITY AND AGGREGATE ECONOMIC ACTIVITY

- ▶ So far, output Y was predetermined in the short-run
 - ▶ Z^* and N fluctuating exogenously.
 - ▶ K predetermined in short run

$$Y = Z^* K^\alpha N^{1-\alpha}$$

- ▶ Focus was on consumption C . Now: model supply and demand-side determinants of Y :
 - ▶ The supply side: Endogenizing labor supply N [not today, see also Chang & Kim 2007]
 - ▶ The demand side: Consumption Externality $Z^* = ZC^\omega$.
Reduction in C feeds back into TFP
- ▶ Key question again: how does wealth distribution affect output dynamics now that Y is meaningfully endogenous.

A MODEL WITH AN AGGREGATE CONSUMPTION EXTERNALITY

- ▶ Now $Z^* = ZC^\omega$ with $\omega > 0$.
- ▶ Reduced form version of **real aggregate demand externalities** [e.g. Bai, Rios-Rull & Storesletten 2012, Huo & Rios-Rull 2013, Kaplan & Menzio 2014]
- ▶ Alternatively, could have introduced **nominal rigidities** making output partially demand determined [Het. HH New Keynesian models: Görnemann, Küster, Nakajima 2014, Challe, Matheron, Ragot, Rubio-Ramirez 2014, Auclert 2015]
- ▶ "Demand management" may be called for even in absence of household heterogeneity
- ▶ Social insurance policies (such as **UI**) may be desirable from **individual insurance** and **aggregate** point of view

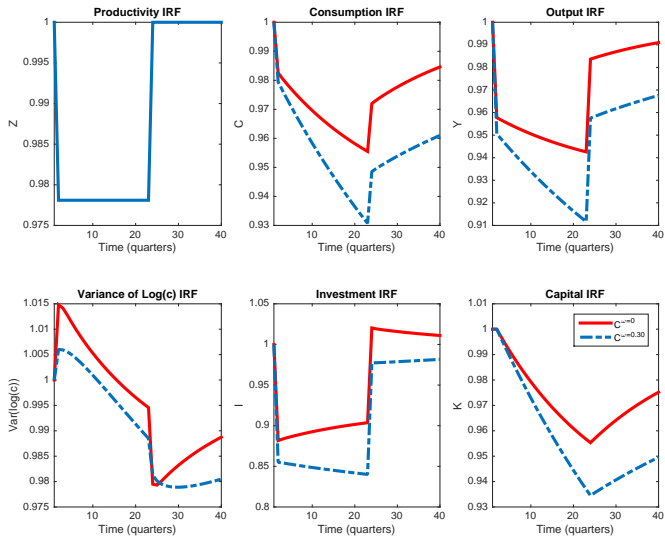
THOUGHT EXPERIMENTS

- ▶ Re-calibrate Z, ω to match output volatility
- ▶ Simulate Great Recession with externality turned on, off.
Question I: How much amplification?
- ▶ Repeat low-UI thought experiment in $\omega > 0$ economy.
Question II: How important is aggregate demand stabilization through UI?
- ▶ Measure welfare losses of falling into a great recession and losing job. *Question III:* How do losses depend on household characteristics, ω , UI?

THOUGHT EXPERIMENTS: EXECUTIVE SUMMARY OF ANSWERS

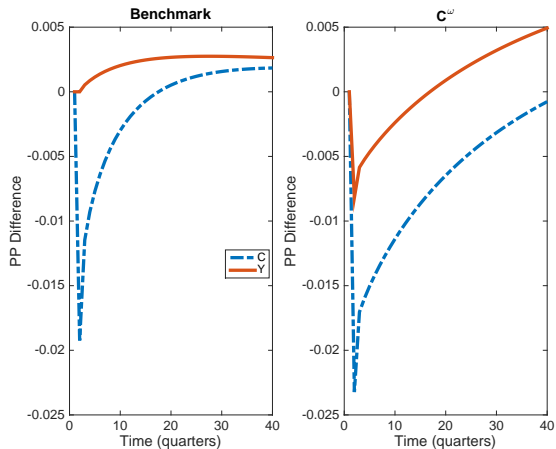
- ▶ Simulate Great Recession with externality turned on, off.
 - ▶ *Question I*: How much amplification?
 - ▶ *Answer*: Recession 2-3 pp deeper. Gap increasing over time
- ▶ Repeat low-UI thought experiment in $\omega > 0$ economy.
 - ▶ *Question II*: How important is aggregate demand stabilization through UI?
 - ▶ *Answer*: Avoids additional output recession of 1%
- ▶ Measure welfare losses of falling into a great recession and losing job.
 - ▶ *Question III*: How do losses depend on household characteristics, ω , UI?
 - ▶ *Answer*: Welfare losses very heterogeneous and large (1.5% to 11%). Have significant aggregate component. Much larger for wealth-poor if UI is small. Amplified by $\omega > 0$.

QUESTION I: HOW MUCH AMPLIFICATION FROM $\omega > 0$?



Recession 2 – 3 pp deeper with $\omega > 0$. Gap increasing over time.

QUESTION II: DIFFERENCE IN C, Y IRF WITH HIGH, LOW UI ($\omega = 0, \omega > 0$), FIXED WEALTH DISTRIBUTION?

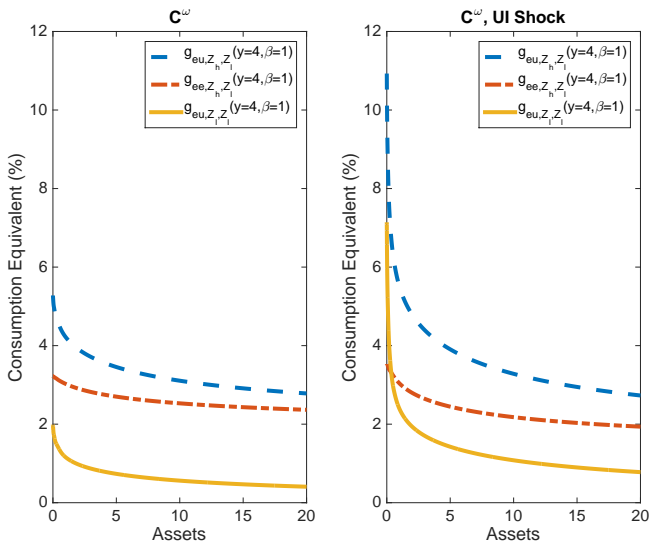


- ▶ Baseline (left panel): **Low UI** makes **consumption recession** much more severe, but no impact on **output dynamics**.
- ▶ Demand externality economy (right panel): Now **low UI** also has persistent negative effect on **output**.

QUESTION III: WHAT IS THE SIZE, SOURCE OF WELFARE LOSSES FROM GREAT RECESSIONS

- ▶ Welfare losses (% of lifetime consumption) from a great recession ($Z_h \Rightarrow Z_l$) with job loss ($e \Rightarrow u$)
 - ▶ Are large (1.5%-6%)
 - ▶ Are strongly decreasing in wealth, especially with low UI
 - ▶ Have significant aggregate component (captures aggregate wage losses and increased future unemployment risk)
 - ▶ Get larger with consumption externality and low UI (up to 11% for households with $a \approx 0$).
- ▶ Approach of calculating welfare losses of recession follows Glover, Heathcote, Krueger & Rios-Rull 2014, Hur 2014.
- ▶ Different question than welfare cost of business cycles [Lucas 1987, Krebs 2003, Krusell, Mukoyama, Sahin & Smith 2009]

WELFARE LOSS FROM RECESSION AND JOB LOSS: $\omega > 0$ WITH HIGH AND LOW UI



$$g_{eu, Z_h, Z_l}(y, a, \beta) \approx g_{ee, Z_h, Z_l}(y, a, \beta) + g_{eu, Z_l, Z_l}(y, a, \beta)$$

CONCLUSIONS: WHERE DO WE STAND?

- ▶ A standard Krusell-Smith model augmented by permanent preference heterogeneity does good job in matching cross-sectional **wealth distribution** (at bottom and at top).
- ▶ That model with **realistic wealth inequality** has significantly stronger **aggregate consumption** recession than low wealth inequality (or RA) economy.
- ▶ Size of **social insurance policies** can have big impact on **aggregate consumption dynamics...**
- ▶ ...and on **aggregate output** if it partially demand determined.

CONCLUSIONS: MOVING FORWARD

- ▶ Great new data
 - ▶ Administrative **individual** income data from social security, tax records
 - ▶ Panel **household** data on y, c, a
- ▶ "Great" new **macro shocks** experienced by households; big changes in cross-sectional distributions of y, c, a
- ▶ Great new challenges: Combine data and theory to...
 - ▶ ...Evaluate existing theories (e.g. Δc behavior at very top and at very bottom of the **distribution** when **macro economy** hits the wall)
 - ▶ ...If needed, develop new models and **computational tools** to solve them
 - ▶ ...Re-evaluate **social insurance policies** in light of these insights

THANK YOU FOR COMING
AND LISTENING!

APPENDIX SLIDES

CONCLUSIONS: MOVING FORWARD

- ▶ Model has some problems, especially at top of wealth distribution:
 - ▶ Too much mean reversion in labor earnings/income. Wealth rich are too income poor.
 - ▶ Missing asset valuation effects
 - ▶ Rich have larger consumption share than in data. Since wealth-rich households \simeq PI consumers (with low MPC's), this likely *understates* aggregate consumption decline.
- ▶ Potential fixes:
 - ▶ Reduce mean revision: introduce ex ante heterogeneous types, increase persistence in earnings.
 - ▶ Higher saving rates for wealth rich: life cycle elements, including bequest motives.

RELATED LITERATURE 1 OF 2

- ▶ Surveys of Heterogeneous Household Macro: Attanasio (1999), Krusell & Smith (2006), Heathcote, Storesletten & Violante (2009), Attanasio & Weber (2010), Quadrini & Rios-Rull (2014), Guvenen (2014)
- ▶ Mechanisms to Generate Plausible Wealth Inequality: Quadrini (1997), Krusell & Smith (1998), Castaneda, Diaz-Gimenez & Rios-Rull (2003), Cagetti & De Nardi (2006), Hintermaier & Koeniger (2011), [Carroll, Slacalek & Tokuoka \(2014\)](#), Benhabib, Bisin & Zhu (2014)
- ▶ Household Heterogeneity and Consumption Dynamics in Recessions: Guerrieri & Lorenzoni (2011), Berger & Vavra (2014), Glover, Heathcote, Krueger & Rios-Rull (2014)
- ▶ Documenting Inequality: Diaz-Gimenez, Glover, & Rios-Rull (2011), Kuhn & Rios-Rull (2015)

RELATED LITERATURE 2 OF 2

- ▶ Role of Unemployment Risk in Heterogenous Agent Models: Krusell, Mukoyama & Sahin (2010), Ravn & Sterk (2015), den Haan, Rendahl & Riegler (2015)
- ▶ Role of Social Insurance Policies in Macroeconomic Stabilization: Kaplan & Violante (2014), McKay & Reis (2014), Jappelli & Pistaferri (2014), Jung & Kuester (2014), Mitman & Rabinovich (2014)
- ▶ Household Heterogeneity and Demand-Determined Recessions: Bai, Rios-Rull & Storesletten (2012), Huo & Rios-Rull (2013), Challe, Matheron, Ragot & Rubio-Ramirez (2014), Gornemann, Kuester & Nakajima (2012)

RECURSIVE COMPETITIVE EQUILIBRIUM

DEFINITION

A recursive competitive equilibrium is given by value and policy functions of the household, v, c, k' , pricing functions r, w and an aggregate law of motion H such that

1. Given the pricing functions r, w , the tax rate and the aggregate law of motion H , the value function v solves the household Bellman equation above and c, k' are the associated policy functions.
2. Factor prices are given by

$$w(Z, \Phi) = ZF_N(K, N)$$

$$r(Z, \Phi) = ZF_K(K, N)$$

3. Budget balance in the unemployment system
4. Market clearing

RECURSIVE COMPETITIVE EQUILIBRIUM

5. Law of motion: for each Borel sets $(\mathcal{S}, \mathcal{Y}, \mathcal{A}, \mathcal{B}) \in P(\mathcal{S}) \times P(\mathcal{Y}) \times B(\mathcal{A}) \times P(\mathcal{B})$

$$H(Z, \Phi, Z')(\mathcal{S}, \mathcal{Y}, \mathcal{A}, \mathcal{B}) = \int Q_{(Z, \Phi, Z')}((s, y, a, \beta), (\mathcal{S}, \mathcal{Y}, \mathcal{A}, \mathcal{B})) d\Phi$$

The Markov transition function Q itself is defined as follows. For $0 \notin \mathcal{A}$ and $y_1 \notin \mathcal{Y}$:

$$\begin{aligned} & Q_{(Z, \Phi, Z')}((s, y, a, \beta), (\mathcal{S}, \mathcal{Y}, \mathcal{A}, \mathcal{B})) \\ = & \sum_{s' \in \mathcal{S}} \sum_{y' \in \mathcal{Y}} \sum_{\beta' \in \mathcal{B}} \begin{cases} \theta \pi(s'|s, Z', Z) \pi(y'|y) \pi(\beta'|\beta) : & a'(s, y, a, \beta; Z, \Phi) \in \mathcal{A} \\ 0 & \text{else} \end{cases} \end{aligned}$$

and

$$\begin{aligned} & Q_{(Z, \Phi, Z')}((s, y, a, \beta), (\mathcal{S}, \{y_1\}, \{0\}, \mathcal{B})) = (1 - \theta) \sum_{s' \in \mathcal{S}} \Pi_Z(s') \sum_{\beta' \in \mathcal{B}} \Pi(\beta') \\ + & \sum_{s' \in \mathcal{S}} \sum_{\beta' \in \mathcal{B}} \begin{cases} \theta \pi(s'|s, Z', Z) \pi(y_1|y) \pi(\beta'|\beta) : & a'(s, y, a, \beta; Z, \Phi) = 0 \\ 0 & \text{else} \end{cases} \end{aligned}$$

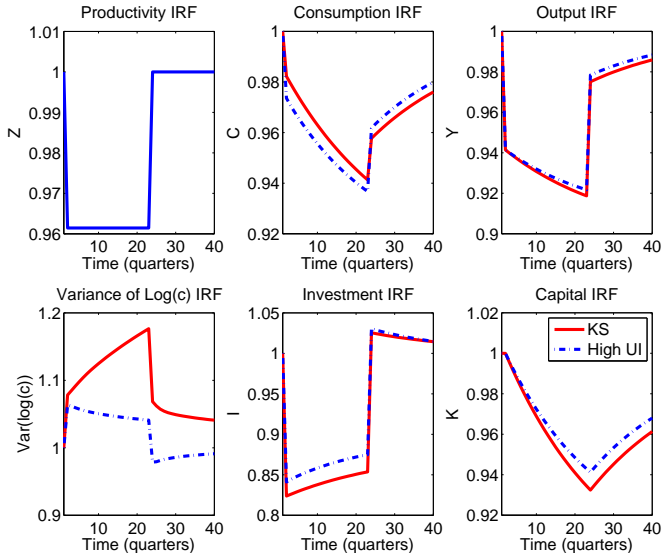
IDIOSYNCRATIC EMPLOYMENT STATUS TRANSITIONS

- ▶ $\pi(s'|s, Z', Z)$ has the form:

$$\begin{bmatrix} \pi_{u,u}^{Z,Z'} & \pi_{u,e}^{Z,Z'} \\ \pi_{e,u}^{Z,Z'} & \pi_{e,e}^{Z,Z'} \end{bmatrix}$$

- ▶ where, e.g. $\pi_{e,u}^{Z,Z'}$ is the probability that unemployed individual finds a job between today and tomorrow, when aggregate productivity transits from Z to Z' .
- ▶ Targeted unemployment rates $u(Z_l), u(Z_h)$ impose joint restriction on $(\pi_{u,u}^{Z,Z'}, \pi_{e,u}^{Z,Z'})$, for each (Z, Z') pair.
- ▶ Thus transition matrices are uniquely pinned down by the quarterly job finding rates
- ▶ Compute job-finding rate (using monthly job-finding and separation rates) and correct for time aggregation

IRF, 2 ECONOMIES: "TYPICAL" GREAT RECESSION



SOCIAL SECURITY

- ▶ Balanced budget PAYGO system
- ▶ Denote by N the number (share) of retired people (assuming total population normalized to 1)
- ▶ Replacement rate $b(Z)$: Each household gets benefits $b(Z)w(Z, \Phi)$ independent of earnings history. Interpretation of replacement rate requires that conditional on having a job, avg. prod. is 1, so that avg earnings of workers are $w(Z, \Phi)$
- ▶ Proportional labor income tax $\tau_{SS}(Z, \Phi)$ on earnings, UI benefits:
- ▶ Define as $LB(Z) = L(Z) + \rho\Pi_Z(u)$. Budget balance:

$$\tau_{SS}(Z, \Phi)w(Z, \Phi)LB(Z) = Nb(Z)w(Z, \Phi)$$

- ▶ Thus

$$\tau_{SS}(Z) = b(Z) * \frac{N}{LB(Z)}$$

SOCIAL SECURITY

- ▶ Suppose that working households have a constant hazard $1 - \theta$ or retiring and retired households have a constant hazard $1 - \nu$ of dying, then the share of retired people and working people in population is:

$$N = \frac{1 - \theta}{(1 - \theta) + (1 - \nu)}; 1 - N = \frac{1 - \nu}{(1 - \theta) + (1 - \nu)}$$

- ▶ Note that with a UI replacement rate of $\rho = 1$ (and with average labor productivity productivity of working people equal to 1) we have

$$\frac{N}{LB(Z)} = \frac{N}{1 - N} = \frac{1 - \theta}{1 - \nu}$$

$$\tau_{SS} = b * \frac{N}{1 - N}$$

- ▶ In this case the social security tax rate is constant and equal to the replacement rate times the old age dependency ratio $\frac{N}{1 - N}$ as would be the case without aggregate risk.

SOCIAL SECURITY: NUMBERS

- ▶ With expected working life of 160 quarters and retirement life of 60 quarters, as well as a tax rate of 15.3% we have $1 - \theta = 1/160$ and $1 - \nu = 1/60$ we get

$$\tau_{SS} = 15.3\% = b * \frac{60}{160}$$

- ▶ This delivers a plausible replacement rate of about 41%. With unemployment, $\rho = 0.5$ it is pro-cyclical (because of countercyclical unemployment rate) and 39% to 40%.
- ▶ Positive population growth would decrease the old-age dependency ratio and thus increase the replacement rate.
- ▶ With retirement hazard independent of wealth, the retired are not necessarily wealthier than the general population. In fact, the first period retired have same wealth distribution as the cross-sectional wealth distribution of working people. Thus retired in the model won't consume disproportionately more than rest of population and C/I ratios in model will fall for workers but not drastically