Innovation Booms, Easy Financing, and Human Capital Accumulation

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Motivation

- Intense technological change often comes with financial speculation

⇒ Easy financing for innovative firms

... can pay high wages and attract talent

⇒ Reallocation of high-skill workers to booming innovative sector

…exposes their human capital to new technologies

- Examples: current AI boom, late 1990s tech bubble, etc.

Questions

Effect of innovation booms and easy financing on human capital?

1. Effect of joining a booming new technology sector on skilled workers' human capital?

2. Role of financial capital flows?
   - Allocative effect: does capital flow to firms whose effect on its workers' human capital is >0 or <0?
   - Direct effect of capital flows on a firm's workers' human capital?

→ Matters for aggregate labor productivity

Effect on human capital ex ante unclear

- Potential upside
  - Exposure to new technologies $\Rightarrow$ workers acquire valuable skills
    - $\approx$ Growth-enhancing tech bubbles (Olivier 2000; Caballero Farhi Hammour 2006)
- Potential downside

Effect on human capital ex ante unclear

- Potential upside
  - Exposure to new technologies ⇒ workers acquire valuable skills
    - ≈ Growth-enhancing tech bubbles (Olivier 2000; Caballero Farhi Hammour 2006)
- Potential downside
  - Skills rapidly lose value
    - Skills linked to rapidly evolving technology ⇒ "vintage-specific human capital" (Chari Hopenhayn 1991; Deming Noray 2020)
    - Easy financing ⇒ lower quality projects

Empirical design

- Episode: Information and Communications Technology (ICT) late 1990s boom
  - Large
  - Plausibly accompanied by speculative capital flows
  - Possible to study long-run effects

- Data: Administrative employer-employee panel data for France (1994–2015)
  - Track workers from when they start in a sector
  - Compare cohorts of workers starting in ICT sector vs. other sectors

Roadmap

The ICT Boom

Wage Dynamics

Role of Financial Capital

Wrap-up

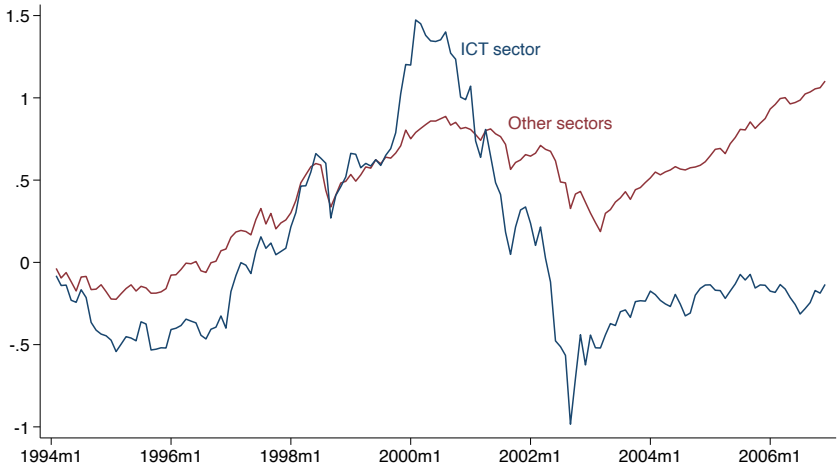
The Information and Communication Technology (ICT) Sector

ICT industries	Share of total employment (%)	Share of skilled employment (%)
ICT: Services	**1.9**	**7.8**
IT consultancy	0.7	3.4
Software	0.7	3.2
Data processing	0.3	0.8
Maintenance computers	0.1	0.2
Other data/computer-related services	0.1	0.2
ICT: Telecommunications	**1.4**	**2.2**
Telecommunications	1.4	2.2
ICT: Manufacturing	**1.7**	**3.7**
Electronic/communication equipment	0.8	1.8
Measurement/navigation equipment	0.5	1.2
Accounting/computing equipment	0.2	0.7
Insulated wire and cable	0.1	0.1
ICT: Wholesale	**0.5**	**1.2**
Computers, electronics, telecoms	0.5	1.2
ICT: Total	**5.4**	**14.9**

OECD (2002) definition, Universe of matched employer-employee data in France (1994–2008)

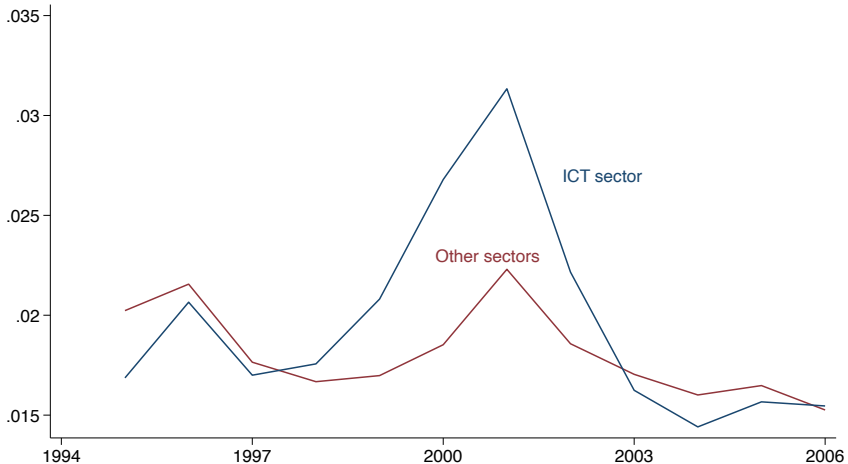
ICT boom: equity valuation

- Cumulative stock return: boom / bust / normalization
- (Similar pattern for stock price/sales)



ICT boom: capital reallocation

- Equity issuance/Total assets for universe of listed+private firms
- Similar pattern for firm creation rate

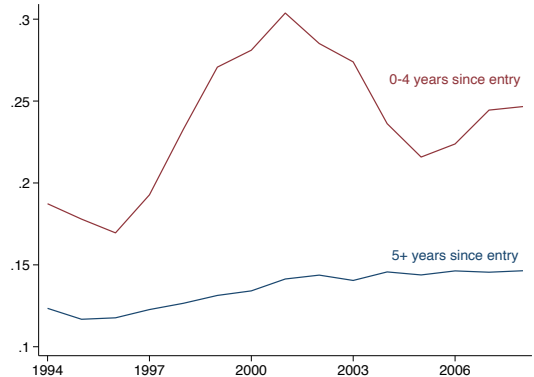


Labor reallocation: the role of extensive margin

- Reallocation of skilled workers to ICT sector (% skilled employment in ICT)

Labor reallocation: the role of extensive margin

- Reallocation of skilled workers to ICT sector (% skilled employment in ICT)
- Dynamics driven by workers starting their career (= extensive margin)



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Wage differences: across workers within **boom cohort**

- Sample: Skilled workers starting between 1998 and 2001

- Baseline regression:

$$\log(wage_{i,t}) = \beta_t \, . \, ICT_{i,0} + \delta_t + \delta_t \times X_i + \epsilon_{i,t}$$

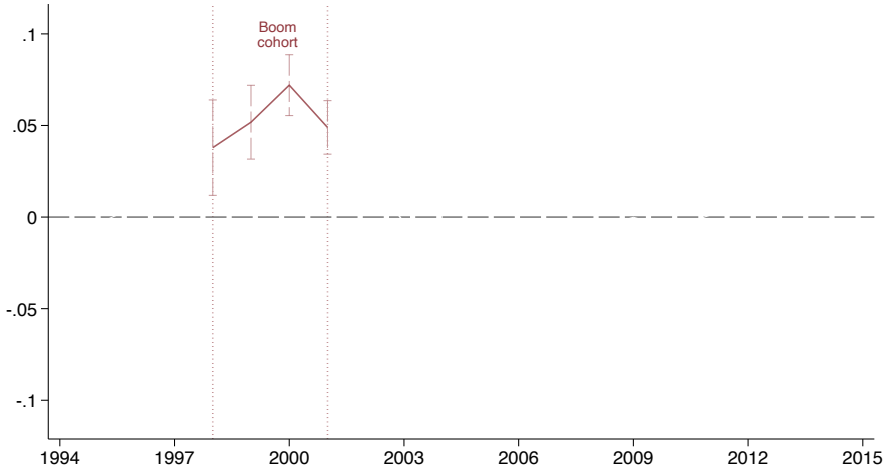
$ICT_{i,0}$ = 1 if worker *i* starts career in ICT sector

→ wage premium can reflect sector reallocation post entry

X_i = entry year, sex, age, age squared, two-digit occupation at entry

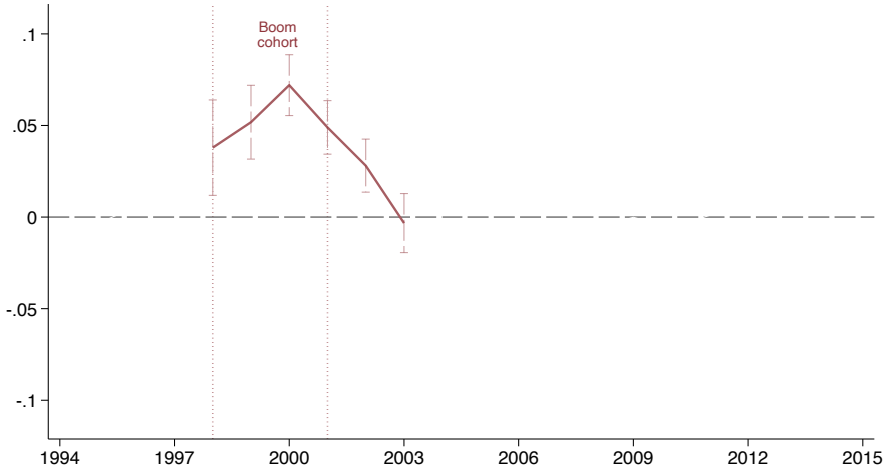
Wage dynamics of boom cohort

– 5% higher entry wage



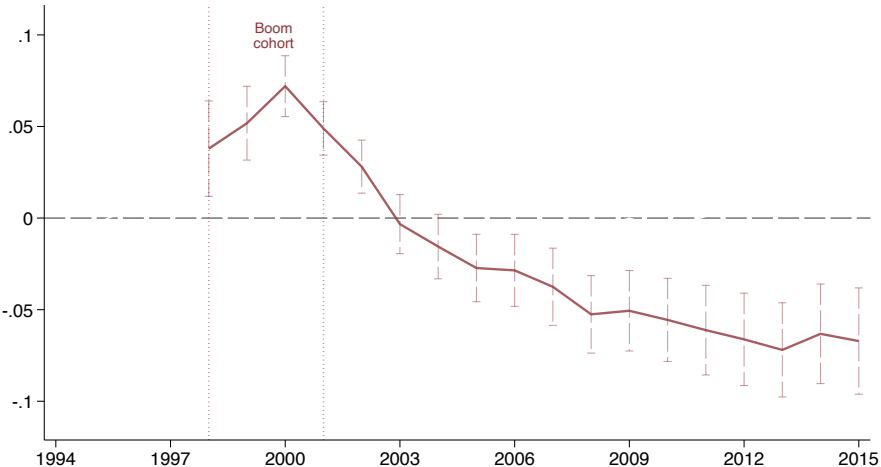
Wage dynamics of boom cohort

– No premium after boom → standard boom-bust



Wage dynamics of boom cohort

– 6% lower wage fifteen years out



Candidate Explanations

1. Human capital accumulated in ICT during the boom rapidly loses value
2. Low labor demand/high labor supply in ICT after the boom
3. Selection: the booming ICT sector attracts low productivity workers

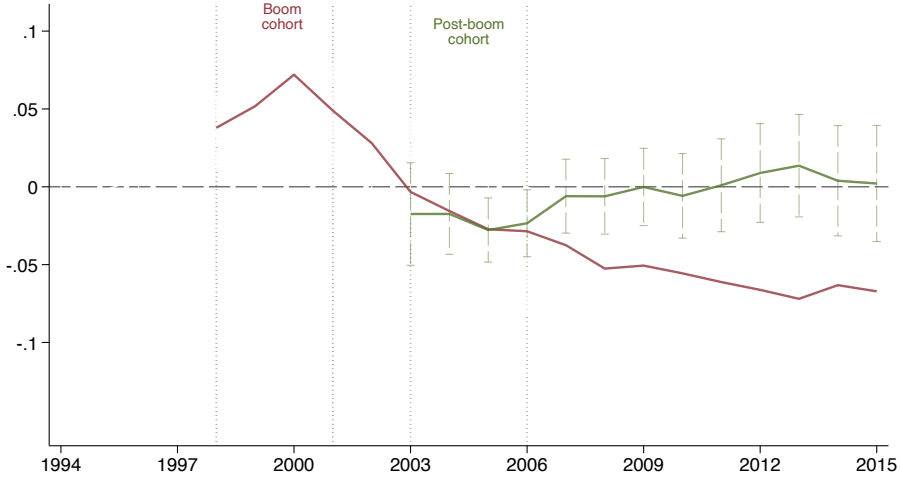
Tighter identification across cohorts to rule out 2. and 3.

Ruling out labor market imbalance

- Hypothesis: low labor demand/high labor supply in ICT after the boom
- Implication: post-boom cohort should also experience wage decline

Wage dynamics of **post-boom** cohort (2003–2005)

– Inconsistent with labor supply / demand shock Test statistical difference

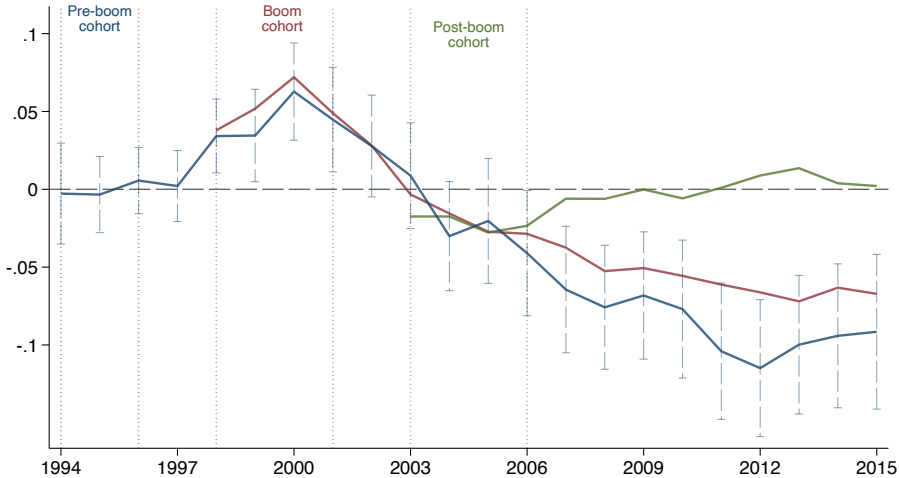


Ruling out selection

- Hypothesis: boom attracts less able workers
- Implication: pre-boom cohort should not display wage decline

Wage dynamics of **pre-boom** cohort (1994–1996)

- Inconsistent with selection Test statistical difference
- Consistent with HK depreciation for all cohorts experiencing the boom



Candidate Explanations

1. Human capital accumulated in ICT during the boom rapidly loses value
2. ~~Low labor demand/high labor supply in ICT after the boom~~
3. ~~Selection: the booming ICT sector attracts low productivity workers~~

Main specification: across sectors + across cohorts

- Sample: boom cohort (1998–2001) + post-boom cohort (2003–2005)

- Estimating equation

$$\log(wage_{i,c,t}) = \beta_t \, . \, ICT_{i,0} \times BoomCohort_c + \delta_t \times ICT_{i,0} + \alpha_i + \gamma_c \times \delta_t \times X_{i,0} + \epsilon_{i,t}$$

- β_t = wage premium in year t

  …of workers starting in ICT sector vs. in other sectors (first difference)

  …of workers starting during the boom vs. after boom ends (second difference)

Long-term wage decline

- Starting in ICT during boom (98–01) ⇒ **7% slower** long-term wage growth from 2003 to 2015

	log(wage)
ICT_0 × BoomCohort × 2003-05	0.001
	(0.013)
ICT_0 × BoomCohort × 2006-10	-0.035**
	(0.014)
ICT_0 × BoomCohort × 2011-15	-0.073***
	(0.019)
Worker controls	✓
ICT_0× Year FE	✓
Cohort × Year FE	✓
Worker FE	–
Observations	93,304

Long-term wage decline

- Starting in ICT during boom (98–01) ⇒ **7% slower** long-term wage growth from 2003 to 2015
- Worker FE → control for non-random attrition + selection on levels

	log(wage)	
ICT_0 × BoomCohort × 2003-05	0.001	ref.
	(0.013)	
ICT_0 × BoomCohort × 2006-10	-0.035**	-0.048***
	(0.014)	(0.010)
ICT_0 × BoomCohort × 2011-15	-0.073***	-0.077***
	(0.019)	(0.015)
Worker controls	✓	✓
ICT_0× Year FE	✓	✓
Cohort × Year FE	✓	✓
Worker FE	–	✓
Observations	93,304	92,901

Selected Robustness Checks

1. In quantile regressions, the effect is there across the wage distribution → not a winner-take-all effect

2. No effect on low skill workers → consistent with a skill obsolescence mechanism

3. Robust to restricting the sample to US firms (e.g., Microsoft France) → not a French firm phenomenon

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Is easy financing making things worse?

Do capital flows amplify the negative effect on aggregate HK?

1. Allocative effect: depends on which ICT firms receive the most capital
   - Firms whose workers' HK depreciate the most? The least?
   - → Cov[Capital flow, HK accumulation]?

     (K flow versus L flow)

Allocative effect: capital flows to firms with largest HK depreciation

- Wage discount only in firms with above-median capital availability
- Cov[Capital flow, HK accumulation]$< 0 \Rightarrow$ aggregate labor productivity $\downarrow$

Proxy of capital availability:	log(Wage)		
	1999 return (Industry level)	1999 P/S (Industry level)	Equity issuance (Industry×geo ×entry year level)
	(1)	(2)	(3)
ICT_0 × Boom cohort × 2011-15	0.022	0.007	-0.029
	(0.044)	(0.042)	(0.025)
ICT_0 × Capital availability × Boom cohort × 2011-15	-0.129***	-0.113**	-0.081***
	(0.049)	(0.047)	(0.031)
ICT_0× Year FE	✓	✓	✓
Worker controls×Cohort×Year FE	✓	✓	✓
Worker FE	✓	✓	✓
Observations	60,420	60,420	85,128

Direct effect: does capital flow **cause** faster HK depreciation?

2. Direct effect: easy financing may worsen average project quality and causally accelerates individual-level HK depreciation
   - Alternatively, Cov[Capital flow, HK depreciation] may be driven by omitted factor: technology change $\Rightarrow$ capital flow and HK depreciation
   - Test: re-estimate Cov holding technology fixed $\rightarrow$ within narrow sectors

Direct effect: capital flow **causes** faster HK depreciation?

– Industry×Cohort×Year FE = within industry, across geography → control for technology shocks

	log(Wage)	
Proxy of capital availability:	Equity issuance (Industry×geo×entry year level)	
	(3)	(4)
ICT_0 × Boom cohort × 2011-15	-0.029	–
	(0.025)	–
ICT_0 × Capital availability × Boom cohort × 2011-15	-0.081***	-0.083**
	(0.031)	(0.035)
ICT_0× Year FE	✓	✓
Worker controls×Cohort×Year FE	✓	✓
Worker FE	✓	✓
Industry×Cohort×Year FE	–	✓
Observations	85,128	85,128

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Two main results:

1. Skilled workers starting in booming tech sector eventually lose human capital
   - Wage 6%–8% lower fifteen years out
   - Not explained by labor market imbalance and selection
2. Aggregate skill obsolescence amplified by easy financing

Wrap-up

Implications:

- Skill-biased technological change?
  - Our paper: *within* skilled workers, those who develop and implement new technologies (who represent one-third of the boom cohort) lose out
- Growth enhancing financial speculation?
  - Maybe positive externalities, but
  - Capital allocated to firms that do not enhance their workers' human capital → lower aggregate labor productivity

Skill obsolescence

- Universe of workers by occupation level: high / middle / low skill
- Wage decline largest in high-skill occupations

	log(Wage)					
	High-skill		Middle-skill		Low-skill	
	(1)	(2)	(3)	(4)	(5)	(6)
ICT_0 × Boom cohort × 2011-15	-0.077***	-0.029	-0.068***	-0.039*	-0.022	-0.027
	(0.015)	(0.025)	(0.014)	(0.023)	(0.020)	(0.040)
ICT_0 × Capital availability × Boom cohort × 2011-15		-0.081***		-0.033		-0.004
		(0.031)		(0.029)		(0.041)
Worker controls×Cohort×Year FE	✓	✓	✓	✓	✓	✓
Worker FE	✓	✓	✓	✓	✓	✓
Observations	92,901	85,128	206,918	186,477	250,620	218,927

Skill obsolescence

- Universe of workers by occupation level: high / middle / low skill
- Wage decline largest in high-skill occupations
- ... particularly so if large inflow of capital

	log(Wage)					
	High-skill		Middle-skill		Low-skill	
	(1)	(2)	(3)	(4)	(5)	(6)
ICT_0 × Boom cohort × 2011-15	-0.077***	-0.029	-0.068***	-0.039*	-0.022	-0.027
	(0.015)	(0.025)	(0.014)	(0.023)	(0.020)	(0.040)
ICT_0 × Capital availability × Boom cohort × 2011-15		-0.081***		-0.033		-0.004
		(0.031)		(0.029)		(0.041)
Worker controls×Cohort×Year FE	✓	✓	✓	✓	✓	✓
Worker FE	✓	✓	✓	✓	✓	✓
Observations	92,901	85,128	206,918	186,477	250,620	218,927

Winner-take-all?

- Quantile regressions
- Entire wage distribution shifts to the left

	Wage quantiles				
	P10	P25	P50	P75	P90
ICT_0 × Capital availability × Boom cohort × 2011-15	-0.056	-0.065**	-0.077***	-0.089***	-0.098***
	(0.036)	(0.026)	(0.018)	(0.023)	(0.032)
Worker controls	✓	✓	✓	✓	✓
Cohort × Year FE	✓	✓	✓	✓	✓
Worker FE	✓	✓	✓	✓	✓
Observations	93,306	93,306	93,306	93,306	93,306