Macroeconomic Dynamics in a Model of Goods, Labor and Credit Market Frictions

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Overview

- Known that financial frictions raise macroeconomic volatility.
- New result: goods market frictions fundamentally change the dynamics of labor markets
- Bridge the gap with data, both in terms of volatility (sd of logs) and persistence (autocorr. in growth rates)

Overview

1. Financial and Goods market frictions are *substitutable* in generating amplification
2. Goods market frictions are *unique* in generating persistence

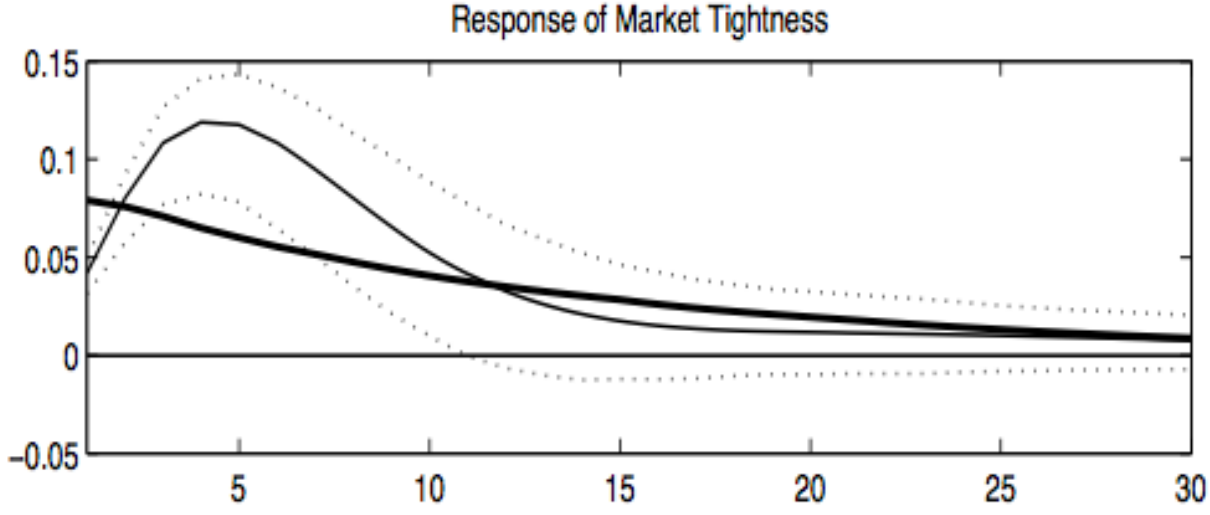
- Two mechanisms
  - Procyclical dynamics of consumers' search for goods (depends on their income)
  - Countercylical dynamics of goods market tightness and prices

Literature: frictions matter

- Labor market frictions: indivisible labor, Hansen (1985), Rogerson (1988)
- Financial / Credit market frictions: agency costs, Bernanke et al. (1998), search, Duffie (2005)
- Goods markets, imperfect competition, frictions (Bai et al. 2010)

Data: dynamics is hump-shaped

Fujita and Ramey (2007)



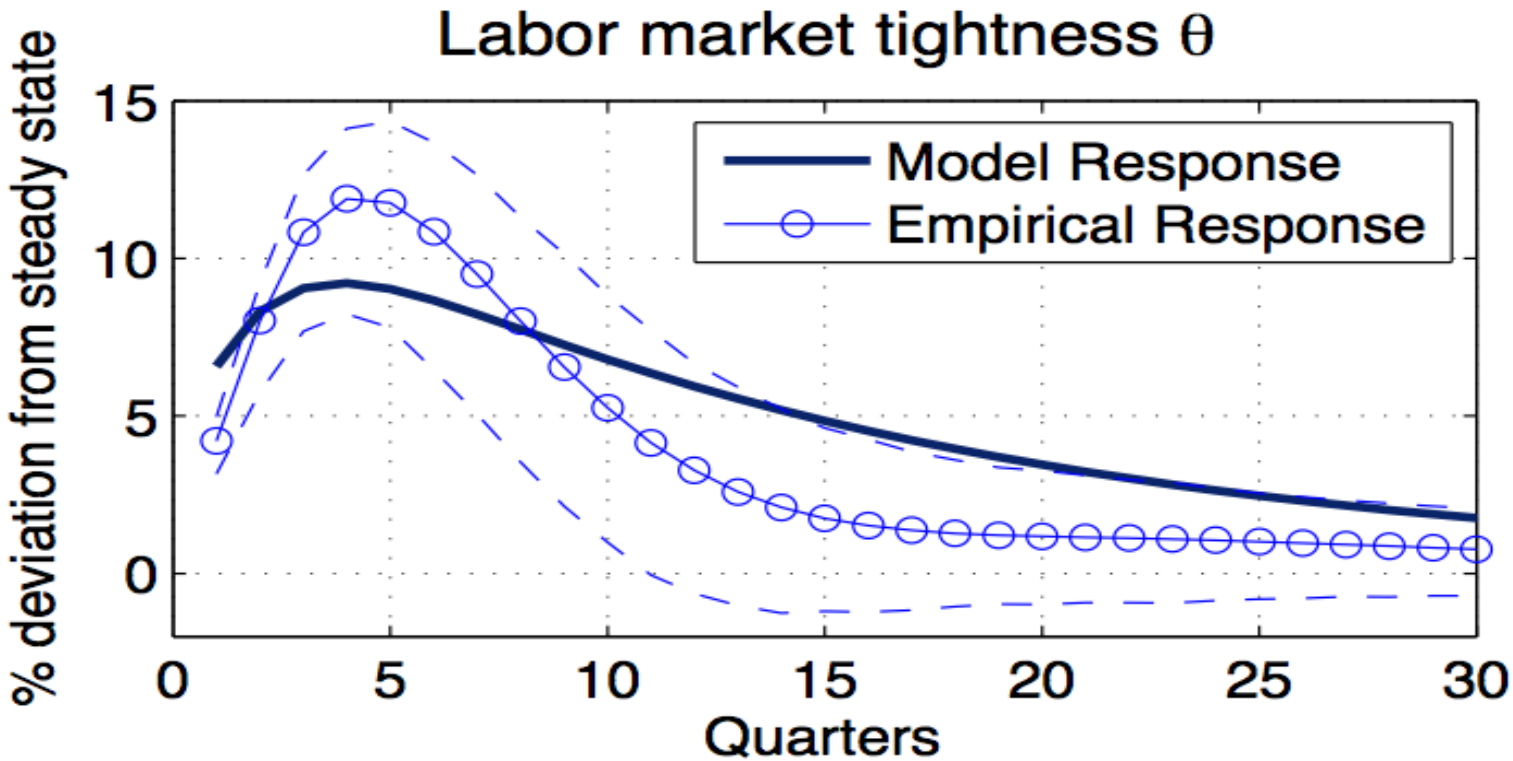
In this paper

Provide here a canonic model with (symmetrical) imperfections on three markets: labor, finance and good markets.

- What role for search frictions in the goods market?
  - Firm's side:
    - Evidence of heterogeneity, short life cycles, product entry and exit (Broda and Weinstein AER 2010)
    - Capacity utilization less than 100%
    - Rents and markups
  - Consumers' side: time use surveys; shopping time

Credit, labor and goods market frictions

	Data		CLG	
Relative to gdp →:	sd	*corr*	sd	*corr*
Labor tightness	15.41	*0.90*	15.51	*0.98*
Vacancies	8.83	*0.89*	11.96	*0.98*
Unemployment	6.82	*-0.88*	5.16	*-0.45*



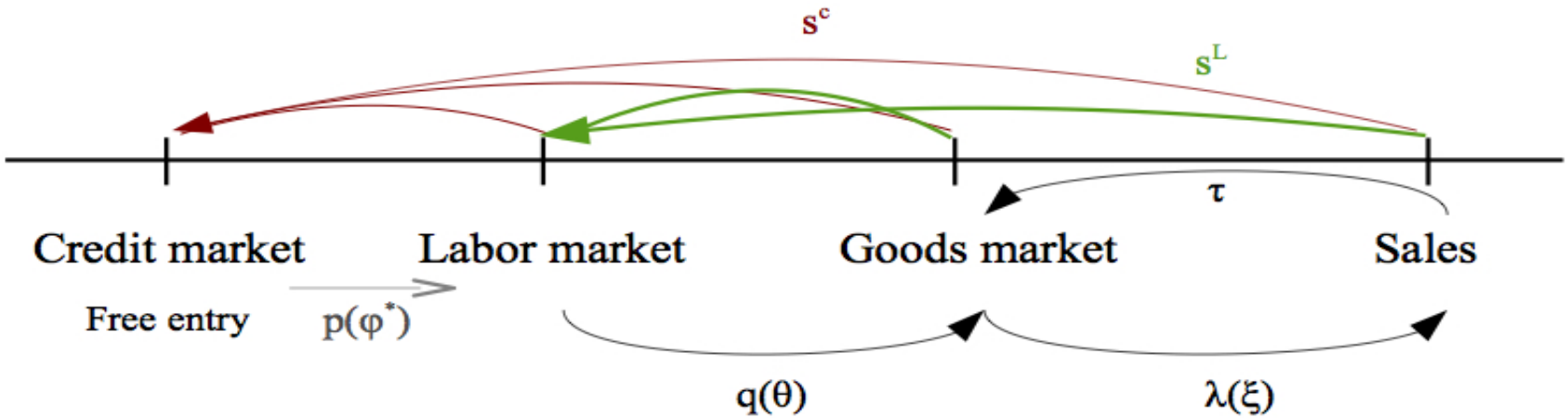
Overview of the model

- 3 types of agents: Banks, Entrepreneurs, Workers
- All three required to produce. Only banks have access to storage and liquidity
- 3 matching frictions: Credit, Labor, Goods

Market	**tightness**	**price**
Credit	ϕ	ρ
Labor	θ	w
Goods	ξ	$\mathcal{P}$

- Lifecycle of a project: search for credit, labor, consumers with endogenous transition rates.
- Exogenous bankruptcy shocks s^c different from labor turnover s^L.

Credit, labor and goods market frictions



Credit market friction

Search on credit markets:

- Creditors ($\mathcal{B}_c$) and investment projects ($\mathcal{N}_c$) meet to form a firm
- Search costs: κ_B - creditors ; κ_I - Investment projects
- Measure of credit market tighness: $\phi_t = \frac{\mathcal{N}_{c,t}}{\mathcal{B}_{c,t}}$

Matching on credit markets:

$$\frac{M_C(\mathcal{B}_{c,t}, \mathcal{N}_{\mathrm{c,t}})}{\mathcal{N}_{\mathrm{c,t}}} = p(\phi_t) \text{ with } p'(\phi_t) < 0.$$

Search on credit markets

Value of search on credit markets with free entry:

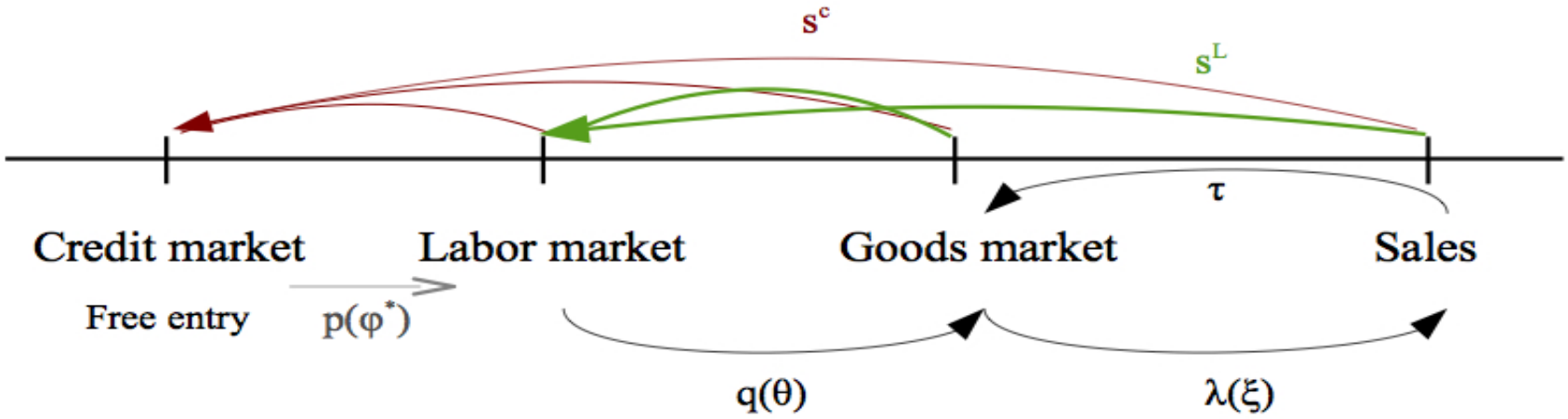
$$E_{c,t} = 0 = -\kappa_I + p(\phi_t)E_{l,t}$$
$$B_{c,t} = 0 = -\kappa_B + \phi_t p(\phi_t)B_{l,t}$$

With Nash bargaining, $(1-\beta)B_{l,t} = \beta E_{l,t}$, implies $\phi^* = \frac{\kappa_B}{\kappa_I}\frac{1-\beta}{\beta}$

Total transaction costs in stage c summarized as

$$K(\phi^*) \equiv \frac{\kappa_I}{p(\phi^*)} + \frac{\kappa_B}{\phi^* p(\phi^*)}$$

Overview of model with goods market frictions



After hiring worker, firm must find a customer first to sell production

Additional costs and dynamics:

- Worker must be paid even if there are no sales
- Consumers are located at rate λ
- Consumers may be tired of good at rate τ

Matching on goods market:

- Mass of firms ready to produce $\mathcal{N}_g$ meets consumers $\mathcal{C}_0$ search for a product with intensity e.
- Concept for tightness in the goods market: $\xi_t = \frac{\mathcal{C}_{0,t}}{\mathcal{N}_{g,t}}$
- Matching on goods market:

$$\text{Firms: } \frac{M_G(\bar{e}_t \mathcal{C}_{0,t}, \mathcal{N}_{g,t})}{\mathcal{N}_{g,t}} = \lambda(\xi_t, \bar{e}_t) \quad \text{with} \quad \lambda'(\xi_t) > 0$$

$$\text{Consumers: } \frac{M_G(\bar{e}_t \mathcal{C}_{0,t}, \mathcal{N}_{g,t})}{\mathcal{C}_{0,t}} = \tilde{\lambda}(\xi_t, \bar{e}_t) \quad \text{with} \quad \tilde{\lambda}'(\xi_t) < 0$$

Consumers and producers on goods market

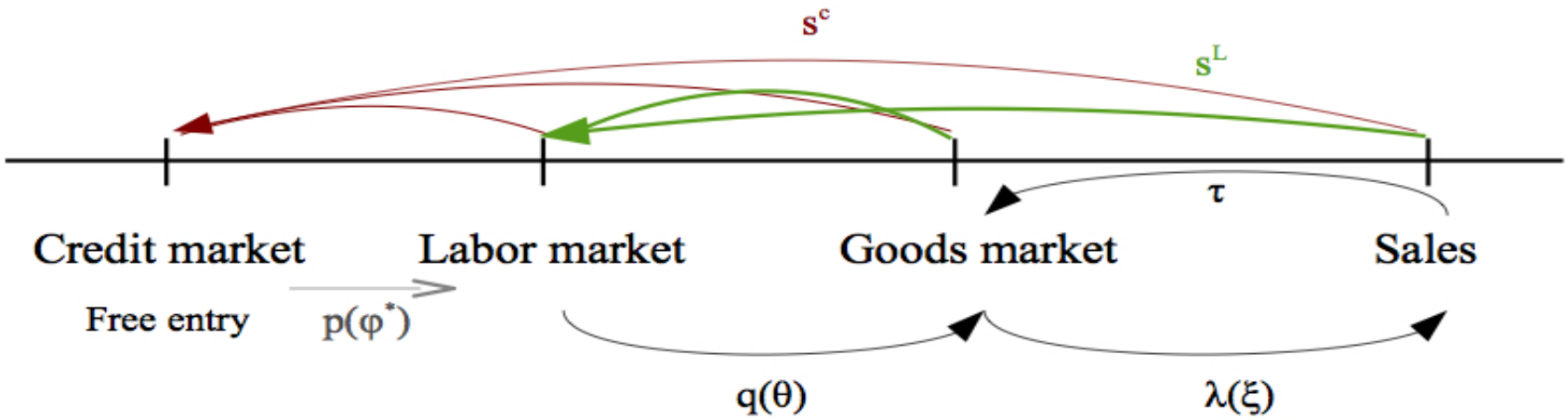
Stocks of Consumers:

$$\begin{aligned}
\mathcal{C}_{0,t+1} &= (1-\tilde{\lambda}_t)\mathcal{C}_{0,t} + \left[s^c + (1-s^c)\left(s^L + \left(1-s^L\right)\tau\right)\right]\mathcal{C}_{1,t} \\
\mathcal{C}_{1,t+1} &= (1-s^c)\left(1-s^L\right)(1-\tau)\mathcal{C}_{1,t} + \tilde{\lambda}_t\mathcal{C}_{0,t}
\end{aligned}$$

Stocks of producers:

$$\begin{aligned}
\mathcal{N}_{g,t+1} &= (1-s^c)\left(1-s^L\right)\left[(1-\lambda_t)\mathcal{N}_{g,t} + \tau N_{\pi,t}\right] + q(\theta_t)\mathcal{N}_{l,t} \\
\mathcal{N}_{\pi,t+1} &= (1-s^c)\left(1-s^L\right)\left[(1-\tau)\mathcal{N}_{\pi,t} + \lambda_t\mathcal{N}_{g,t}\right]
\end{aligned}$$

Value of filled position - S_g



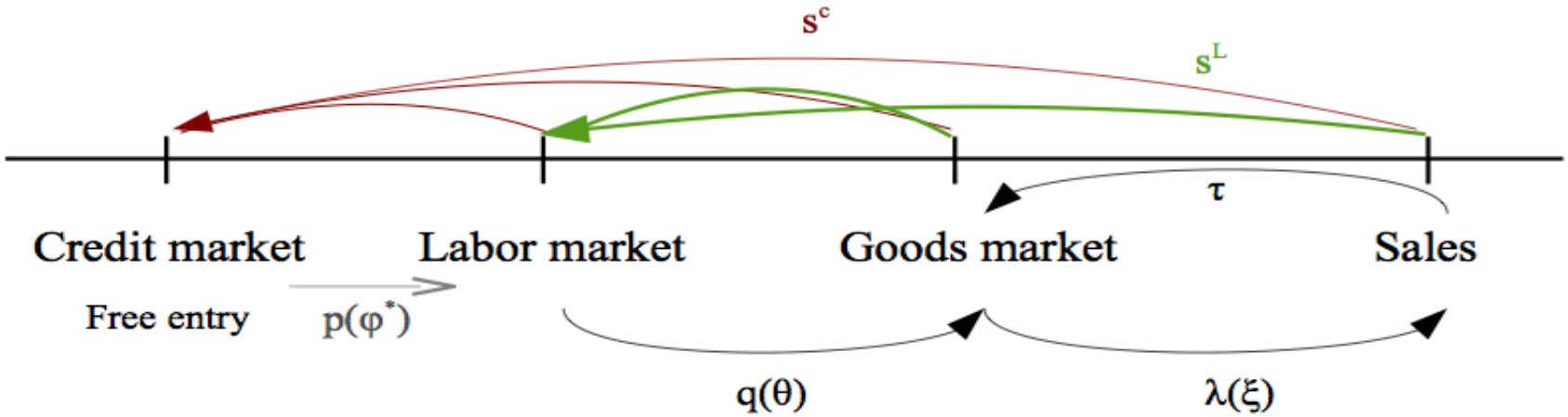
Values of goods market and sales stages:

$$S_{g,t} = -w_t + \frac{1-s^c}{1+r}\mathbb{E}_t\left[\left(1-s^L\right)\left[\lambda_t S_{\pi,t+1} + (1-\lambda_t)S_{g,t+1}\right] + s^L S_{l,t+1}\right]$$

$$S_{\pi,t} = \mathcal{P}_t x_t - w_t - \Omega + \frac{1-s^c}{1+r}\mathbb{E}_t\left[\left(1-s^L\right)\left[(1-\tau)S_{\pi,t+1} + \tau S_{g,t+1}\right] + s^L S_{l,t+1}\right.$$

- Small production cost Ω to ensure no production undertaken in stage g

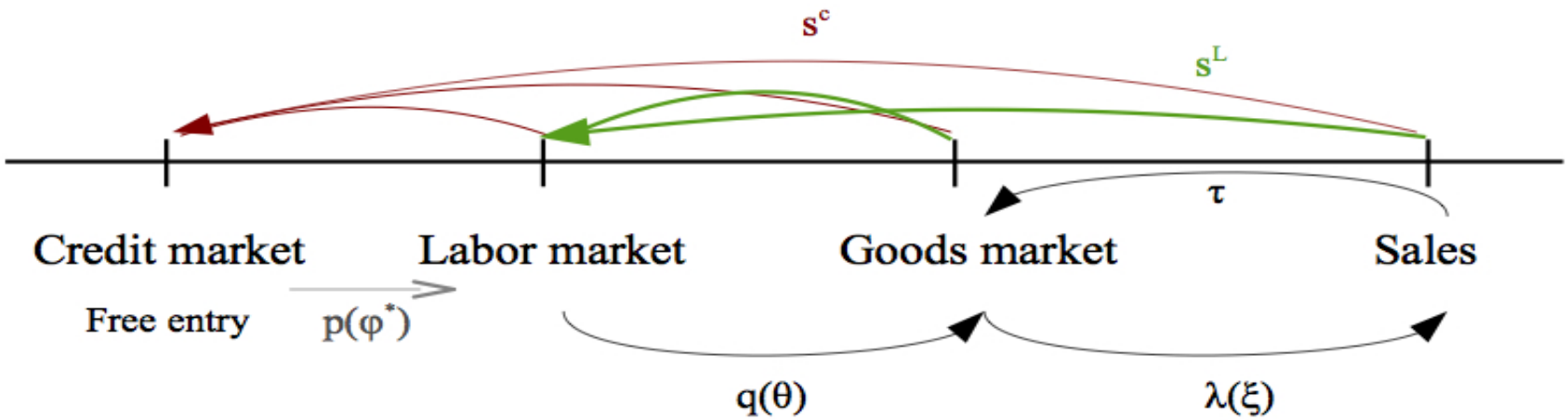
Overview of model - Job creation dynamics



Value of firm in recruiting stage:

$$\underbrace{K(\phi^*)(1+o_t(r))}_{\text{Credit friction}} \quad \underbrace{+\frac{\gamma}{q(\theta_t)}}_{\text{Labor frictions}} \quad \underbrace{=\frac{1}{1+r}\mathbb{E}_t S_{g,t+1}}_{\text{Goods friction}}$$

Overview of model - Job creation dynamics



Dynamics of job creation:

$$\widehat{\theta}_t = \frac{1}{\eta_L} \frac{S_g}{S_g - K(\phi^*)} \mathbb{E}_t \widehat{S}_{g,t+1}$$

- Wasmer-Weil (2004), Petrosky-Nadeau and Wasmer (2011): financial accelerator from small *firm* surplus $S_g - K(\phi^*)$
  - In that sense, financial frictions and goods market frictions are substitutes.

Determining price $\mathcal{P}$ 1/2

Two consumption goods: numeraire c_0 and manufactured c_1

- Second good c_1 yields higher marginal utility but must be found (frictions): manufacturing, some services.
  - First good: food exp. + utility
- Search cost σ(e), with $\sigma'(e) > 0$ and $\sigma''(e) \geq 0$

Consumer goods market values

$$
\begin{aligned}
D_{0,t} &= \mathcal{U}(0, c_{0,t}) - \sigma(e_{i,t}) + \frac{1}{1+r}\mathbb{E}_t\left[\frac{e_{i,t}\tilde{\lambda}_t}{\bar{e}_t} D_{1,t+1} + \left(1 - \frac{e_{i,t}\tilde{\lambda}_t}{\bar{e}_t}\right) D_{0,t+1}\right] \\
D_{1,t} &= \mathcal{U}(c_{1,t}, c_{0,t}) + \left(\frac{1-s^c}{1+r}\right)\mathbb{E}_t\left(1-s^L\right)\left[\tau D_{0,t+1} + (1-\tau) D_{1,t+1}\right] \\
&\quad + \frac{s^c + (1-s^c)\, s^L}{1+r}\mathbb{E}_t D_{0,t+1}
\end{aligned}
$$

Determining price $\mathcal{P}$ 2/2

- Optimal search effort is the same for all consumers by

$$\bar{e}_t \sigma'(e^*_{it}) = \frac{\tilde{\lambda}_t}{1+r} \mathbb{E}_t \left[(D_{1,t+1} - D_{0,t+1}) \right]$$

- Goods surplus $G_t = (S_{\pi,t} - S_{g,t}) + (D_{1,t} - D_{0,t})$
  - Nash bargaining: $\delta \in (0,1)$ the share of the goods surplus going to consumers
  - Price equation: function of past income, current prices and expected future conditions Price equation

- Resources pooled across categories of workers (Merz (1995) and Andofaltto (1996)).

Calibration: labor and credit markets

- Quarterly frequency: risk free rate $r = 0.01$
- Productivity: $\log x_t = \rho_x \log x_{t-1} + \varepsilon_t^x$,
  $\rho_x = 0.95$, $\sigma_x = 0.0072$
- Wage rule: $w_t = \chi_w (\mathcal{P}_t x_t)^{\eta_w}$
- Cobb-Douglas matching functions:

  $M_j(X_1, X_2) = \chi_j X_1^{\eta_j} X_2^{1-\eta_j}$, $j = C, L, G$

Calibration: labor and credit markets

- Labor targets:
  - 8% unemployment rate, job separation $s^c + (1 - s^c)s^L = 0.05$ (Davis et alii. 2006), implies $f = 0.45$
  - Elasticity of wages to productivity ≈ 0.65, W/P=0.75.
- Credit market targets: credit market's share of GDP $\Sigma = \frac{\mathcal{B}_\pi \rho - \mathcal{B}_g w - \mathcal{B}_l \gamma - \mathcal{B}_c \kappa}{Y} = 3\%$
- Goods market targets
  - $\frac{\mathcal{N}_\pi}{\mathcal{N}_g + \mathcal{N}_\pi}$ of 81% $\approx$ Federal Reserve's Statistical Release of Industrial Production and Capacity Utilization
  - Price mark-up over cost of 25%
  - Broda and Weistein (2010): average rate of product entry $\tilde{\lambda} = 0.78$, average product exit rate $s^c + (1 - s^c)s^L = 0.24$ implies τ
  - Cost of time searching in the goods market corresponds to approximately 7% of wage income
  - Φ : obtained from the target on the share of expenditures on primary goods (food consumed at home plus utilities): 10 to 15%

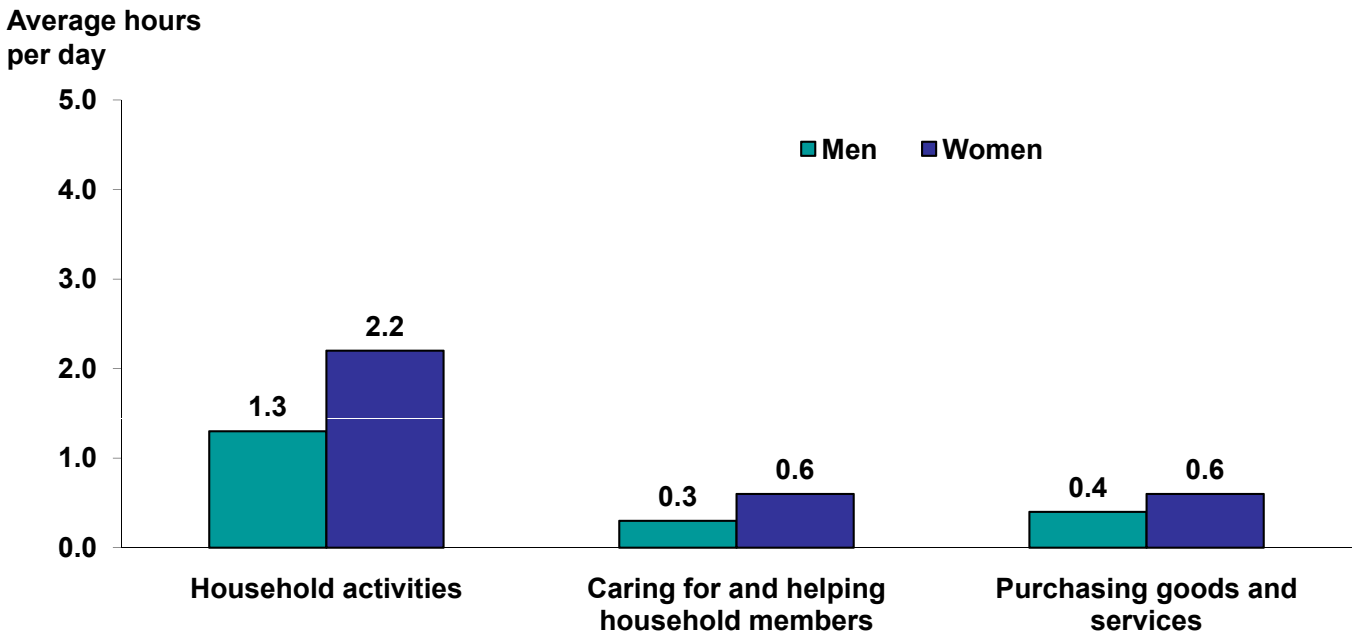
Calibration: goods market

Table 1: Baseline Parameter Values

Labor market			**Goods market**		
job-separation rate	s^L	0.04	goods exit rate	τ	0.01
matching elasticity	η_L	0.50	matching elasticity	η_G	0.38
wage elasticity	η_w	0.75	consumer bargaining weight	δ	0.38
matching level parameter	χ_L	0.64	cost function elasticity	η_σ	2.00
wage level parameter	χ_w	0.75	marginal utility of c_1	Φ	2.24
vacancy cost	γ	0.026	production cost	Ω	0.31
bargaining weight	α	0.25			
non-employment utility	b	0.5			
Credit market			**Technology**		
bank bargaining weight	β	0.15	persistence parameter	ρ_x	0.935
separation rate	s^c	0.01	standard deviation	σ_x	0.01
search costs	$\kappa_B = \kappa_I$	0.01	risk-free rate	r	0.01

Search for goods

Average hours per day men and women spent in various activities



NOTE: Data include all noninstitutionalized persons age 15 and over. Data include all days of the week and are annual averages for 2008. Travel related to these activities is not included in these estimates.

SOURCE: Bureau of Labor Statistics

Full results

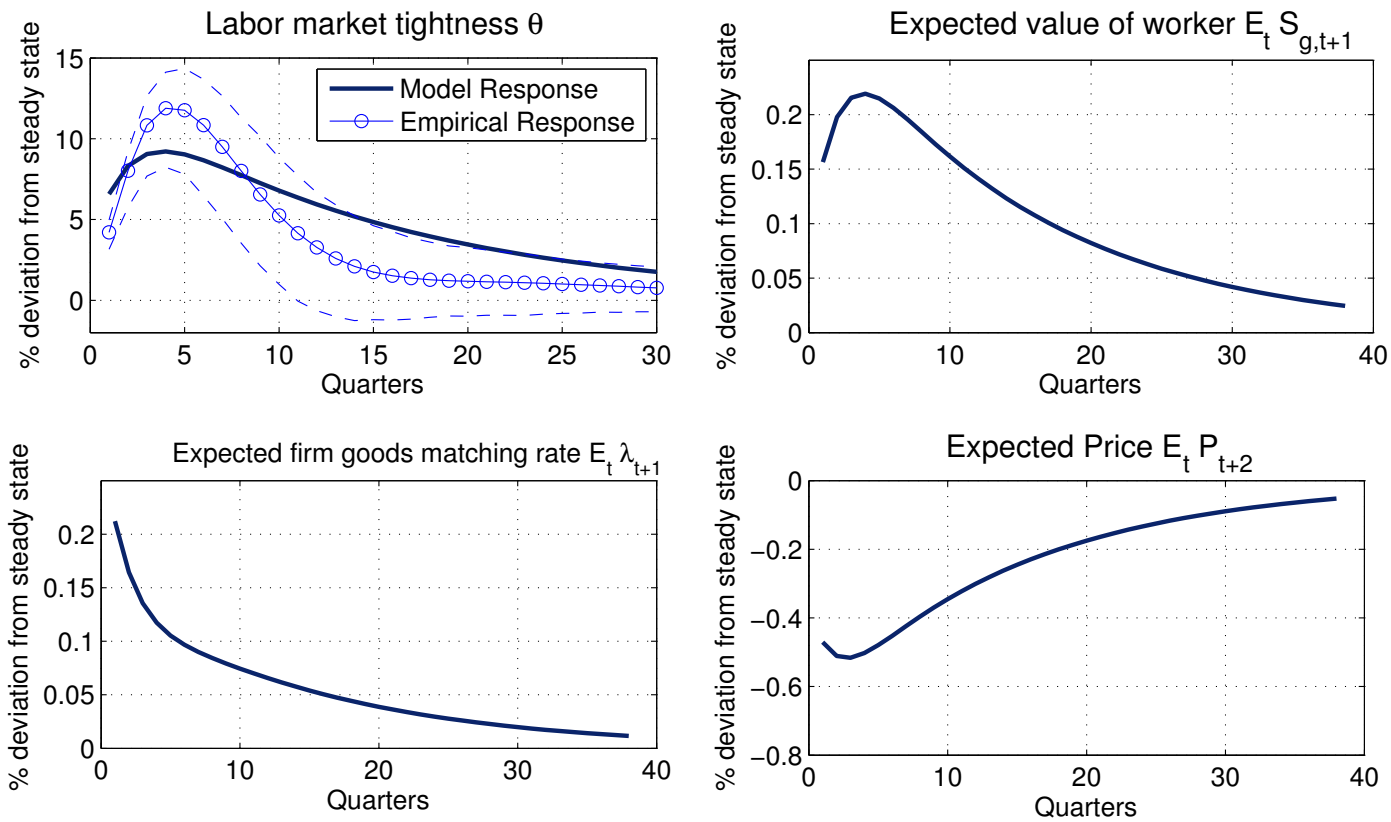


Figure: Goods Market Frictions - Inspecting the Propagation Mechanism and Comparing the Model and Empirical Responses of Labor Market Tightness to a Positive Technology Shock

Full results

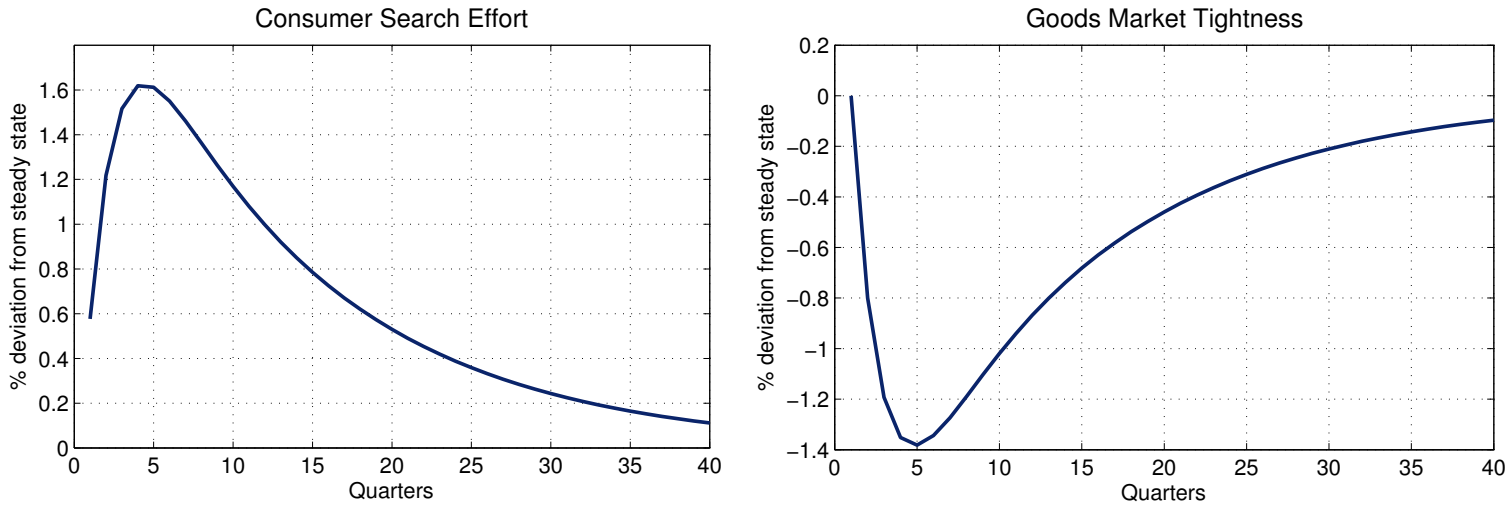


Figure: Impulse Response - Consumer Search Effort and Goods Market Tightness

Summary

- Sequence:
  1. Positive productivity shock ⇒ more firms enter
  2. More competition to sell goods (both goods market tightness and price *decline*)
  3. Overall effect still positive for firms, BUT in addition...
  4. .. consumers get higher income (only after the two matching lags) and also meet goods more frequently
     - 4.1 Hence strong increase in consumer search effort
  5. Amplification, hump-shape and the shock is prolongated (persistence).

Role of goods market frictions

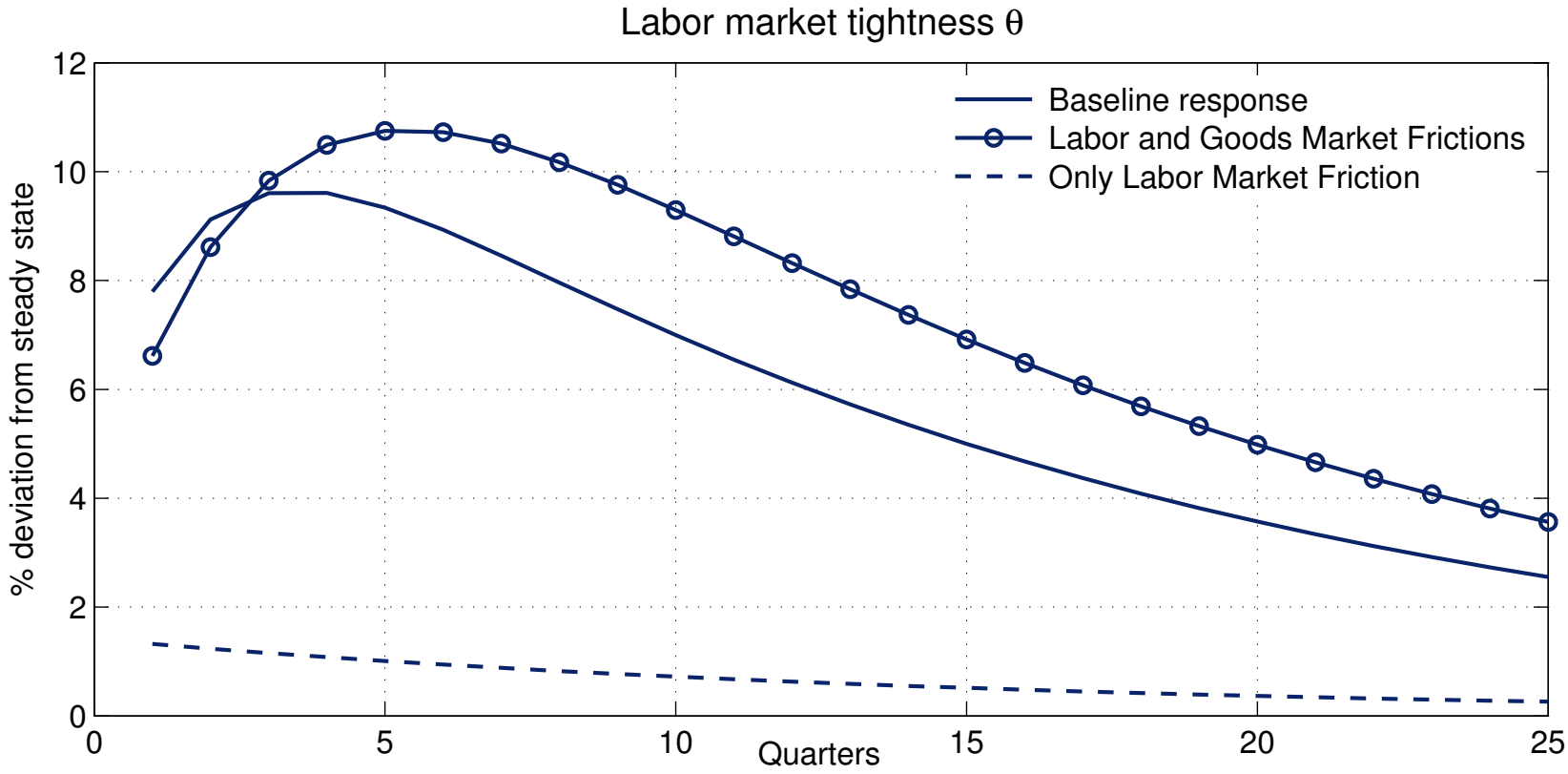


Figure: Comparing Frictions Impulse Responses to a Positive Technology Shock.

Comparisons with alternative frictions

Table: Business Cycle Statistics - Comparing Frictions

	U.S. data		Goods, labor and credit		Goods & labor		Labor only	
	a	b	a	b	a	b	a	b
Vacan.	8.83	0.89	11.96	0.98	11.16	0.16	1.14	0.94
Unemp.	6.82	-0.88	5.16	-0.45	5.19	-0.40	0.48	-0.70
θ	15.41	0.90	15.51	0.91	15.06	0.84	1.40	0.99
Wage	0.52	0.56	0.89	0.92	0.96	0.92	0.69	0.99
Conso	0.59	0.80	0.99	0.99	0.99	0.99	0.99	0.99

Notes: H.-P. filtered (a) sd relative to GDP; (b) contemp. correlation with GDP. Data sources: B.E.A., B.L.S. 1977:Q1 to 2007:Q4.
Wages from Gertler and Trigari (2009), Table 2 p. 61

Sensitivity: specification of wages

Table: Business Cycle Moments - Sensitivity to the Specification of Wages

	Baseline wage setting $\zeta_{w,p} = 0.75$ (instead of 0.65)				Nash bargained wages			
	LMG frictions		L frictions		LMG frictions		L frictions	
	a	b	a	b	a	b	a	b
Vacancies	10.51	0.98	1.05	0.94	8.28	0.97	3.09	0.88
Unemployment	4.66	-0.44	0.44	-0.69	4.94	-0.47	0.16	-0.67
Labor tightness	13.74	0.90	1.29	0.99	11.39	0.91	3.20	0.88
Wage	0.95	0.93	0.74	0.00	0.75	0.9	0.40	0.88
Consumption	0.99	0.99	1.00	0.00	0.95	0.9	0.66	0.75

Notes: H.-P. filtered (a) sd relative to GDP; (b) contemp. correlation with GDP.

Sensitivity: other parameters

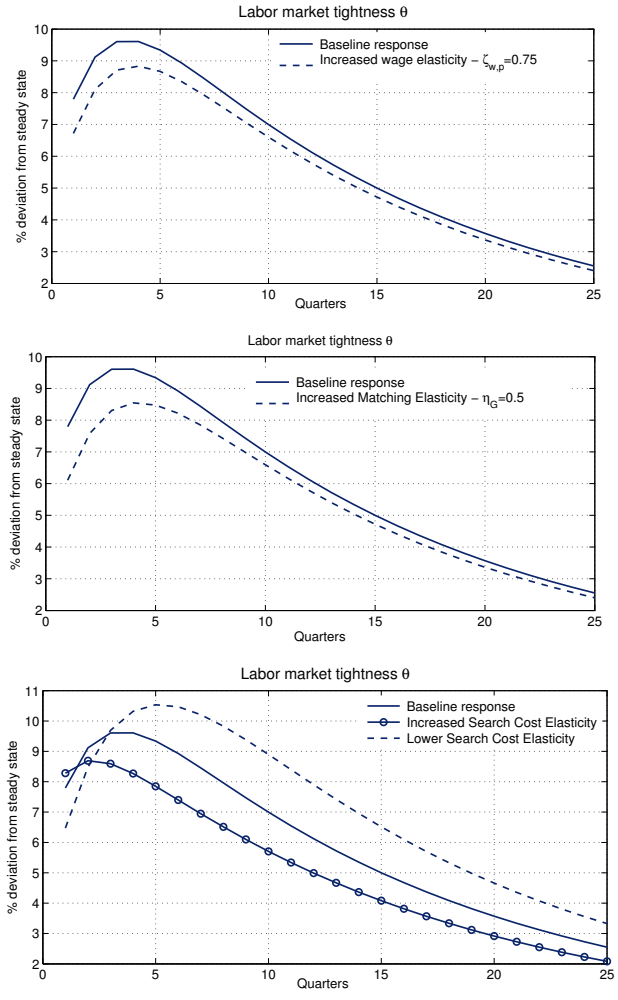


Figure: Different Parameterizations

Sensitivity to goods market parameters

Table: Business Cycle Moments - Sensitivity to Goods Market Parameters

	Baseline $\delta = \eta_G = 0.38$		Goods Matching $\eta_G = 0.5$		Search effort cost elasticity $\eta_\sigma = 1.9$	
	a	b	a	b	a	b
Vacancies	11.96	0.98	9.92	0.97	11.64	0.93
Unemployment	5.16	-0.45	4.46	-0.42	5.41	-0.35
Labor tightness	15.51	0.91	13.10	0.88	15.69	0.81

Notes: H.-P. filtered (a) sd relative to GDP; (b) contemp. correlation with GDP.

Conclusion

Credit market imperfections amplify the response of labor market tightness to productivity

Goods market imperfections provide both amplification and persistence

- dynamics of congestion and prices induce increasing incentive to hire, even as productivity returning to trend
- results sensitive to dynamics of prices on goods market

Framework for aggregate demand shocks AD shock

- could be exogenous changes in consumer search intensity
- real effects you expect: increases in output and employment

Price equation

This price equation is

$$\begin{aligned}\mathcal{P}_t x_t &= (1-\delta)\left[\Phi x_t + (1-\eta_\sigma)\sigma(\bar{e}_t)\right] + \delta\Omega \\ &\quad +(1-\delta)\lambda_t\left(1-s^L\right)\frac{1-s^c}{1+r}\mathbb{E}_t\left[\delta G_{t+1}\right]\end{aligned}$$

Back

Related challenge specific to labor market

Amplification: Large elasticity of v-u ratio to productivity: 7 to 20

1. Increase elasticity of Expected Benefit of Hire to productivity:
   - with rigid wages, Hall, 2005, Shimer, 2005 ; with small labor surplus, Hagedorn and Manovskii, 2008
2. Reduce elasticity of Recruiting Cost to productivity:
   - add financial frictions: Wasmer and Weil, 2004 (matching), Petrosky-Nadeau, 2008 (CSV)
     - Petrosky-Nadeau and Wasmer, 2012: no goods market frictions but a financial multiplier of 4.5