Goal of the paper

Which shocks and frictions do shape the euro area business cycle?
1. Business-cycle facts

2. Estimation technique

3. Model

4. Model's t

5. Shocks and frictions

6. Alternative estimation technique
Euro area business-cycle facts
Euro Area Data from 1985:Q1 to 2006:Q1 expressed in log-deviations from sample average.
Spectral densities of euro area data

Yearly Output Growth

Vacancy/Unemployment Ratio

Yearly Consumption Growth

Yearly Inflation

Yearly Investment Growth

Period of cycles (in quarters)

Interest Rate

Yearly Wage Growth
Estimation: Spectra matching (Wen 1998)

2 focus on auto-covariances, ignores cross-covariances

2 weights more frequencies contributing to variance
A new Keynesian model with unemployment
Standard features (CEE 2005, SW 2003)

² Quadratic price adjustment costs à la Rotemberg

² Hybrid NKPC through ad-hoc inflation indexation

² Habit, Investment adjustment cost & Variable capital utilization

² 7 shocks: Techno, Investment, Preference, Markup, Wage bargaining, Exogenous spending, Monetary
Search-and-matching frictions in labor market

² Income pooling hypothesis (Merz 1995)

² No out-of-labor-force status

² Hours per worker constant

² Exogenous job destruction

² Wage inertia (Hall 2005) and Convex hiring costs (Yashiv 2006)

² Newly hired workers start producing immediately
Model's $t$
Data spectrum and model's 90% confidence bands.
Sources of business cycles in the euro area
Sources of business cycles in the euro area.
Sources of business cycles in the euro area.
Median impulse responses to a one-standard-deviation price markup shock and 90% bands.
Key frictions
Impulse responses and spectra conditional on a one-std-dev cost-push shock in the estimated model (baseline).
Effects on propagation of cost-push shocks of reducing the degree of interest rate smoothing.
Effects on propagation of cost-push shocks of reducing the degree of backward-lookingness in inflation.
Effects on propagation of cost-push shocks of reducing the degree of price stickiness.
Model's $t$ of squared correlations
Failures of the model...
or artifacts of the estimation technique?
Conclusions

1. US and EA business cycles are different

2. Markup shocks: main source of business cycle in euro area

3. DSGE misspecified → spectra matching for Business Cycle Analysis
Improving model specification

1. Model fails to generate large variance of investment

2. Model fails to replicate trend in $\omega$ and $r$

3. Model unable to get hump-shaped $\text{Coh} (\cdot Y; V=U)$
Appendix
The spectra-matching estimator is given by

\[ \hat{\mu}_W = \arg\min_{\mu} [G_W (\mu)] \]

\[ G_W (\mu) = \text{tr} \sum_{j=2}^{3} X \left( F_{m, j; \mu} \right) \hat{\Phi}_d (\theta_j) \]

\[ W (\mu) = \hat{\Phi}_d (\theta_j) \otimes \sum_{j=2}^{3} X \left( \hat{\Phi}_d (\theta_j) \right) \]

Where \( \sum_{j=2}^{3} \) represents the summation over the range 2 to 3.
Household

Household chooses $C_t, B_t, u_t, I_t,$ and $\overline{K}_t$ to max

$$E_t \sum_{s=0}^{\infty} \beta^s a_{t+s} \ln(C_{t+s} - hC_{t+s-1})$$

subject to

$$\overline{K}_t \leq (1 - \delta)\overline{K}_{t-1} + \mu_t \left[ 1 - S\left(\frac{I_t}{I_{t-1}}\right) \right] I_t$$

$$P_tC_t + P_tI_t + B_t/r_t - B_{t-1} \leq W_tN_t + (1 - N_t)b_t + r^K_t u_t \overline{K}_{t-1} - P_t a(u_t) \overline{K}_{t-1} - T_t + D_t$$

where

$$K_t = u_t \overline{K}_{t-1}$$

$$\ln(a_t) = \rho_a \ln(a_{t-1}) + \varepsilon_{at}$$

$$\ln(\mu_t) = \rho_\mu \ln(\mu_{t-1}) + \varepsilon_{\mu t}$$
Finished goods-producing firm

Given $P_{i,t}$ and $P_t$, firm chooses $Y_{i,t}$ for all $i \in [0, 1]$ to max

$$P_t Y_t - \int_0^1 P_{i,t} Y_{i,t} \, di$$

subject to

$$Y_t = \left[ \int_0^1 Y_{i,t} \, (\theta_{t-1}/\theta_t \, di \right]^{\theta_t/(\theta_{t-1})}$$

where

$$\ln(\theta_t) = (1 - \rho_\theta) \ln(\theta) + \rho_\theta \ln(\theta_{t-1}) + \varepsilon_{\theta t}$$
Intermediate goods-producing firm

Firm $i$ chooses $K_{i,t}$, $N_{i,t}$, $V_{i,t}$, $Y_{i,t}$ and $P_{i,t}$ to max

$$E_t \sum_{s=0}^{\infty} \beta^s \Lambda_{t+s} \left( \frac{D_{i,t+s}}{P_{t+s}} \right)$$

where

$$D_{i,t} = P_{i,t}Y_{i,t} - W_{i,t}N_{i,t} - r_t^K K_{i,t} - \left[ \frac{\phi_N}{2} \left( \frac{q_t V_{i,t}}{N_{i,t}} \right)^2 + \frac{\phi_P}{2} \left( \frac{P_{i,t}}{\pi P_{i,t-1}} - 1 \right)^2 \right] P_t Y_t$$

subject to

$$Y_{i,t} = \left( \frac{P_{i,t}}{P_t} \right)^{-\theta_i} Y_t$$

$$Y_{i,t} \leq K_{i,t}^\alpha (A_t N_{i,t})^{1-\alpha}, \quad \ln(A_t) = \ln(A_{t-1}) + \ln(z) + \varepsilon_{zt}$$

$$N_{i,t} = \chi N_{i,t-1} + q_t V_{i,t}$$

$$q_t = \frac{m_t}{V_t}, \quad m_t = \zeta S_t^\sigma V_t^{1-\sigma}, \quad S_t = 1 - \chi N_{t-1}$$
Empirical inflation equation

- Log-linearized *microfunded* inflation equation (NKPC)

\[ \hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \kappa \hat{mc}_t + \hat{\theta}_t \]

- Log-linearized *empirical* inflation equation (Hybrid NKPC)

\[ \hat{\pi}_t = \beta [\gamma_\pi \hat{\pi}_{t-1} + (1 - \gamma_\pi)E_t \hat{\pi}_{t+1}] + \kappa \hat{mc}_t + \hat{\theta}_t \]
Wage setting

$W_{NB}^t$ Nash bargaining wage

$$W_{NB}^t = \arg \max_{W_t} (S_t^W)^{\eta_t} (S_t^F)^{1-\eta_t}$$

where

$$\ln \eta_t = (1 - \rho_\eta) \ln \eta + \rho_\eta \ln \eta_{t-1} + \varepsilon_{\eta_t}$$

$$S_t^W = W_t - b_t + \beta \chi E_t \left[ \frac{\Lambda_{t+1}}{\Lambda_t} \frac{P_t}{P_{t+1}} (1 - s_{t+1}) S_{t+1}^W \right], \quad b_t = \tau W \exp(zt)$$

$$S_t^F = P_t \left( \frac{\Xi_t}{\Lambda_t} \right) \left[ (1 - \alpha) \frac{Y_t}{N_t} \right] - W_t + P_t \left( \frac{\phi_N Y_t x_t^2}{N_t} \right) + \beta \chi E_t \left( \frac{\Lambda_{t+1} P_t}{\Lambda_t P_{t+1}} S_{t+1}^F \right)$$
Empirical wage equation

- **Microfunded** real wage equation

\[
W_{t}^{NB} = \eta_t \left\{ \left( \frac{X_t}{A_t} \right) (1 - \alpha) \frac{Y_t}{N_t} + \frac{\phi_N Y_t}{N_t} x_t^2 + \beta \chi E_t \left( \frac{\Lambda_{t+1}}{A_t} \frac{\phi_N Y_{t+1}}{N_{t+1}} s_{t+1} x_{t+1} \right) \right\} + (1 - \eta_t) \tilde{b}_t
\]

- **Empirical** log-linearized real wage equation

\[
\hat{W}_t = \gamma_w \hat{W}_{t-1} + (1 - \gamma_w) \hat{W}_t^{NB}
\]
Fiscal Policy

The government’s budget constraint is

\[
P_t G_t + (1 - N_t) b_t = \left( B_t / r_t - B_{t-1} \right) + T_t
\]

Government spending \( G_t \) is a time-varying fraction of GDP

\[
G_t = \left( 1 - \frac{1}{g_t} \right) Y_t
\]

with

\[
\ln g_t = (1 - \rho_g) \ln g + \rho_g \ln g_{t-1} + \varepsilon_{gt}
\]
Central bank adjusts $r_t$ following a Taylor rule

$$\ln \left( \frac{r_t}{r} \right) = \rho_r \ln \left( \frac{r_{t-1}}{r} \right) + \rho_\pi \ln \left( \frac{\pi_t}{\pi} \right) + \rho_y \ln \left( \frac{Y_t}{Y_t^N} \right) + \varepsilon_{rt}$$

$Y_t^N$: “flex price - flex wage level of output” ($\phi_P = 0, \gamma_w = 0$)

in absence of price markup and wage bargaining shocks ($\hat{\theta}_t = 0, \hat{\eta}_t = 0$)