Macroeconomic Effects of Technological Transition

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Plan

Motivation

- New technologies such as Ultrabroadband technologies are "General Purpose Technologies"
- Dramatic change of technology at the aggregate level
- Magnified by network effects such technologies trigger
- Usually : More capital intensive $\Longrightarrow$ Potential Macroeconomic effects
  - Aggregate productivity (and growth)
  - Sectoral allocation of resources
  - (Un–)Employment
  - Welfare
- This paper investigates this issue

Motivation

- Develop a macroeconomic model of technological change
- Growth model with technology adoption
- Features
  - Several sectors
  - Capital accumulation
  - Frictions on the labor market : Unemployment
  - Endogenous technology adoption
  - Network effects
- Estimate the model and derive quantitative implications

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The Model

- Dynamic General Equilibrium model
- 3 kinds of agents :
  1. Households (consume, save supply labor)
  2. Firms (Produce goods, use capital and labor, decide on technology)
  3. Government (unemployment spells)

The Model : Households

- Continuum of households with finite (but uncertain) lifetime (Constant Population)
- Beginning of each period, told whether he/she will survive (prob 1-ψ)
- If drawn, he/she will be employed and will get the wage, if not will be unemployed and will get unemployment spells.
- Decide on consumption and labor supply so as to maximize expected lifetime preferences

$$\mathscr{U}_t = \sum_{s=0}^{\infty} \rho^s (1-\psi)^s \log(c_{t+s}) + \sum_{s=1}^{\infty} \rho^s \psi (1-\psi)^{s-1} \log(d_{t+s})$$

The Model : Firms

- 2 types of firms
  - Those producing "intermediate" goods in each sector by means of capital and labor.
  - Those producing the final good, Y_t, by combining intermediate goods

$$Y_t = \left(\sum_{i=1}^{n} \zeta_i^{1-\varepsilon} Q_{i,t}^{\varepsilon} \right)^{\frac{1}{\varepsilon}}$$

- the final good can be consumed or invested to form capital

$$K_{t+1} = I_t + (1 - \delta) K_t$$

The Model : Sectoral Firms

- n sectors with a representative firm that produces a specific good by means of capital and labor
- May use 2 technologies

$$Q_{1,i,t} = K_{i,t}^{\alpha_i}(\Theta_t L_{i,t})^{1-\alpha_i}$$
$$Q_{2,i,t} = \Phi_{i,t} K_{i,t}^{\beta_i}(\Theta_t L_{i,t})^{1-\beta_i}$$

  where $0 \leqslant \alpha \leqslant \beta \leqslant 1$. Θ_t : Harrod neutral technological progress
- $\Phi_t > 0$ measure the differential productivity b/w the 2 technologies

The Model : Sectoral Firms

- Either, the old technology is implemented :
  $Q_{i,t} = Q_{1,i,t} = K_{i,t}^{\alpha_i}(\Theta_t L_{i,t})^{1-\alpha_i}$
- Or only the new technology is implemented :
  $Q_{i,t} = Q_{2,i,t} = \Phi_{i,t} K_{i,t}^{\beta_i}(\Theta_t L_{i,t})^{1-\beta_i}$
- Or a technology mix (Partial Adoption)

$$Q_{i,t} = (\sigma_{i,t} K_{i,t})^{\alpha_i}(\nu_{i,t}\Theta_t L_{i,t})^{1-\alpha_i} + \Phi_{i,t}((1-\sigma_{i,t})K_{i,t})^{\beta_i}((1-\nu_{i,t})\Theta_t L_{i,t})^{1-\beta_i}$$

The Model : Sectoral Firms

- Evolution of Differential productivity

$$\Phi_{i,t} = \gamma_{i,t}^{\varphi} \Phi_{i,t-1}$$

- A stochastic rate of technology improvements

$$\gamma_{i,t}^{\varphi} = \begin{cases} \overline{\gamma}_i^{\varphi} & \text{with proba.} \pi_t \\ 0 & \text{with proba.} 1 - \pi_t \end{cases}$$

- Time–varying probability

$$\pi_t = \rho_\pi \pi_{t-1} + \pi^\star(\overline{\varsigma}_{k,t}) \text{ with } |\rho_\pi| < 1$$

- Network effects

$$\pi^\star(\overline{\varsigma}_{k,t}) = (1 - \varpi_0)\overline{\varsigma}_{k,t} - \overline{\varsigma}_{k,t}^{1+\varpi_1} + \varpi_0 \text{ with } \varpi_0, \varpi_1 > 0$$

The Model : Sectoral Firms

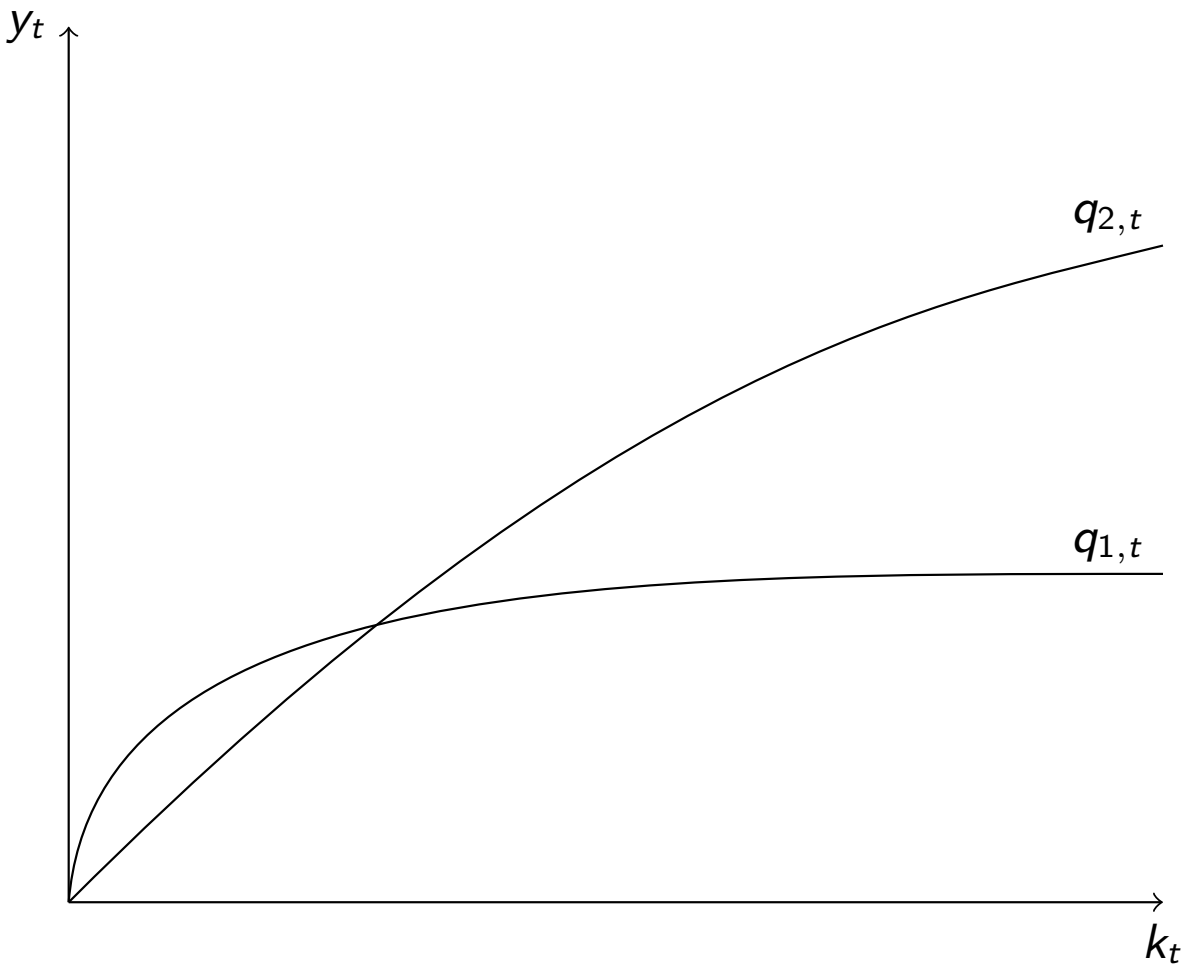
Technology Adoption

- Firms decides on capital, labor, vacancies posting labor and technology maximizing profits

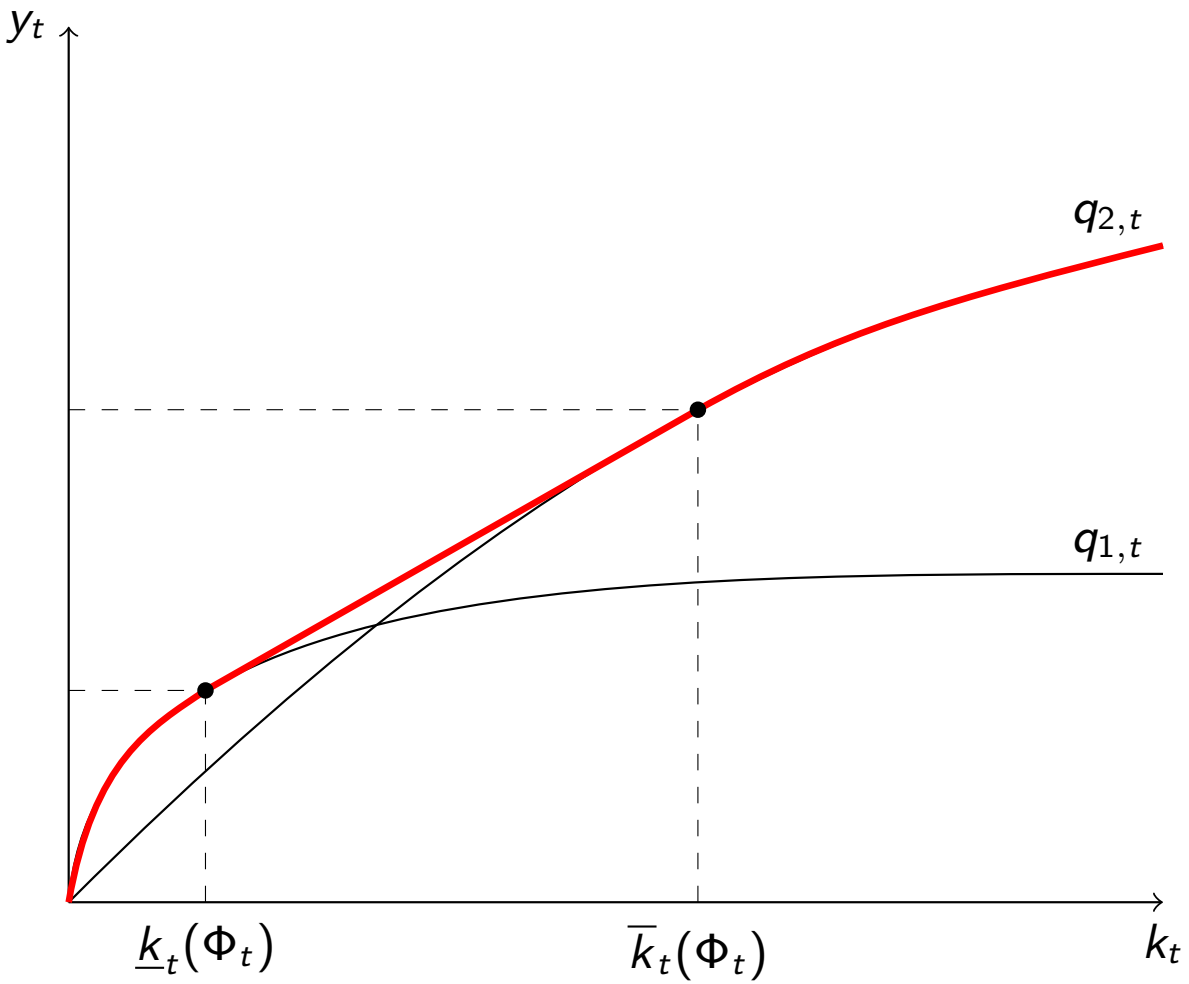
$$p_{q,i,t}Q_{i,t} - p_{k,i,t}K_{i,t} - W_{i,t}L_{i,t}$$

- Technology adoption depends on prices, and the capital labor ratio in each sector

Technology Adoption



Technology Adoption



The Model : Labor Market

- Assumption : It is costly to find a job (worker) or fill a position (firms)
- Captured by the so–called "matching function"

$$\overline{L}_t = \mathscr{M}(\overline{U}_t, \overline{V}_t) \equiv m_0 \overline{U}_t^{\zeta} \overline{V}_t^{1-\zeta} \text{ avec } 0 < \zeta < 1$$

  Beyond the control of any economic agent.
- Creates congestion externalities, and unemployment.

General Equilibrium

An equilibrium of this economy is a sequence of prices $\{\mathcal{P}_t\}_{t=0}^{\infty} = \{r_t, W_t, p_{k,t}\}_{t=0}^{\infty}$ and a sequence of quantities $\{\mathcal{Q}_t\}_{t=0}^{\infty} = \{c_t, d_t, a_t, C_t, A_t, I_t, K_{t+1}, Y_t, \Theta_t L_t, \sigma_t, \nu_t\}_{t=0}^{\infty}$ such that

(i) Given $\{\mathcal{P}_t\}_{t=0}^{\infty}$, $\{\mathcal{Q}_t\}_{t=0}^{\infty}$ solves the household program ;

(ii) Given $\{\mathcal{P}_t\}_{t=0}^{\infty}$, $\{\mathcal{Q}_t\}_{t=0}^{\infty}$ solves the program of each firm ;

(iii) Given $\{\mathcal{Q}_t\}_{t=0}^{\infty}$, $\{\mathcal{P}_t\}_{t=0}^{\infty}$ clear the markets

(iv) Equilibrium unemployment

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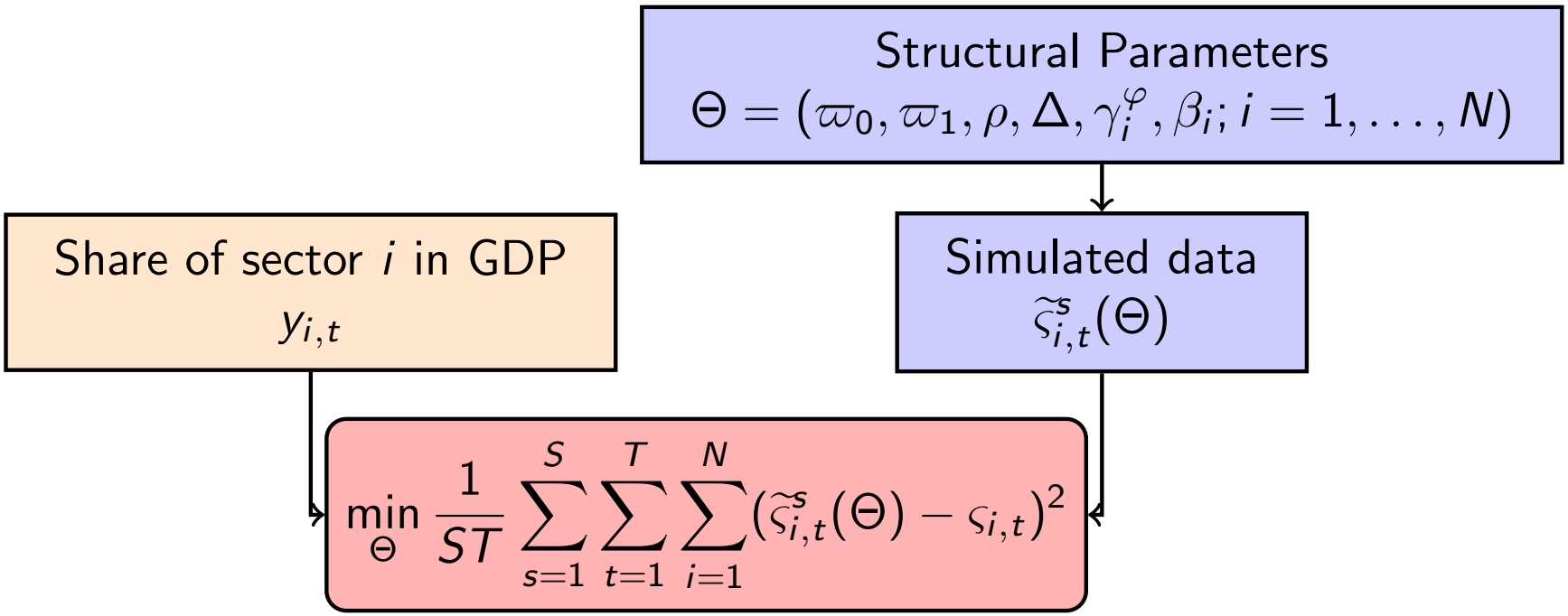
Quantitative Evaluation

- Quantitative Evaluation on the French economy, 3 main sectors (Agriculture, Manufacturing, Services)
- Preferences : Calibrated using previous studies
- Labor market : Match the situation of the labor market in the pre 1979 era
- Old technology : Match some ratios for the pre 1979 era (WN/Y, K/Y ...)
- New Technology : Estimation

Quantitative Evaluation



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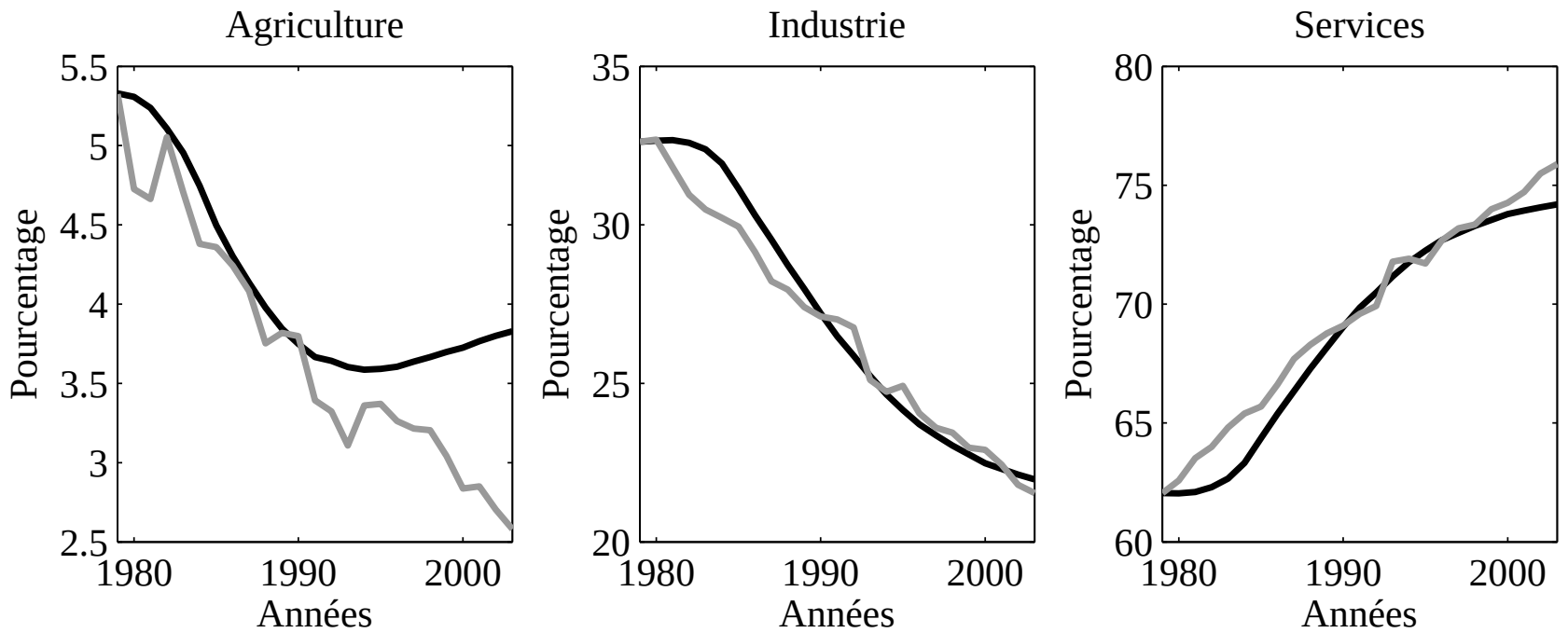
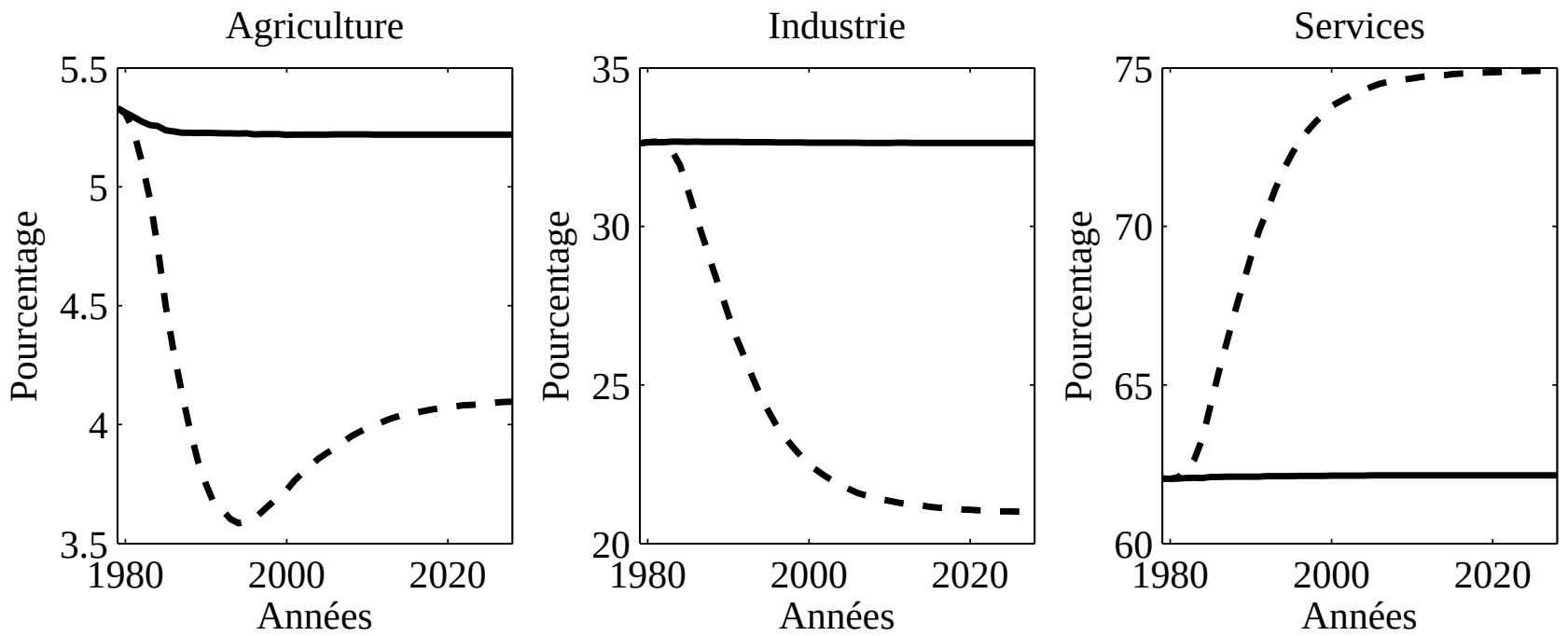
Evolution of Sectoral Shares

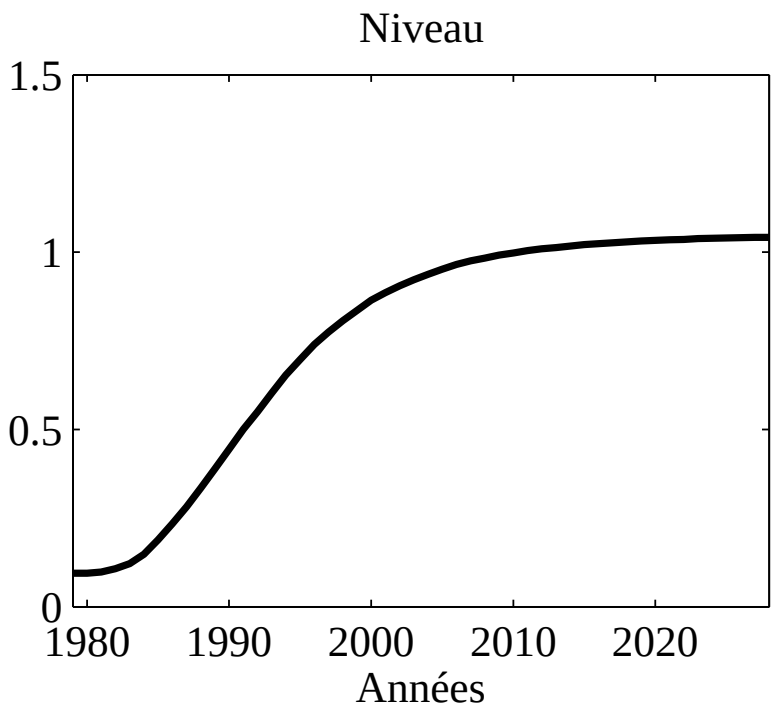


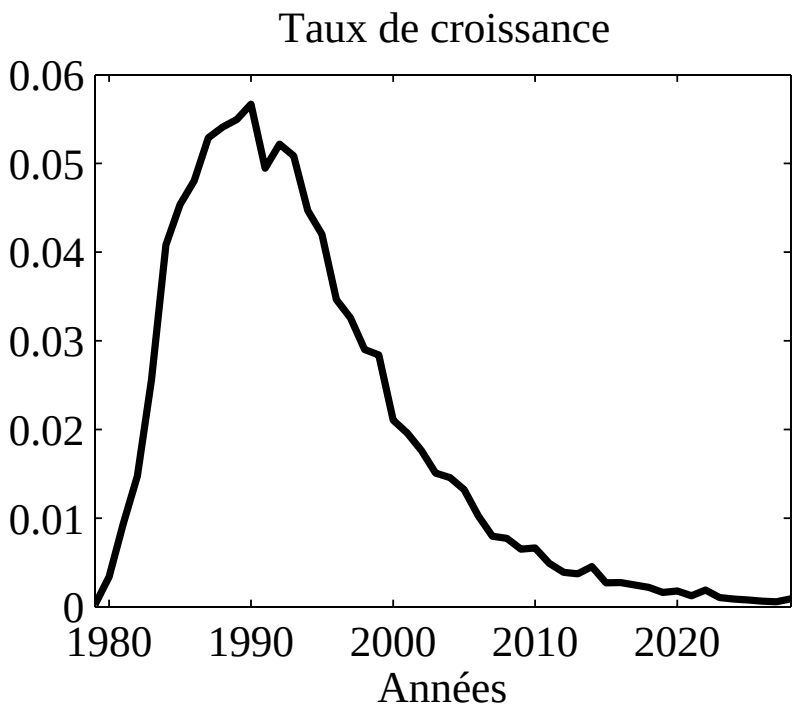
Evolution of Sectoral Shares

Role of Network Effects

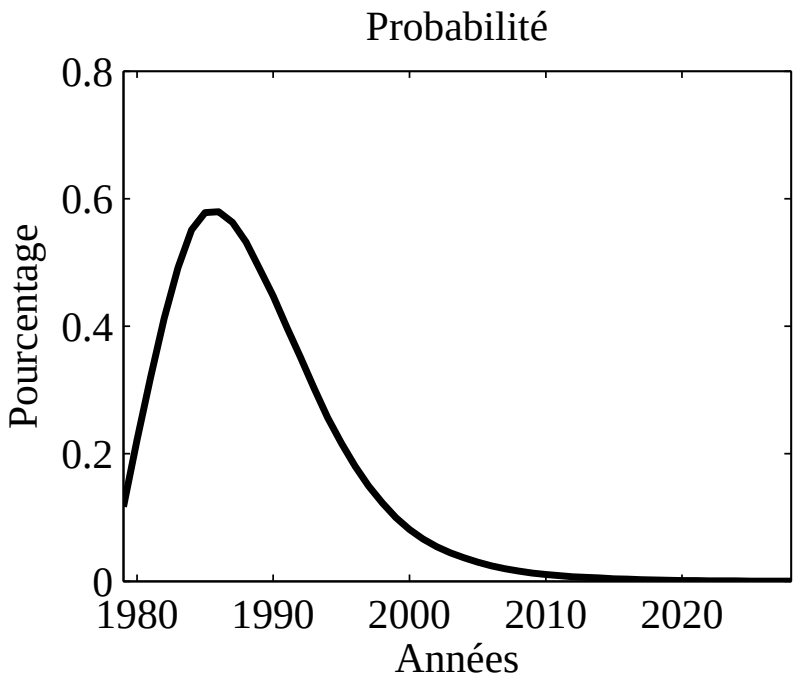


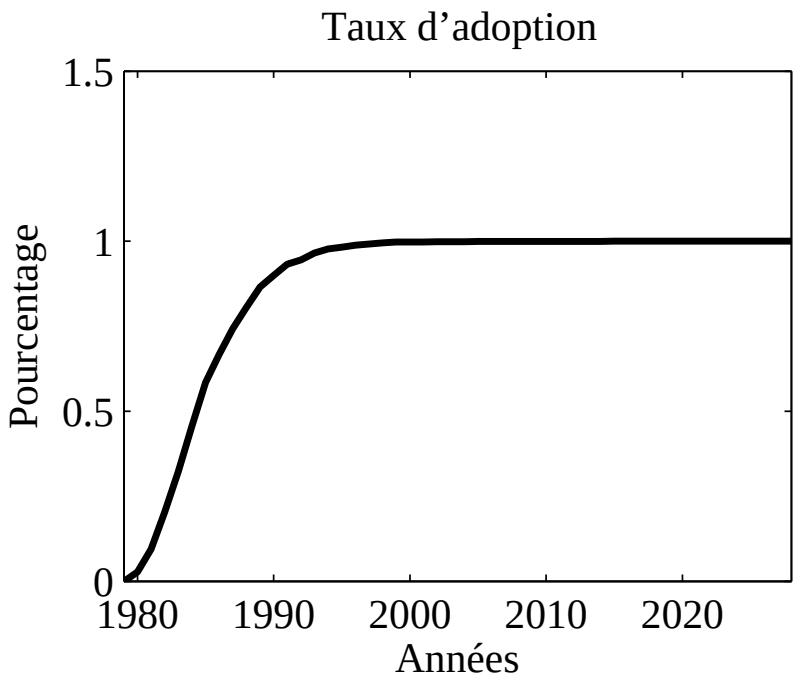
Evolution of GDP



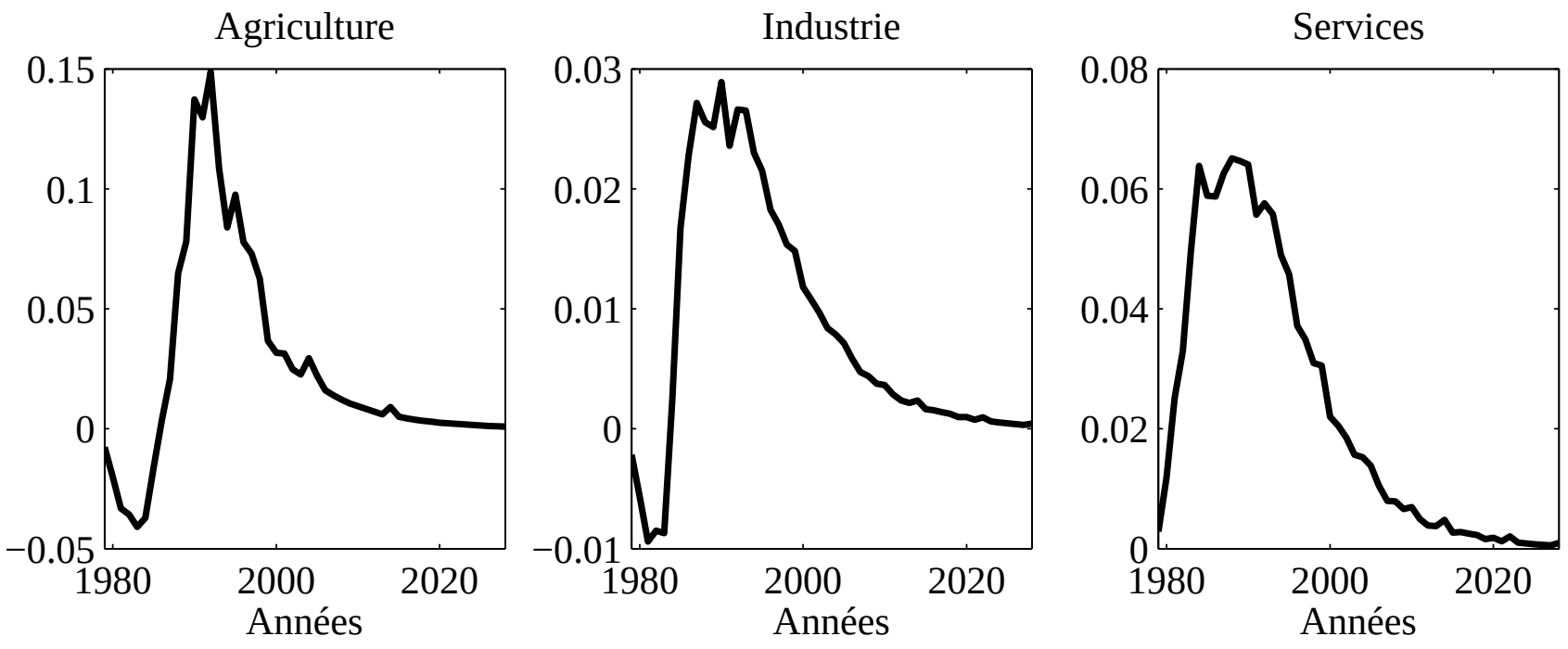


Evolution of probability

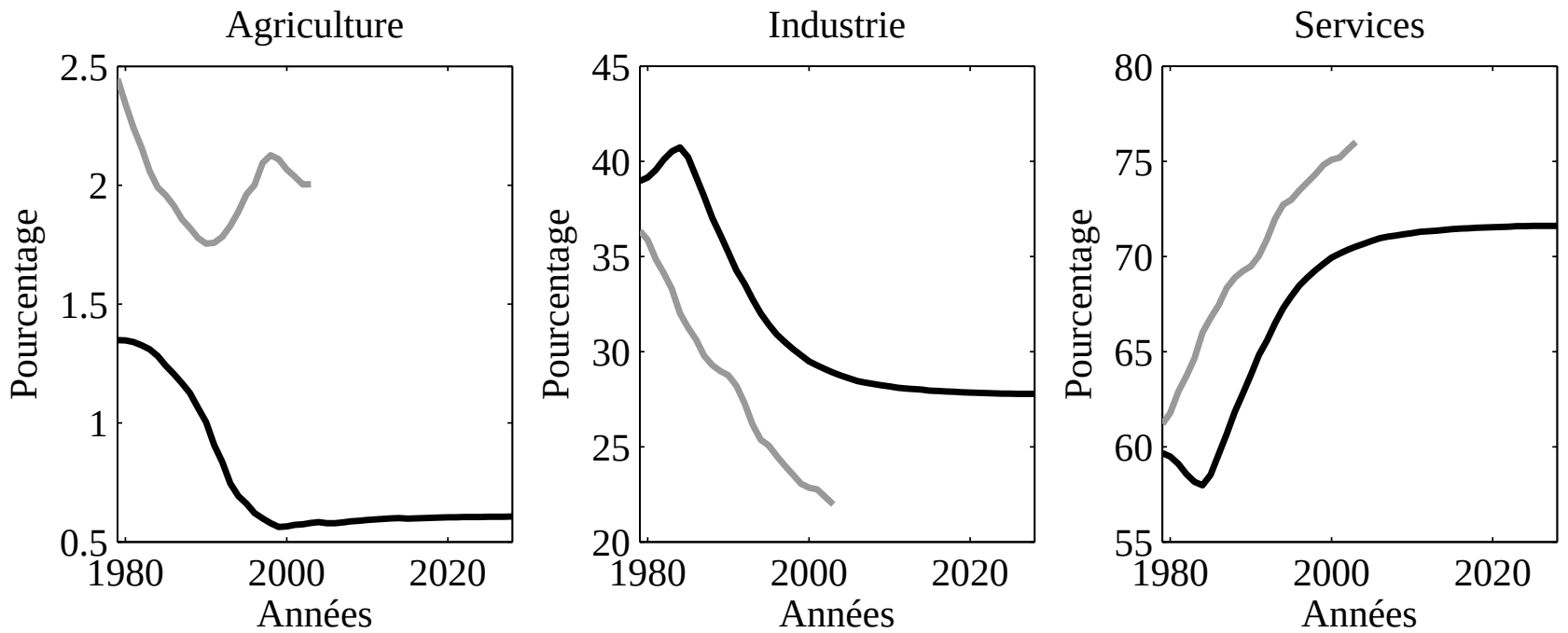




Evolution of Sectoral Productivity



Evolution of Labor Markets



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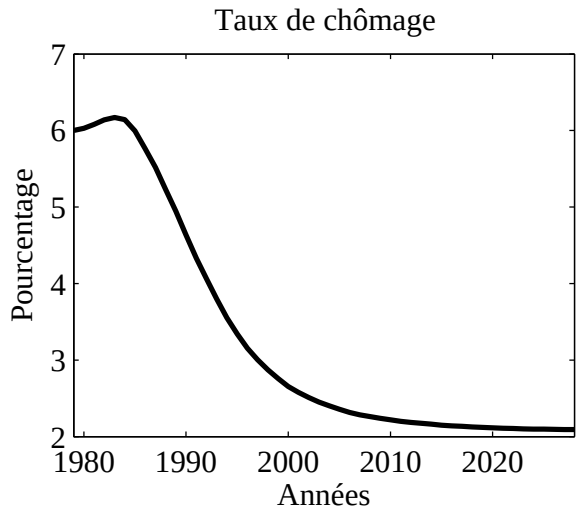

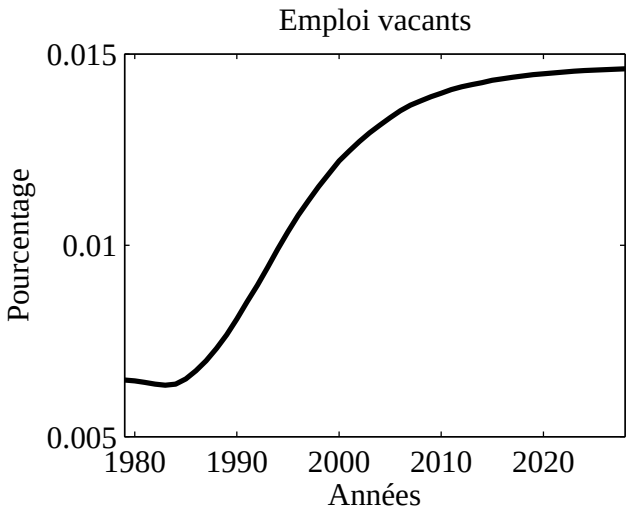

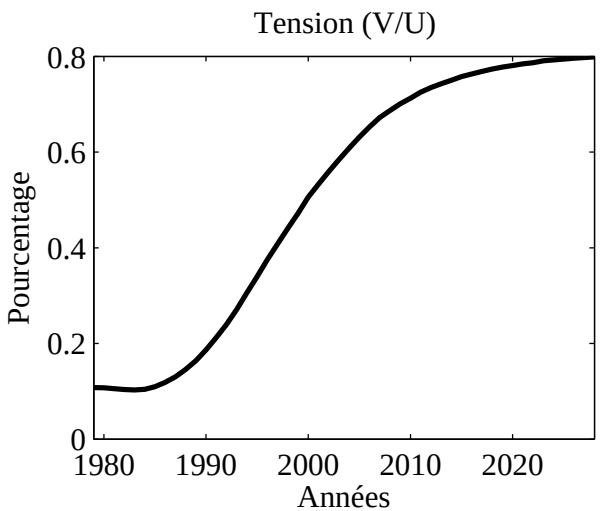

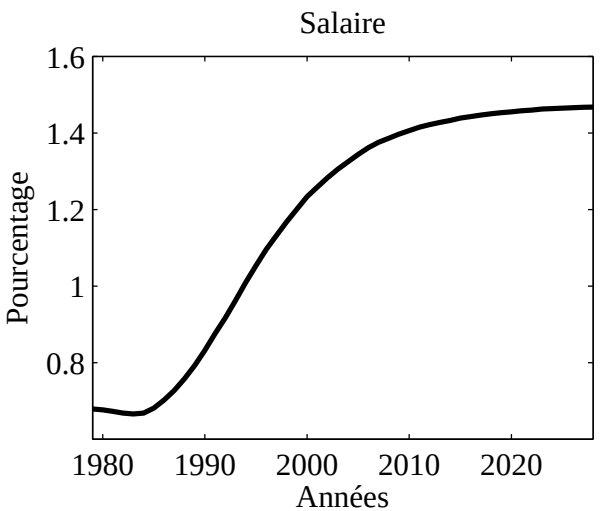

Welfare

- Potential Tradeoffs
  - Accumulate vs Consumption
  - Short run/long–run (e.g. unemployment)
- But in this case : Strong productivity effects due to network externality

$\mathscr{U}_t(\mathscr{C}_t)$	$\mathscr{U}_t(\mathscr{C}_t^{No})$	x
6.432178	6.211738	0.246625

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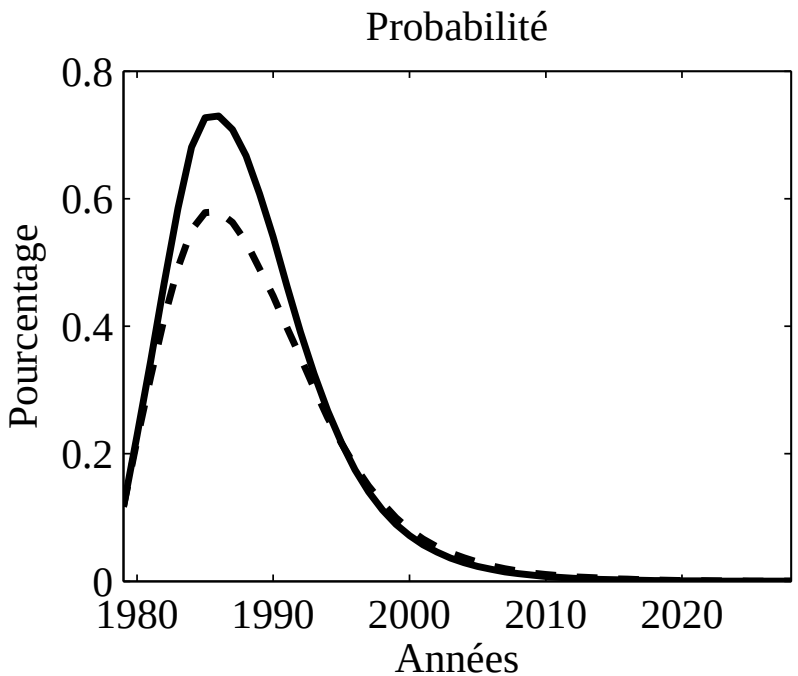
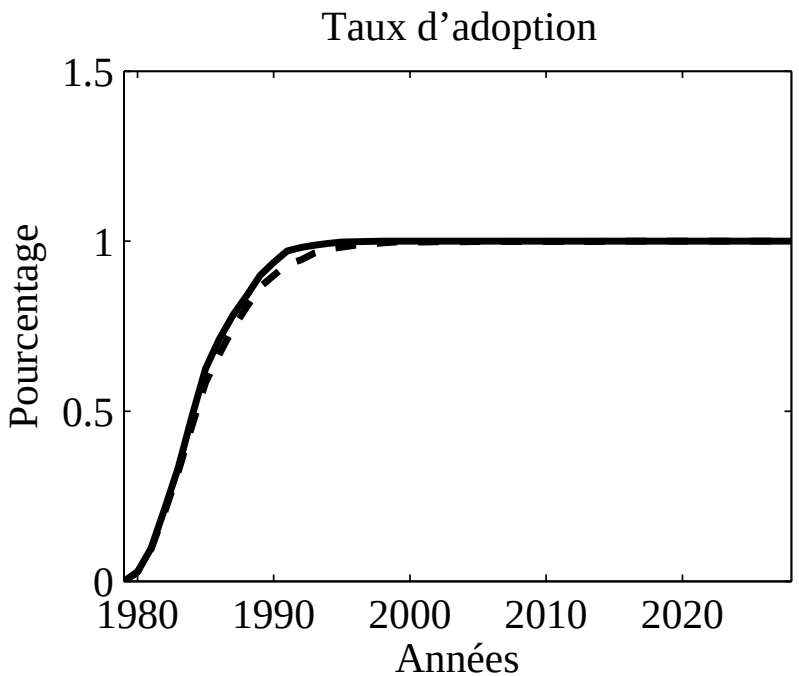
Stronger Network Effects

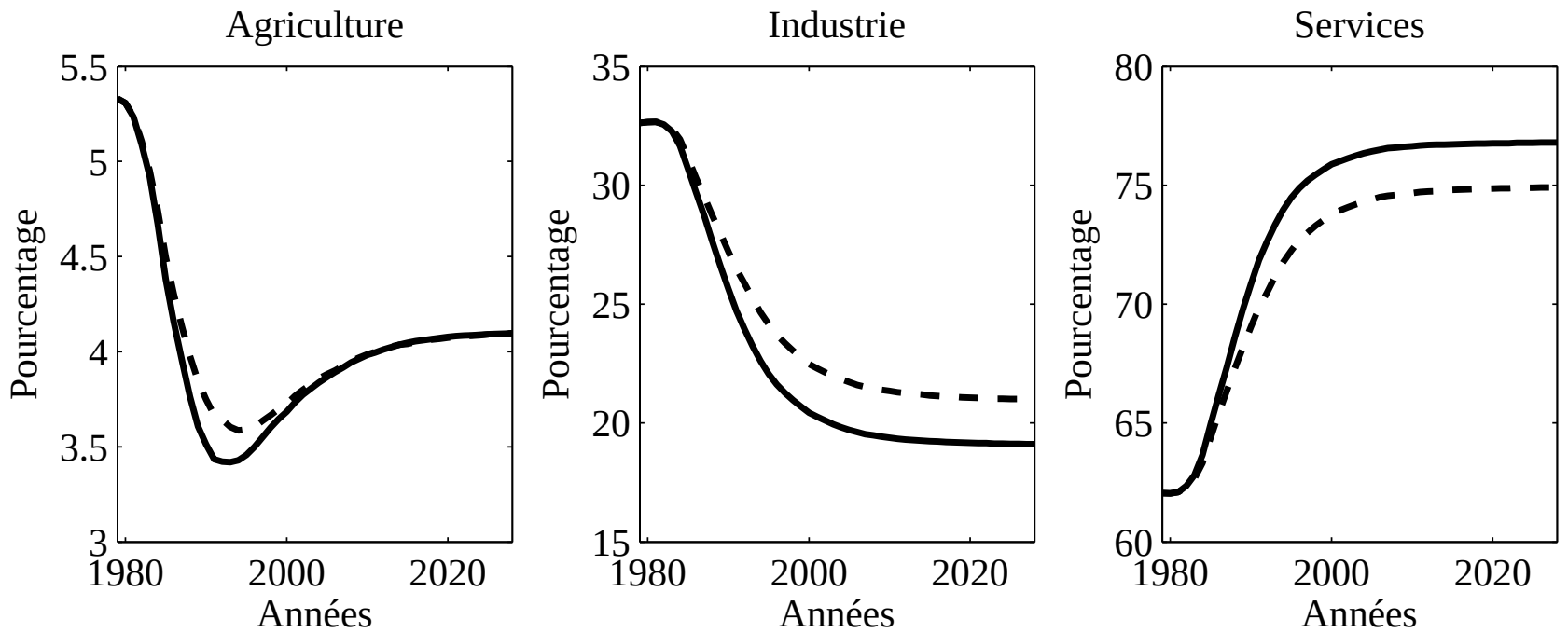
- Reinforce network effects
- increase π_1 such that probability increase by 20% at peak

Evolution of probability

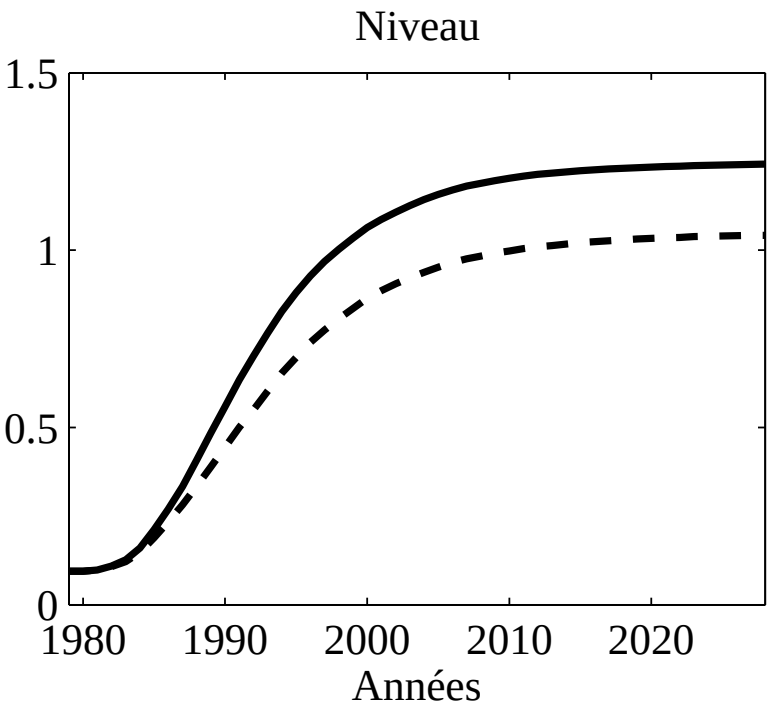


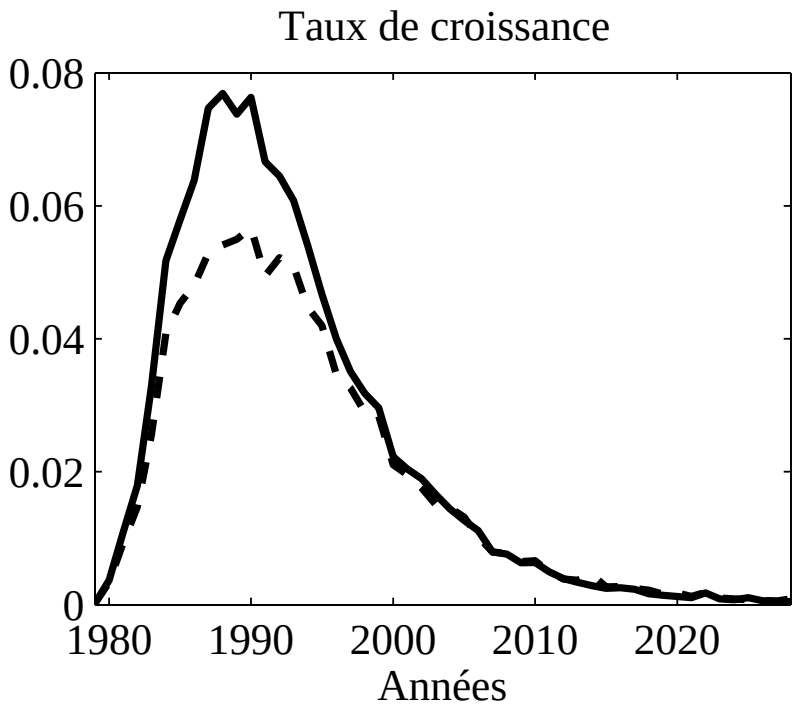


Evolution of Sectoral Shares

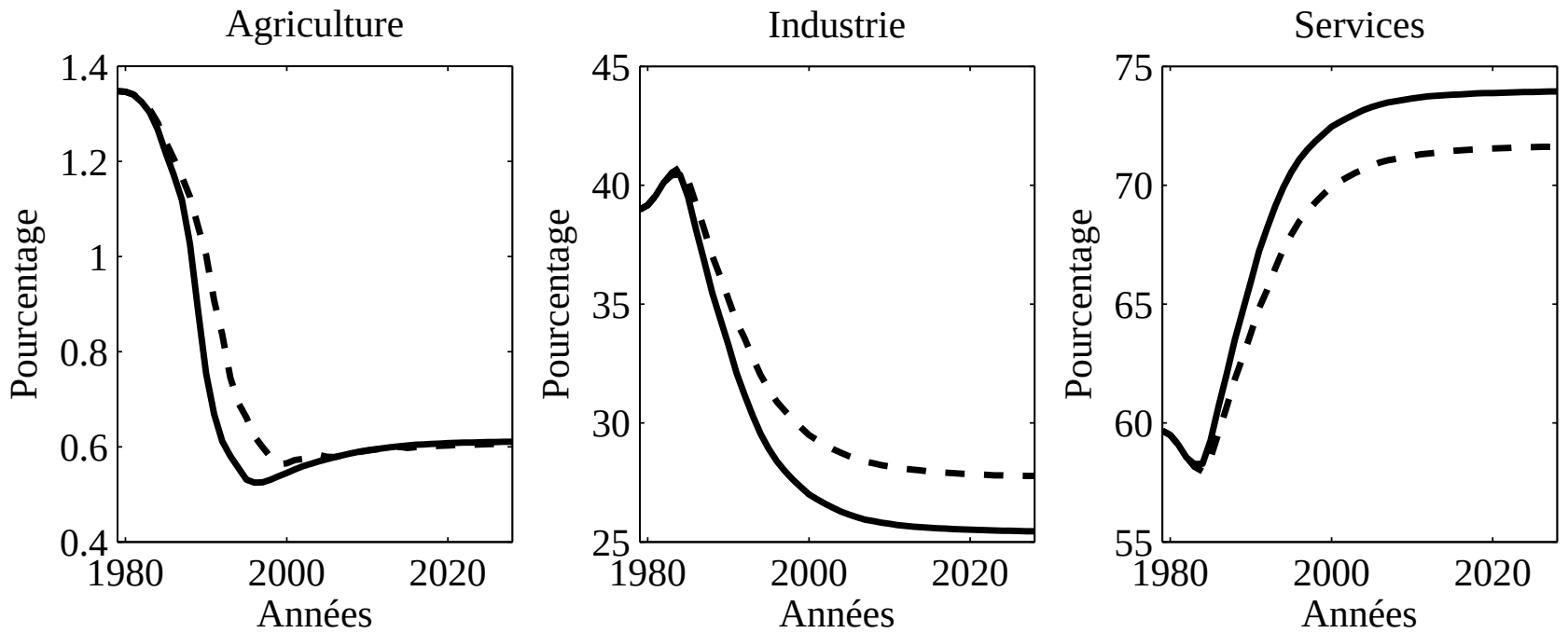


Evolution of GDP





Evolution of Labor Markets



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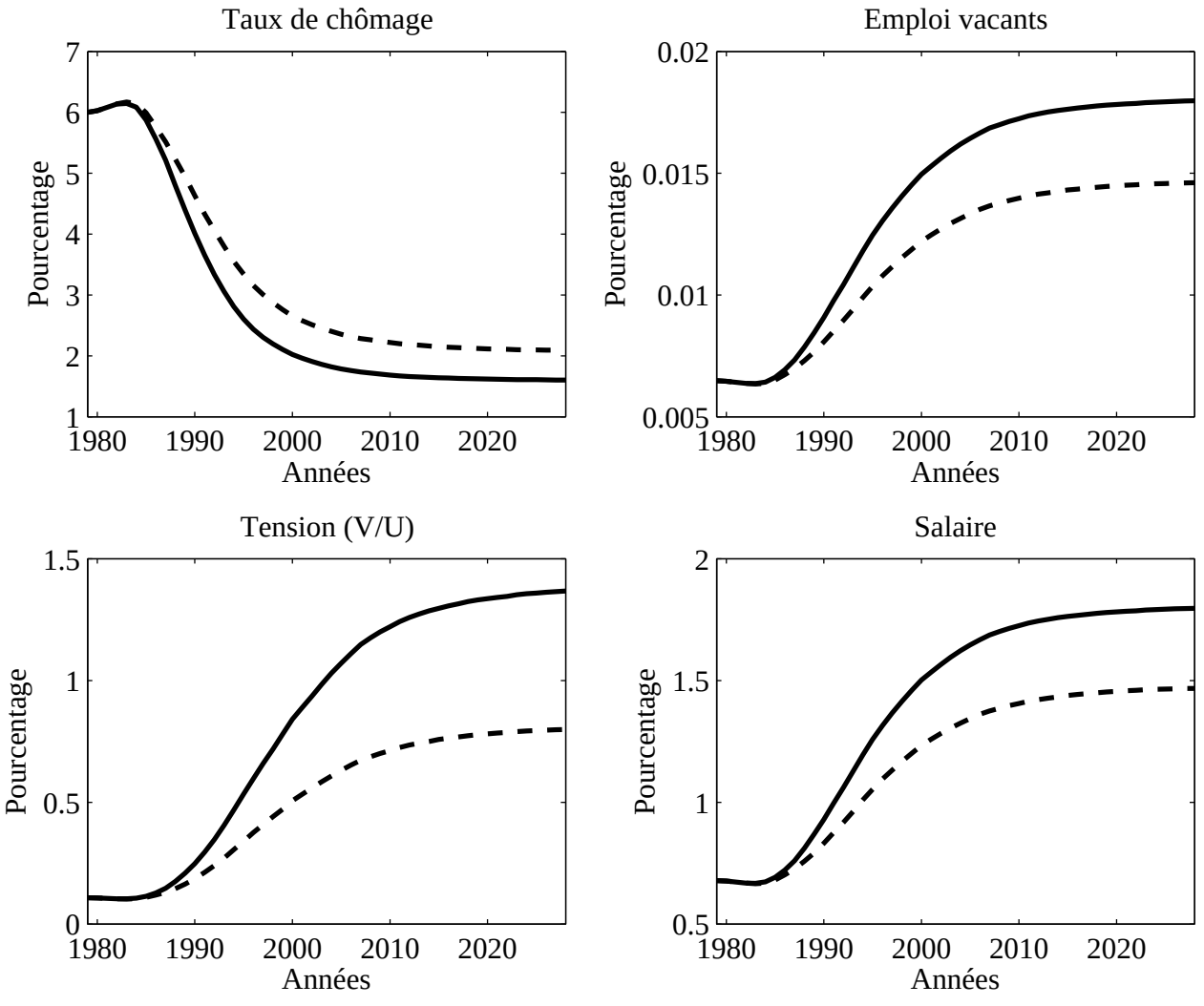

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Concluding remarks

- Introduction of new technologies usually thought of as Harmful for employment and welfare
- Show that this is not the case when it is associated with strong productivity effects
- Particularly true with strong network effects