Cyclical Upgrading of Labor and Unemployment Differences Across Skill Groups

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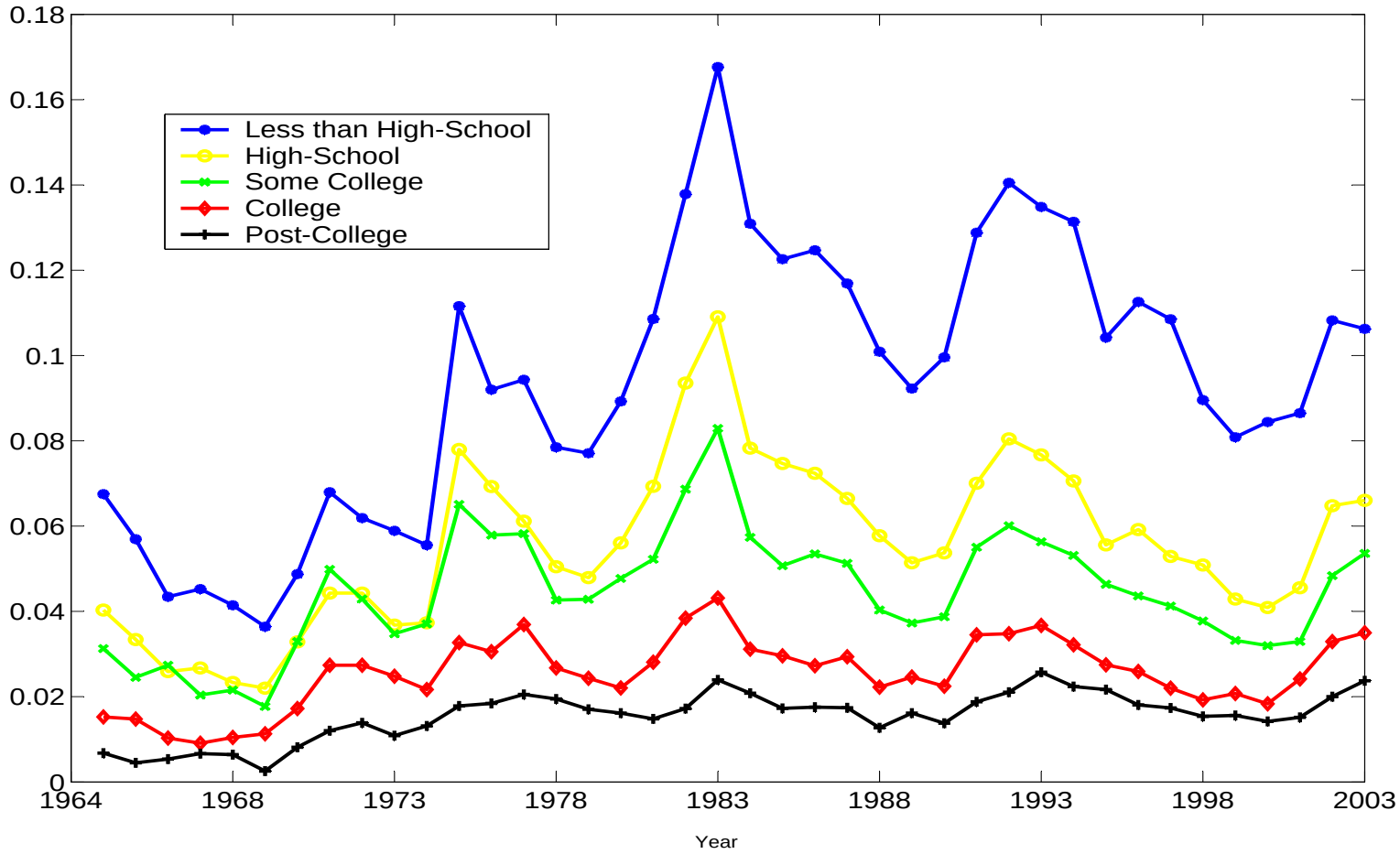
Motivation- Facts (cont.)

Typically, the burden of joblessness falls on the less educated.

- The unemployment (employment) rate falls (rises) with education.
- Exit rates from unemployment rise with education.
- Cyclical sensitivity of employment rates falls with education
  - measured as the standard deviation of percentage deviations from trend.

Unemployment rates of civilians between the ages 22 to 65. Source: March CPS, Annual Demographic Survey files.



Motivation- Facts (cont.)

Possible Explanations:

- Skilled individuals accumulate firm specific capital, making it more difficult for firms to make them redundant.
  - but, as Shimer (2005) and Hall (2005) point out, separation rates are almost acyclical.
- High productivity gains associated with hiring skilled individuals.
- Skilled individuals are relatively more likely to search on the job than off the job (Nickell, 1979).

Motivation- Facts (cont.)

This last channel (on-the-job search) is supported by a number of empirical observations:

- On average, 17-18% of college graduates are in jobs that do not require a college degree (Hecker, 1992, 1995)
- The proportion of job-to-job transitions in total separations rise with education (Nagypal, 2008)
- The proportion of quits followed by direct transition to a new job rise with education (Nagypal, 2008)
- The propensity to search on the job rises with education (Pissarides and Wadsworth, 1994)

This Paper:

- Investigates the importance of a vertical type of skill-mismatch – workers accept jobs below their skill level to escape unemployment and upgrade by on-the-job search – in explaining the cyclical behavior of unemployment rates of different skill groups.

- **Framework:** a stochastic search and matching model of the labor market that features:
  - **two-sided heterogeneity**: high- and low-skill jobs; high- and low-skilled workers
  - **minimum skill requirements of jobs** (asymmetric matching): high-skilled workers can perform both skilled and unskilled jobs, whereas low-skilled individuals only low-skill jobs
  - **random search:** workers cannot ex-ante target jobs – captures across-skill congestion effects in job search
  - **on-the-job search:** high-skill workers accept transitorily low-skill jobs, and upgrade by on-the-job search, thereby influencing the probability low-skilled workers find jobs

This Paper - (cont):

By accepting transitorily low-skill jobs high-skilled workers influence the profits of low-kill vacancies in two countervailing ways:

- lower recruitment costs by raising the effective matching rate of low-skill firms
- lower the expected surplus of low-skill jobs because their more likely to quit

Existing Literature

- Models with asymmetric matching: focus on skill biased productivity shocks and the crowding out of low-skill workers—long run implications(Albrecht and Vroman, 2002, Gautier, 2002, Dolado et al., 2004.)
- The role of cyclical skill-mismatch and on-the-job search have been emphasized in Barlevy (2002), but in a symmetric framework – focuses on productivity implications, and more recently in Krause and Lubik (2006), but without worker heterogeneity – focuses on implications for worker mobility patterns.
- A recent strand of literatures focuses on adjusting the standard search and matching model to match the observed business cycle fluctuations by introducing worker heterogeneity and on-the-job search, but their focus is not on across-skill differences (Pries, 2006, Krause and Lubik, 2007, Nagypal, 2008.)

Findings

- After accounting for separation rates and productivity differences, I find that on average 17.9% of college graduates are in jobs that require less than college education (in line with evidence.)

- The share of over-educated college graduates is countercyclical; transitions to suitable jobs happen more frequently in booms – consistent with the salient regularity that job-to-job transitions are procyclical, and evidence that the quality of job-worker matches is lower in recessions.

- On-the-job search is important – a model without this feature fails to match the observed unemployment rate patterns
  - requires unrealistically high skill premiums to match the so much lower unemployment rate of skilled workers
  - even then, produces an excessively volatile low-skill unemployment rate relative to high-skill unemployment rate.

Findings-(cont)

Consequences of transitory over-education on the less educated:

- By accepting transitorily low-skill jobs high-skill workers crowd out low-skill workers into unemployment, but the impact on cyclical sensitivity of the low-skill unemployment rate is small.

Outline

- Brief presentation of the model.
- Model analysis.
  - steady state analytical results
  - calibration and numerical simulations of stochastic model-quantitative results.
- Summary.

The Standard Search and Matching Model

- Each worker can be in any of the two states:
  - employed and producing
  - unemployed and searching for a job.
- Each firm has one job, which can be in any of the two states:
  - filled and producing
  - vacant and searching for a worker.
- Nash bargaining in wage setting: the worker and firm share the surplus of a match in fixed proportions.
  - the surplus is net of each party's value of opportunities outside the match
  - both parties agree to match as long as the match surplus is positive.
- Separations occur exogenously.
- Key variable: workers' job finding rate, which determines the unemployment rate – it depends positively on the number of vacancies per unemployed

The Standard Search and Matching Model-(cont)

- Free-entry: vacancies are posted until the value of posting an additional vacancy drops to zero.
- There are recruitment costs associated with setting up and filling vacancies; keeps firms from posting ∞ number of vacancies
- The number of vacancies posted (per unemployed) increases when jobs generate higher surplus. In turn, the job surplus depends on:
  - job productivity (positively)
  - separation rate (negatively)
  - worker's opportunity cost of working: unemployment benefit, home production, value of leisure, value of giving up searching etc. (negatively)

Model

- A fraction δ of the labor force is high-skilled and a fraction $(1-\delta)$ low-skilled.
- Firms post either low-skill vacancies that are suitable for low-skilled workers but can be filled by high-skilled workers as well, or high-skill vacancies that can be filled only by high-skilled workers until the value of each type of vacancy drops to zero (2 free entry conditions).
- As long as the wage low-skill firms offer is higher than high-skilled workers' opportunity cost of working, the possibility of on-the-job search induces high-skilled workers to accept low-skill jobs, until a high-skill job comes along.
- Mismatched workers always have incentive to search on the job, because the wage they can earn in a high-skill job is higher.

Model – Match Productivities

- Product of a match specific component α_{ij} and an aggregate component y, which is stochastic.

- $\alpha_{hl} - b_h > 0$ where b_h is the high-skilled workers' opportunity costs of working – ensures that wage low-skill firms offer to over-educated workers is higher than b_h.

- High-skilled workers are best suited for high-skill jobs: $\alpha_{hh} - b_h \geq \alpha_{hl} - b_h$ – ensures that the match surplus, and thus the wage offered, is higher when high-skilled workers are suitably matched – incentive to search on the job.

- Low-skilled workers are at least as productive as high-skilled workers in low-skill jobs: $\alpha_{ll} - b_l \geq \alpha_{hl} - b_h$ – ensures that firms with low-skill vacancies prefer hiring low- instead of high-skill workers, because the latter are more likely to quit.

Model – Matching

- $m(v_t, z_t)$ is the number of worker-vacancy meetings
  - $z_t = u_t^h + u_t^l + e_t^{hl}$ = high- and low-skill unemployed + on-the-job searchers (total number of searchers)
  - $v_t = v_t^h + v_t^l$ = high- + low-skill vacancies (total number of vacancies)
  - $m(.,.)$ has CRTS
- $\frac{m(v_t,z_t)}{z_t} = m(\theta_t)$ is the number of meetings per job seeker $(m'(\theta_t) > 0)$
- $\frac{m(v_t,z_t)}{v_t} = q(\theta_t)$ is the number of meetings per vacancy $(q'(\theta_t) < 0)$
- $\theta_t = \frac{v_t}{z_t}$ measures market tightness

Firm's matching rates:

- Low-High: $q(\theta_t)\frac{u_t^h}{z_t}$
- Low-Low: $q(\theta_t)\frac{u_t^l}{z_t}$
- High-High: $q(\theta_t)\frac{u_t^h+e_t^{hl}}{z_t}$
- High-Low: NONE

Worker's matching rates

- Low-Low: $m(\theta_t)\frac{v_t^l}{v_t}$
- High-Low: $m(\theta_t)\frac{v_t^l}{v_t}$
- High-High: $m(\theta_t)\frac{v_t^h}{v_t}$
- Low-High: NONE

Laws of Motion:

$$
\begin{aligned}
e_{t+1}^{ll} &= e_t^{ll}(1-s_l) + m(\theta_t)\eta_t u_t^l \\
e_{t+1}^{hh} &= e_t^{hh}(1-s_h) + m(\theta_t)(1-\eta)\left[u_t^h + e_t^{hl}(1-s_h)\right] \\
e_{t+1}^{hl} &= e_t^{hl}(1-s_h) + m(\theta_t)\eta_t u_t^h - m(\theta_t)(1-\eta)e_t^{hl}(1-sh)
\end{aligned}
$$

where e_t^{ij} is the number of matches (employed) of each type, $\eta_t = \frac{v_t^l}{v_t}$, and s_i the exogenous separation rate.

Model – Free Entry Conditions

$$\frac{c_l}{q(\theta_t)} = \frac{(1-\gamma)}{(1+r)} E_t \left[\left(\frac{u_t^l}{z_t}\right) S_{t+1}^{ll} + \left(\frac{u_t^h}{z_t}\right) S_{t+1}^{hl} \right]$$

$$\frac{c_h}{q(\theta_t)} = \frac{(1-\gamma)}{(1+r)} E_t \left[\left(\frac{u_t^h + e_t^{hl}}{z_t}\right) S_{t+1}^{hh} \right]$$

where S^{ij} is the match surplus, c_i the recruitment costs, and γ, the worker's bargaining share.

Each condition equates recruitment costs (LHS) to the expected surplus of filling a vacancy (RHS).

These conditions give the equilibrium value of θ and η (the vacancy mix) for each realization of aggregate state y and employment distribution $e_t = \{e_t^{hh}, e_t^{hl}, e_t^{ll}\}$, which evolves according to the lows of motion defined above.

Free Entry Conditions-(cont)

$$\frac{c_l}{q(\theta_t)} = \frac{(1-\gamma)}{(1+r)} E_t \left[\left(\frac{u_t^l}{z_t}\right) S_{t+1}^{ll} + \left(\frac{u_t^h}{z_t}\right) S_{t+1}^{hl} \right]$$

$$\frac{c_h}{q(\theta_t)} = \frac{(1-\gamma)}{(1+r)} E_t \left[\left(\frac{u_t^h + e_t^{hl}}{z_t}\right) S_{t+1}^{hh} \right]$$

Note that shifts in the composition of job seekers affect the expected surpluses unevenly:

- $\uparrow \frac{e^{hl}}{z}$ (or $\downarrow \frac{u^h+u^l}{z}$) lowers the expected surplus of low-skill vacancies and raises the expected surplus of high-skill vacancies
- $\downarrow \frac{u^l}{z}$ (or $\uparrow \frac{u^h}{z}$) lowers the expected surplus of low-skill vacancies and raises the expected surplus of high-skill vacancies, because $E_t[S_{t+1}^{ll} - S_{t+1}^{hl}] > 0$.

A permanent fall in Aggregate Productivity (y)

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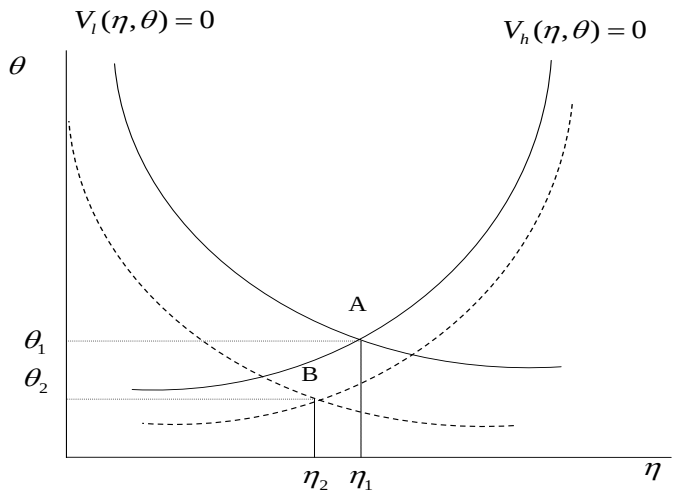


- when y falls firms post fewer vacancies per job searcher; θ declines
- a fall in y has a stronger negative impact on the value of low-skill vacancies; $\eta = \frac{v_l}{v}$ declines

Reason: the productivity of low-skill jobs net of the opportunity cost of working is lower than that of high-skill jobs. The same productivity shock has a greater impact in percentage terms on net productivity and thus, match surplus when net productivity is small (also pointed out by Shimer (2005), Hagedorn and Manovskii (2007) and Pries (2007)).

A permanent fall in Aggregate Productivity (y)-(cont)

Hence, the model suggests that vacancy posting in the low-skill sector is more volatile than in the high-skill sector.

How does transitory over-education affects volatility?

It amplifies volatility in the low-skill sector, while moderating volatility in the high-skill sector.

A permanent fall in Aggregate Productivity (y)-(cont)

Reason:

- A larger weight is placed on the surplus generated by over-educated workers (S^{hl}), which is smaller, and therefore more volatile.
- The opposite holds for high-skill vacancies. A larger weight is placed on the surplus generated by workers accepting jobs in both sectors (S_2^{hh}) which is less volatile, and a smaller weight on the surplus generated by workers accepting only high-skill jobs (S_1^{hh}) which is more volatile.

Steady-State Free Entry Conditions:

$$\frac{c_l}{q(\theta)} = \frac{(1-\gamma)}{(1+r)}\left[(\frac{u^l}{z})S^{ll} + (\frac{u_2^h}{z})S^{hl}\right]$$

$$\frac{c_h}{q(\theta)} = \frac{(1-\gamma)}{(1+r)}\left[(\frac{u_2^h + e^{hl}}{z})S_2^{hh} + (\frac{u_1^h}{z})S_1^{hh}\right]$$

and $S_2^{hh} = S_1^{hh} - \gamma m(\theta)\eta S^{hl}$

Calibration

Parameter	Value	Data Match
Proportion of low-skill(δ)	0.73	Proportion of high-school grad. without college degree (CPS, ADF 1964-2003)
Discount rate (r)	0.012	Time period: one quarter
Sep. rates (s_l and s_h)	0.6 and 0.3	Nagypal's (2004) monthly estimates (CPS, ADF, March 1994 -January 2004)
Recruit. costs (c_l and c_h)	0.14 0.22	Less than 5% of total output and roughly equal to one month's wages
Match. Parameter (a)	0.4	Lies at the lower range of estimates of Petrongolo and Pissarides (2001)
Worker's bargaining share (γ)	0.5	Standard choice

- Cobb Douglas matching technology: $m(v,z) = z^a v^{(1-a)}$
- Aggregate productivity was calibrated to approximate through a 9-state Markov Chain the U.S. GDP, from 1963 to 2003
- Separation rates where adjusted to account for those moving from employment to out of the labor force, but still take part in matching.

Calibration-(cont)

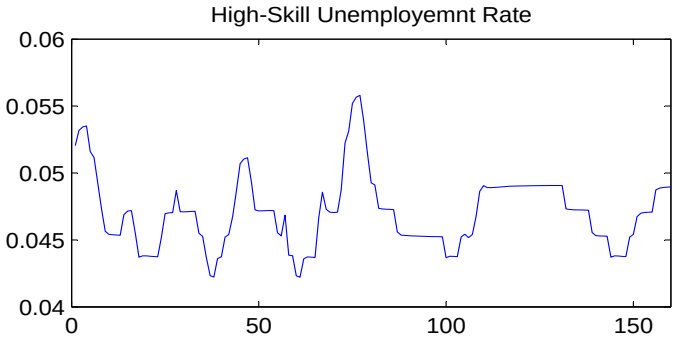
I choose values for match productivities and opportunity costs of working $\{a_{hh} = 0.66, a_{ll} = 0.41, a_{hl} = 0.57, b_h = 0.51, b_l = 0.29\}$ to match:

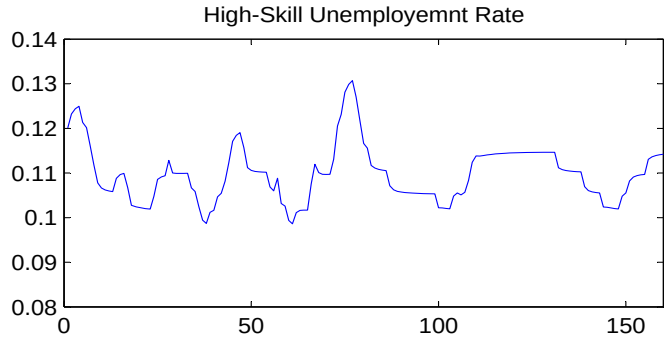
- the unemployment rate of college graduates and workers with less than college education— 0.044 and 0.11, respectively, inflated to account for out of the labor force job seekers (CPS, ADF 1963-2003)
- average job finding rate of 0.06 adjusted to account for the out of the labor force job searchers, estimated in Hall (2005)
- college-plus wage premium of 55% (CPS, ADF 1963-2003.)
- wage differences between suitably matched and over-educated workers. The latter, earn 5% less according to Sicherman (1991). Considering this as a lower bound, I target 10%

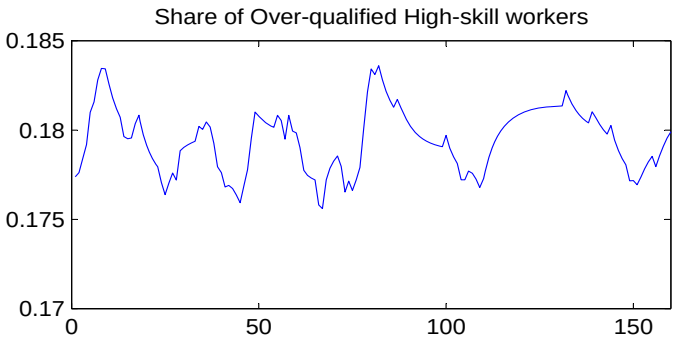
Results

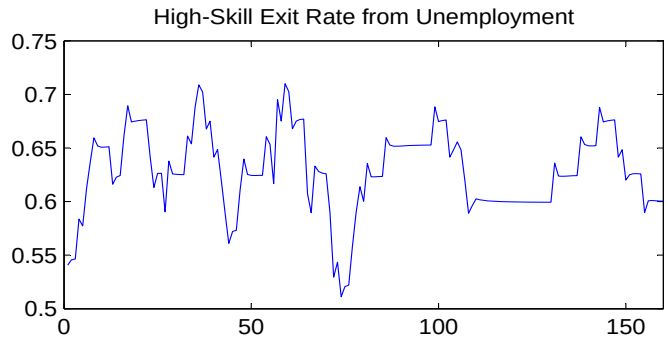
Variable	Model	Data
Fraction of low-skill vacancies (η)	0.83	
Probability of a low-skill match ($m(\theta)\eta$)	0.59	
Probability of a high-skill match ($m(\theta)(1-\eta)$)	0.11	
Fraction of overqualified high-skill workers ($\frac{e_{hl}}{\delta}$)	0.179	0.17-0.18
Job-to-job flows as share of employment	0.02	0.06
Job-to-job flows as share of total separations	0.39	0.53
Unemployment rates: ratio of std of dev. from trend	2.3	2.4
Unemployment rates: Ratio of std of percentage dev. from trend	0.98	0.97
Employment rates: ratio of std of dev. from trend	2.36	2.4
Employment rates: ratio of std of percentage dev. from trend	2.45	2.48
Matching rates for low-skill firms	0.90	
Matching rates for high-skill firms	0.58	
Average matching rate for firms	0.85	

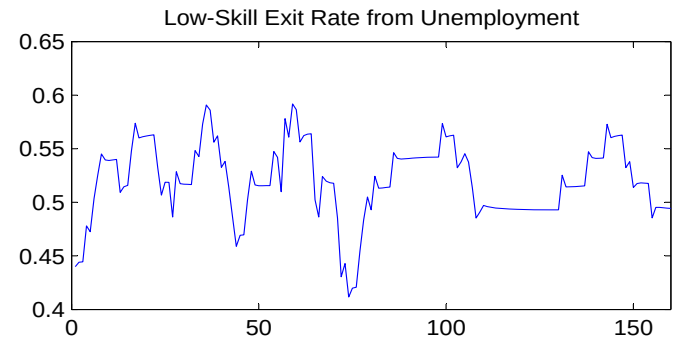
Results-(cont)

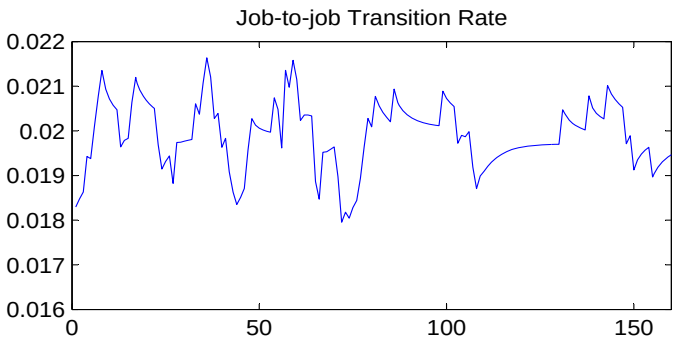












The importance of on-the-job search

Suppose high-skill workers reject the low-skill jobs they encounter:

- to match the unemployment rates requires that college graduates earn a wage 2.55 times higher than that of high-school graduated with no college degree
- the ratio of standard deviation of percentage deviations from trend of the corresponding unemployment (employment) rates is 2.64 (6.66)

When we **eliminate matching imperfections** so that workers can target only the jobs they are best suited for:

- to match the unemployment rates requires that college graduates earn 2.25 times more
- the ratio of standard deviation of percentage deviations from trend of the corresponding unemployment (employment) rates is 2 (5.10)

The Importance of On-the-job Search-(cont)

The channels through which on-the-job search helps matching the facts are:

- by searching on the job high-skill workers manage to keep their employment rates high, while congesting the low-skill sector and thus pushing low-skill workers into unemployment. Therefore, there is no need for unrealistic productivity differences to produce the observed unemployment dispersion, which also produces unrealistically high skill premium and differences in the cyclical volatility of unemployment rates.
- as more high-skill workers rely on low-skill jobs to keep their employment rates high, the more cyclical vacancy posting in the low-skill sector becomes. Thus, the high-skill job finding rate becomes more sensitive to productivity shocks.

The Consequences on Low-skill Workers

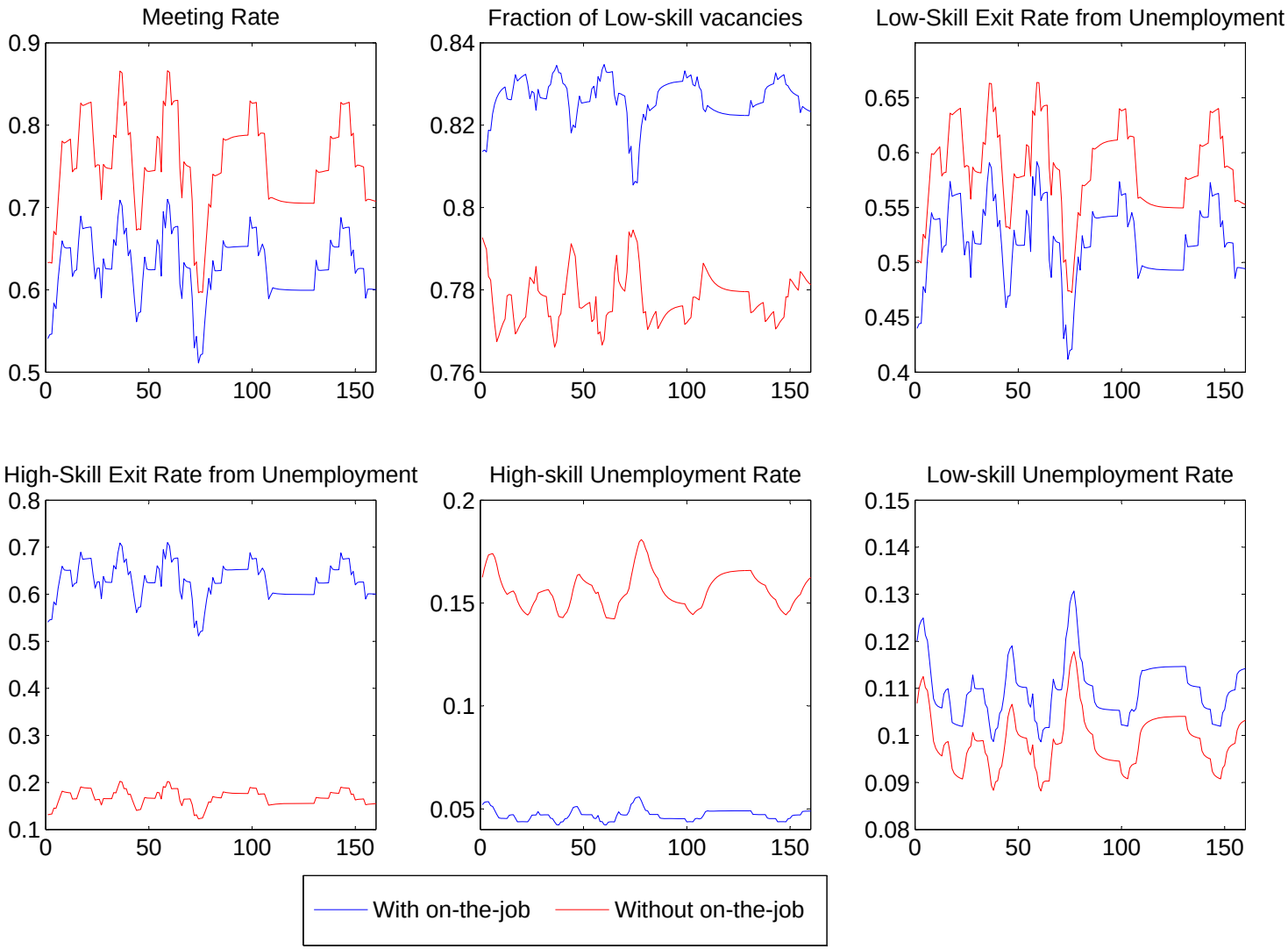
Steady State:

- On-the-job search increases the fraction of low-skill vacancies
- The impact on the number of vacancies per job seeker, is hard to determine analytically.
- By keeping the number of high- and low-skill job searchers constant, does not capture across-skill congestion effects.

Numerical simulations:

- High-skill on-the-job search increases the fraction of low-skill vacancies
- Lowers the number of vacancies per job seeker
- Increases the low-skill unemployment rate.

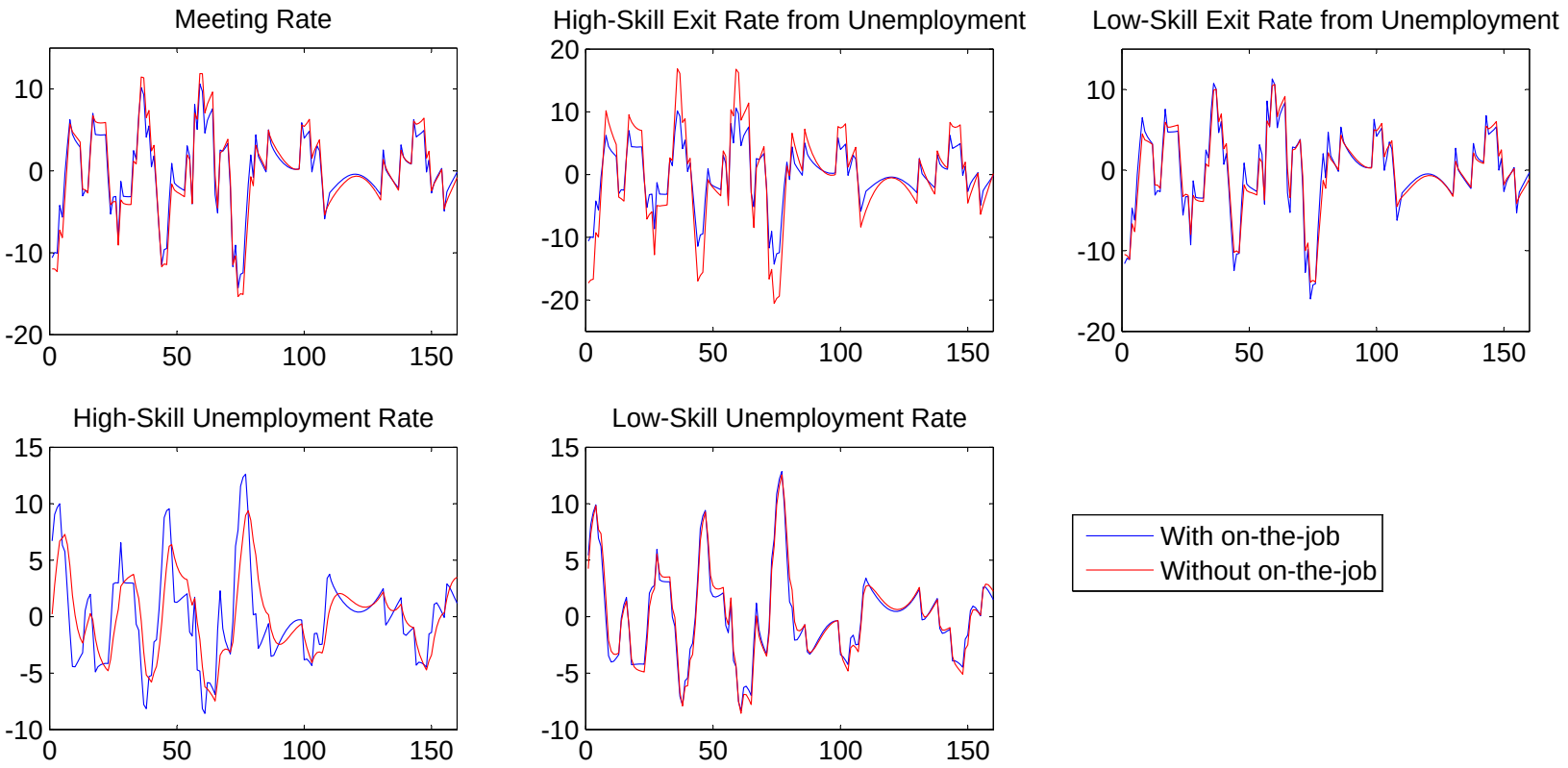
The Consequences on Low-skill Workers-(cont)



The Consequences on Low-skill Workers-(cont)

The Consequences on Low-skill Workers-(cont)

Percentage deviations from trend:



Summary

The paper presents a search and matching model that allows for:

- job finding rates to vary not only over the business cycle but across skill groups as well
- captures across-skill congestion effects in job search

The model highlights the importance of a cyclical pattern in the matching behavior of skilled workers (downgrading to lower job levels and upgrading by on-the-job search) in matching important features of the labor market:

- unemployment (employment) rates differences across skill groups
- procyclical job-to-job transitions and match quality