Appendix: the Great Moderation in the Japanese Economy

Jun-Hyung Ko\textsuperscript{a} and Koichi Murase\textsuperscript{b}

\textsuperscript{a} Graduate School of Economics, Hitotsubashi University
\textsuperscript{b} Sompo Japan.Inc

December 19, 2010

e-mail: ed074002@g.hit-u.ac.jp
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 Equilibrium 1)


- Interactions among a collection of adaptive agents, each of whom averages past data to approximate moments of the conditional probability distributions.

- If outcomes converge, a Law of Large Numbers implies agents’ beliefs about conditional moments become correct on events that are infrequently observed.

- Beliefs are not necessarily correct about events that are infrequently observed.

- Where beliefs are correct, a self-confirming equilibrium is like a rational expectations equilibrium.
Self-Confirming Equilibrium 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 $u_i : A_i \times X_i \rightarrow R$
- $\mu_i(: a_i)$: 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

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

- 18 Models
- Robust Results
Priors 1)

- the conditional prior density of $\theta^T$ 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 $T$.
- $I(\theta^T) = \prod_{t=0}^{T} I(\theta_t)$,
- $f(\theta^T | \alpha^T, h^T, Q, \Psi, \Xi) = f(\theta_0) \prod_{t=1}^{T} f(\theta_t | \theta_{t-1}, \alpha^T, h^T, Q, \Psi, \Xi)$
- $I(\theta^T)$ takes a unit value if all the roots of the VAR polynomial associated with $\theta_t$ are larger than one in modulus and 0 otherwise, ruling out a non-stationary process.
Following Cogley and Sargent (2005) and Gali and Gambetti (2009), prior distributions and its hyperparameters:

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

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

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

**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
We use a Markov Chain Monte Carlo (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 \( \theta_T \)
  is computed using standard Kalman filter recursions.

- For all the other states, the following backward recursions are employed:

  \[
  \theta_{t|t+1} = \theta_{t|t} + P_{t|t}^{-1} P_{t+1|t} (\theta_{t+1} - \theta_{t|t}), \tag{2}
  \]

  \[
  P_{t+1|t} = P_{t|t} - P_{t|t} P_{t+1|t} P_{t|t}, \tag{3}
  \]

  where \( p(\theta^T | x^T, \alpha^T, h^T, Q, \Psi, \Xi) \sim N(\theta_{t+1|t}, P_{t|t+1}). \)
Step 2: \( p(\alpha^T | x^T, \theta^T, h^T, Q, \Psi, \Xi) \)

- Conditional on \( \theta^T \),
  \[
  \hat{y}_t = x_t - \beta_{0,t} - \beta_{1,t}x_{t-1} - \cdots - \beta_{p,t}x_{t-p}
  \]
  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 \( \alpha_t \)
  taking the above system as observational equations and unobserved states equations.

- Given that the \( \alpha_t \) and the \( \nu_t \) 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
Covvergence

- Geweke (1992)
- Convergence Diagnostics (CD)
Cannot reject the null hypothesis in most cases
stationary distn

Ko and Murase (2010)
stationary distn
Fig: Draws and Means of posterior $\beta_{1,t}$

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

stationary distn

Ko and Murase (2010)
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)*
  2. Kuroda (2010): No effect on large firms

- Worker Dispatching Act *(Roudou Haken Hou)*
  1. 1986, 1999, 2004
Taxes

  - 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. \((1 - \tau)F_k(k, 1) = \text{const.} \) hold along a B.G.P.
  4. stationary \( \tau \) 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 distinct Phases in our economy

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

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

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

Ko and Murase (2010)
upper trend in the 1st Phase
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

- **Number of Bankruptcy (liability: more than 10 mil. Yen)**
  - 1955: 1
  - 1960: 1.5
  - 1965: 2
  - 1970: \(10^4\)
  - 1975: \(10^5\)
  - 1980: \(10^4\)
  - 1985: \(10^5\)
  - 1990: \(10^4\)
  - 1995: \(10^5\)
  - 2000: 2
  - 2005: 1

- **Number of Opening (total)**
  - 1955: 1
  - 1960: 1.5
  - 1965: 2
  - 1970: \(10^5\)
  - 1975: \(10^5\)
  - 1980: \(10^5\)
  - 1985: \(10^5\)
  - 1990: \(10^5\)
  - 1995: \(10^5\)
  - 2000: 1
  - 2005: 0.5

- Different feature in the 3rd Phase

Ko and Murase (2010)
Phases

Fig: Rates of Bankruptcy and Opening

Ko and Murase (2010)

12th Macroeconomics Conference

GM in the Japanese economy
Five Phases

4th Phase: Early-1990s to Mid-2000s
1. stable output (GM period)
2. labor input ↑
3. labor productivity ↓

5th: Late-2009s
1. Global crisis
2. all volatile
SD of labor input ↑ in the 4th and 5th Phases

Ko and Murase (2010)
Fig: Employed Person (by gender) and Employees (by type of employment)

- Participation Rate: Male ↑ until 1975, Female ↑ from 1975
- Participation Rate of Non-regular staff ↑
- Saito (2003): home production: husband ↓ → wife ↑
- Gaston and Kishi (2007): long time working by part-time workers
Comparison with 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 \( e \):
     \[ v(n_t, h_t, e_t) ≡ n_t\left(\frac{\lambda_h}{1+\eta_h} h_t^{1+\eta_h} + \frac{\lambda_e}{1+\eta_e} e_t^{1+\eta_e}\right) \]
  2. \[ y_t = a_t n_t (h_t e_t)\alpha \]
     \[ = a_t n_t h_t^\phi \text{ where } \phi = \alpha (1 + \frac{\eta_h}{1+\eta_e}) \]

- U.S. with the labor-search model
  1. Hiring cost ↓.
  2. Substitution from \( e_t \) to \( n_t \) and \( h_t \).
Comparison with the U.S.

Hours and Employment

- Negative Correlations of Ip and li in all periods (Contributed by NT shocks)

- the labor-search model: Not Our Story in Japan

Ko and Murase (2010)