Endogenous growth mechanism as a source of medium term fluctuations in the labour market - application to the US economy

Michał Gradzewicz

April 8, 2008

National Bank of Poland and Warsaw School of Economics
Behaviour of unemployment in US

M. Gradzewicz - Sources of medium term fluctuations
Definition of the medium term cycle

- **Medium term cycle** - fluctuations with periodicity between 1 and 50 years (following Comin & Gertler, 2005):
  - **High frequency component** (business cycle), with periodicity between 1 and 8 years
  - **Medium frequency component**, with periodicity between 8 and 50 years
Unemployment in US - medium term cycle

M. Gradzewicz - Sources of medium term fluctuations
GDP in US - medium term cycle

M. Gradzewicz - Sources of medium term fluctuations
Motivation

• There is a need to create models of medium term fluctuations, stressed by Blanchard (1997) and Solow (2000)

• Important work of Comin and Gertler (2005)
  – endogenous growth via changes in the numbers of available products - Romer (1990)
  – usual sources of business cycle fluctuations induce also medium term fluctuations
  – focus on goods and capital markets, leaving the floor open to research on labour market

• Hall (2005) documented medium term fluctuations of labour market variables

• Possible reasons:
  – hysteresis (e.g. insider-outsider theory of Blanchard, Summers, 1987),
  – demographics - baby-boom generations, Flaim (1990),
  – endogenous growth
• **Questions**

1. Are fluctuations in medium term frequencies substantial?
2. Can fluctuations in both goods and labor market be explained by the same sources?
3. Can endogenous growth mechanism explain a large part of variation in medium term fluctuations?

• **Methodology**

  – RBC
  – search-matching on the labor market (DMP)
  – endogenous growth (Romer, 1990)
  – technology shock
  – (wage rigidity)
### Data

#### US Economy

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- **Unemployment-vacancies correlation:**
  - [2, 32] is -0.9
  - [32, 200] is -0.8
Households

- Optimization problem

\[
\max_{C_t, S_t, I_t, K_{t+1}} \quad E_0 \sum_{t=0}^{\infty} \beta^t \left( \frac{C_t^{1-\zeta}}{1-\zeta} \right)
\]  

subject to:

\[
C_t + I_t + L_t + T_t + \Pi_t = w_t N_t + b_t U_t + r_t K_t + R_t L_{t-1}
\]  

\[
K_{t+1} = (1 - \delta) K_t + I_t
\]
Labour market

- Matching technology:

\[ M_t = m(U_t, V_t) = \sigma_m U_t^\sigma V_t^{1-\sigma} \tag{4} \]

- The probability \( q_t \) that a firm fills a vacancy in period \( t \): \( q_t = \frac{M_t}{V_t} \)

- The probability \( s_t \) that any worker looking for a job is matched: \( s_t = \frac{M_t}{U_t} \)

- Employment:

\[ N_t = (1 - \rho)N_{t-1} + M_{t-1} \tag{5} \]

- Unemployment:

\[ U_t = 1 - N_t - \rho N_t = 1 - (1 - \rho)N_t \tag{6} \]
Final good producers

Assumption: competitive market

- Optimization problem:

\[
\max_{y_t(i)} P_t Y_t - \int_0^{A_t} p_t(i) y_t(i) \, di \quad (7)
\]

subject to

\[
Y_t = \left( \int_0^{A_t} y(i)^{\frac{1}{\mu}} \, di \right)^\mu 
\]  

\[
\quad (8)
\]
Intermediate good producers

Assumption: monopolistic competition

- Optimization problem:

$$\max_{n_t(i), v_t(i), k_t(i), p_t(i)} \sum_{t=0}^{\infty} \Lambda_{0,t} \left[ \frac{p_t(i)}{P_t} y_t(i) - w_t(i) n_t(i) - c(v_t(i), w_t(i)) - r_t(i) k_t(i) \right]$$

subject to:

$$y_t(i) = z_t k_t(i)^\alpha n_t(i)^{1-\alpha}$$

$$n_t(i) = (1 - \rho) n_{t-1}(i) + q_{t-1} v_{t-1}(i)$$

$$y_t(i) = \left( \frac{p_t(i)}{P_t} \right)^{-\frac{\mu}{\mu-1}} Y_t$$
Wage setting

- The value of a job for a firm:
  \[ J_t(i) = mc_t(i)f_{n,t}(i) - w_t(i) + E_t\Lambda_{t,t+1}[(1 - \rho)J_{t+1}(i) + \rho\Gamma_{t+1}(i)] \] (9)

- The value of a vacancy for a firm:
  \[ \Gamma_t(i) = c(v_t(i), w_t(i)) + E_t\Lambda_{t,t+1}[(1 - q_t)\Gamma_{t+1}(i) + q_tJ_t(i)] = 0 \]

- The value of a job for a worker:
  \[ W_t(i) = w_t(i) + E_t\Lambda_{t,t+1}[(1 - \rho)W_{t+1}(i) + \rho U_{t+1}] \] (10)

- The value of being unemployed:
  \[ U_t = b_t + E_t\Lambda_{t,t+1}[s_tW_{t+1}(i) + (1 - s_t)U_{t+1}] \] (11)

- Negotiations (Nash bargaining): \[ \max_{w_t(i)} [J_t(i)^{1-\eta} (W_t(i) - U_t)^{\eta}] \]
R&D Sector

Assumption: competitive market

- The value of a unit of a new intermediate good:

\[ v^I_t(p) = \pi_t + E_t \Lambda_{t,t+1} v^I_{t+1}(p) \]

- Production technology:

\[ A_{t+1}(p) - (1 - \phi) A_t(p) = \phi_l L_t(p) \]  

where \( \phi_l = \chi A_t L_t K_t^{-\psi-1} \) assures 1) positive spillover effect, 2) congestion effect, 3) stationarity.

- Each innovative firm \( p \) maximizes its profits:

\[ \pi^I_t(p) = E_t \Lambda_{t,t+1} v^I_{t+1}(p) [A_{t+1}(p) - A_t(p)] - L_t(p) \]  

subject to the technology of production (12).
Government and resource constraint

• No possibility to accumulate debt:

\[ b_t U_t = T_t \]  \hspace{1cm} (14)

\[ b_{t+1} = \gamma_b b_t \]

• The resource constraint in the final goods market:

\[ Y_t = C_t + I_t + \int_0^1 L_t(p)dp + \kappa w_t \int_0^{A_t} v_t(i)di \]  \hspace{1cm} (15)
Steady state

Steady state consistent with balanced growth path need to have the following properties:

- stationary variables: $R$, $r$, $q$, $s$, $\theta$, $Z$;
- variables growing at a rate $\gamma_Y$: $Y$, $C$, $V^l$, $L$, $K$;
- variables growing at a rate $\gamma_N$: $U$, $N$, $V$, $M$;
- variables growing at a rate $\gamma_w$: $w$, $b$;
- variables growing at a rate $\gamma_A$: $A$;
- and some steady state restrictions (Balanced Growth Path).
Calibration

Most important parameters of the model:

- Elasticity of production with respect to capital: $\alpha = 0.33$ (Prescott, 1986)
- Elasticity of intertemporal substitution in utility function $\zeta = 2$ (Greenwood, Hercovitz, Huffman, 1988)
- Job destruction rate $\rho = 0.1$ (Shimer, 2007)
- Steady state employment $\bar{U} = 0.056$ (US data)
- Probability that a vacancy will be filled $\bar{q} = 0.7$ (Cooley, Quadrini, 1999)
- Probability that a worker will find a job $\bar{s} = 0.63$ (Shimer, 2007 + steady state calculations)
- Replacement ratio 0.5 (Hall, 2005 + Shimer, 2005)
- Degree of real wage rigidity $\alpha_w = 0.086$ (Christoffel, Linzert, 2005, wages-output correlation)
Discussion

• Basic version of the model:
  – pattern of medium vs short term fluctuations - roughly matched
  – goods market - well depicted
  – labor market - too little volatility, too high wages-output correlation

• Extension I (additional shock to the matching technology - Beveridge curve)
  – solve the volatility problem (even more - labor market is too volatile)
  – wages-output correlation still too high
  – destroys the Beveridge Curve

• Extension II - Wage rigidity (Hall’s, 2005 notion of a wage norm):

\[ w_t = \alpha_w w_t^n + (1 - \alpha_w) w_{t-1} \]
Impulse responses

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Time series generated by the model
## A. US Economy

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## B. Model Economy

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Comparison with the benchmark model - no endogenous growth

A. Model with rigid wages and endogenous growth

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B. Benchmark model - with rigid wages and without endogenous growth

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Conclusions

• There are substantial fluctuations with periodicity above 8 years, should not be regarded as trend.

• It is possible to generate medium term cycle with standard model, extended for endogenous growth considerations

• Technology shocks, when properly propagated, can be a possible reason of the medium term fluctuations in both goods and labor markets

• A sort of endogenous growth mechanism is an important ingredient of explanation of the medium term fluctuations

• The effects of monetary policy could last longer than we think, due to additional channels of monetary policy transmission