Appendix: the Great Moderation in the Japanese Economy

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Omitted Variables

Omitted Variables

1. Capital?
   - Gali (1999)
   - assumption: Stationary Capital output ratio
2. Other Variables (Shocks)?
   - IST shocks, Monetary shock, and so on
   - Future work

Equilibrium

Self-Confirming Equlibrium 1)

- Fudenberg and Levine (1993), Cho and Sargent (2006), Sargent (2008)
- interactions among a collection of adaptive agents , each of whom averages past data to approximate moments of the conditional probability distns
- If outcome converge, a Law of Large Numbers implies agents' beliefs about conditional moments become correct on events that are infrequently observed.
- Beleifs are not necessarily correct about events that are infrequently oberved.
- Where beliefs are correct, a self-confirming equilibrium is like a rational expectations equilibrium.

Self-Confirming Equlibrium 2)

- Agent i with strategy space A_i and state space X_i.
- Probability distn P_i over $A_i \times X_i$:
  how actions and states are related.
- utility fcn is $u_i : A_i \times X_i \to R$
- $\mu_i(: a_i)$: a probability distn over X_i
  represent i's belief about the state conditional on action a_i.
- Agent i's decision problem is to solve

$$\max_{a_i \in A_i} \int_{x_i} u_i(a_i, x_i) d\mu_i(x_i : a_i). \tag{1}$$

Priors

Priors

- 18 Models
- Robost Results

Priors 1)

- the conditional prior density of θ^T is given by

$$p(\theta^T|\alpha^T, h^T, Q, \Psi, \Xi) \propto I(\theta^T) f(\theta^T|\alpha^T, h^T, Q, \Psi, \Xi),$$

  - z^T: a sequence of z's up to time T.
  - $I(\theta^T) = \Pi_{t=0}^{T} I(\theta_t)$,
  - $f(\theta^T|\alpha^T, h^T, Q, \Psi, \Xi) = f(\theta_0)\Pi_{t-1}^{T} f(\theta_t|\theta_{t-1}, \alpha^T, h^T, Q, \Psi, \Xi)$
  - $I(\theta^T)$ takes a unit value

    if all the roots of the VAR polynomial associated with θ_t

    are larger than one in modulus

    and 0 otherwise,

    ruling out a non-stationary process.

Priors 2) distributions

- Following Cogley and Sargent (2005) and Gali and Gambetti (2009), prior distributions and its hyperparameters :

$$p(\theta_0) \propto I(\theta_0) N(\hat{\theta}_{OLS}, \hat{V}(\hat{\theta}_{OLS}))$$
$$p(\log h_0) = N(\log \hat{h}_{OLS}, 10 \times I)$$
$$p(\alpha_0) = N(\hat{\alpha}_{OLS}, |\hat{\alpha}_{OLS}|)$$

$$p(Q) = IW(\bar{Q}^{-1}, T_0)$$
$$p(\Xi_{i,i}) = IG\left(\frac{\bar{\Xi}}{2}, \frac{1}{2}\right)$$
$$p(\Psi) = IW(\bar{\Psi}^{-1}, 2).$$

- not flat but uninformative

Priors 3) values

- $\hat{\theta}_{OLS}$: OLS estimates of VAR coefficients.
- $\hat{V}(\hat{\theta}_{OLS})$: the estimate of their covariance matrix.

- $\hat{h}_{OLS}$: vector containing elements of the diagonal matrix $\hat{H}$.
- $\hat{\alpha}_{OLS}$: the element (2,1) of the lower triangular matrix $\hat{A}$.

- $\overline{Q} = k_Q \times \hat{V}(\hat{\theta}_{OLS})$.
- T_0: # of observations in the initial sample.
- $\overline{\Xi} = k_\xi$.
- $\overline{\Psi} = k_\Psi \times |\hat{\alpha}_{OLS}|$.

- Benchmark: $k_Q = 0.005$, $k_\xi = 0.0001$, $k_\Psi = 0.001$.

Priors 4) robustness

- 18 models
- $k_Q = \{0.005, 0.001, 0.1\}$.
- $k_\xi = \{0.0001, 0.001\}$.
- $k_\Psi = \{0.001, 0.01, 1\}$.
- Robust in all cases!!!

Estimation

Estimation

- We use a Markov Chain Monte Calro (MCMC) method, the Gibbs sampling .
    - The Gibbs sampler partitions the vector of unknowns into blocks.
    - The transition density is defined by the product of conditional densities.

Step 1: $p(\theta^T | x^T, \alpha^T, h^T, Q, \Psi, \Xi)$

- Conditional on $x^T, \alpha^T, h^T, Q, \Psi, \Xi$, the unrestricted posterior of the states is normal.
- To draw from the conditional posterior, we employ the algorithm of Carter and Kohn (1994).
- The conditional mean and variance of the terminal state θ_T is computed using standard Kalman filter recursions .
- For all the other states, the following backward recursions are employed:

$$\theta_{t|t+1} = \theta_{t|t} + P_{t|t} P_{t|t+1}^{-1} (\theta_{t+1} - \theta_{t|t}), \qquad (2)$$

$$P_{t|t+1} = P_{t|t} - P_{t|t} P_{t+1|t}^{-1} P_{t|t}, \qquad (3)$$

where $p(\theta^T | x^T, \alpha^T, h^T, Q, \Psi, \Xi) \sim N(\theta_{t|t+1}, P_{t|t+1})$.

Step 2: $p(\alpha^T | x^T, \theta^T, h^T, Q, \Psi, \Xi)$

- Conditional on θ^T,
  $\hat{y}_t = x_t - \beta_{0,t} - \beta_{1,t} x_{t-1} - \cdots - \beta_{p,t} x_{t-p}$ is observable.
- We can rewrite our system of equations as $A_t \hat{y}_t = H_t \nu_t$,
  where $\nu_t \sim N(0, I)$.
- Conditional on h^T,
  we use the algorithm of Carter and Kohn (1994)
  to obtain a draw for α_t
  taking the above system as observational equations and unobserved states equations.
- Given that the α_t and the ν_t are independent across equations, the algorithm can be applied equation by equation.

Step 3: $p(h^T|x^T, \theta^T, \alpha^T, Q, \Psi, \Xi)$

- This is done by using the univariate algorithm by Jacquier et al. (1994) .

Step 4: $p(\Psi|x^T, \theta^T, \alpha^T, h^T, Q, \Xi)$, $p(\Xi_{i,i}|x^T, \theta^T, \alpha^T, h^T, Q, \Psi)$, $p(Q|x^T, \theta^T, \alpha^T, h^T, \Psi, \Xi)$

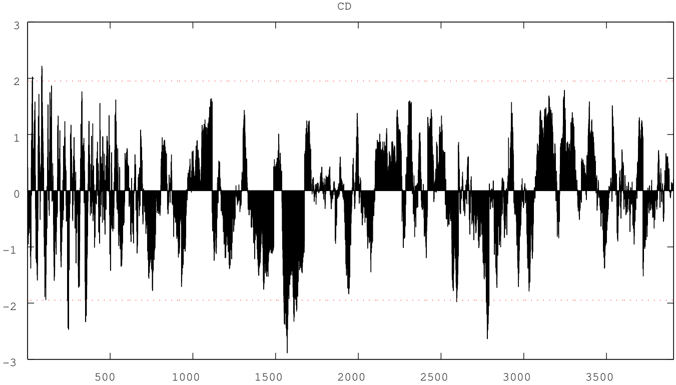
- Conditional on $x^T, \theta^T, \alpha^T, h^T$,
  all the remaining hyperparameters,
  under conjugate priors,
  can be sampled in a standard way from
  Inverted Wishart and Inverted Gamma densities.

Convergence

Covergence

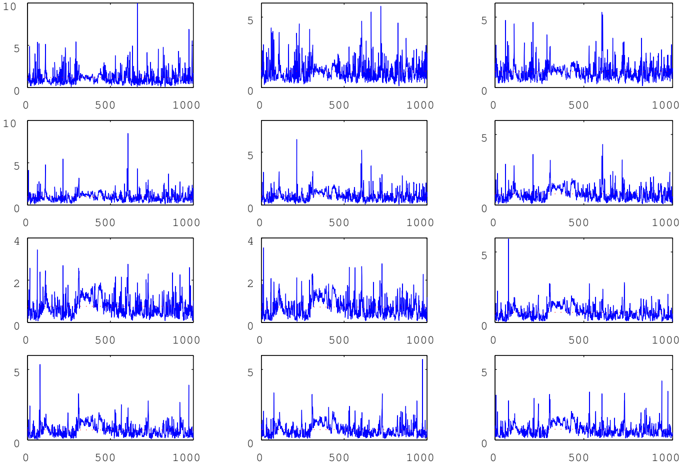
- Geweke (1992)
- Convergence Diagnotics (CD)

Fig: CD statistics



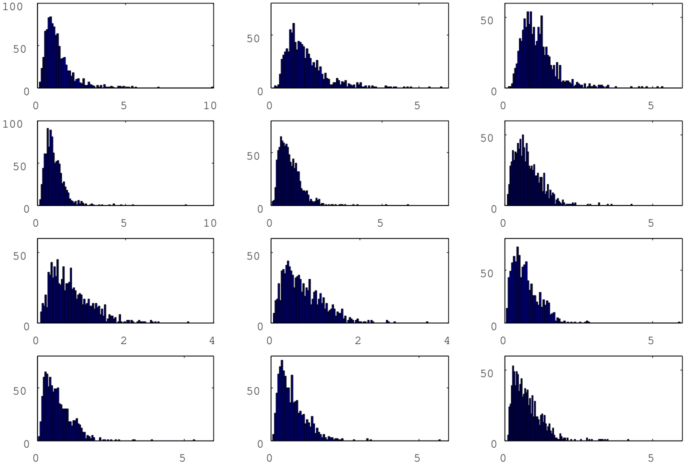
- Cannot reject the null hypothesis in most cases

Fig: Draws and Means of posterior $\log h_t$



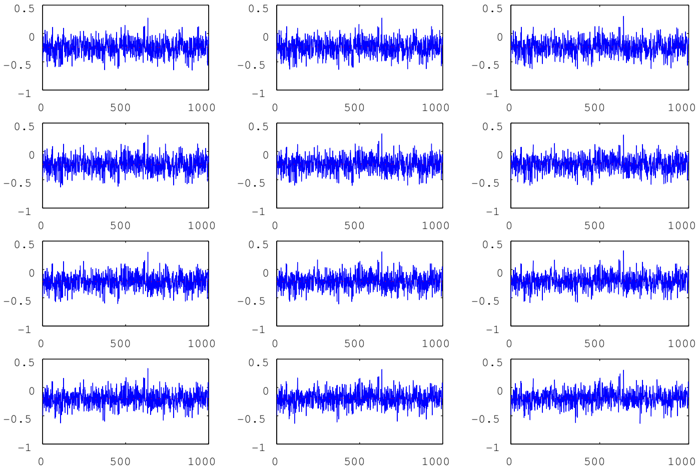
- stationary distn

Fig: Density of Posterior $\log h_t$



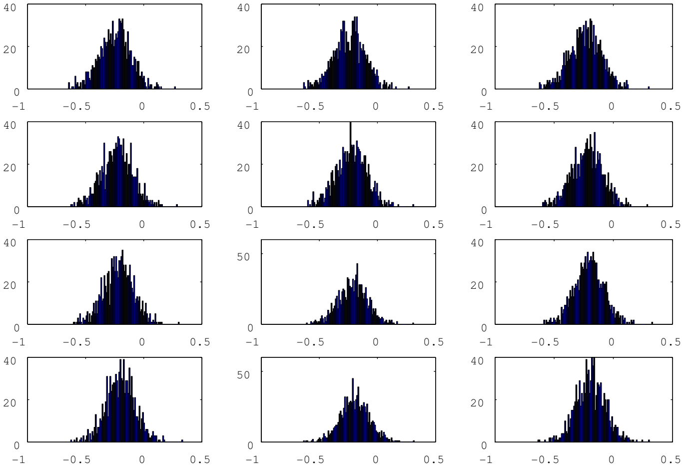
- stationary distn

Fig: Draws and Means of posterior $\beta_{1,t}$



- stationary distn

Fig: Density of Posterior $\beta_{1,t}$



- stationary distn

Government and labor

Labor Market Dynamics

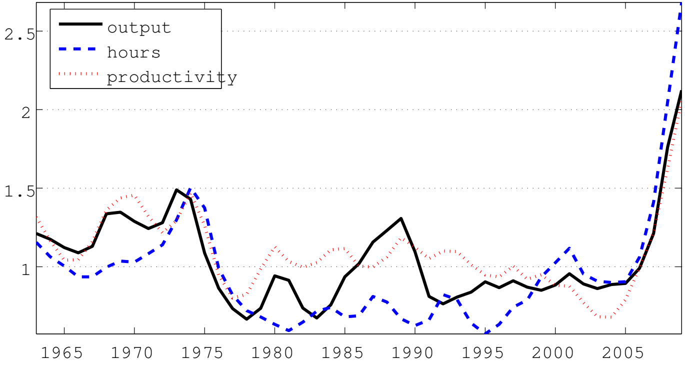
- Employment Protection by Case Laws (Kaiko Kisei)
  1. employers must meet four conditions before they fire an employee.
  2. Kawaguchi and Murao (2009)
- Life-time employment system
  1. Endo and Hirakata (2010)
  2. still survives
- Labor Standard Law (Jitan)
  1. Kawaguchi and Tsuru (2010): endogenous working hours $\Downarrow$.
  2. Kuroda (2010): No effect on large firms
- Worker Dispatching Act (Roudou Haken Hou)
  1. 1986, 1999, 2004

Taxes

- Gali (2003), Uhlig (2004)
  - Capital tax: included in productivity shocks
- Suppose
  1. prod. fcn: $Y = F(K, AN)$
  2. Homo. of degree 1: $\frac{Y}{N} = AF(k, 1)$
     where $k \equiv (K/AN)$: the ratio of capital to labor
  3. $(1 - \tau)F_k(k, 1) = const.$ hold along a B.G.P.
  4. stationary τ may be unwarranted.
- But, at least
  1. theory: $\tau \Uparrow \rightarrow lp \Downarrow N \Uparrow$
  2. our result (IR): $lp \Uparrow N \Uparrow$

Phases

Unconditional SDs



- 5 Phases

Five Phases

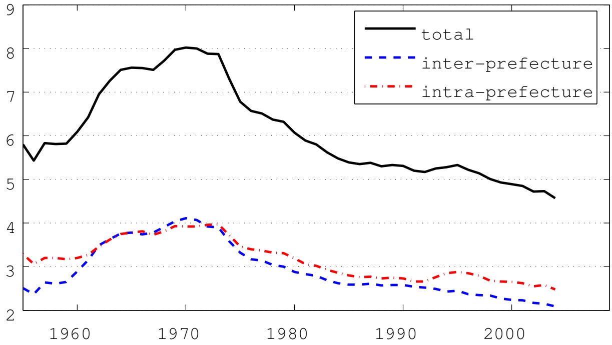
- 5 distint Phases in our economy

- *1st Phase: Until Mid-1970s*
  1. participation of Baby-boomers
  2. geographical and sectoral movement

- *2nd Phase: Mid-1970s to Late-1980s*
  1. Very stable economy (GM period)

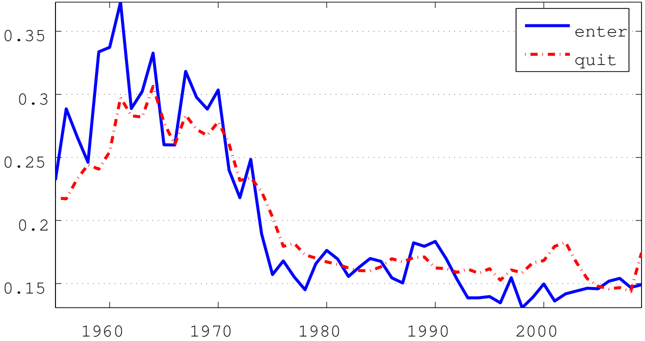
- *3rd Phase: Late-1980s to Early-1990s*
  1. Bubble periods
  2. volatile output while stable labor input and productivity
  3. disappearence of negative correlation

Fig: Migration Rates



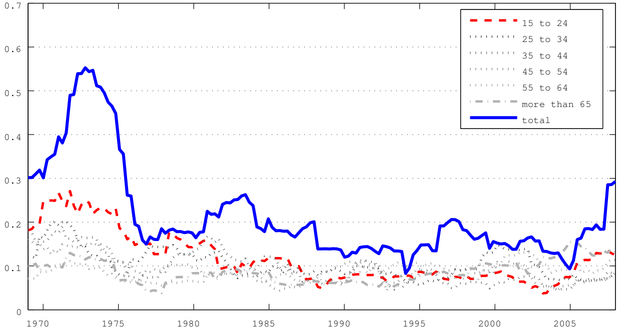
- upper trend in the 1st Phase

Fig: Turnover Rates



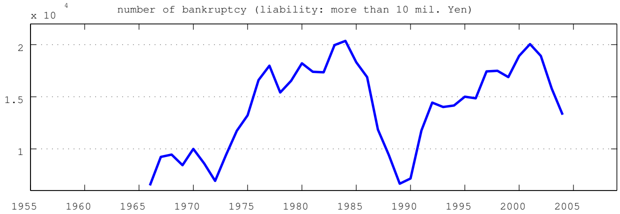
- volatile in the 1st Phase

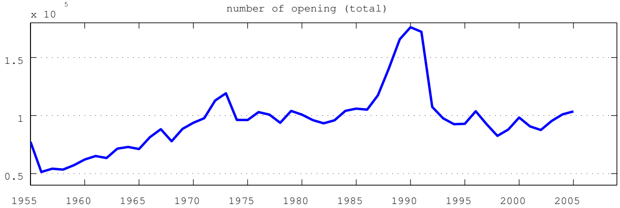
Fig: SD of employment rate among ages



- main role of 15-24 in the 1st Phase
- consistent with Jaimovichi and Siu (2009)

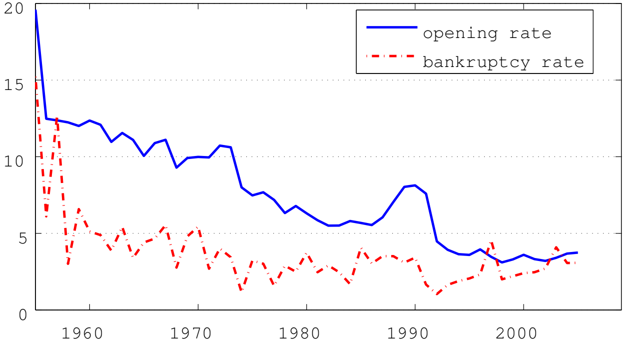
Fig: Number of Bankruptcy and Opening





- different feature in the 3rd Phase

Fig: Rates of Bankruptcy and Opening

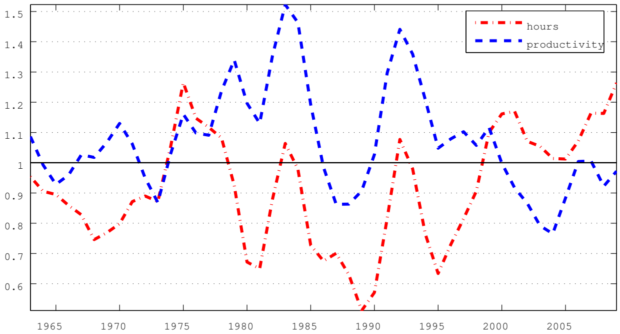


Five Phases

- *4th Phase: Early-1990s to Mid-2000s*
  1. stable output (GM period)
  2. labor input $\Uparrow$
  3. labor productivity $\Downarrow$

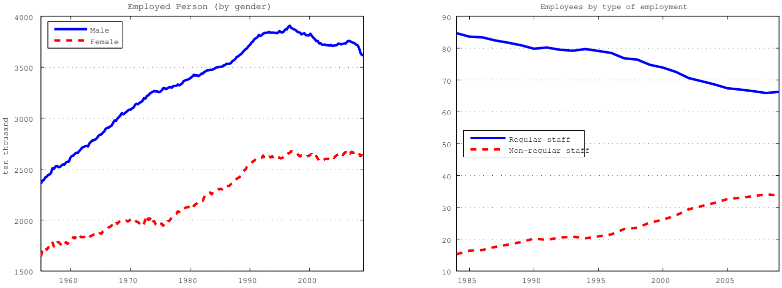
- *5th: Late-2009s*
  1. Global crisis
  2. all volatile

Fig: Relative SDs



- SD of labor input ⇑ in the 4th and 5th Phases

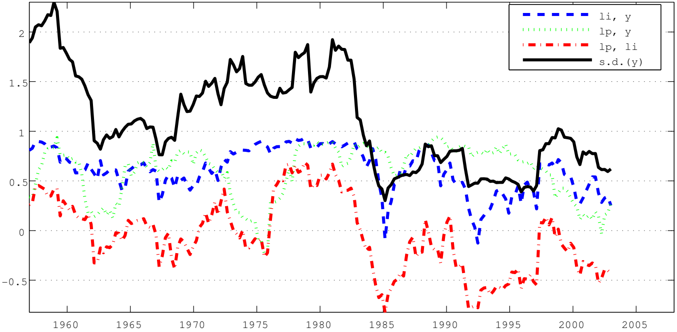
Fig: Employed Person (by gender) and Employees (by type of employment)



- Participation Rate: Male $\Uparrow$ until 1975, Female $\Uparrow$ from 1975
- Participation Rate of Non-regular staff $\Uparrow$
- Saito (2003): home production: husband $\Downarrow \rightarrow$ wife $\Uparrow$
- Gaston and Kishi (2007): long time working by part-time workers

Comparison with the U.S.

Fig: Rolling Correlations of the U.S.



- procyclical movement of productivity under NT shocks
- sign changes of correlation btw li and lp

Relationship with theory

- Relationship with labor hoarding models
  1. Disutility from work depends on employment (n), hours (h), and effort (e): $v(n_t, h_t, e_t) \equiv n_t(\frac{\lambda_h}{1+\eta_h} h_t^{1+\eta_h} + \frac{\lambda_e}{1+\eta_e} e_t^{1+\eta_e})$
  2. $y_t = a_t n_t (h_t e_t)^{\alpha}$ $= a_t n_t h_t^{\phi}$ where $\phi = \alpha(1 + \frac{\eta_h}{1+\eta_e})$.
- U.S. with the labor-search model
  1. Hiring cost $\Downarrow$.
  2. substitution from e_t to n_t and h_t.

Hours and Employment

- Negative Correlations of lp and li in all periods (Contributed by NT shocks)
- the labor-search model: Not Our Story in Japan