Business cycles and the two margins of labor adjustment

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Introduction

- New Keynesian model with (or without) nominal and real rigidities is the reference framework for business cycle analysis.
- Model based on agents that are optimizing intertemporally that can be used for policy analysis.
- However, the standard version of the model (Woodford (2003), Gali (2008)) has no unemployment!
- Recent literature introduced labor market frictions in the New Keynesian model to study unemployment dynamics
  - Frictions in the labor market because it is costly to find a match and it takes time (Mortensen-Pissarides).

Introduction

1. Real Business Cycle models. Seminal contributions by Andolfatto (1996) and Merz (1995). Fluctuations are driven only by neutral technology shocks.
   - Shimer (2005 and 2009): the model does not deliver enough employment volatility.
2. Monetary models with nominal and real rigidities: Walsh (2005), Trigari (2004 and 2006). Fluctuations are driven by monetary shocks. Challenge: explain inflation persistence
   - Labor market frictions do not help generating more inflation persistence.
3. Estimated models with a series of shocks using Bayesian techniques (Gertler, Sala and Trigari (2007), Groshenny (2009))
   - The performance of the model is at best comparable with standard models with no labor market frictions (Smets-Wouters 2007)
   - Large problems of identification. No internal propagation (Lubik 2009)

Introduction

- Our paper also studies the role of labor market frictions in the transmission mechanism for shocks (technology, investment-specific and monetary).
- In particular, we consider the effects on the two margins of labor adjustment:
    - Extensive margin (number of workers): fluctuations in employment
    - Intensive margin (hours per capita): fluctuations in hours

1. Review some empirical evidence on the adjustment along the two margins
2. Provide a model that is able to deliver a reasonable split across the two margins
3. Compare with existing literature

Motivation: empirical evidence

- Unconditional evidence: In the data, around 1/3 of the overall volatility of hours worked is due to variation in hours per worker (Krause and Lubik (2009)).

Standard Deviation in US data

Unemployment	Hours per capita	Total hours	GDP
7.71	0.30	1.10	1.41

- Motivation for having a model with two margins
  - Fluctuations on the hours margin are not negligible but much larger volatility in employment.
  - The second margin imposes more discipline on the theoretical model

Motivation: empirical evidence

- Conditional evidence: Positive neutral technology shocks contract both hours and employment, but employment reacts slightly more. Canova, Lopez-Salido and Michelacci (2009)
  - Similar results in Baleer (2007) and Barnichon (2008). Consistent with Gali (1999).
- Conditional evidence: Expansionary monetary policy shock expand both hours and employment but employment reacts more (Trigari, 2008).
- Conditional evidence: Positive investment-specific shocks expand hours per capita whereas the employment response is not significant. (Canova et al. 2009).

Motivation: theory

- Krause and Lubik (2009): the RBC model with two margins of labor adjustment has difficulty explaining the relative volatilities of hours and employment
  - hours per worker are too volatile relative to employment
  - the model cannot explain the volatilities of vacancies and unemployment (Shimer puzzle).
- The same is true in New Keynesian models with nominal and real rigidities.

Our contribution

Our goal is to provide a theoretical model that is able to obtain a reasonable split across the two margins.
Important ingredients in our model:

1. Timing assumption (as in Ravenna and Walsh (2008))
2. Bargaining set-up (as in Sveen and Weinke (2007))

These two features are useful to increase the adjustment through the employment margin.

The timing assumption

We follow Ravenna and Walsh (2008) and Blanchard and Gali (2009)

- Employment is not a predetermined variable (instantaneous hiring).

$$N_t(i) = (1-s)\,N_{t-1}(i) + L_t(i)\,. \tag{1}$$

- In case of separation, workers can find a job in the period.

The bargaining set-up

- Firms trade-off on the use of the two margins of labor adjustment:
  - Using hours more intensively increases average wages
  - Hiring new workers is costly (hiring cost)
- This is achieved by a specific bargaining set-up where the firm takes rationally into account that using hours more intensively increases average wages (Sveen and Weinke 2007)
  - Wages are set by Nash bargaining
  - Hours are decided by firms in a game where the firm is the leader and the wage negociation is the follower
    - In the Right to Manage framework (Trigari 2006) the firm is the follower and takes the wage as given.

Preview of the results

- Neutral technology shocks.
  - The model implies a large response of employment and can reproduce the evidence for plausible calibrations.
  - Nominal and real rigidities are essential.
- Investment-specific shocks
  - The adjustment is achieved mainly through hours in keeping with the evidence
  - Little propagation in the model for a plausible labor supply elasticity
- Monetary shocks
  - The adjustment is achieved mainly through employment in keeping with the evidence and confirming results in Sveen and Weinke (2007).

Our framework in perspective

- Our model relies on Ravenna and Walsh (2008) and Sveen and Weinke (2007)
  - It includes capital accumulation (potentially important for technology shocks, Shimer 2009)
  - It includes nominal and real rigidities (important for monetary shocks)
  - it includes variable capacity utilization for completeness (third margin of adjustment).
- Few papers have two margins of labor adjustment and capital accumulation: Krause and Lubik (2009), Andolfatto (1996).

Our framework in perspective

- Canova, Lopez-Salido and Michelacci (2009) rationalize their evidence in the context of a growth model featuring a vintage structure of technology shocks and search and matching frictions in the labor market.
- Trigari (2008) studies monetary shocks in a model with endogenous separation.
- We provide an alternative explanation using a model that is close to the "standard" New Keynesian model.

Baseline Model

Households

$$E_t \int_0^1 \left[\sum_{k=0}^{\infty} \beta^k U\left(C_{t+k}, H_{t+k}\left(h\right)\right) \right] dh, \tag{2}$$

$$U\left(C_t, H_t\left(h\right)\right) = \ln\left(C_t - hC_{t-1}\right) - \chi \frac{H_t\left(h\right)^{1+\eta}}{1+\eta}, \tag{3}$$

$$\begin{aligned} P_t\left(C_t + I_t + f\left(UT_t\right)\right) + D_t \quad \leq \quad & D_{t-1}R_{t-1} + P_t W_t H_t N_t \\ & + BZ_t \Psi_t^{\frac{\alpha}{1-\alpha}} U_t + T_t + P_t R_t^K K_t . \end{aligned} \tag{4}$$

$$\bar{K}_{t+1} = (1-\delta)\bar{K}_t + \Psi_t \left(1 - S\left(\frac{I_t}{I_{t-1}}\right)\right) I_t, \tag{5}$$

$$K_t = UT_t \bar{K}_t \tag{6}$$

- Technology is Cobb-Douglas

$$Y_t(i) = K_t(i)^{\alpha}\left(Z_t N_t(i) H_t(i)\right)^{1-\alpha}, \tag{7}$$

- We follow Blanchard and Galí (2007) in assuming restrictions on firms' hiring decisions.
- The law of motion of employment

$$N_t(i) = (1-s) N_{t-1}(i) + L_t(i). \tag{8}$$

- Hiring costs (per unit of employment)

$$G_t = \Upsilon Z_t \Psi_t^{\frac{\alpha}{1-\alpha}} \left(\frac{L_t}{U_t^S}\right)^{\vartheta}, \tag{9}$$

where $U_t^S \equiv 1-(1-s) N_{t-1}$.

- Each firm i maximizes the following problem:

$$\sum_{k=0}^{\infty} E_t \left\{ \Lambda^R_{t,t+1} \left[\begin{array}{c} Y_{t+k}(i) \frac{P_{t+k}(i)}{P_{t+k}} - R^K_{t+k} K_{t+k}(i) \\ -W_{t+k}(i) N_{t+k}(i) H_{t+k}(i) - G_{t+k} L_{t+k}(i) \end{array} \right] \right\}$$

s.t.

$$\begin{aligned}
Y_{t+k}(i) &= \left(\frac{P_{t+k}(i)}{P_{t+k}} \right)^{-\epsilon} Y_{t+k}, \\
Y_{t+k}(i) &= K_{t+k}(i)^{\alpha} \left(Z_{t+k} N_{t+k}(i) H_{t+k}(i) \right)^{1-\alpha}, \\
N_{t+k}(i) &= (1-s) N_{t+k-1}(i) + L_{t+k}(i), \\
P_{t+k+1}(i) &= \begin{cases} P^*_{t+k+1}(i) & \text{with prob. } (1-\theta) \\ P_{t+k}(i) & \text{with prob. } \theta \end{cases} .
\end{aligned}$$

- The remaining first-order conditions read

$$W_t(i) + \frac{\partial W_t(i)}{\partial H_t(i)} H_t(i) = \frac{(1-\alpha) MC_t Y_t(i)}{H_t(i) N_t(i)}, \quad (10)$$

$$W_t(i) H_t(i) + G_t = (1-\alpha) MC_t Y_t(i) / N_t(i) + (1-s) E_t \left\{ \Lambda^R_{t,t+1} G_{t+1} \right\}. \quad (11)$$

- The two equations have similar interpretations:
  - On the LHS is the cost of increasing the use of hours or hiring an additional worker.
  - On the RHS is the benefit of the marginal hour or worker.

- The wage resulting from the bargain is then

$$W_t(i)\, H_t(i) = \chi C_t \frac{H_t(i)^{1+\eta}}{1+\eta} + \Psi_t \tag{12}$$

where

$$\begin{aligned}\Psi_t \quad &\equiv \quad BZ_t \Psi_t^{\frac{\alpha}{1-\alpha}} + \frac{1-\phi}{\phi} G(F_t) \\ &-\frac{1-\phi}{\phi} E_t \left\{ \Lambda^R_{t,t+1} (1-s)(1-F_{t+1})\, G(F_{t+1}) \right\}. \end{aligned} \tag{13}$$

- Monetary policy rule

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\rho_R} \left[\left(\frac{\Pi_t}{\Pi}\right)^{\phi_\pi}\right]^{1-\rho_R},$$

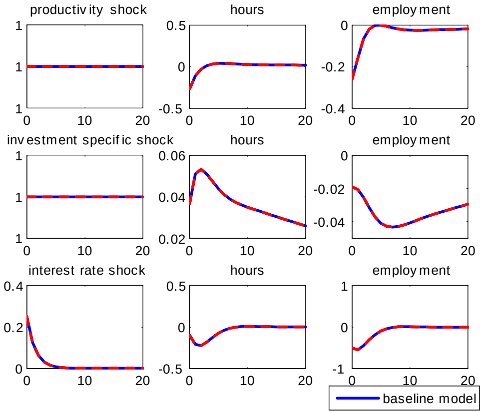
where ρ_R denotes the degree of interest rate smoothing.

$\eta = 7$ (inverse of labor supply elasticity)
$\theta = 0.66$ (price rigidity, slightly more than 3 quarters)
$h = 0.8$ (habit persistence)
$\phi = 1/2$ (bargaining power)
$B = 0.4$ (unemployment benefits)

β	χ	ϵ	δ	α	λ_1	λ_2	ϑ	ϕ_π	ρ_R
0.99	$H = \frac{1}{3}$	7	0.025	0.33	0.33	1	1	1.5	0.9

U	$N = 1 - U$	F	$s = \frac{F*U}{(1-F)*N}$	$U^s = 1 - (1 - s) N$
0.057	0.943	0.71	0.148	0.197

Results



productiv ity shock
hours
employ ment
inv estment specif ic shock
hours
employ ment
interest rate shock
hours
employ ment
baseline model

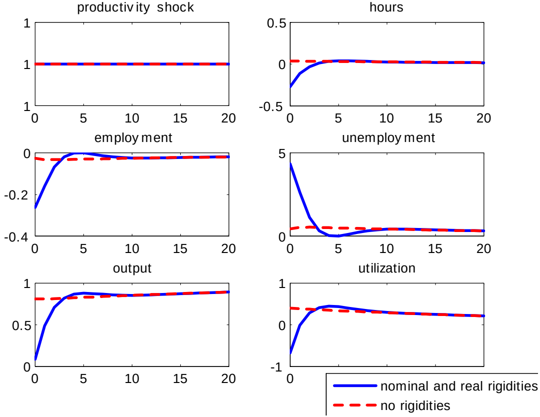
Results: Volatility

St.Dev. (relative to GDP)

	U	N	H	Tot. H
Data	5.46		0.21	0.78
Neutral	3.85	0.22	0.17	0.39
Inv.Spec.	1.46	0.08	0.2	0.19
Monetary	7.58	0.45	0.23	0.69

- Monetary shocks produce large employment fluctuations, comparable to the unconditional data.
- Neutral technology shocks imply a fair amount of employment volatility.
- Investment-specific shocks barely affect the labor market.

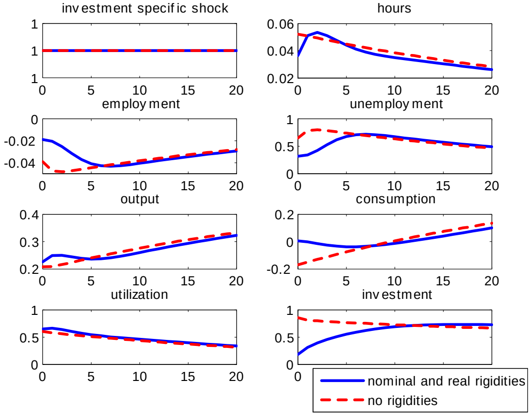
Results: neutral technology shocks



Results: neutral technology shocks

- With flexible prices, no habits and no investment adjustment costs, the model is close to reproduce the Blanchard-Gali (2009) "neutrality result", although capital accumulation is modeled explicitly.
- With nominal and real rigidities the model achieves an equal split on the two margins and rationalizes the evidence by Canova et al. (2009).
- When $\eta > 7$ the employment response is larger.

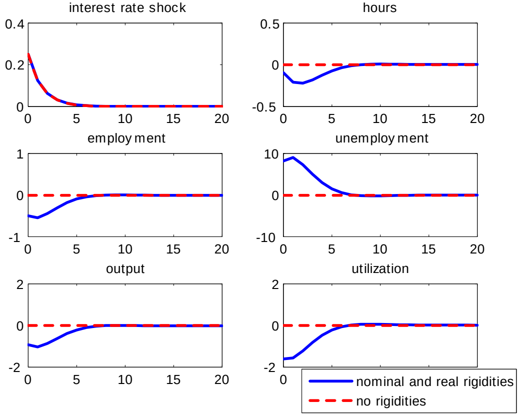
Results: investment-specific shocks



Results: investment-specific shocks

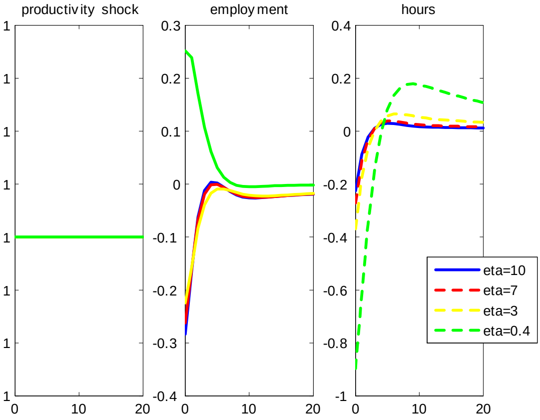
- Employment almost does not move in keeping with the evidence.
- Hours move more but still very little propagation.
- Nominal and real rigidities barely affect the transmission mechanism

Results: monetary shocks

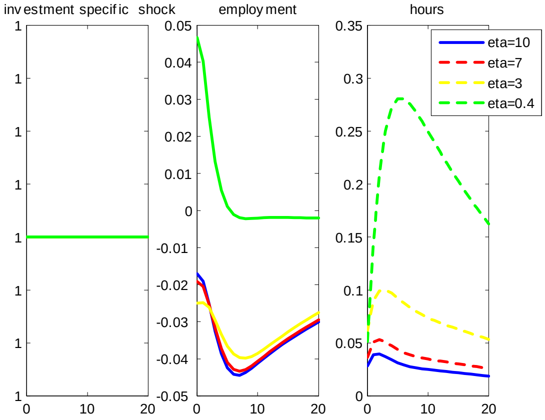


Adjustment is larger on the employment margin as in Sveen and Weinke (2007)

Results: sensitivity to labor supply elasticity



Results: sensitivity to labor supply elasticity



Results: sensitivity to labor supply elasticity

- Several papers (Jaimovich and Rebelo (2009), Ravn and Simonelli (2008), Schmitt-Grohe and Uribe (2008)) study investment-specific shocks
  - Large propagation
  - Positive comovement between consumption and investment
- All these papers use η around 0.4 arguing that it refers to variations across both margins.
- Here we model explicitly the two margins but we still need η around 0.4 to obtain propagation.
- No propagation and the impact consumption response is at most zero for plausible values of η (see Furlanetto, Gomes and Seneca (2009)).

Conclusion

- We present a New Keynesian model that obtains a reasonable split across the two margins of labor adjustment
- Large employment variations in response to technology shocks and monetary shocks.
- Relatively larger response of hours in response to investment shocks. However, no propagation.
- The use of a very elastic labor supply in models with one margin is not justified.

- The household's value of a match with firm i

$$\widetilde{W}_t(i) = W_t(i) H_t(i) - \chi_t C_t \frac{H_t(i)^{1+\eta}}{1+\eta} + E_t \left\{ \Lambda^R_{t,t+1} \left[(1-s)\widetilde{W}_{t+1}(i) + s\left(F_{t+1}\widetilde{W}_{t+1} + (1-F_{t+1})\widetilde{U}_{t+1} \right) \right] \right\}. \quad (14)$$

where $\widetilde{W}_t \equiv \int_0^1 \widetilde{W}_t(i) \frac{L_t(i)}{L_t} di$ and $F_t \equiv \frac{L_t}{U_t}$.

- The value of being unemployed

$$\widetilde{U}_t = BZ_t \Psi_t^{\frac{\alpha}{1-\alpha}} + E_t \left\{ \Lambda^R_{t,t+1} \left[F_{t+1}\widetilde{W}_{t+1} + (1-F_{t+1})\widetilde{U}_{t+1} \right] \right\}. \quad (15)$$

- As in Blanchard and Galí (2009) the value of a match for firm i corresponds to the cost of hiring a worker

$$\widetilde{J}_t(i) = G(F_t), \tag{16}$$

which is independent of the firm.

- Surplus splitting implies

$$(1-\phi)\widetilde{J}_t = \phi\left(\widetilde{W}_t(i) - \widetilde{U}_t\right), \tag{17}$$

where $(1-\phi)$ denotes the weight of workers in the bargain.