Limited Asset Market Partecipation, Sticky Wages and Monetary Policy

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- **MAIN POINT: LAMP has only negligible quantitative effects on the analysis of optimal monetary policy**

Liquidity constrained agents

- LAMP

We assume that a fraction $\lambda \in [0, 1]$ of agents have zero asset holdings, and hence do not smooth consumption but merely consume their current disposable income, while the rest of the agents hold all assets and smooth consumption. See e.g. Mankiw (AER 2000), Galí et al (JMCB 2004, JEEA 2007), Bilbiie (JET 2008), Colciago (JMCB, 2011)

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2. Bilbiie (JET 2008): optimal monetary policy with LAMP

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  1. loss function depends on output gap, price inflation and **wage inflation** variances
  2. the model exhibits endogenous trade-off in stabilizing those three gaps
  3. *Strict price inflation targeting rules generate large welfare losses* $=>$ need to incorporate one of the other two gaps (wage inflation or output)

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- Possible policy implication: reappraisal of the conduct of monetary policy in the Pre-Volcker period

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- **BOTTOM LINE: LAMP has only negligible quantitative effects on the analysis of (optimal) monetary policy**

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  2. Optimal simple rules: no matter LAMP optimal simple rules are active
  3. *Strict targeting rules: Price inflation targeting outperform wage inflation targeting only for very high values of* λ

The model: General Features

- Continuum of households indexed by $i \in [0, 1]$.
- Households in the interval $[0, \lambda]$ are liquidity constrained households. Their consumption equals labor income in each period.
- Households on the interval $(\lambda, 1]$ are standard households who holds assets.

  In particular they hold firms, thus receive profits. Individual profits are $\frac{\Pi}{1-\lambda}$.
- Period utility function is separable in consumption (C_t) and hours worked (L_t)

$$U_t = \Psi_t u\left[C_{k,t}(i)\right] - v\left[L_{k,t}(i)\right]$$

  where k= H(non asset holder),S (asset holder)
- Two shocks: Ψ_t : preferences; A_t : technology

The Model: Labor Markets

- We assume a continuum of differentiated labor inputs indexed with $j \in [0, 1]$;
- As in Schmitt-Grohe and Uribe (2005), agent i supplies each possible type of labor input.
- Wage-setting decisions are made by labor type specific unions indexed with $j \in [0, 1]$;
- Given the wage W^j fixed by union j, agents stand ready to supply as many hours to the labor market j as required by firms

The Model: Labor Markets

- Wage and Price staggering a là Calvo: In each period there is a probability $(1 - \xi_w)$ that a wage is reoptimized and a chance $(1 - \xi_p)$ for a firm to reoptimize its price;

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- It follows that the individual quantity of hours worked, $L_t(i)$, is common across households, and we denote it as L_t.
- The union problem is then to maximize wrt to W_t^j:

$$E_t \sum_{k=0}^{\infty} (\beta \xi_w)^k \left\{ \Psi_{t+k} \left[(1-\lambda) u \left(C_{S,t+k} \right) + \lambda u \left(C_{H,t+k} \right) \right] - v \left(L_{t+k} \right) \right\},$$

subject to the B.C. of the two types of households

Definitions

- The model is log-linearized around the efficient steady state => Woodfordian subsidy
- A quadratic loss function is derived;
- x_t : output gap. Deviation of output from flex prices counterpart
- $\tilde{\omega}_t = \omega_t - \omega_t^{Eff} = \omega_t - a_t$: wage gap. Deviation of wage from flex prices counterpart
- π_t: price inflation
- π_t^w :wage inflation

The model equations

$$\pi_t = \beta E_t \pi_{t+1} + \kappa_p \tilde{\omega}_t$$ **New Keynesian Phillips Curve (NKPC)**

$$\pi_t^w = \beta E_t \pi_{t+1}^w + \kappa_w [(\sigma + \phi) x_t - \tilde{\omega}_t]$$ **Wage Inflation Curve**

$$\tilde{\omega}_t = \tilde{\omega}_{t-1} + \pi_t^w - \pi_t + \Delta\omega_t^{Eff}$$ **Real Wage Gap**

$$x_t = E_t x_{t+1} - \frac{1}{\sigma} E_t \left(i_t - \pi_{t+1} - r_t^{Eff} \right) - \frac{\lambda}{1-\lambda} E_t \Delta\tilde{\omega}_{t+1}$$ **IS curve**

where ϕ : elasticity of marginal disutility of labor; σ : risk aversion

$$\kappa_p = \frac{\left(1-\beta\xi_p\right)\left(1-\xi_p\right)}{\xi_p}; \;\; \kappa_w = \frac{(1-\beta\xi_w)(1-\xi_w)}{\xi_w}$$

- **the supply side of the model not affected by LAMP**

TWO WEDGES (ERCEG ET AL.)

1. Sticky wages => *labour supply wedge*

$$(1-\lambda)\, mrs_{S,t} + \lambda mrs_{H,t} - \omega_t = (\sigma+\phi)\, x_t - \tilde{\omega}_t,$$

$$\pi_t^w = \beta E_t \pi_{t+1}^w + \kappa_w \left[(\sigma+\phi) x_t - \tilde{\omega}_t\right]$$

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2. Sticky prices => *labour demand wedge*

$$\tilde{\omega}_t = \omega_t - \omega_t^{Eff} = \omega_t - a_t$$

$$\pi_t = \beta E_t \pi_{t+1} + \kappa_p \tilde{\omega}_t$$

The IS

$$x_t = E_t x_{t+1} - \frac{1}{\sigma} E_t \left(i_t - \pi_{t+1} - r_t^{Eff} \right) - \underbrace{\frac{\lambda}{1-\lambda} E_t \Delta \tilde{\omega}_{t+1}}_{EXTRA\ TERM}$$

due to the interaction between wage and price staggering and liquidity constrained consumers

Needed: (i) price and wage staggering; and (ii) LAMP

The IS: A special case: flexible wages (Bilbiie)

In this case => no *labour supply wedge*

$$\tilde{\omega}_t = (\sigma + \phi)\, x_t$$

then

$$x_t = E_t x_{t+1} - \delta^{fw} E_t \left(i_t - \pi_{t+1} - r_t^{Eff} \right)$$

where $\delta^{fw} = \frac{1}{\sigma}\left[1 - \frac{\lambda(\sigma+\phi)}{1-\lambda}\right]^{-1}$

$\delta^{fw} < 0$ iff $\lambda > \bar{\lambda}^{fw} = \frac{1}{1+\sigma+\phi}$ => IADL: the interest rate elasticity of aggregate demand turns positive

- In our case the IS can be written

$$x_t = E_t x_{t+1} - \delta^{sw} E_t \left(i_t - \pi_{t+1} - r_t^{Eff} \right) + \frac{\lambda}{1-\lambda} \frac{\sigma \delta^{sw}}{1+\beta+\kappa_w} \Theta_t$$

where $\delta^{sw} = \frac{1}{\sigma} \left[1 - \frac{\lambda(\sigma+\phi)}{1-\lambda} \frac{\kappa_w}{1+\beta+\kappa_w} \right]^{-1}$.

- $\xi_w = 0$, then $\kappa_w -> \infty$, and $\delta^{sw} -> \delta^{fw} = \frac{1}{\sigma} \left[1 - \frac{\lambda(\sigma+\phi)}{1-\lambda} \right]^{-1}$.

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- *(iii) it turns positive if* $\lambda > \bar{\lambda}^{sw}$*, where the threshold value* $\bar{\lambda}^{sw}$ *increases with the degree of wage stickiness*

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- This will make an inverted Taylor principle as in Bilbiie (2008) less likely: **Under sticky wages and sticky prices the Taylor Principle is a necessary condition for equilibrium determinacy for all the plausible parametrizations of the share of liquidity constrained agents.** Colciago (2011), Ascari et al. (2016)

Intutition

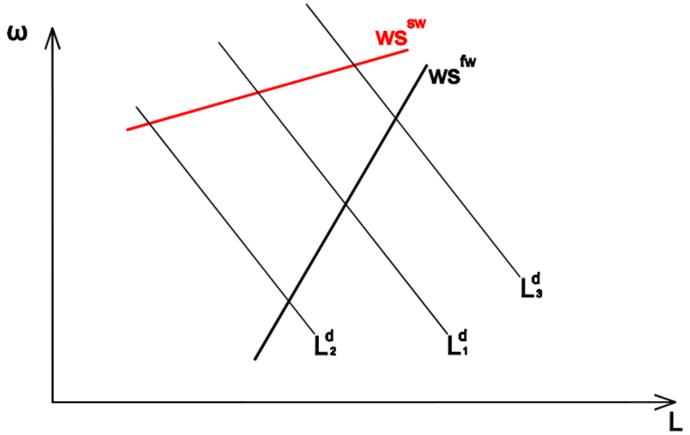

Figure: The wage schedule under sticky wages (WS^{sw}) and flexible wages (WS^{fw}) and the equilibrium in the labor market.

Intutition

$$\underbrace{-\delta^{i}}_{\text{Slope of IS Curve}} = -\frac{1}{\sigma}\left[1-\frac{\lambda}{(1-\lambda)}\times\underbrace{\Phi^{i}}_{\text{Slope of wage schedule}}\right]^{-1}$$
$$\textit{for } i = fw, sw$$

$\Phi^{fw} > \Phi^{sw}$

Optimal Monetary Policy

- Proposition 2. *The aggregate welfare loss function approximated at second-order around the efficient steady state is given by:*

$$L = -\frac{1}{2}\sum_{t=0}^{\infty}\beta^t\left(\frac{(\sigma-1)\lambda}{1-\lambda}\tilde{\omega}_t^2 + (\sigma+\phi)\,x_t^2 + \frac{\theta_w}{\kappa_w}\left(\pi_t^w\right)^2 + \frac{\theta_p}{\kappa_p}\pi_t^2\right).$$

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- $\frac{(\sigma-1)\lambda}{1-\lambda}\tilde{\omega}_t^2$: additional term with respect to Erceg et al.(2000) : $=>$ consumption of liquidity constrained households directly depends on real wage $=>$ the volatility of wage gap affects the welfare level;

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- No LAMP => Erceg et al (2000)
- Flexible wages => Bilbiie (2008)

$$L = -\frac{1}{2}\sum_{t=0}^{\infty}\beta^t\left((\sigma+\phi)\left(1+\frac{(\sigma-1)(\phi+\sigma)\lambda}{1-\lambda}\right)x_t^2 + \frac{\theta_p}{\kappa_p}\pi_t^2\right),$$

Optimal Monetary Policy

- *As in Erceg et al. (2000): (i) With sticky wages and prices, it is impossible for monetary policy to attain the optimal social welfare after a technology shock, while it is possible in response to a preference shock. (ii) If either the prices or the wages are flexible, it would be possible for monetary policy to attain the optimal social welfare also in response to a technology shock.*

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- When $\sigma = 1$, objective function independent of λ
  $=>$ recall only the IS depends on λ
  $=>$ the planner can implement the same equilibrium as in the full participation economy
  $=>$ but with a different response of i, depending on λ

Calibration

Preferences. Time is measured in quarters. $\beta = 0.99$, $\sigma = 2$, $\phi = 3$.
Production. $\theta_p = 6$, $\xi_p = 2/3$.
Labour markets. $\theta_w = 6$. $\xi_{w'} = 2/3$.
Exogenous shocks. $\rho_a = 0.855$, $\sigma_a = 0.0064$, $\rho_\psi = 0.93$ and $\sigma_\psi = 0.025$

IRFs to a technology shocks=> trade-off

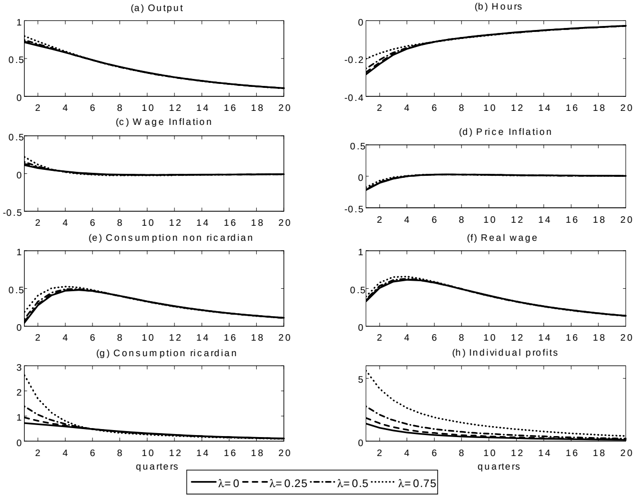
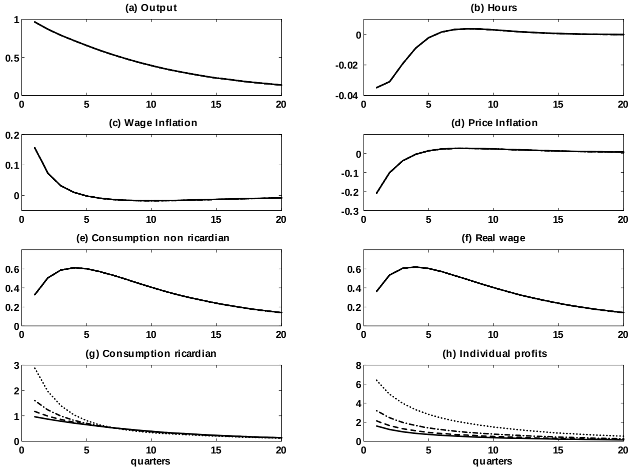


Figure 3. IRFs to a technology shock under optimal policy

IRFs to a technology shocks=> trade-off



IRFs to a technology shock under optimal policy (case $\sigma = 1$).

Optimal Monetary policy

BOTTOM LINE: The optimal policy response of a NK model with price and wage stickiness is only marginally affected by the LAMP assumption.

Optimal Monetary Policy

Average duration of wage contracts $(1-\xi_w)^{-1}$	$\lambda = 0$	$\lambda = 0.25$	$\lambda = 0.5$	$\lambda = 0.75$
		Full Commitment		
1	0	0	0	0
2	0.0046	0.0054	0.007	0.0108
3	0.0059	0.0066	0.008	0.0125
4	0.0066	0.0071	0.0084	0.0125
5	0.0069	0.0075	0.0086	0.0124

Table: Unconditional welfare loss under full commitment.
We consider alternative parameterizations for the share of non ricardian consumers and alternative average duration of wage contracts. The welfare cost is expressed as a percentage of the efficient steady state level of consumption, while the mean duration of wage contracts is expressed in quarters.

Optimal simple rules I

Average duration of wage contracts $(1-\xi_w)^{-1}$	$\lambda = 0$	$\lambda = 0.25$	$\lambda = 0.5$	$\lambda = 0.75$
		1) $i_t = \phi_\pi \pi_t$		
1	10,0.03	-10,0.02	-10,0.02	-10,0.02
2	5,1.3	5.1,1.1	6.1,0.9	-10,0.48
3	4.3,2.1	4.5,1.9	5.4,1.6	10,1.4
4	4.3,2.8	4.6,2.5	5.4,2.1	9.6,1.9
5	4.4,3.5	4.8,3.2	5.6,2.8	9.4,2.4
		2) $i_t = \phi_\pi E_t \pi_{t+1}$		
1	10,0.06	-5.2,0.1	-10,0.06	-10,0.06
2	7.8,1	8.4,0.9	10,0.8	-10,0.6
3	6.5,1.6	7.1,1.4	9.4,1.3	10,2.2
4	6.4,2.2	7.1,2	9,1.8	10,2.7
5	6.7,2.8	7.3,2.6	9.1,2.3	10,3.4

Optimal simple rules I

Result 1. *In the case of pure inflation targeting rules, the optimal rule calls for a strong response of monetary policy.*
The LAMP assumption makes the optimal rule highly passive if wages are flexible. However, if wages are sticky, the optimal rule is restored to be highly active, as in the standard NK model.

Optimal simple rules II

Average duration of wage contracts $(1-\xi_w)^{-1}$	$\lambda = 0$	$\lambda = 0.25$	$\lambda = 0.5$	$\lambda = 0.75$
		A) $i_t = \phi_\pi \pi_t + \phi_y y_t$		
1	10,0.05,0.04	-10,0.04,0.03	-10,0.05,0.03	-10,0.05,0.03
2	5.5,0.2,1.2	5.6,0.16,1.1	6.45,0.08,0.9	-10,-1.3,3.4
3	4.42,0.15,1.9	4.7,0.12,1.8	5.59,0.07,1.5	10,-0.07,1.4
4	4.8,0.2,2	5.04,0.17,1.8	5.8,0.1,1.5	9.5,-0.04,1.8
5	5.05,0.2,3.2	5.37,0.18,3	6.5,0.13,2.7	9.4,-0.01,2.4
		B) $i_t = \phi_\pi \pi_t + \phi_\pi \pi_t^w$		
1	10,-0.006,0.04	-10,-0.13,0.02	-10,-0.11,0.03	-9.2,0.5,0.04
2	10,7.24,0.4	10,6.13,0.5	10,4.18,0.6	-10,-10,0.7
3	6.75,10,0.6	7.9,10,0.7	10,10,0.8	10,7.8,1.2
4	4.33,10,0.7	5.2,10,0.8	7.2,10,0.9	10,10,1.2
5	3.3,10,0.8	4.12,10,0.8	5.82,10,0.9	10,10,1.3

Optimal simple rules II

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3. *Responding to output only marginally improves the performance of a pure targeting rule.*

$$\pi_t = \beta E_t \pi_{t+1} + \kappa_p \tilde{\omega}_t$$ **New Keynesian Phillips Curve (NKPC)**

$$\pi_t^w = \beta E_t \pi_{t+1}^w + \kappa_w \left[(\sigma + \phi) x_t - \tilde{\omega}_t \right]$$ **Wage Inflation Curve**

$$\tilde{\omega}_t = \tilde{\omega}_{t-1} + \pi_t^w - \pi_t + \Delta\omega_t^{Eff}$$ **Real Wage Gap**

$$x_t = E_t x_{t+1} - \frac{1}{\sigma} E_t \left(i_t - \pi_{t+1} - r_t^{Eff} \right) - \frac{\lambda}{1-\lambda} E_t \Delta\tilde{\omega}_{t+1}$$ **IS curve**

where ϕ : elasticity of marginal disutility of labor; σ : risk aversion

$$\kappa_p = \frac{(1-\beta\xi_p)(1-\xi_p)}{\xi_p}; \;\; \kappa_w = \frac{(1-\beta\xi_w)(1-\xi_w)}{\xi_w}$$

Strict targeting rules

- *Proposition 3. Under a strict targeting rule (whatever the target among* $(\tilde{\omega}, \pi, \pi^w, x)$ *the path* $\{\tilde{\omega}_t, \pi_t, \pi_t^w, x_t\}_{t=0}^{\infty}$ *is not affected by LAMP. The only difference with respect to a full Ricardian model is in the path of the instrument,* $\{i_t\}_{t=0}^{\infty}$*, needed to implement the allocation. This implies that the unconditional variances of* $(\tilde{\omega}, \pi, \pi^w, x)$ *do not depend on* λ*. Notice, however, that the unconditional welfare loss will depend on the degree of LAMP given the presence of the term* $\frac{(\sigma-1)\lambda}{1-\lambda}$.

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- *Proposition 4. Beside implementing the same allocation $\{\tilde{\omega}, \pi, \pi^w, x\}_{t=0}^{\infty}$, strict price inflation targeting and strict real wage gap targeting implement the same path for the policy instrument $\{i_t\}_{t=0}^{\infty}$. Also they deliver the same welfare loss which is independent of the degree of asset market participation.*

Strict targeting rules

- *Proposition 5. Under strict wage inflation targeting the wage gap is proportional to the output gap. The path* $\{\pi_t, \tilde{\omega}_t, x_t\}_{t=0}^{\infty}$ *is independent of the degree of asset market participation, while the path of the instrument needed to implement the equilibrium does depend on it. Unconditional welfare loss increases with the extent of LAMP.*

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- *Corollary. If* $\sigma > 1$*, under nominal wage stickiness, there exist a threshold value* $\tilde{\lambda}$*, such that for* $\lambda > \tilde{\lambda}$ *wage inflation targeting delivers a higher society's welfare loss with respect to price inflation targeting.*

Strict targeting rules

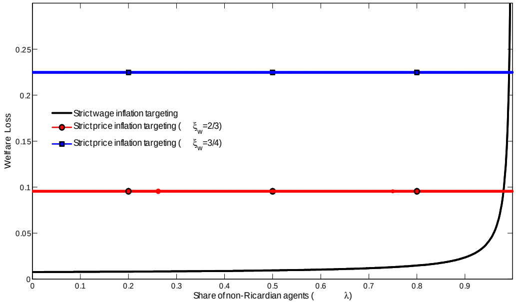

Figure 3. Unconditional welfare loss under strict wage inflation targeting and strict price inflation targeting. The latter is reported for two alternative average durations of wage contracts: 3 quarters ($\xi_w = 2/3$) and 4 quarters ($\xi_w = 3/4$).

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