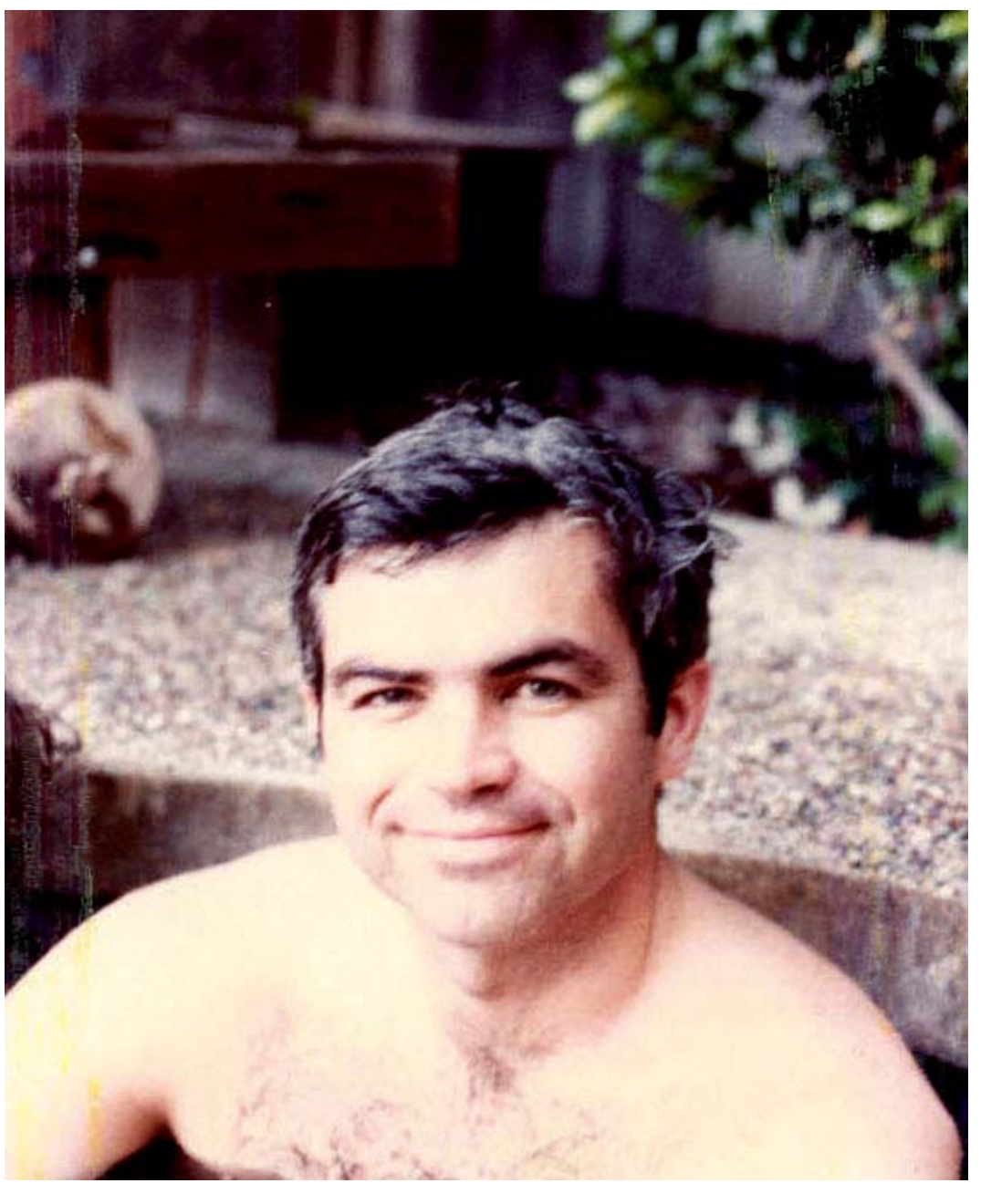

We present a model embodying moderate amounts of nominal rigidities that accounts for the observed inertia in inflation and persistence in output. The key features of our model are those that prevent a sharp rise in marginal costs after an expansionary shock to monetary policy. Of these features, the most important are staggered wage contracts that have an average duration of three quarters and variable capital utilization.

Household

- S: Shopping, that is, searching for an appropriate goods supplier

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- U: Seeking work
- J: Working at a job

Search and matching

Success rate for shopper: $\frac{\theta_R}{1+\theta_R}$

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Success rate for job-seeker: $\frac{\theta_J}{1+\theta_J}$

Success rate for retailer attracting customer: $\frac{1}{1+\theta_R}$

Success rate for producer recruiting worker: $\frac{1}{1+\theta_J}$

Household Bellman system

$$H_S = \beta \left(\frac{\theta_R}{1+\theta_R} H_R + \frac{1}{1+\theta_R} H_S \right)$$

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$$H_R = \alpha(\tilde{p} - p) + \beta \left[s_R H_S + (1 - s_R) H_R \right]$$

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$$H_U = \beta \left(\frac{\theta_J}{1+\theta_J} H_J + \frac{1}{1+\theta_J} H_U \right)$$

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$$H_R = \alpha(\tilde{p} - p) + \beta \left[s_R H_S + (1 - s_R) H_R \right]$$

$$H_U = \beta \left(\frac{\theta_J}{1+\theta_J} H_J + \frac{1}{1+\theta_J} H_U \right)$$

$$H_J = w - z\tilde{p} + \beta \left[s_J H_U + (1 - s_J) H_J \right]$$

Household optimization

$$H_S = H_U.$$

Retailer's Bellman system

$$F_O = -k_R y + \beta \left(\frac{1}{1+\theta_R} F_R + \frac{\theta_R}{1+\theta_R} F_O \right)$$

Retailer's Bellman system

$$F_O = -k_R y + \beta \left(\frac{1}{1+\theta_R} F_R + \frac{\theta_R}{1+\theta_R} F_O \right)$$

$$F_R = \alpha(p - y) + \beta \, (1 - s_R) F_R$$

Producer's Bellman system

$$F_V = -k_J y + \beta \left(\frac{1}{1+\theta_J} F_J + \frac{\theta_J}{1+\theta_J} F_V \right)$$

Producer's Bellman system

$$F_V = -k_J y + \beta \left(\frac{1}{1+\theta_J} F_J + \frac{\theta_J}{1+\theta_J} F_V \right)$$

$$F_J = yx - w + \beta \, (1 - s_J) F_J$$

Free entry to retailing and production

$$F_O = 0$$

and

$$F_V = 0.$$

Calibration

s_R and s_J = known value for the labor market of 3 percent per month

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$\theta_R = \theta_J = 1$, implies supplier-finding and job-finding rates of 0.5, and an unemployment rate of 5.7 percent

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α, the number of units of output purchased each period by a buyer, =4.6, from American Time Use Survey

Calibration, continued

Disamenity of work $z = 0.6$

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$\beta = 0.95^{1/12}$

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Normalize productivity at $x = 1$ and the intermediate product price at $y = 1$.

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$\beta = 0.95^{1/12}$

Normalize productivity at $x = 1$ and the intermediate product price at $y = 1$.

Households and sellers have equal shares of the transaction surplus and where workers and producers have equal shares of the employment surplus.

Implications

Value of a shopper or a job-seeker is $H_S = H_U = 73.0$

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Value of a customer relationship or employment relationship $F_R = 0.625$.

Implications

Value of a shopper or a job-seeker is $H_S = H_U = 73.0$

Value of a buyer or a worker is $H_R = H_J = 73.6$

Value of a customer relationship or employment relationship $F_R = 0.625$.

Wage $w = 0.979$

Implications

Value of a shopper or a job-seeker is $H_S = H_U = 73.0$

Value of a buyer or a worker is $H_R = H_J = 73.6$

Value of a customer relationship or employment relationship $F_R = 0.625$.

Wage $w = 0.979$

Product price $p = 1.005$

Implications

Value of a shopper or a job-seeker is $H_S = H_U = 73.0$

Value of a buyer or a worker is $H_R = H_J = 73.6$

Value of a customer relationship or employment relationship $F_R = 0.625$.

Wage $w = 0.979$

Product price $p = 1.005$

Shadow price of the product delivered to the home is $\tilde{p} = 1.077$.

Implications

Value of a shopper or a job-seeker is $H_S = H_U = 73.0$

Value of a buyer or a worker is $H_R = H_J = 73.6$

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Value of a buyer or a worker is $H_R = H_J = 73.6$

Value of a customer relationship or employment relationship $F_R = 0.625$.

Wage $w = 0.979$

Product price $p = 1.005$

Shadow price of the product delivered to the home is $\tilde{p} = 1.077$.

Cost of maintaining a consumer opening $k_R = 0.063$

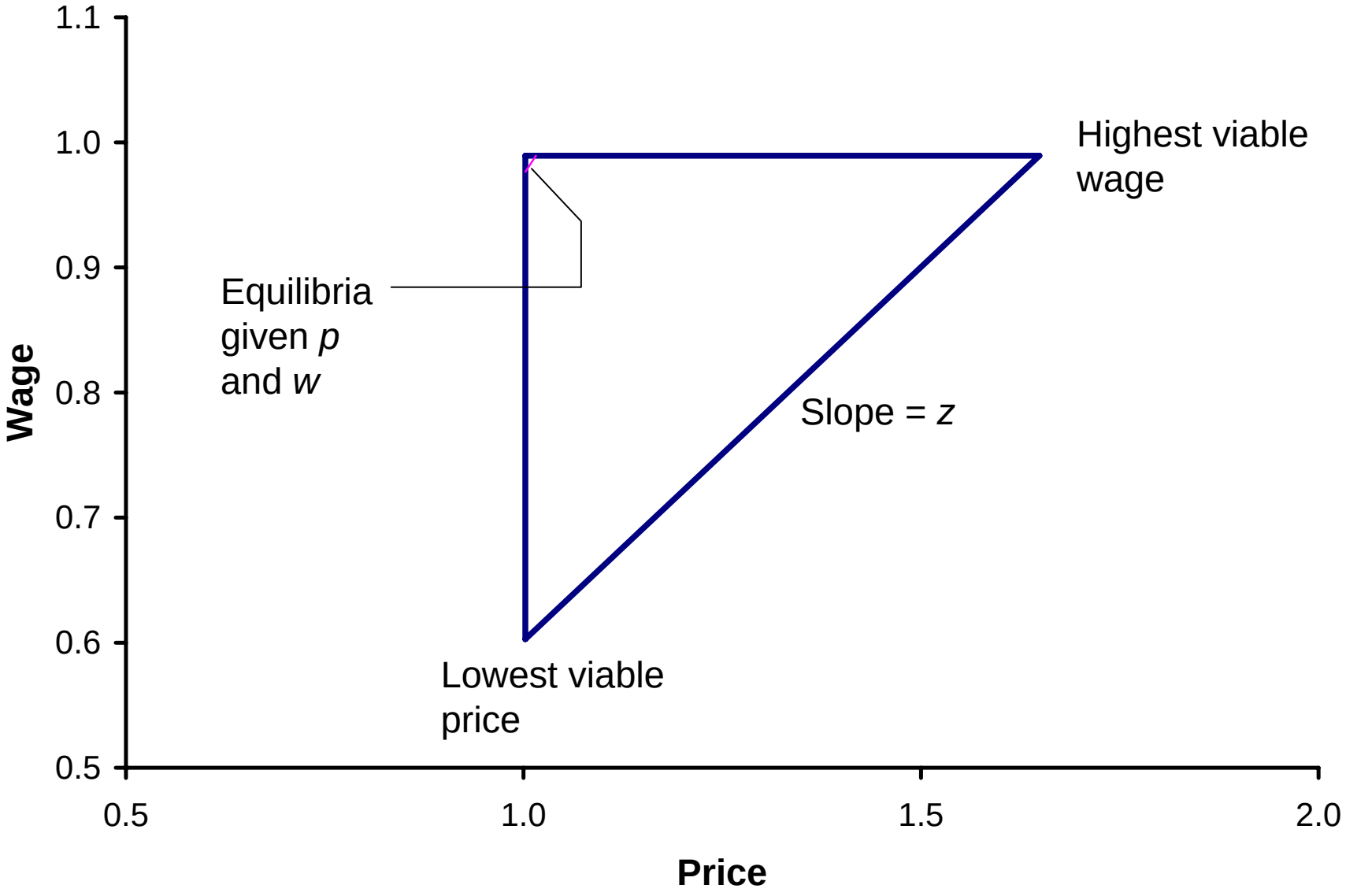
Cost of maintaining a vacancy $k_J = 0.313$.

Homogeneity

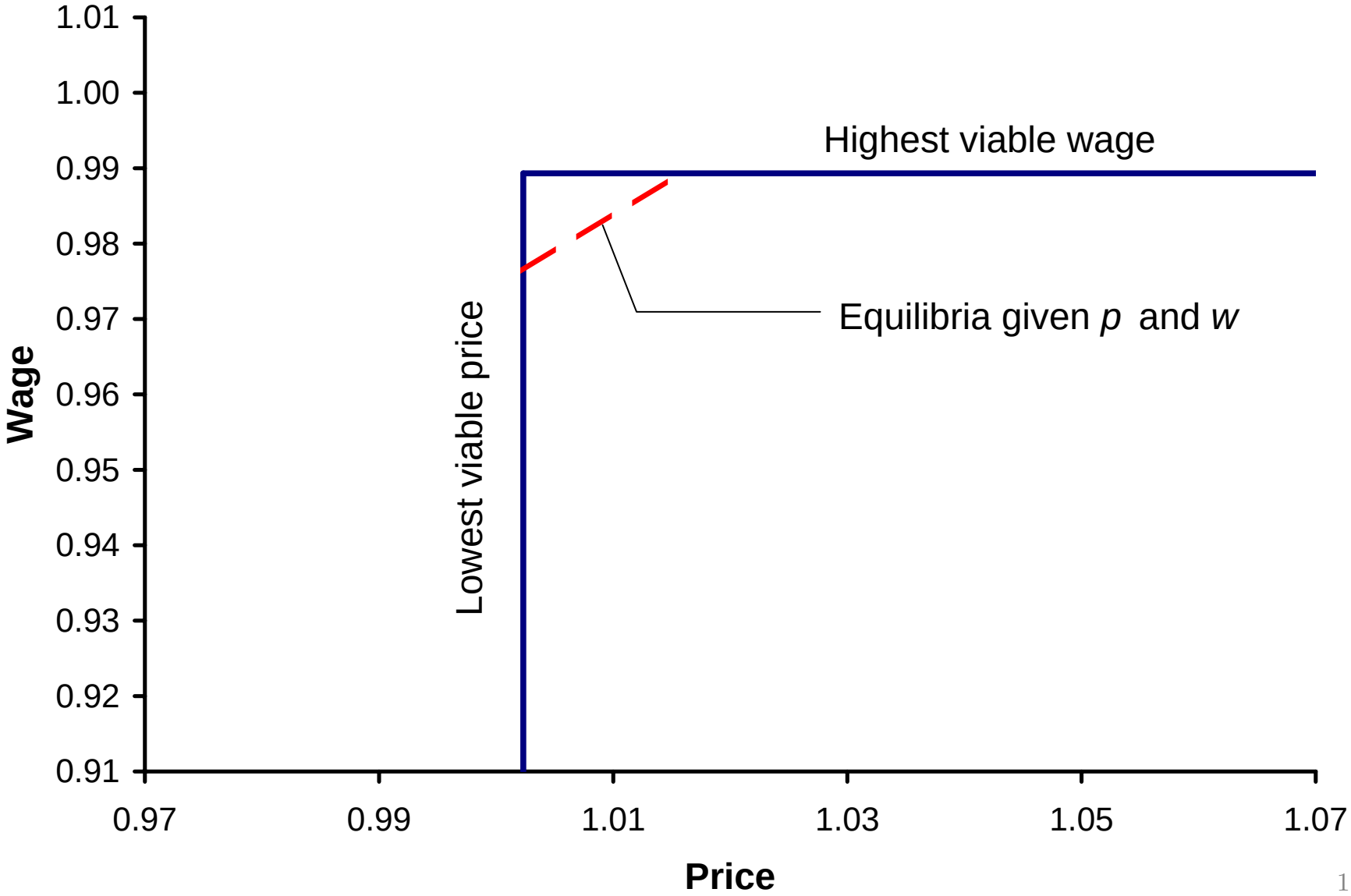
If (p, y, w) is an equilibrium, so is $(\lambda p, \lambda y, \lambda w)$ for any positive λ

Normalize as $(p/y, w/y)$

Equilibrium wage and price



Equilibrium wage and price, magnified



Static equilibrium set

$$z \leq \frac{w}{y} \leq x - \frac{1 - \beta(1 - s_J)}{\beta} k_J$$

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$$z \leq \frac{w}{y} \leq x - \frac{1-\beta(1-s_J)}{\beta} k_J$$

$$\frac{1-\beta(1-s_R)}{\alpha\beta} k_R \leq \frac{p}{y} \leq \frac{w}{yz}.$$

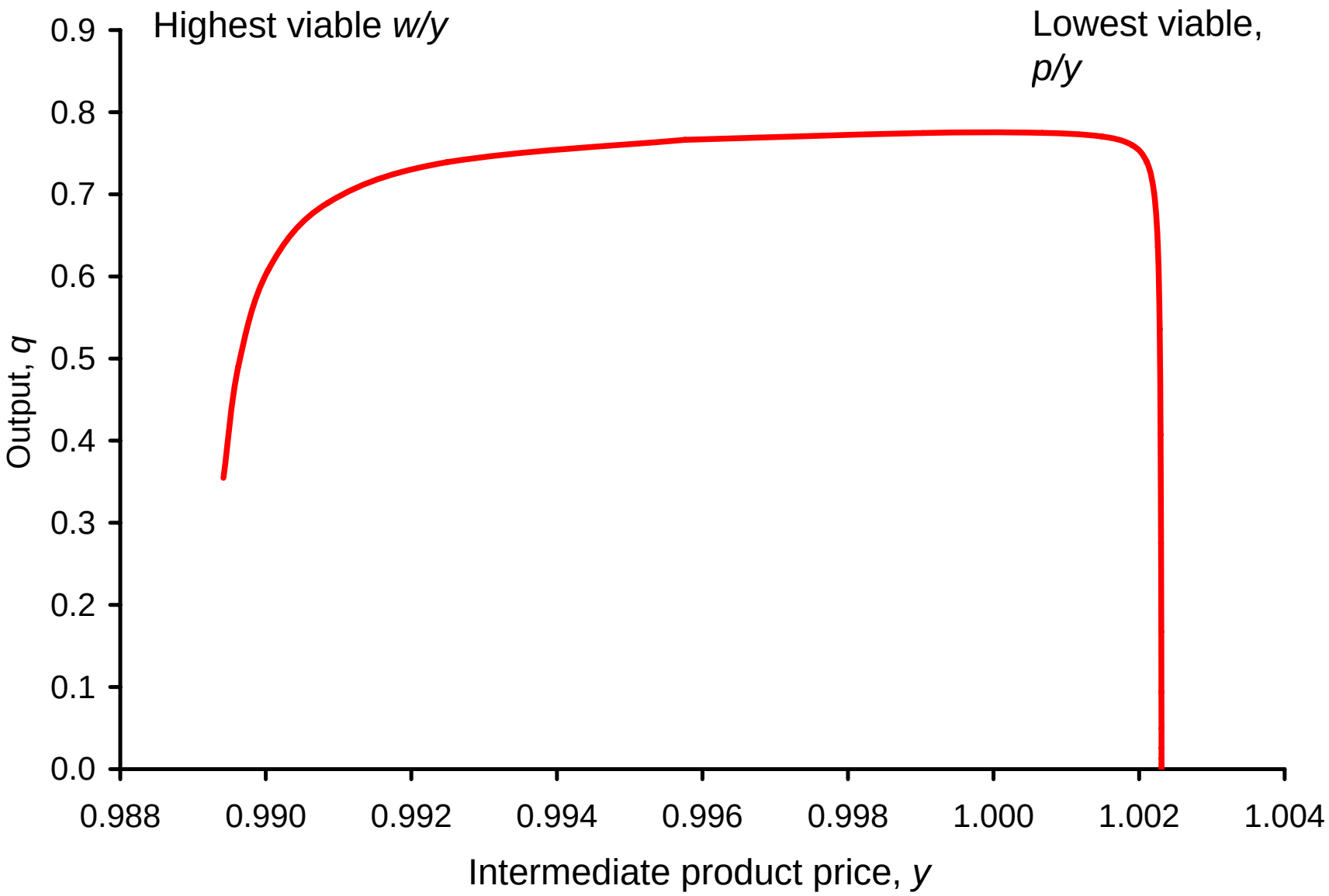
Real wage

$$z \leq \frac{w}{p} \leq \frac{x - \frac{1-\beta(1-s_J)}{\beta} k_J}{\frac{1-\beta(1-s_R)}{\alpha\beta} k_R - 1}$$

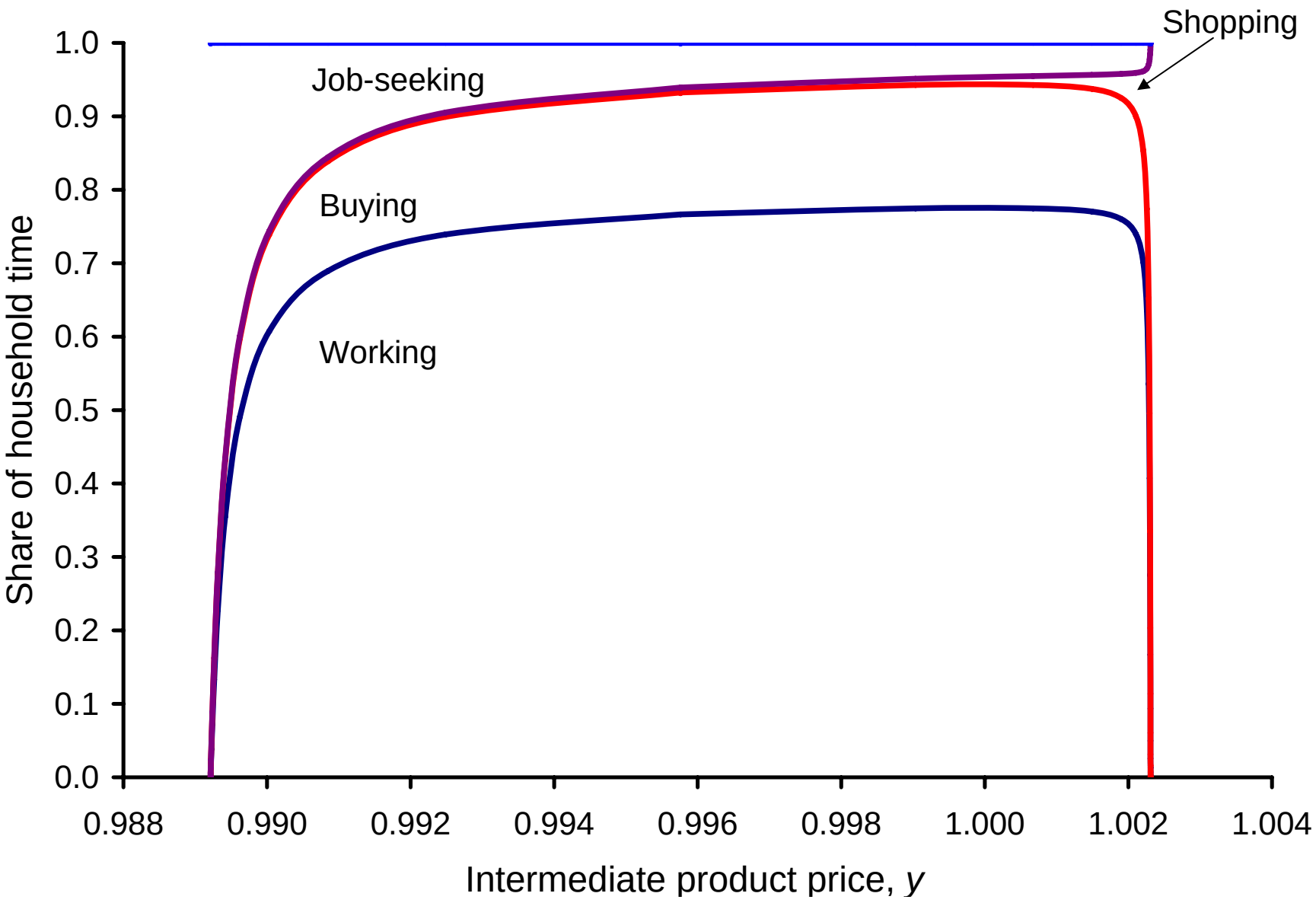
Time allocation

$$\left(1+\frac{s_R(1+\theta_R)}{\theta_R}\right)\frac{q}{\alpha}+\left(1+\frac{s_J(1+\theta_J}{\theta_J}\right)\frac{q}{x}=1$$

Output and price



Allocation of time



Dynamic model

$$H_{S,i} = H_{U,i}.$$

$$H_{S,i} = \beta E\left(\frac{\theta_{R,i}}{1+\theta_{R,i}} H_{R,i'} + \frac{1}{1+\theta_{R,i}} H_{S,i'}\right)$$

$$H_{R,i} = \alpha(\tilde{p}_i - p_{L(i)}) + \beta E\left[s_R H_{S,i'} + (1-s_R) H_{R,i'}\right]$$

$$H_{U,i} = \beta E\left(\frac{\theta_{J,i}}{1+\theta_{J,i}} H_{J,i'} + \frac{1}{1+\theta_{J,i}} H_{U,i'}\right)$$

$$H_{J,i} = w_{L(i)} - z\tilde{p} + \beta E\left[s_J H_{U,i'} + (1-s_J) H_{J,i'}\right]$$

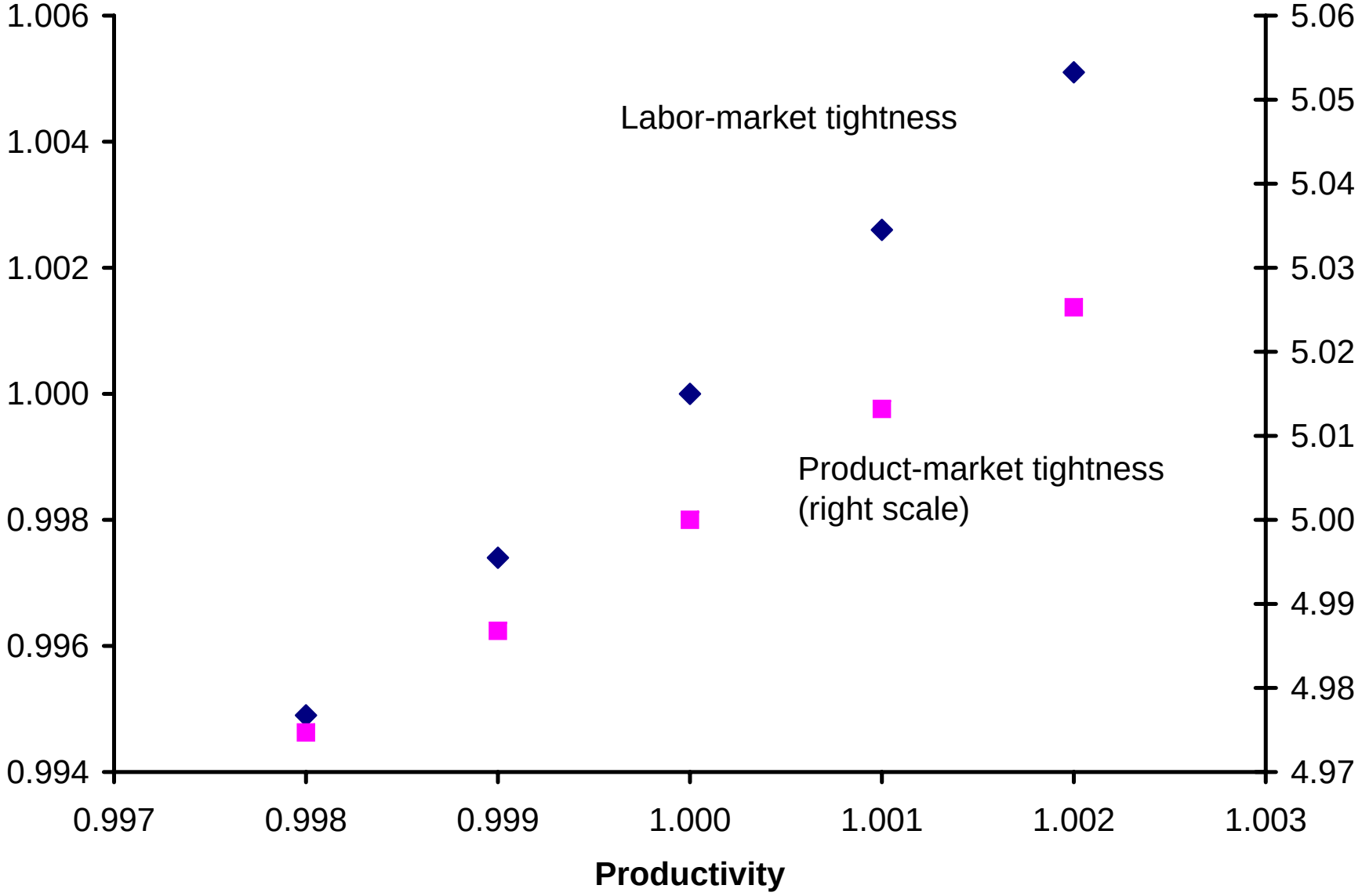
$$0 = -k_R y_i + \beta E\left(\frac{1}{1+\theta_{R,i}} F_{R,i'}\right)$$

$$F_{R,i} = \alpha(p_{L(i)} - y_i) + \beta\ E\left[(1-s_R) F_{R,i'}\right]$$

$$0 = -k_J y_i + \beta E\left(\frac{1}{1+\theta_{J,i}} F_{J,i'}\right)$$

$$F_{J,i} = y_i x_{C(i)} - w_L(i) + \beta\ E\left[(1-s_J) F_{J,i'}\right]$$

Response to productivity



Alternative outcomes

	Productivity				
	Lowest	*Low*	*Medium*	*High*	*Highest*
Productivity	0.998	0.999	1.000	1.001	1.002
Stabilize labor market					
Labor market tightness	1.00	1.00	1.00	1.00	1.00
Product market tightness	2.2	3.3	5.0	6.7	7.8
Intermediate price	0.9993	0.9982	0.9972	0.9962	0.9951
Stabilize product market					
Labor market tightness	0.88	0.93	1.00	1.07	1.12
Product market tightness	5.0	5.0	5.0	5.0	5.0
Intermediate price	0.9972	0.9972	0.9972	0.9972	0.9972

Central bank policy

$$\bar{y}_\iota = E(y_i | C(i) = \iota)$$

Hypothetical economy

$$H_{R,\iota} - H_{S,\iota} = F_{R,\iota},$$
$$H_{J,\iota} - H_{U,\iota} = F_{J,\iota},$$

Let the price and wage in this hypothetical economy be $\hat{p}_\iota$ and $\hat{w}_\iota$

Hawk and dove policies

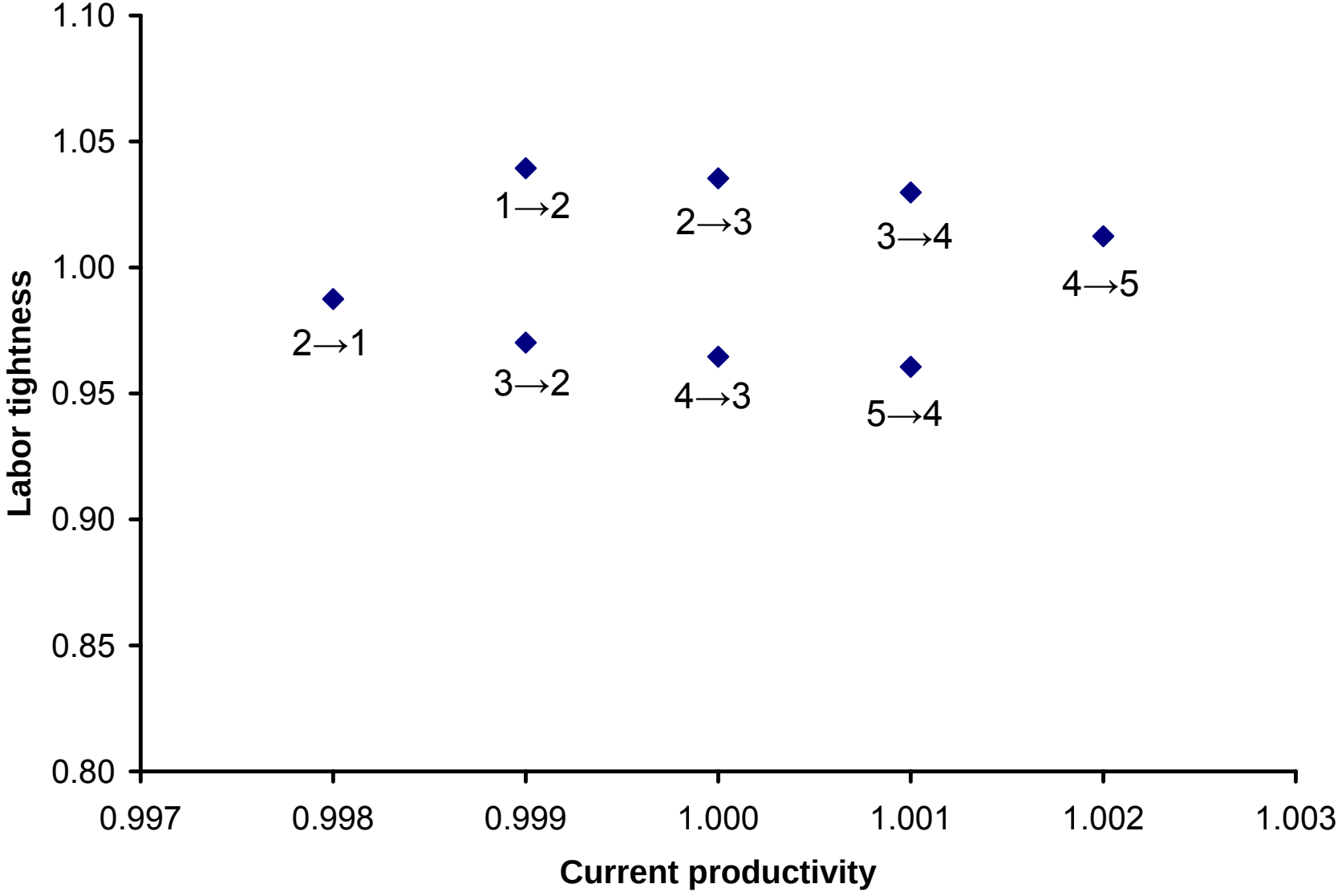
Hawk: Solve the hypothetical model for the policy $y_{H,i}$ that keeps the price level p_ι constant across the fundamental states

Hawk and dove policies

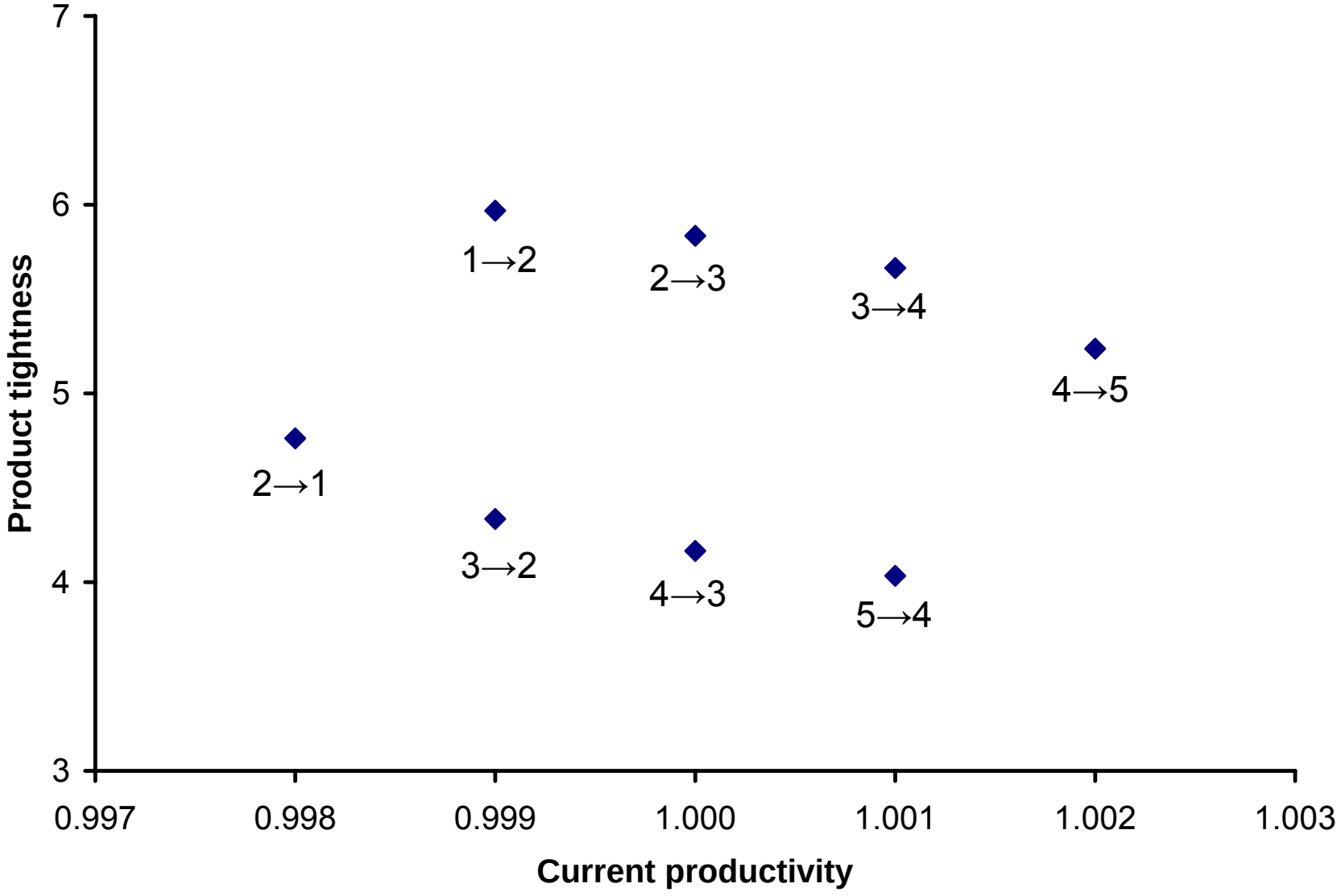
Hawk: Solve the hypothetical model for the policy $y_{H,i}$ that keeps the price level p_ι constant across the fundamental states

Dove: solve for the policy $y_{D,i}$ that keeps θ_J constant

Hawk policy


1.10
1.05
1.00
0.95
0.90
0.85
0.80
Labor tightness
0.997
0.998
0.999
1.000
1.001
1.002
1.003
Current productivity
1→2
2→3
3→4
4→5
2→1
3→2
4→3
5→4

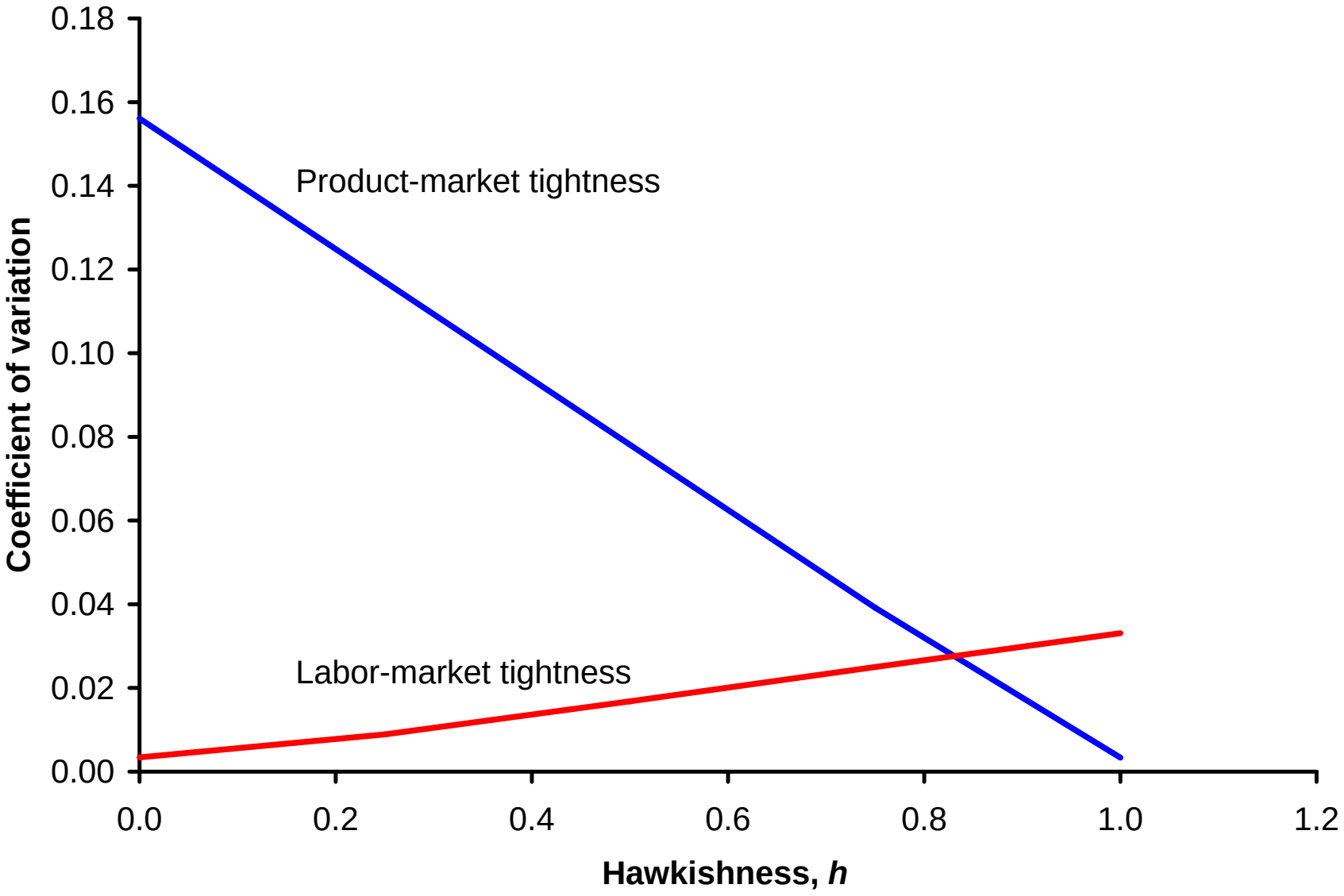
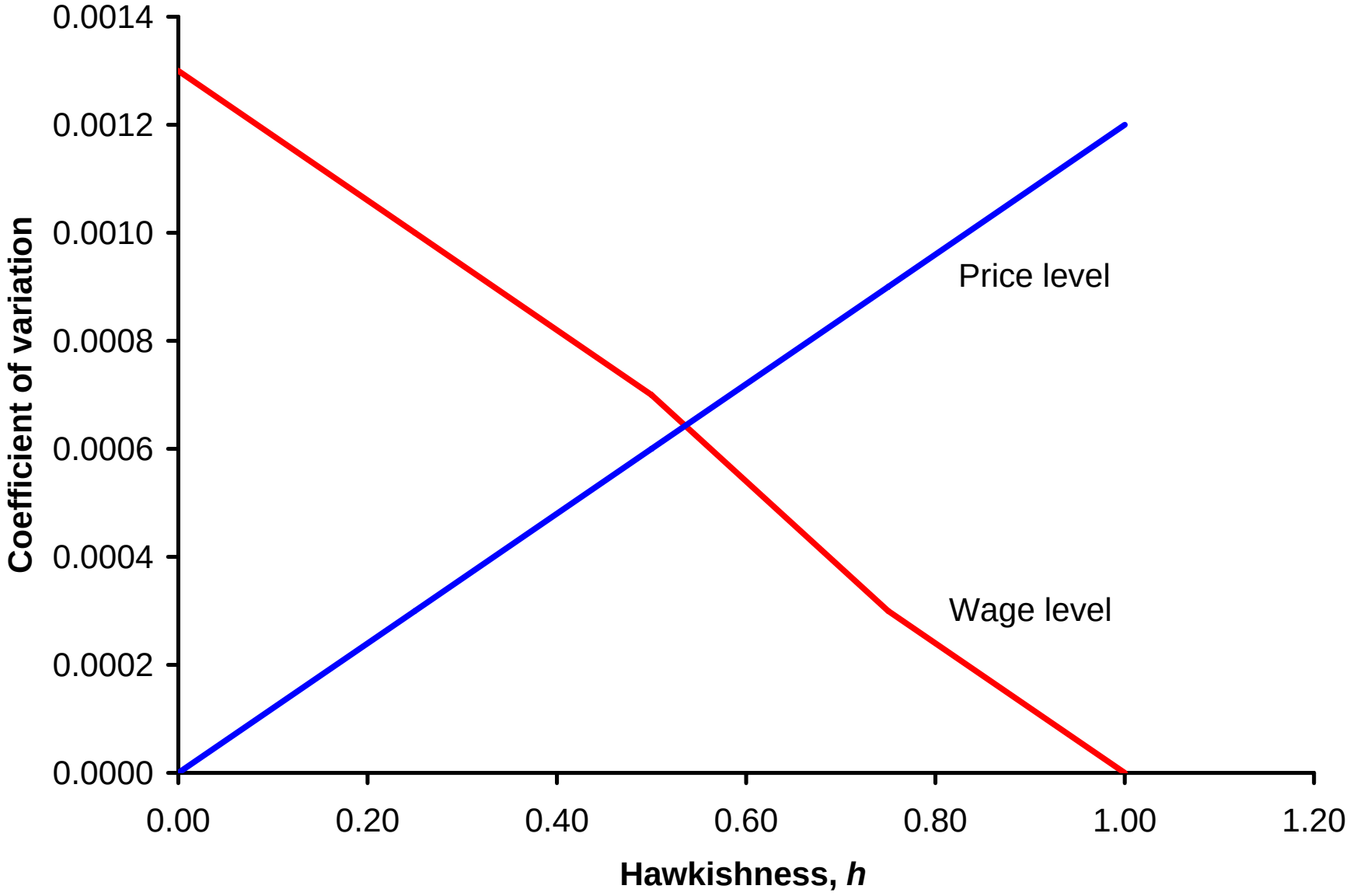
Dove policy


7
6
5
4
3
Product tightness
1→2
2→3
3→4
4→5
2→1
3→2
4→3
5→4
0.997
0.998
0.999
1.000
1.001
1.002
1.003
Current productivity

Policy frontier

$$y_i = hy_{H,i} + (1-h)y_{D,i}.$$

Volatility of tightness



Volatilities of price and wage