Quantitative Macro-Labor: Business Cycles and Search

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Announcements

- Today: BRE with more sources of heterogeneity.
- Herkenhoff (2019): Search with business cycles and realistic credit markets.
- Empirical regularities project is due in two weeks!
- Data projects due 11/3.
- Data projects presentations 10/27 and 10/29.

Incorporating Heterogeneity into Search Models

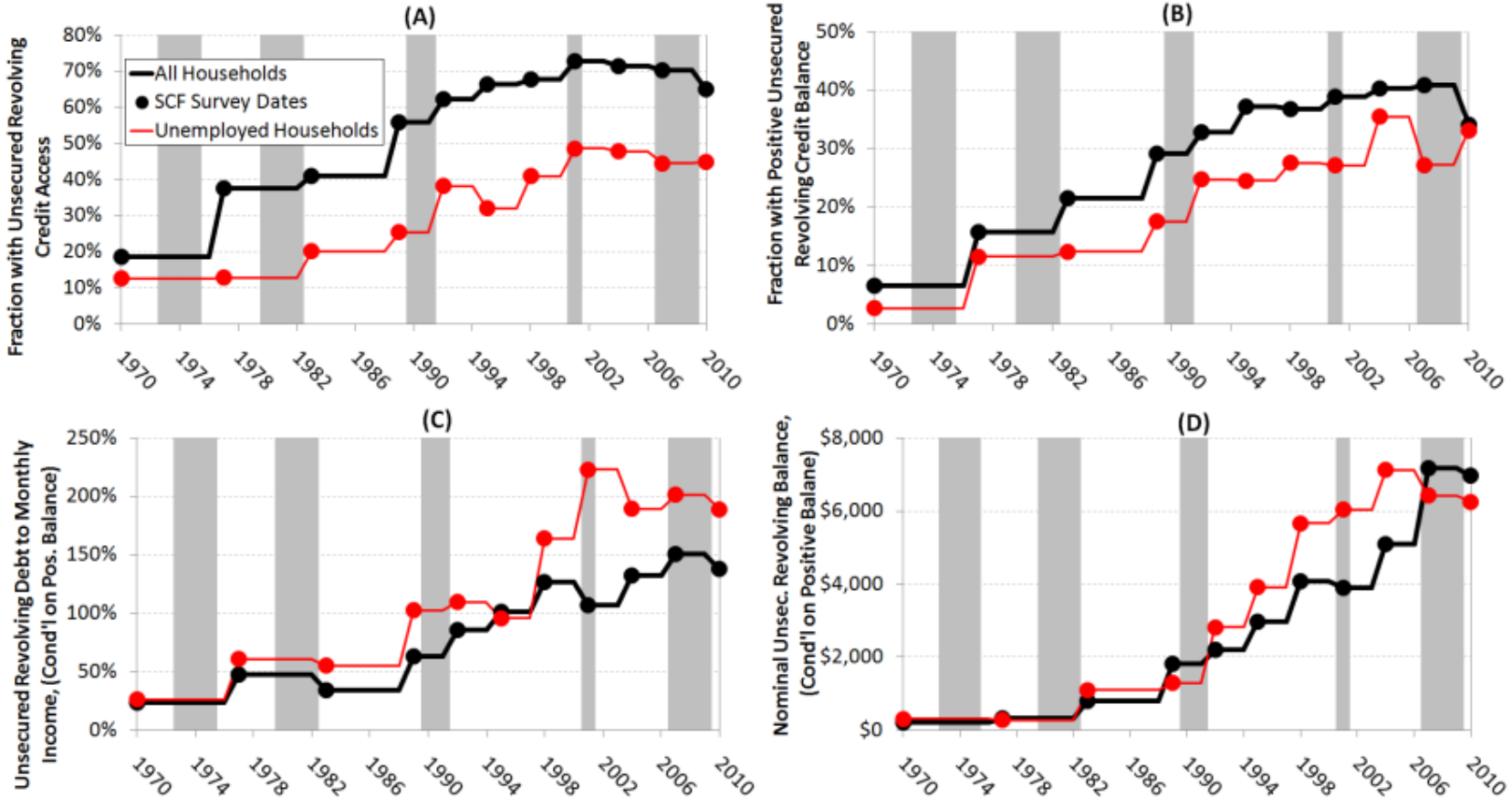
- What makes the Block Recursive Model tractable?
  1. Simple general equilibrium.
  2. Segment markets appropriately and the rest is easy.
- What makes other GE search models tricky?
  1. Vacancy creation decision.
  2. On-the-job search decision.
- Today: one more extension of BRE.

Herkenhoff (2019)

- What is the impact of credit constraints on business cycles?
- Basic model:
  1. Menzio & Shi (2011), life-cycle version.
  2. + endogenous credit constraints.
  3. + search for lenders.
- Credit can constrict in response to labor market shocks and aggregate conditions.

Regularities (2015 WP version)

Figure 1: Survey of Consumer Finances, (A) Fraction of Population with Access to Credit, (B) Fraction of Population with Positive Balances, (C) Debt-to-Monthly-Income Ratios (DTIs), and (D) Nominal Balances



- Credit expanded until the Great Recession.

Model Environment

- Life-cycle model: age discrete, indexed by t; exit at $T + 1$.
- Agents:
  - Employed and unemployed workers.
  - Matched and unmatched firms.
  - Credit lending agencies.
- Technology:
  - Frictional matching in labor & credit markets.
  - Endogenous credit constraints.
- Initial heterogeneity:
  - Initial wealth (a_0) and employment status.

Agents

- Risk-averse workers indexed by (e, a, w, b, z, t)
  - Employed (w), unemployed w/ UI (z).
  - Search for credit among offers. Make default decision.
  - With credit: borrow up to b'. Without, $b' \geq 0$.
- Continuum of profit maximizing employers:
  - Risk neutral.
  - Post vacancies that specify wage (w).
- Continuum of lenders:
  - Risk neutral. Pay r_F on deposits.
  - Post offers for credit to potential borrowers with schedule $q(w, b')$.
- Type-distribution $\phi' = \Phi(\phi)$ (suppressed throughout).

Search and Matching Technology

- Directed search (Moen, 1997):
  - Labor submarket: homogeneous workers (e, a, b, z, t) and firms (w)
  - Credit submarket: homogeneous workers (e, a, b, z, t) and firms (q)
- Matching technology:
  - # of matches in submkt: $M_t = M(u_t, v_t)$ (CRS).
  - Submarket tightness: $\theta_t(\cdot) = \frac{v_t}{u_t}$
  - Worker finding rate: $q(\theta_t) = \frac{M(u_t, v_t)}{v_t}$
  - Job finding rates: $p(\theta_t) = \frac{M(u_t, v_t)}{u_t} = \theta_t q(\theta_t)$

Credit Searcher's Problem

- States: $s_U = (z, b)$, $s'_C = S'_N = (z, b)$, $z = \gamma w$
- Each period, borrowers search for lender:
  - Meet w/ prob. $A\psi(\theta_t(s'_C))$.
  - Continue w/ value $U_t^C(s'_C)$ if offered job.
  - Continue w/ value $U_t^N(s'_N)$ if no offer.
- Bellman for credit searcher:

$$U_t(s_U) = A\psi(\theta_t(s'_C))U_t^C(s'_C) + (1 - A\psi(\theta_t(s'_C)))U_t^N(s'_N)$$

- The lending market tightness will be defined after the problem.

Worker's Problem with Lender

- States:
  - Unemp. w/ Credit: $s_U = (z, b)$, $s'_U = (z, b')$, $s'_E = (w, b')$
- Policies:
  - Consume & save s.t. $b' \geq \underline{b}$.
  - Default fraction $D \in [0, 1]$
- Value of unemployment (w/ credit):

$$
\begin{aligned}
U_t^C(s_U) = \max_{b \in B, D \in [0,1]} & \; u(c) - x(D) + \eta \\
& + \beta(1 - S(D))R_{t+1}^C + S(D)R_{t+1}^N \\
\text{s.t. } & \; c + q_{U,t}(z, b')b' \leq z + (1 - D)b \\
& \; y' \sim F(y'|y)
\end{aligned}
$$

$$
\begin{aligned}
R_{t+1}^X = E[\max_{w \in W} & \; p(\theta_{t+1}(s'_E))W_{t+1}^X(s'_E) \\
& + (1 - p(\theta_{t+1}(s'_E)))U_{t+1}^X(s'_U))]
\end{aligned}
$$

- No OTJS, but employed similar.

Worker's Problem without Lender

- States:
  - Unemp. w/o Credit: $s_U = (z, b)$, $s'_U = (z, b')$, $s'_E = (w, b')$
- Policies:
  - Consume & save s.t. $b' \geq 0$.
  - Default fraction $D \in [0, 1]$
- Value of unemployment (w/o credit):

$$
\begin{aligned}
U_t^N(s_U) = & \max_{b \in B, D \in [0,1]} u(c) \\
& + \beta E[\max_{w \in W} p(\theta_{t+1}(s'_E)) W_{t+1}(s'_E) \\
& + (1 - p(\theta_{t+1}(s'_E))) U_{t+1}(s'_U))] \\
& \text{s.t. } c + \frac{1}{1 + r_F} b' \leq z + (1 - D) b \\
& y' \sim F(y'|y)
\end{aligned}
$$

- No OTJS, but employed similar.

Savings and Lendings Institutions

- Two types:
  1. Savings institutions: offer risk free rate r_F to everyone $b > 0$.
  2. Credit institutions: offer schedule or prices q based on credit requested and worker state.
- States: $s_q = (e, w, b)$
- Matched firms:
  - Price q, quantity b';
  - Worker defaults on fraction D;
  - Must borrow at world risk free rate.
- (Highly simplified) Value of one-period lending relation:

$$Q_t(s_q) = q(s_q)b' - \frac{1}{1 + r_F} E[(1 - D)b'] \tag{1}$$

- Worker decisions: D, b'.
- Actual model profit function much more complicated: basic idea is that firm lends $q \times b'$, receives $(1 - D)b'$ back at world risk-free rate.

Credit Market Free Entry

- States: $s_q = (e, w, b)$
- Normally, free entry used in labor market.
- Here, lenders compete away profits.
- Two types:
  - Paying risk-free rate.
  - Lending at price q at servicing fee τ (total amount $\tau \times q \times b'$).

$$q((s_q)) = \begin{cases} \frac{E[(1-D(s_q))]}{1+r_F+\tau} & \hat{b} \in B_-, D = 0 \\ 0 & \hat{b} \in B_-, D > 0 \\ \frac{1}{1+r_F} & \hat{b} \in B_+ \end{cases}$$

- Contracts are offered to each type s_q.

Firms

- States: $s_J = (w), s'_J = (w)$
- Why not b'?
- Matched firms:
  - Net profits $y_t - w_t$;
  - separate exog. w/ prob. δ;
  - continue w/ value $J_{t+1}(s'_J)$
- Value of filled vacancy with age-t type-s_J worker:

$$J_t(s_J) = y - w + \beta E[(1-\delta)J_{t+1}(s'_J)]$$
$$y' = F(y'|y)$$

Free Entry and Equilibrium Job-Finding Rates

- States: $s_J = (w)$
- Unmatched firms:
  - Pay κ_L to post (profitable) vacancies.
  - Match w/ prob. $f(\theta_t(s_J))$.
- Value of vacancy with age-t worker paying wage w:

$$V_t(s_J) = -\kappa_L + f(\theta_t(s_J))J_t(s_J)$$

- Free Entry ($V_t(s_J) = 0$):

$$f(\theta_t(s_J)) = \frac{\kappa_L}{J_t(s_J)}$$

$$\theta_t(s_J) = q^{-1}(\frac{\kappa_L}{J_t(s_J)})$$

Equilibrium

A *Block Recursive Equilibrium* (BRE) in this model is a set of value functions, $U_t, W_t, U_t^C, U_t^N, W_t^C, W_t^N, J_t^L, V_t^L, J_t^C, V_t^C$, associated policy and market tightness functions, b', c, w', θ_t^L, and θ_t^C, which satisfy

1. The policy functions solve the workers problems.
2. $\theta_t(w)^L$ satisfies the free entry condition for all submarkets (w) in the labor market.
3. $\theta_t(e, w, b)^C$ satisfies the free entry condition for all submarkets (w) in the credit market.
4. The aggregate law of motion is consistent with all policy functions.

Calibration (Stochastic Steady State)

TABLE 5
Summary of parameters, 2010 stochastic steady state calibration

Parameter	Value	Description
Non-calibrated		
$\bar{s}$	0.01	Exogenous credit separation rate
r_f	0.04	Annualized risk free rate
τ	0.049	Annualized proportional servicing fee
δ	0.1	Job destruction rate
ρ	0.8961	Auto correlation of labour productivity
σ_ϵ	0.0055	Standard deviation of labour productivity
γ	0.5	Benefit replacement rate
ζ	1.6	Labour match elasticity
ζ_C	0.37	Credit match elasticity
κ_C	$1.75e^{-6}$	Credit vacancy cost
σ	2	Risk aversion
T	120	Lifespan in quarters
p_x	0.022	Probability of expense shock
x	0.263	Size of expense shock
Calibrated		
κ_L	0.021	Vacancy posting cost
κ_D	0.184	Disutility of default
χ_C	0.210	Utility cost of applying
η	0.604	Flow utility of leisure
A_{2010}	0.718	Credit matching efficiency
β	0.974	Discount factor

Fit

TABLE 6
Simulated moments, 2010 stochastic steady state calibration

Parameter	Target	Model	Data	Source
κ_L	Unemployment Rate	0.0586	0.0582	BLS (1948-2013)
κ_D	Chargeoff Rate	0.0107	0.0106	Flow of Funds (1985-2007)
χ_C	Fraction of Unemployed Borrowing	0.3316	0.3310	SCF (2010)
η	Autocorrelation of Unemployment	0.9045	0.9360	Shimer (2005)
A_{2010}	Approval Rate	0.6769	0.6720	SCF Panel (2007-2009)
β	Gross Unempl. DTI	0.0576	0.0519	SCF (2010)

Fit

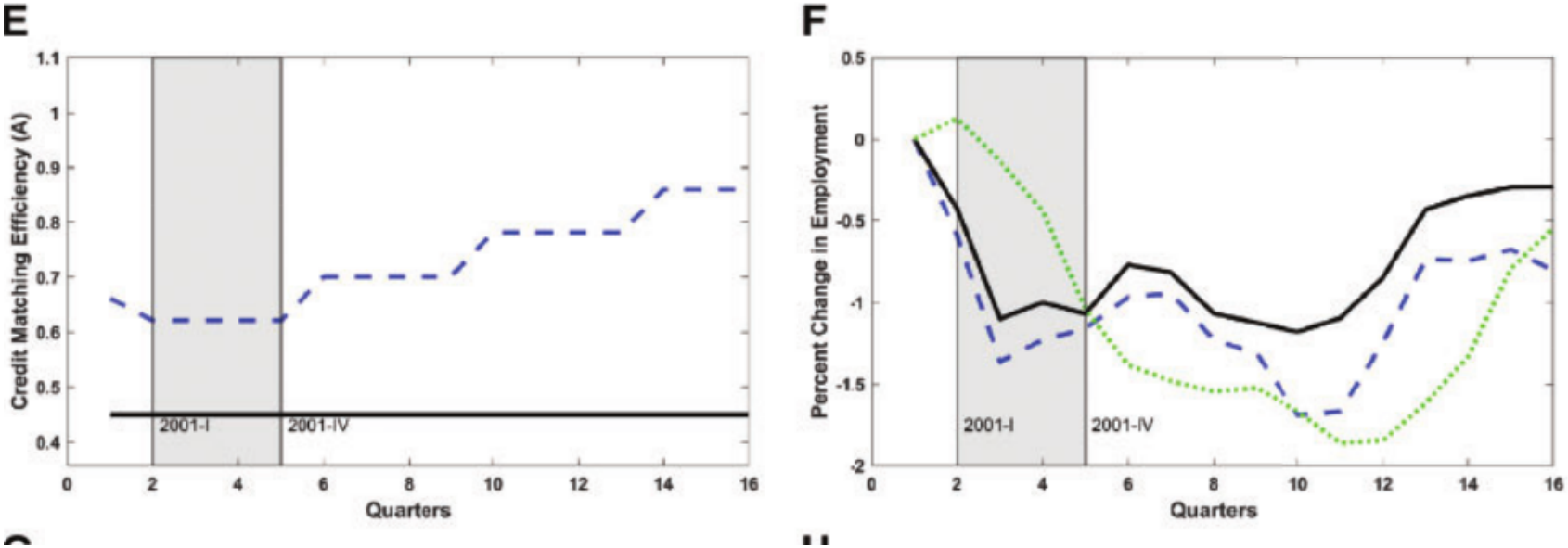
TABLE 7
Stochastic steady state comparison

	2010	**1977**	**Ratio (2010/1977)**
Fraction unemployed borrowing	0.33	0.13	2.56
Avg. unemployment rate	5.87%	5.56%	1.06
Unemployment volatility	14.0	14.4	0.97
Credit matching efficiency (A)	0.72	0.48	1.49
Newborns: fraction of lifetime consumption willing to forego to move from 1977 to 2010 SS			0.12%
Employed newborns and non-newborns: fraction of lifetime consumption willing to forego to move from 1977 to 2010 SS			0.11%
Unemployed newborns and non-newborns: fraction of lifetime consumption willing to forego to move from 1977 to 2010 SS			0.15%

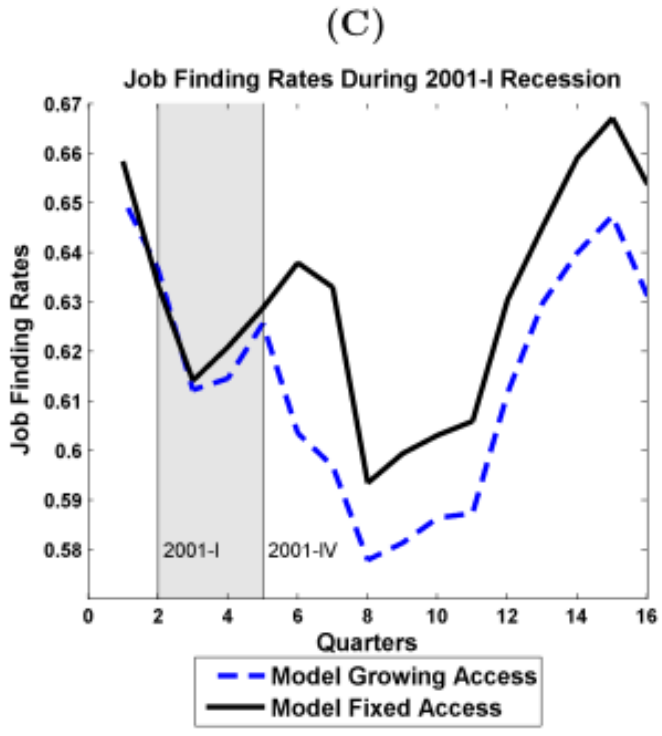
How Does Credit Affect Employment?

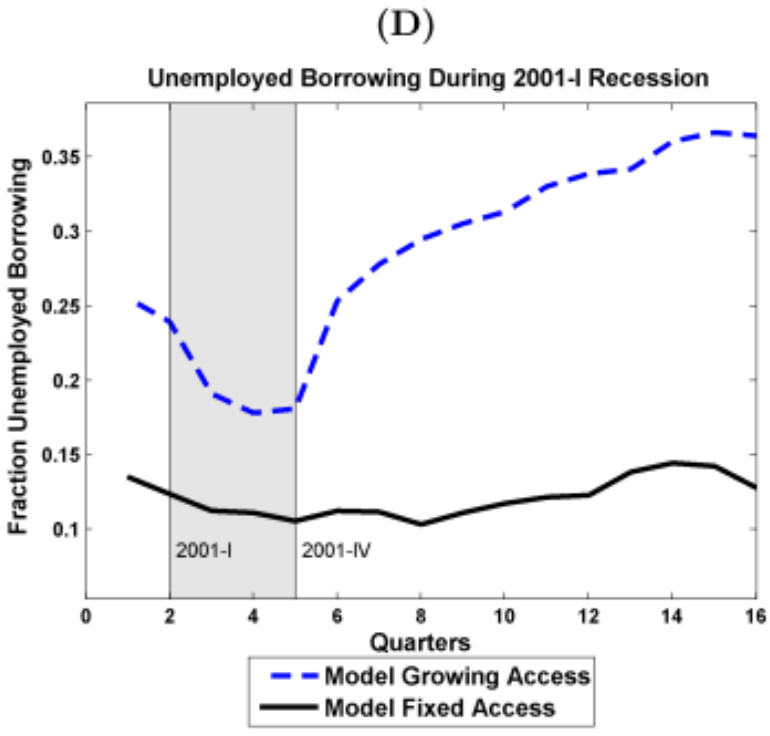
- Four recent business cycles: 1980 (exp), 1990 (rec), 2001 (rec), and 2007 (rec).
- Input path of aggregate shocks & credit access.
- Quantify impact of credit on aggregates.

2001 Transition Path

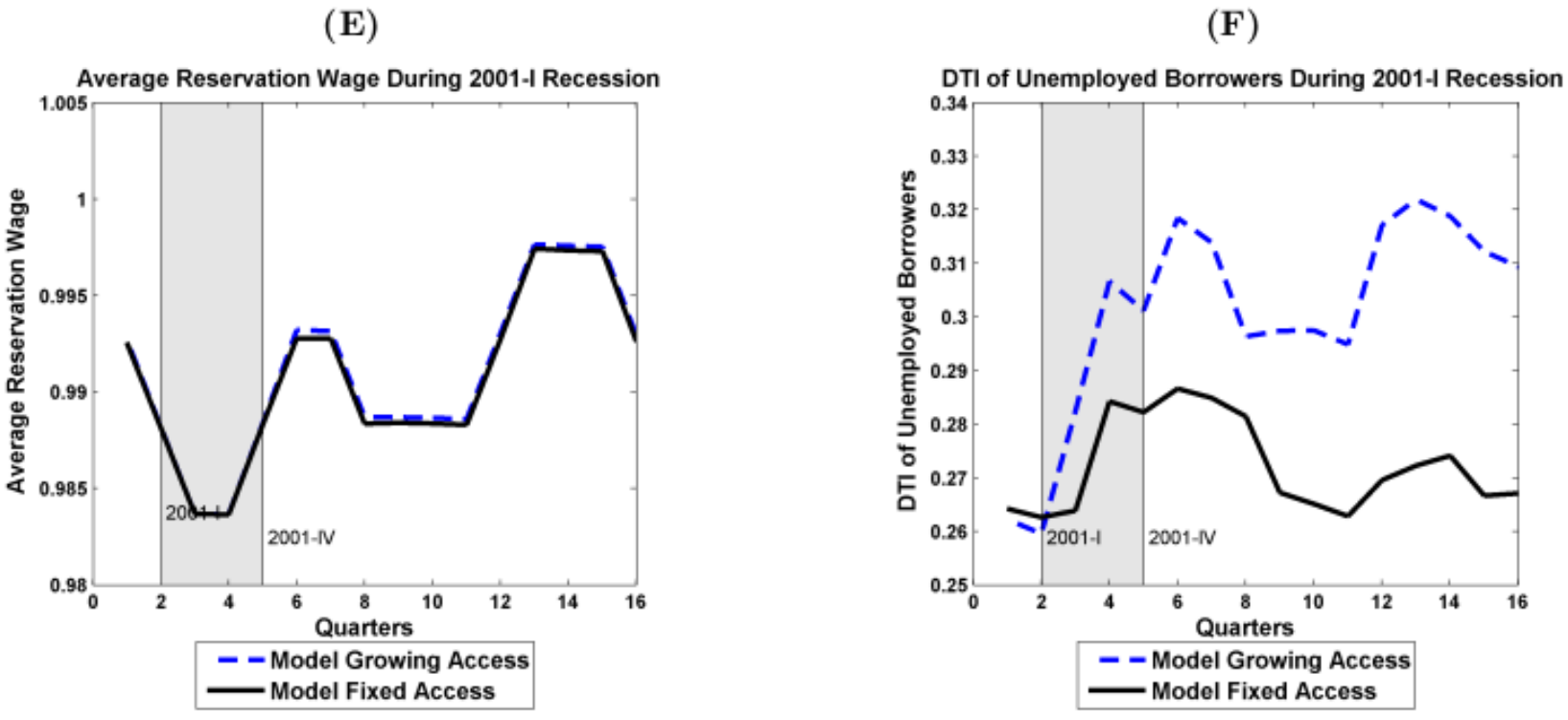


Job-Finding and Employment 2001 (2015 WP version)

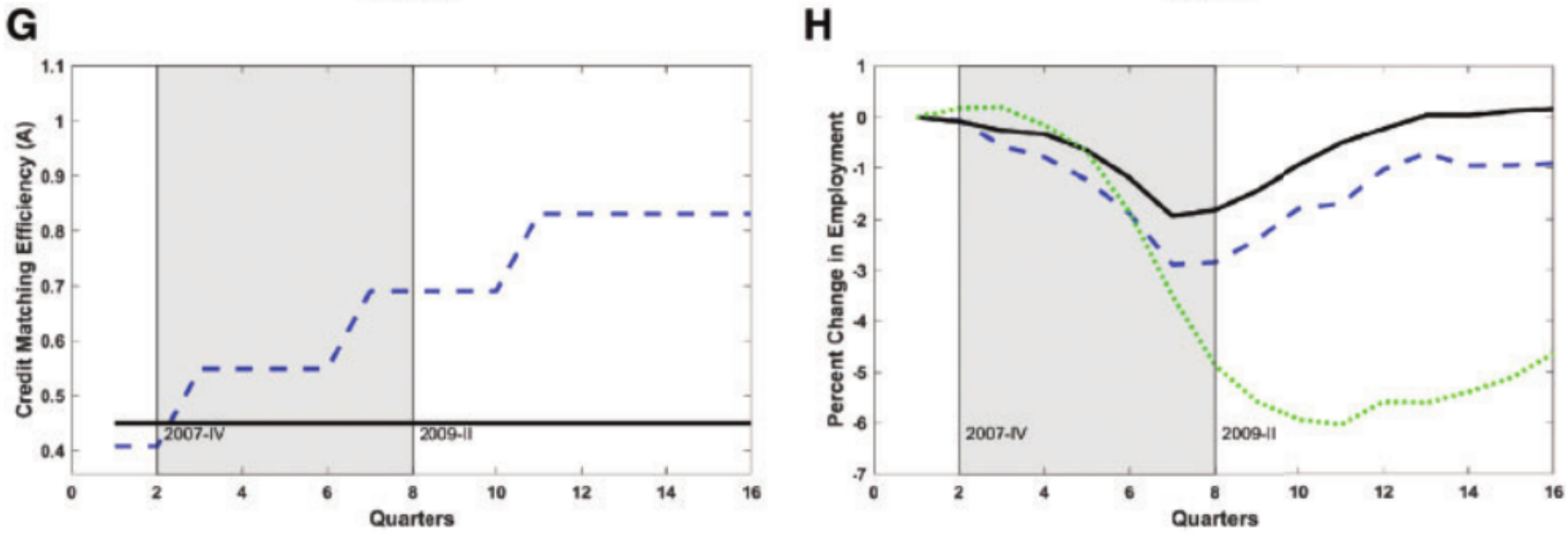




Consumption Risk during 2001 (2015 WP version)



Inputs and Outputs



Transition Experiments (2015 WP version)

Figure 8: Transition Experiment: Consumption Dispersion over Income Dispersion

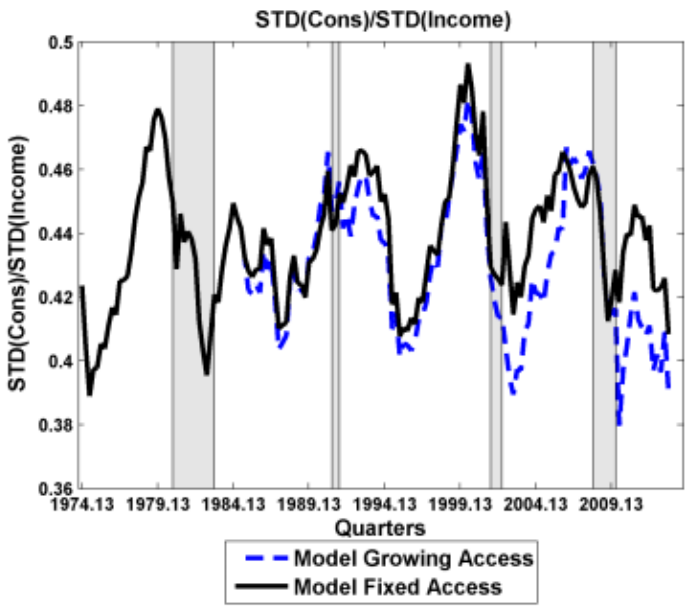
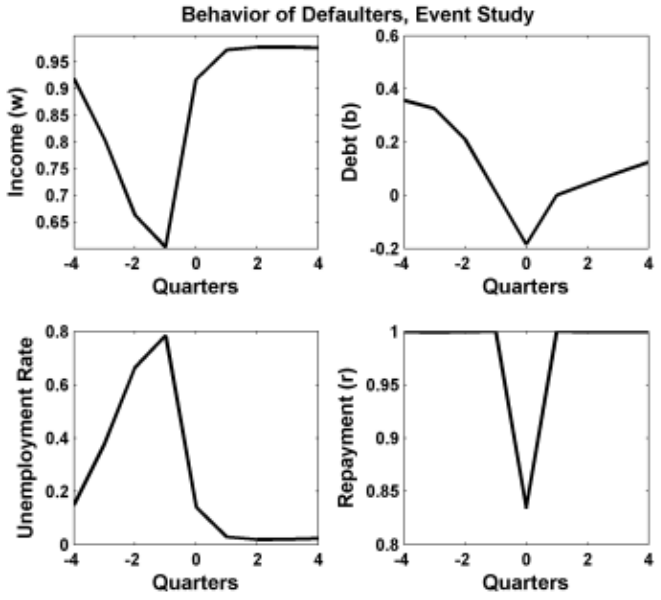
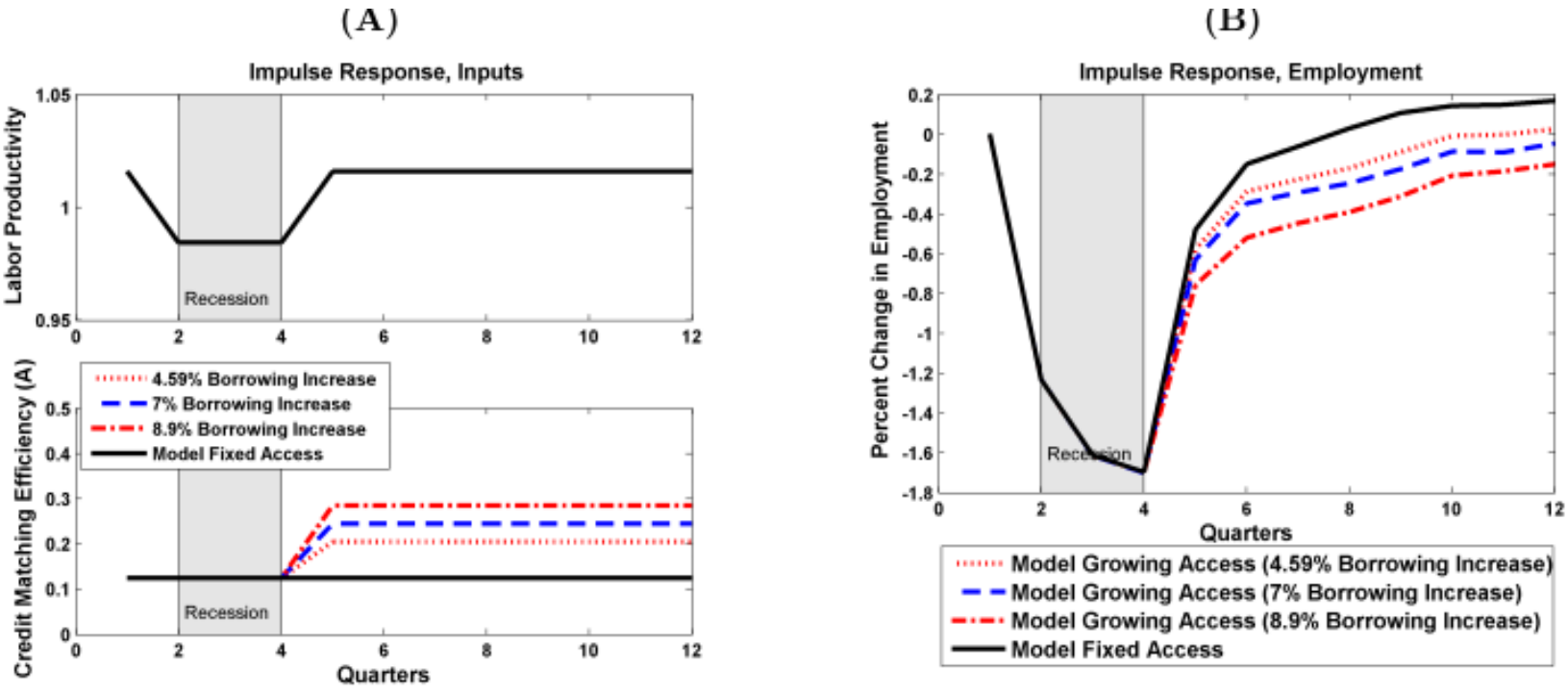


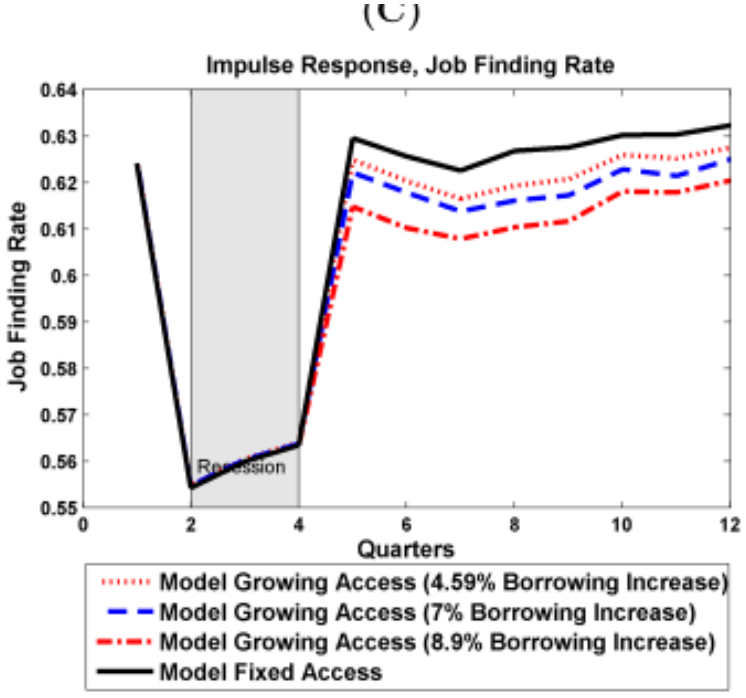
Figure 9: Average Default Episode, Employment, Income, Repayment

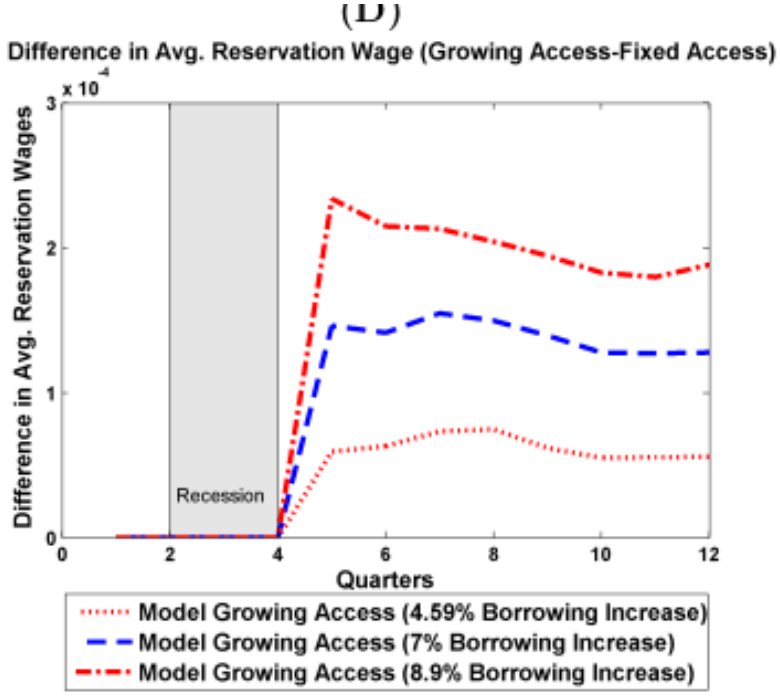


Employment Impulse Responses (2015 WP version)



Consumption Risk Impulse Responses (2015 WP version)





Numerical Findings

Table 4: Transition Experiment: Percentage Change in Employment 12 Quarters Since the Peak

	Percentage Change in Employment 12Q Since Peak			
	Model with Fixed Access	Model with Access	Data	Decr. in Empl. Discrepancy*
1990	1.24	1.06	0.12	16.3%
2001	-1.08	-1.47	-1.85	51.6%
2007	0.08	-0.74	-5.59	14.6%
Average	NA	NA	NA	27.5%

Notes. Data is Nonfarm Business Sector Employment. E(t) is employment in period t after recession. Percentage change formula: 100*(E(12)/E(0)-1) where E(0) is employment in period prior to NBER dated recession. *Decr. in Empl. Discrepancy stands for "the reduction in employment discrepancy between the model and the data by including credit expansions." The formula for calculating the reduction in employment discrepancy between the model and the data by including credit expansions is given by: (E(Fixed Access)-E(Access))/(E(Fixed Access)-E(Data)) where E(·) is employment.

Conclusion

- Next time: maybe solution techniques?
- Empirical regularities project is due in two weeks!
- Data projects due 11/3.
- Data projects presentations 10/27 and 10/29.