Cyclical Behavior of Equilibrium Unemployment and Vacancies

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Question

Can a calibrated search and matching model match cyclical component of unemployment and vacancy data for reasonable magnitudes of shocks?

Finding

- No. The calibrated model is just 10$\%$ as volatile as data. Shocks of reasonable magnitude do not generate enough amplification.
- Reason-Wages are closely tied with labor productivity. When labor productivity increases, increase in wage absorbs most of the increase in productivity.

U.S. labor market data

- Unemployment (u)
  - Data-CPS, quarterly, 1951 to 2003.
  - It is countercyclical.
- Vacancies (v)
  - Data: Help-wanted index (Conference Board).
  - It is procyclical.

Vacancies-Unemployment ratio (θ)

- "Beveridge curve"
- Correlation is -0.89 and it is extremely procyclical.

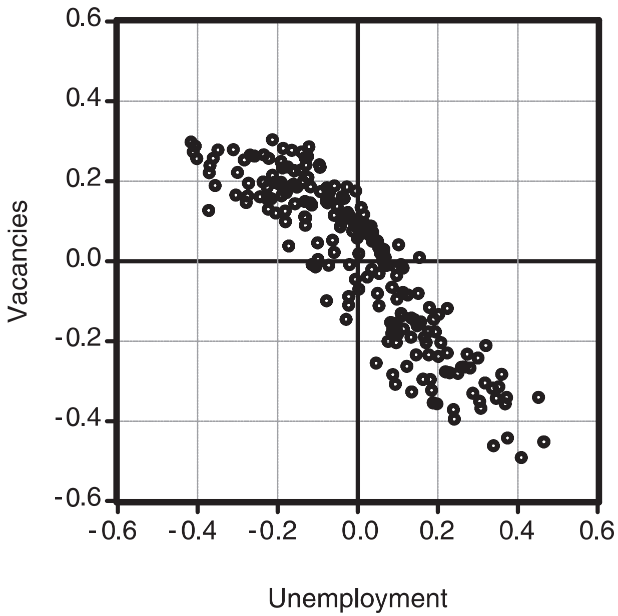

FIGURE 4. QUARTERLY U.S. BEVERIDGE CURVE, 1951–2003

U.S. labor market data (contd.)

- Job-finding rate (f)
  - It is the rate at which an unemployed worker finds a job.
  - The number of newly hired workers is given by an increasing and constant returns to scale matching function $m(u, v)$.
  - $f = m(u, v)/u = m(1, \theta)$.
  - f is measured using the following relationship

$$u_{t+1} = u_t(1 - f_t) + u^s_{t+1}.$$

Matching function

- Using the relationship between f and θ, and assuming that $m(1, \theta) = \mu\theta^{1-\alpha}$, estimate α. It is 0.72.

FIGURE 6. MONTHLY U.S. MATCHING FUNCTION, 1951–2003

Notes: The v-u ratio is constructed by the BLS from the CPS and by the Conference Board. The job-finding rate is constructed using equation (1) and BLS data from the CPS. Both are quarterly averages of seasonally adjusted monthly series and are expressed as deviations from an HP filter with smoothing parameter 10^5.

U.S. labor market data (contd.)

- Separation rate (s)
  - It is the rate at which an employed worker loses his/her job.
  - Simple measure: $u^s_{t+1} = e_t s_t$. Assumes that a separated worker cannot find a job within a month.
  - Better measure: $u^s_{t+1} = e_t s_t (1 - 0.5 f_t)$. On average the worker has half a month to find a new job before he is recorded as unemployed.
  - It is procyclical.
- Labor productivity (p)
  - Data series: Real output per person in non-farm business sector.
  - It is weakly procyclical.

Summary of data

TABLE 1—SUMMARY STATISTICS, QUARTERLY U.S. DATA, 1951–2003

	u	v	v/u	f	s	p
	0.190	0.202	0.382	0.118	0.075	0.020
	0.936	0.940	0.941	0.908	0.733	0.878
u	1	−0.894	−0.971	−0.949	0.709	−0.408
v	—	1	0.975	0.897	−0.684	0.364
v/u	—	—	1	0.948	−0.715	0.396
f	—	—	—	1	−0.574	0.396
s	—	—	—	—	1	−0.524
p	—	—	—	—	—	1

Model

Workers and firms

- There is a continuum of infinitely lived workers of measure 1. And there is a a continuum of infinitely lived firms. There is free entry of firms.
- Workers can either be employed and get wages w or they can be unemployed and get utility from leisure z.
- Firms can either be matched with a worker with profits $p - w$ or have a vacancy at cost c.
- Wages are determined through a Nash bargaining process. $\beta \in (0, 1)$ is the bargaining power of workers.

Exogenous shock process

- Labor productivity (p) and separation rate (s) are stochastic and they follow a first order Markov process.
- An aggregate shock hits the economy according to a Poisson process with arrival rate λ at which point a new pair (p', s') is drawn from a state dependent distribution.

Matching process

- u_t is the number of unemployed people, $e_t = 1 - u_t$ is the number of employed people, and v_t is the number of vacancies posted and $m(u_t, v_t)$ be the matching function at date t.
- $f(\theta) = m(1, \theta)$ is the probability with which unemployed worker finds a job and $q(\theta) = f(\theta)/\theta$ is the probability that a vacancy finds an unemployed worker.
- Evolution of unemployment is given by

$$\dot{u}_t = s_t(1 - u_t) - f(\theta_{p(t),s(t)})u_t$$

where $p(t)$ and $s(t)$ is the aggregate state at date t.

Equilibrium

Following Bellman equations describe the model

$$rU_{p,s} = z + f(\theta_{p,s})(E_{p,s} - U_{p,s}) + \lambda(Exp_{p,s}U_{p',s'} - U_{p,s})$$

$$rE_{p,s} = w_{p,s} + s(U_{p,s} - E_{p,s}) + \lambda(Exp_{p,s}E_{p',s'} - E_{p,s})$$

$$rJ_{p,s} = p - w_{p,s} + s(0 - J_{p,s}) + \lambda(Exp_{p,s}J_{p',s'} - J_{p,s})$$

Key equation

Since $V_{p,s} = J_{p,s} + E_{p,s} - U_{p,s}$, $(E_{p,s} - U_{p,s}) = \beta V_{p,s}$, and there is free entry such that $c = q(\theta_{p,s})(1-\beta)V_{p,s}$, we get

$$\frac{r+s+\lambda}{q(\theta_{p,s})} + \beta\theta_{p,s} = (1-\beta)\frac{p-z}{c} + \lambda\frac{1}{q(\theta_{p',s'})}$$

- Elasticity of $v-u$ ratio with respect to net productivity $p-z$ is 1.03. Lower values of β increase this elasticity.
- Elasticity of $v-u$ with respect to separation rate s is -.10.

Calibration I

Stochastic process

- Poisson shock hits $\rightarrow$ underlying variable y moves up or down by one point $\rightarrow$ stochastic variables p and s are functions of y.
- Model y as a *Ornstein Uhlenbeck* process. Hence y is stationary, mean reverting and has bounded variance.
- Two cases
  - s is constant but p satisfies $p = z + e^y(p^* - z)$.
  - p is constant but s satisfies $s = e^y s^*$.

Calibration II

TABLE 2—PARAMETER VALUES IN SIMULATIONS OF THE MODEL

	Source of shocks	
Parameter	Productivity	Separation
Productivity p	stochastic	1
Separation rate s	0.1	stochastic
Discount rate r	0.012	0.012
Value of leisure z	0.4	0.4
Matching function $q(\theta)$	$1.355\theta^{-0.72}$	$1.355\theta^{-0.72}$
Bargaining power β	0.72	0.72
Cost of vacancy c	0.213	0.213
Standard deviation σ	0.0165	0.0570
Autoregressive parameter γ	0.004	0.220
Grid size $2n + 1$	2001	2001

Results I

TABLE 3—LABOR PRODUCTIVITY SHOCKS

	u	v	v/u	f	p
	0.009	0.027	0.035	0.010	0.020
	(0.001)	(0.004)	(0.005)	(0.001)	(0.003)
	0.939	0.835	0.878	0.878	0.878
	(0.018)	(0.045)	(0.035)	(0.035)	(0.035)
u	1	−0.927	−0.958	−0.958	−0.958
		(0.020)	(0.012)	(0.012)	(0.012)
v	—	1	0.996	0.996	0.995
			(0.001)	(0.001)	(0.001)
v/u	—	—	1	1.000	0.999
				(0.000)	(0.001)
f	—	—	—	1	0.999
					(0.001)
p	—	—	—	—	1

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Results II

TABLE 4—SEPARATION RATE SHOCKS

	u	v	v/u	f	s
	0.065	0.059	0.006	0.002	0.075
	(0.007)	(0.006)	(0.001)	(0.000)	(0.007)
	0.864	0.862	0.732	0.732	0.733
	(0.026)	(0.026)	(0.048)	(0.048)	(0.048)
u	1	0.999	−0.906	−0.906	0.908
		(0.000)	(0.017)	(0.017)	(0.017)
v	—	1	−0.887	−0.887	0.888
			(0.020)	(0.020)	(0.021)
v/u	—	—	1	1.000	−0.999
				(0.000)	(0.000)
f	—	—	—	1	−0.999
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Conclusion

- Search and matching model where wages are determined through Nash bargaining cannot generate substantial movements along the Beveridge curve in response to shocks.
- Better model for wage determination.
- Results from Hagedorn and Manovskii: Higher z and lower β.