Degree Inflation and Hierarchical Labor Demand

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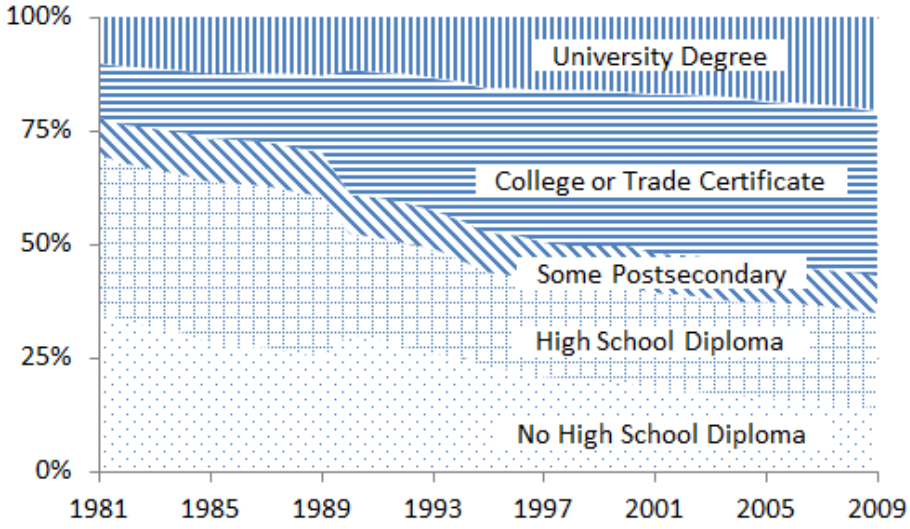
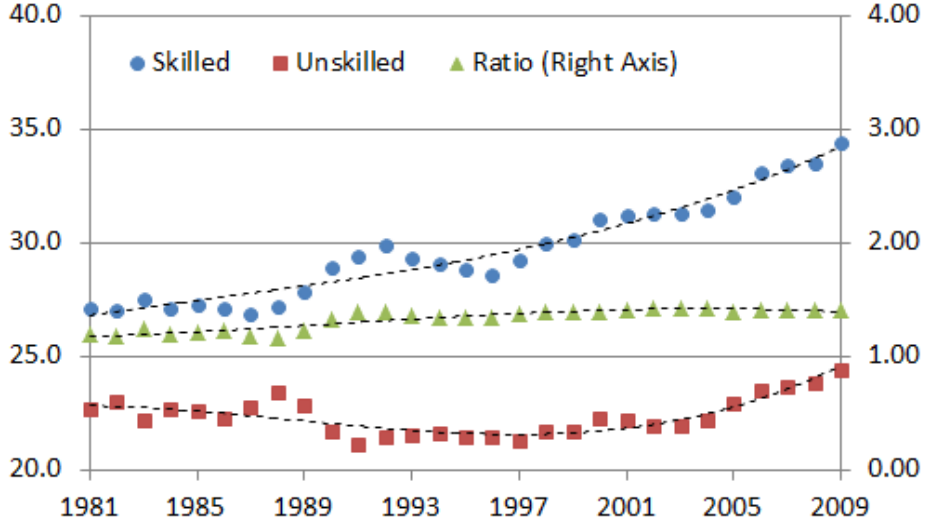
Motivation

- During the past few decades, college attainment and premium have been increasing in developed countries including Canada.



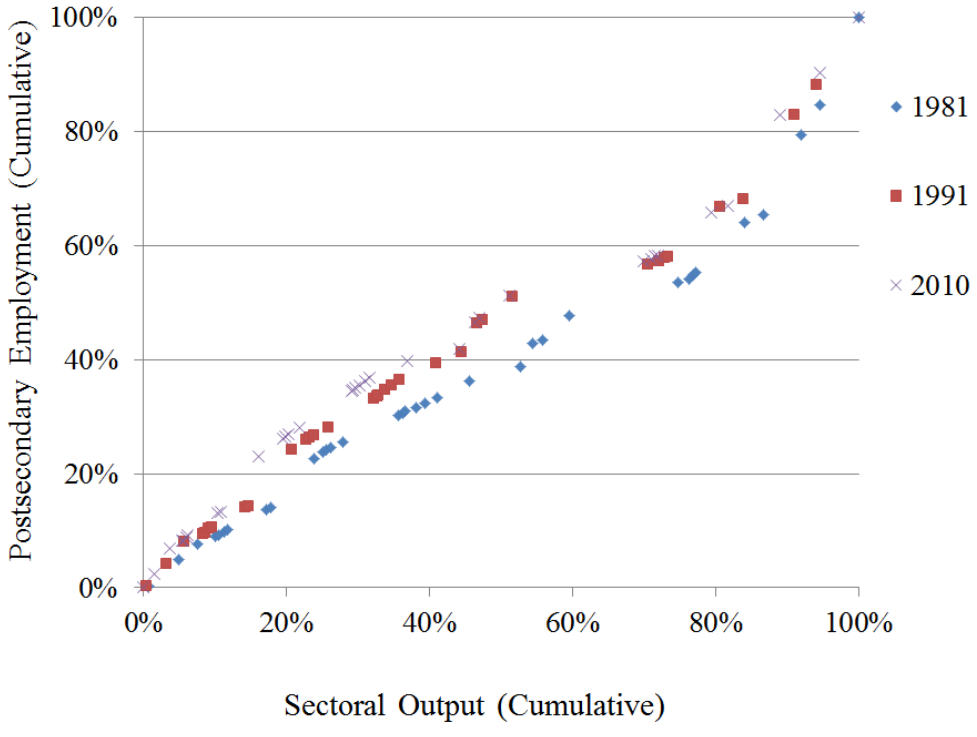
(a) Educational Attainment of Workers



(b) College Premium

Motivation

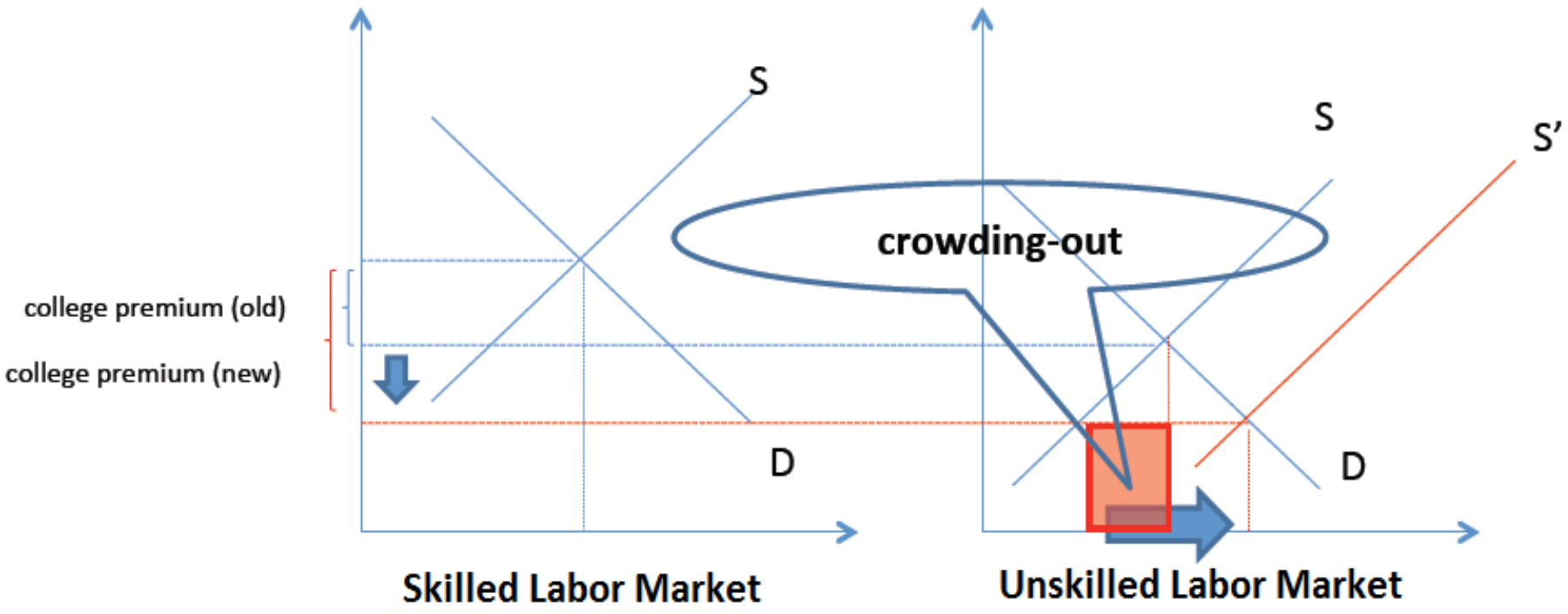
- Growth of college employment was lower in skill-intensive sectors than that in (general) labor-intensive sectors.
- However, output growth was lower in the latters.



Sectoral Output and Skilled Worker Ratio

Degree Inflation

- Degree-inflation is a supply shift mainly in the (general) labor-intensive, where skilled workers crowd out unskilled workers.

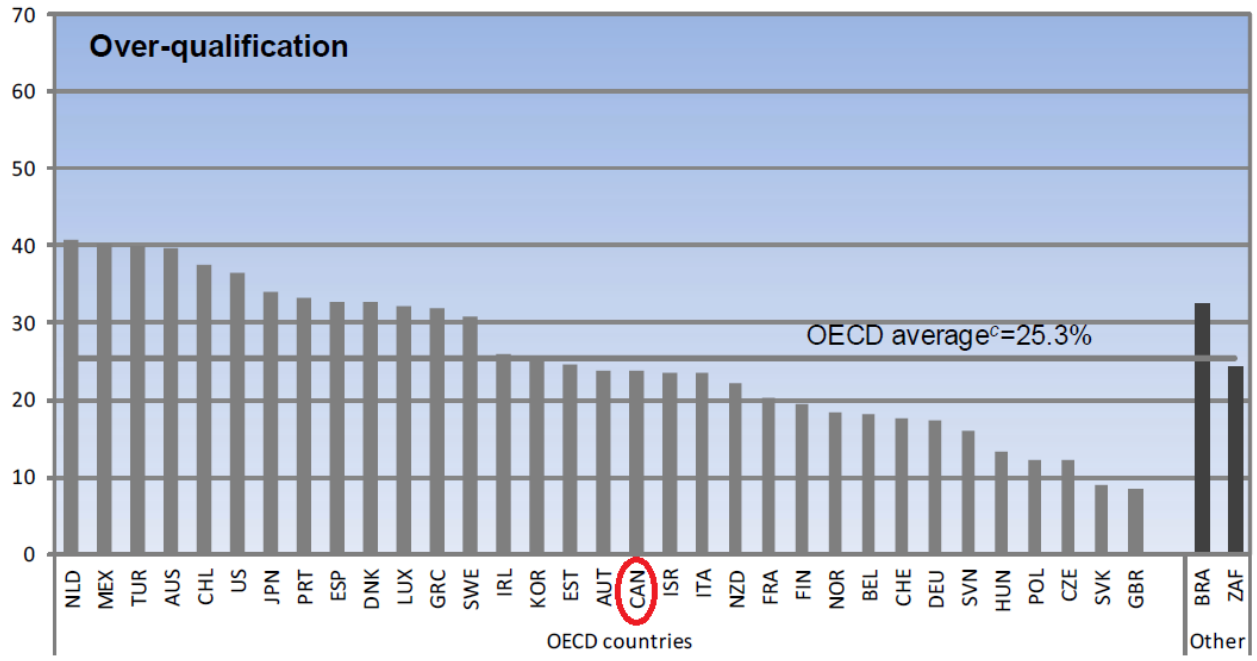


Degree Inflation: Cross-Skill Matches

- Indeed, 25% of workforce in OECD countries is considered to be overeducated (Quintini, 2011).
- Canada is close to the OECD average, but the impact is large due to the high college enrolment rate.

Figure 1. **Indicators of qualification mismatch[a], OECD and selected countries, 2005**

Percentages of employees and self-employed[b]

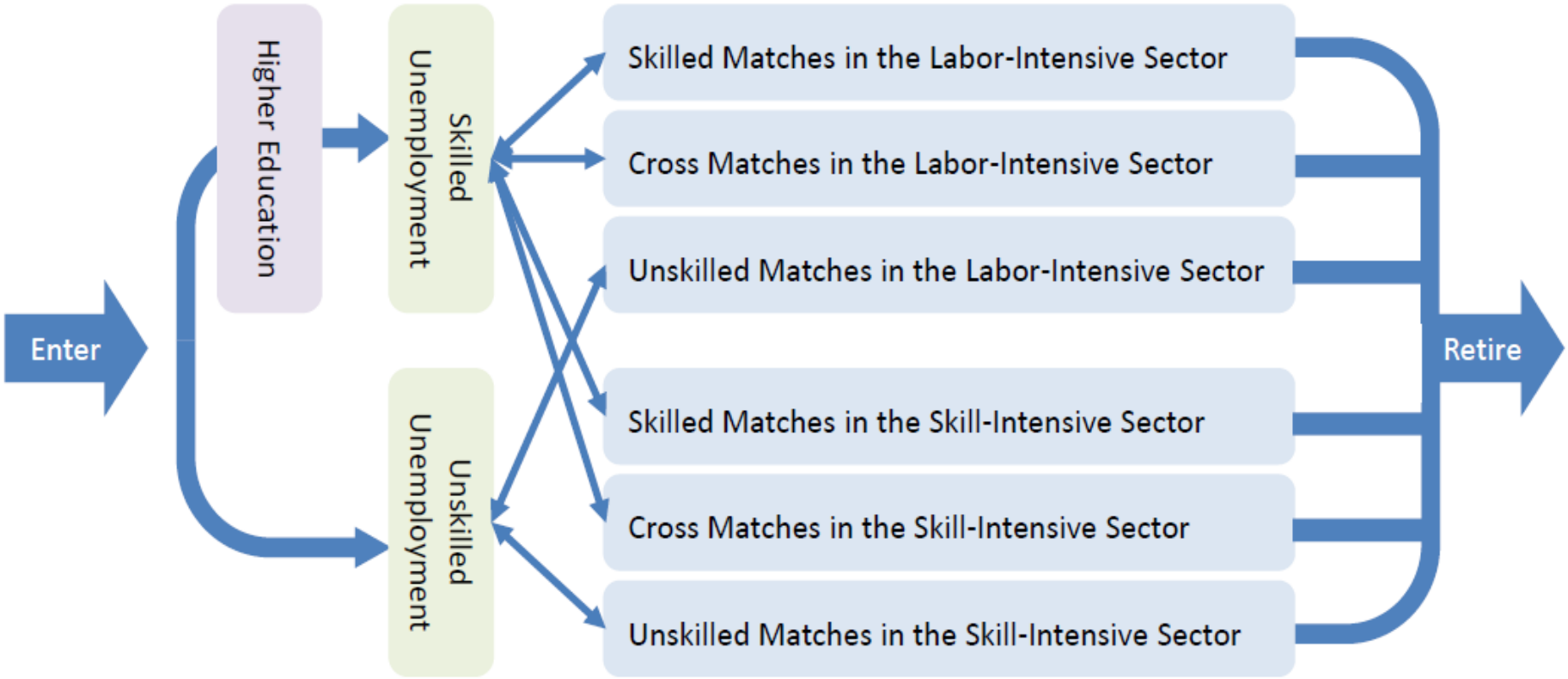


Cross-Skill Matches

- Suppose that a large scale chain store wants to hire 2 managers and 10 cashiers.
- Different types of vacancy postings
  - “We look for somebody to work for our store (cashiers, managers, etc)” We prefer degree holders in the related fields.
  - “We look for cashiers.”

Three Types of Match

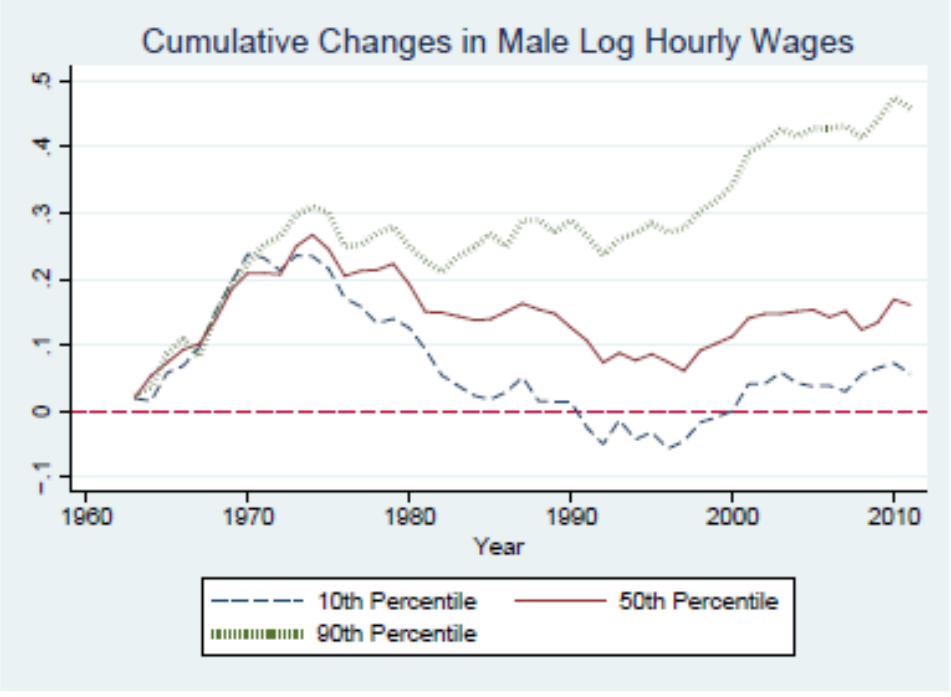
- In the model we consider three types of worker-job match
  - unskilled matches: unskilled workers and jobs,
  - skilled matches: skilled workers and jobs, and
  - cross-skill matches: skilled workers and unskilled jobs



Wage Convexification

- The wage distribution convexifies in the U.S. (Kroeger, 2013).

Figure 1: Evolution of Hourly Wages (Men)



Data for Tables 1 & 2 from Current Population Survey, available at www.nber.org

Summary of the Findings

- Positive ICT shocks prompt the creation of vacancies for the highly educated rather than general workforce,
- a significant proportion of skilled workers eventually perform unskilled tasks,
- the resulting cross-skill matches crowd out the general workforce and suppress unskilled wages,
- the college premium escalates and the college enrollment rate is self-reinforced, and
- the wage distribution convexifies.

Outline of the Presentation

- Model
- Calibration Results
- Remarks

Environment

- Two-sector economy (i):
  - skill-intensive sectors
  - (general) labor-intensive sectors
- Entrepreneurs: jobs with and without skill requirements, as in Albrecht and Vroman (2002)
- Workers: make schooling decisions before the labor market
- Labor market: search and matching, as in Mortensen and Pissarides (1994)
- Three-types of matches (j):
  - Skilled-matches (j = s)
  - Cross-skill matches (j = c)
  - Unskilled matches (j = u)

Final Goods

- Technology:

$$Y = (y_1^{\frac{\sigma-1}{\sigma}} + y_2^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma}{\sigma-1}}$$

- Individual Demand:

$$y_i = p_i^{-\sigma} P^{\sigma-1}, \quad \text{where} \quad P = (p_1^{1-\sigma} + p_2^{1-\sigma})^{\frac{1}{1-\sigma}}$$

- Market Clearing Condition:

$$P = 1, \quad \text{and} \quad \frac{p_i y_i}{p_1 y_1 + p_2 y_2} = \frac{p_i^{1-\sigma}}{p_1^{1-\sigma} + p_2^{1-\sigma}}, \quad \text{for each} \quad i \in \{1, 2\}$$

Intermediate Goods

- Technology

$$y_i = \alpha_i[\beta_{is} k_i^{\gamma_i} h_{is}^{\kappa_i} + \beta_{iu}(h_{ic} + h_{iu})^{\kappa_i}]^{1/\kappa_i}, \quad \text{for each } i \in \{1, 2\}$$

- ICT Capital Flow (on the steady state equilibrium)

$$\lambda k_i = x_i$$

- Worker Flow (on the steady state equilibrium)

$$(\delta + \rho) h_{ij} = \begin{cases} \chi_i q(\theta_s) v_{is} & \text{if } j = s \\ (1 - \chi_i) q(\theta_s) v_{is} & \text{if } j = c \\ q(\theta_{ut}) v_{iu} & \text{if } j = u \end{cases}.$$

Intermediate Goods

- Value Equation:

$$rJ_{ij}(k_i, h_{is}, h_{ic}, h_{iu}) = \max_{x_i, v_{is}, v_{iu}} \frac{\partial \pi_i(k_i, h_{is}, h_{ic}, h_{iu})}{\partial h_{ij}} - (\delta + \rho) J_{ij}(k_i, h_{is}, h_{ic}, h_{iu}),$$

where

$$\pi_i = p_i y_i - p_x x_i - \sum_{j \in \{s,c,u\}} w_{ij} h_{ij} - \eta v_{is} - \eta v_{iu}, \quad \text{for each } i \in \{1,2\}.$$

- Policy Rule:

$$\begin{aligned}
p_x &= \int_s^\infty e^{-(r+\lambda_i)(\tau - s)} \left(\frac{\partial \pi_{i\tau}}{\partial k_{i\tau}}\right) d\tau, \\
\eta &= q(\theta_{ut}) \int_t^\infty e^{-(r+\delta+\rho)(\tau - t)} \frac{\partial \pi_{i\tau}}{\partial h_{iu\tau}} d\tau = q(\theta_{ut}) J_{iut}, \quad \text{and} \\
\eta &= q(\theta_{st}) \int_t^\infty e^{-(r+\delta+\rho)(\tau - t)} \left[\chi_i \frac{\partial \pi_{i\tau}}{\partial h_{is\tau}} + (1 - \chi_i) \frac{\partial \pi_{i\tau}}{\partial h_{ic\tau}}\right] d\tau = q(\theta_{st}) J_{ist},
\end{aligned}$$

for each $i \in \{1,2\}$.

Workers

- Matching Technology: CRS matching technology

$$f(\theta_j) = \theta_j q(\theta_j), \quad \text{for each } \; j \in \{u, s\}.$$

- Value Equations:

$$\begin{aligned} rV_u &= b - \rho V_u + f(\theta_u)[(\ell_{1u} W_{1u} + \ell_{2u} W_{2u}) - V_u], \\ rV_s &= b - \rho V_s + f(\theta_s)[\sum_{i=1,2} \ell_{is}(\chi_i W_{is} + (1-\chi_i) W_{ic}) - V_s)], \quad \text{and} \\ rW_{ij} &= w_{ij} - \rho W_{ij} + \delta(V_j - W_{ij}), \quad \text{for each } \; j \in \{s, c, u\}. \end{aligned}$$

- Schooling Decision (McFadden (1974) and Rust (1987)):

$$s = \left[1 + \exp[-(V_s - V_u - \varepsilon)/\zeta]\right]^{-1}.$$

Wage Determination

- The Bargaining Protocol (Stole and Zwiebel (1996)):

$$w_{ij} = \begin{cases} \phi p_i \frac{\partial y_i}{\partial h_{is}} + (1-\phi)b + \eta\phi\theta_s & \text{if } j = s \\ \phi p_i \frac{\partial y_i}{\partial h_{ic}} + (1-\phi)b + \eta\phi\theta_s & \text{if } j = c \\ \phi p_i \frac{\partial y_i}{\partial h_{iu}} + (1-\phi)b + \eta\phi\theta_u & \text{if } j = u \end{cases} .$$

Equilibrium

Definition *A* steady state equilibrium *consists of choice rules* $\{x_i, v_{is}, v_{iu}\}_{i=1,2}$*, a labor market tightness parameter* $\{\theta_s, \theta_u\}$*, value equations* $\{W_{1s}, W_{1c}, W_{1u}, W_{2s}, W_{2c}, W_{2u}, V_s, V_u\}$*, and measures* $\{H_{1s}, H_{1c}, H_{1u}, H_{2s}, H_{2c}, H_{2u}, u_s, u_u\}$ *such that:*

(*i*) *Newly born workers optimally choose their schooling level.*

(*ii*) *Each representative entrepreneur creates the optimal number of vacancies at every moment.*

(*iii*) *Aggregate consistency requires that the vacancy creation decision be consistent with the definition of market tightness* $\{\theta_s, \theta_u\}$*.*

(*iv*) *The wage setting rule determines the wage payment for each type of match, the market clearing condition the price of each of the intermediate goods.*

Data

- Two steady states: 1981-1985 (pre-ICT shock) and 2000-2005 (post-ICT shock)
- Output by industries, employment by education categories etc: LFS micro-data (labor force survey)
- Hourly earnings data by education categories: constructed by the Statistics Canada with Census and LFS information

Calibration Strategy

- Selected group of parameters are given
- The remaining parameters are calibrated to minimize the sum of the squared distance between the target moments in the data and corresponding statistics in the model
- The price of ICT investment goods alone causes the transition from the pre- to post-shock steady state

Parameters

Table 1 : Parameters Exogenously Given

Parameter	Value	Interpretation
r	0.05	Discount Rate
ρ	0.025	Retirement Rate
σ	3.8	Elasticity of Substitution in Preference
δ	0.335	Separation Rate
(ν_s, ν_u)	(0.46,0.46)	Elasticity Parameter of Matching Function
ϕ	0.46	Bargaining Power of Workers
η	1.0	Vacancy Creation Cost
λ	0.320	Capital Depreciation Rate
p_k	1.00	Price of ICT Goods in 1981-1985
	0.23	Price of ICT Goods in 2000-2005

Target Moments

Table 2: The Target Moments

Variable	Value in 1981-85	Value in 1996-2000	Interpretation
$p_{1t}y_{1t}/(p_{1t}y_{1t}+p_{2t}y_{2t})$	0.497 (0.528)	0.438 (0.474)	GDP Share of Labor-intensive Sector
$(\sum_{j=s,c,u} H_{1jt})/(\sum_{i=1,2}\sum_{j=s,c,u} H_{ijt})$	0.567 (0.542)	0.514 (0.491)	Employment Share of Labor-intensive Sector
$(\sum_{j=s,c} H_{1jt})/(\sum_{i=1,2}\sum_{j=s,c} H_{ijt})$	0.366 (0.370)	0.403 (0.391)	College Graduate Employment Share of Labor-intensive Sector
$(\sum_{i=1,2}\sum_{j=s,c} H_{ijt})/(\sum_{i=1,2}\sum_{j=s,c,u} H_{ijt})$	0.335 (0.325)	0.590 (0.604)	Proportion of College Graduate Employees in Total Employment
$u_{st}/(u_{st}+\sum_{i=1,2}\sum_{j=s,c} H_{ijt})$	NA (0.085)	0.064 (0.077)	Unemployment Rate of College Graduates
$u_{ut}/(u_{ut}+\sum_{i=1,2} H_{iut})$	NA (0.094)	0.111 (0.086)	Unemployment Rate of Non-college Graduates
$(p_{kt}x_{1t})/(p_{1t}y_{1t})$	0.006 (0.005)	0.016 (0.010)	ICT Investment-Value Added Ratio in Labor-Intensive Sector
$(p_{kt}x_{2t})/(p_{2t}y_{2t})$	0.035 (0.020)	0.046 (0.031)	ICT Investment-Value Added Ratio Skill-Intensive Sector
$\frac{(\sum_{i=1,2}\sum_{j=s,c} w_{ijt}H_{ijt})/(\sum_{i=1,2}\sum_{j=s,c} H_{ijt})}{(\sum_{i=1,2} w_{iut}H_{iut})/(\sum_{i=1,2} H_{iut})} - 1$	0.201 (0.268)	0.374 (0.315)	College Premium
$\frac{b}{(\sum_{i=1,2}\sum_{j=s,c,u} w_{ijt}H_{ijt})/(\sum_{i=1,2}\sum_{j=s,c,u} H_{ijt})}$	0.600 (0.644)	0.600 (0.556)	Replacement Ratio

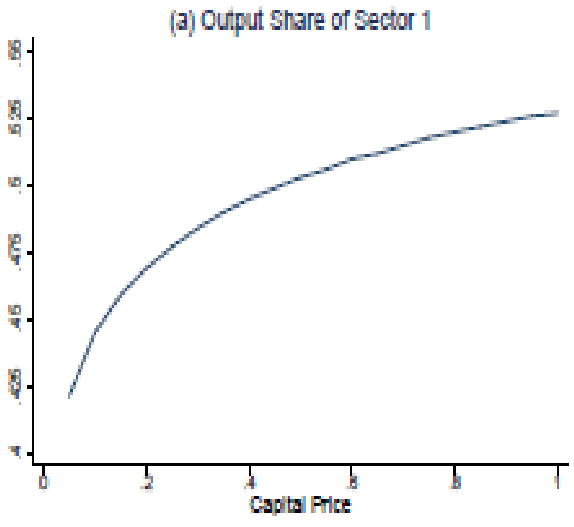
Note: Values without parentheses are from the data, values within parentheses from the model. The data is from Statistics Canada.

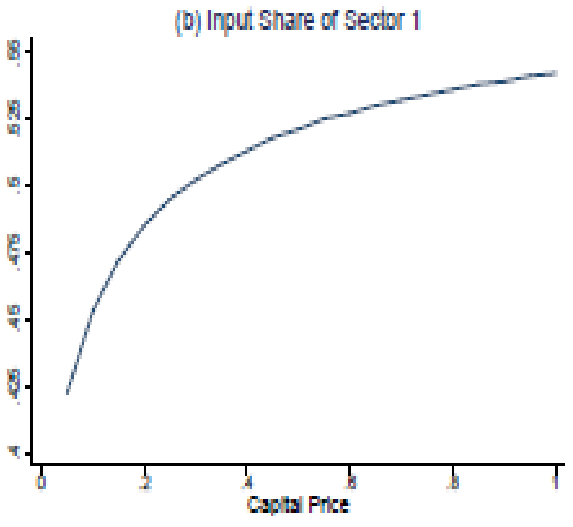
Endogenously Determined Parameters

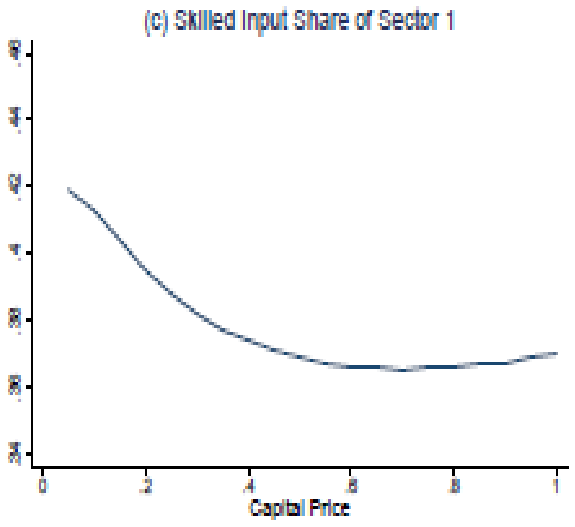
Table 2 : Parameters Endogenously Determined

Parameter	Value	Interpretation
α_2/α_1	0.709	TFP Ratio
β_{1s}	0.708	Skill Intensity in the Labor-Intensive Sector
β_{2s}	0.641	Skill Intensity in the Skill-Intensive Sector
κ	0.891	elasticity of substitution
χ_1	0.263	Qualification Probability in the Labor-Intensive Sector
χ_2	1.000	Qualification Probability in the Skill-Intensive Sector
ε	1.175	Average Cost of Education
ζ	4.508	Sensitivity of Education Choice
μ_s	9.542	Scale of Matching Technology for College Graduates
μ_u	12.225	Scale of Matching Technology for Non-college Graduates
γ	0.075	Capital Contribution Parameter
b	0.217	Value of Unemployment

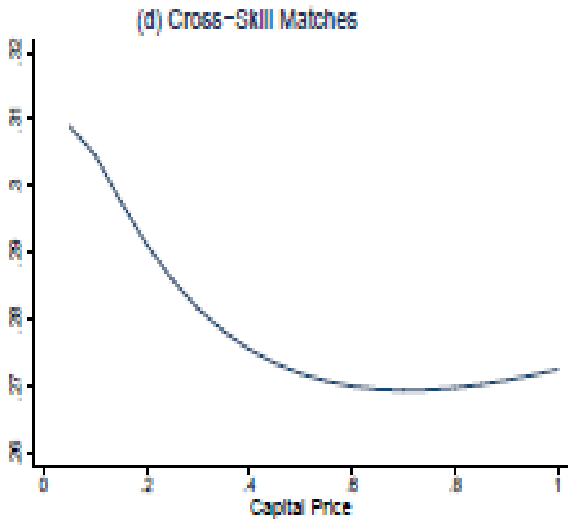
Calibration Results: ICT-shock and (general) Labor-Intensive Sectors

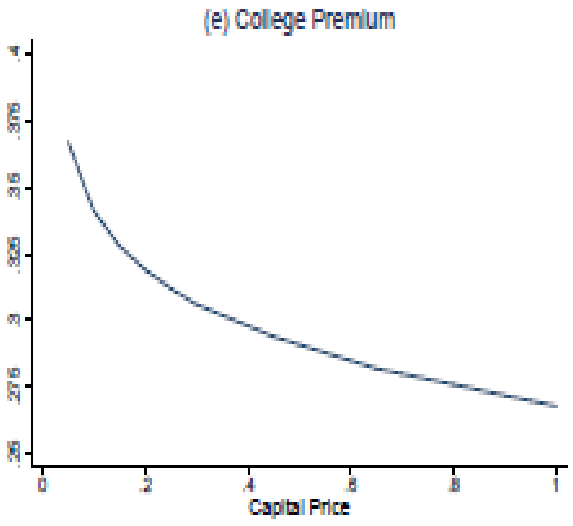


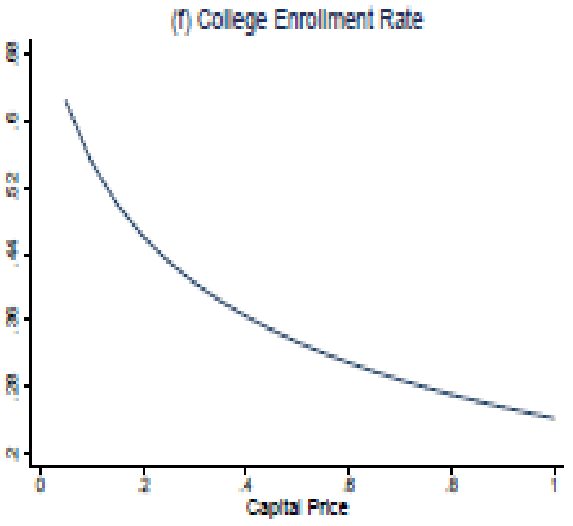




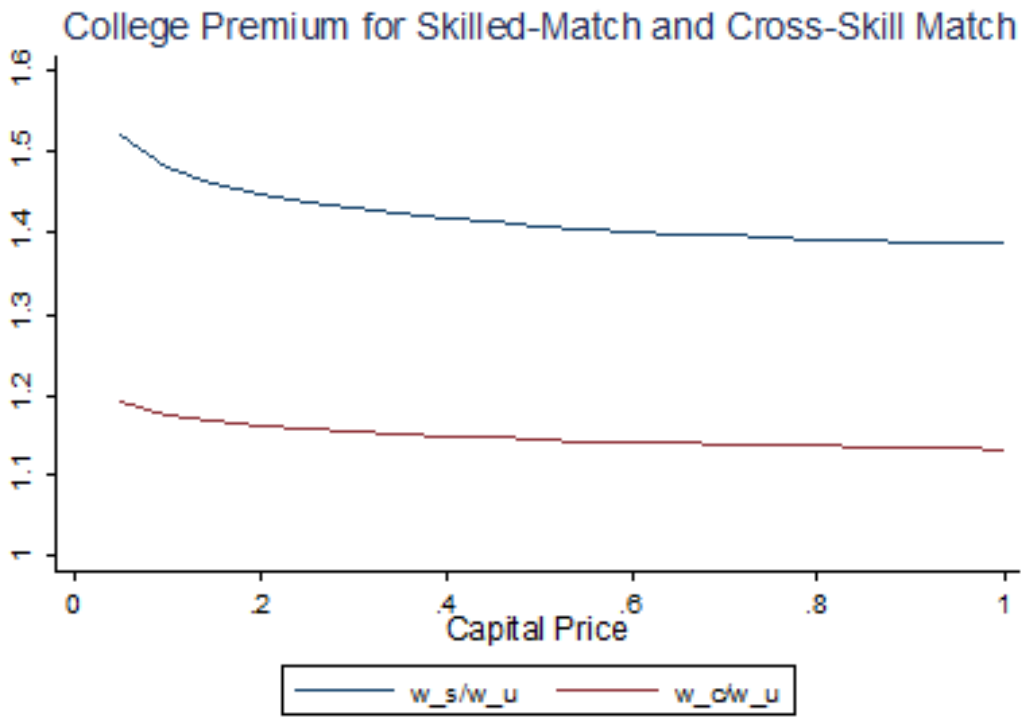
Calibration Results: ICT-shock and Overall Economy







Calibration Results: Labor Market Inequality



Counterfactual Analysis

Table 3 : Steady State Equilibrium Outcomes across Qualification Rates

Qualification Probability	Weighted-Average MPL of Non-College	College	Overall	Average Wage of Non-College	College	Overall
0.263	0.340	0.452	0.407	0.327	0.430	0.389
0.289	0.340	0.459	0.421	0.328	0.437	0.402
0.316	0.342	0.466	0.435	0.329	0.444	0.415
0.342	0.343	0.474	0.449	0.330	0.451	0.428
1.000	0.497	0.648	0.638	0.478	0.619	0.609

Conclusion

- During recent several decades, college attainment and premium have increased together.
- An increased number of college graduates work in (general) labor intensive sectors.
- The wage distribution convexifies, maintaining unskilled wages unchanged.

- We identify and quantify the channel through which degree inflation causes the vicious circle with the above phenomena.

- We argue that in higher education, “the more, the better” may not work.