Labor Market in EURACE

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Aims for the labor market: Wage

- Aims for the labor market regarding wages:

1. Wage dispersion across workers with different general skill levels.
   $\Rightarrow$ High skilled workers should generally receive higher wages than low skilled.

2. Wage dispersion within a group of equally qualified workers.
   $\Rightarrow$ It should be possible that a high (low) skilled worker receives a higher or lower wage than another equally high (low) skilled worker.

3. Wage competition between firms.
   $\Rightarrow$ Firms should increase the wage offers to attract more (high skilled) workers.

4. The development of wages should be connected to the development of the productivity of workers.
   $\Rightarrow$ Increasing productivity of workers should lead to increasing wages.

Aims for the labor market: Employment

- Aims for the labor market regarding employment:

1. Reasonable unemployment rate.

   $\Rightarrow$ The unemployment rate should be in the range of real European unemployment rates.

2. Different unemployment rates across households with different education levels.

   $\Rightarrow$ The unemployment rate for high skilled workers should be lower than for low skilled.

3. The unemployment rate should be connected to the production development in the economy.

   $\Rightarrow$ An increasing production level should lead to a decreasing (stable) unemployment rate.

4. Voluntary unemployment.

   $\Rightarrow$ It should be possible that workers do not apply for jobs although they are unemployed.

Other aims for the labor market

- Other aims for the labor market:

  1. Frictions on the labor market.

     $\Rightarrow$ Vacancies and unemployed should exist contemporaneously.

  2. Spatial frictions on the labor market.

     $\Rightarrow$ In a multiple region setting different flows of commuters should be generated.

Important modeling features of workers to reach these aims

- Workers have a differentiated skill structure.
  1. General skills - Education:
     - 5 exogenously given general skill groups.
     - Proxy for individual education.
     - Heterogenous within and across regions.
  2. Specific skills - Productivity:
     - Capabilities and experiences attained on the job.
     - Associated with technology used by the employer.
- Workers increase specific skills over time.
  - Speed depends on the general skill level b_w^{gen} and quality of technology used by employer $A_{i,t}$

$$b_{w,t+1} = b_{w,t} + \chi(b_w^{gen})(A_{i,t} - b_{w,t})$$

Important features of firms to reach these aims

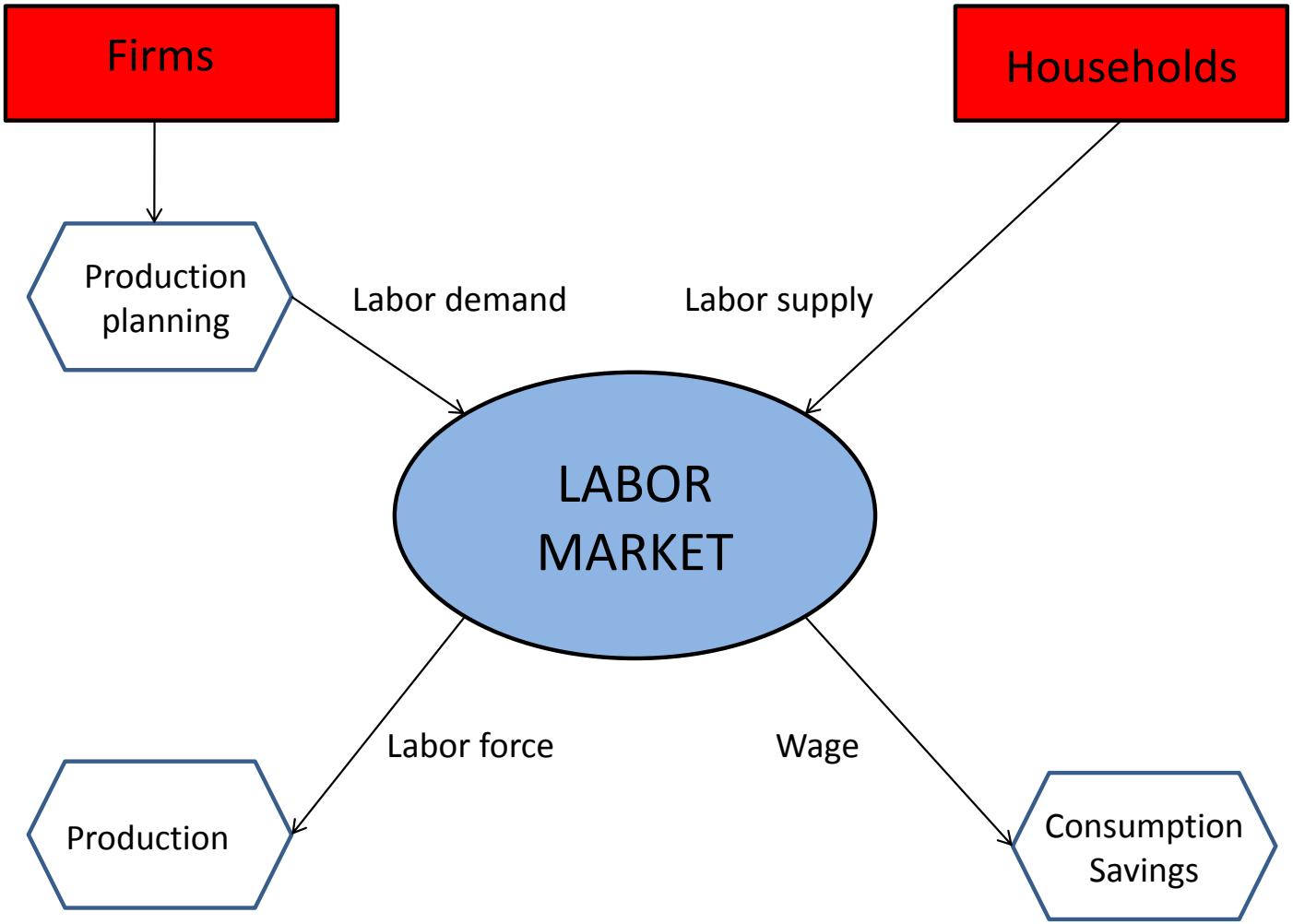
- Firms invest in new capital goods to increase the used technology $A_{i,t}$.

  $\Rightarrow$ Employees can improve their specific skills.

- Firms post wage offers for each skill group.

  $\Rightarrow$ Differentiated wage structure.

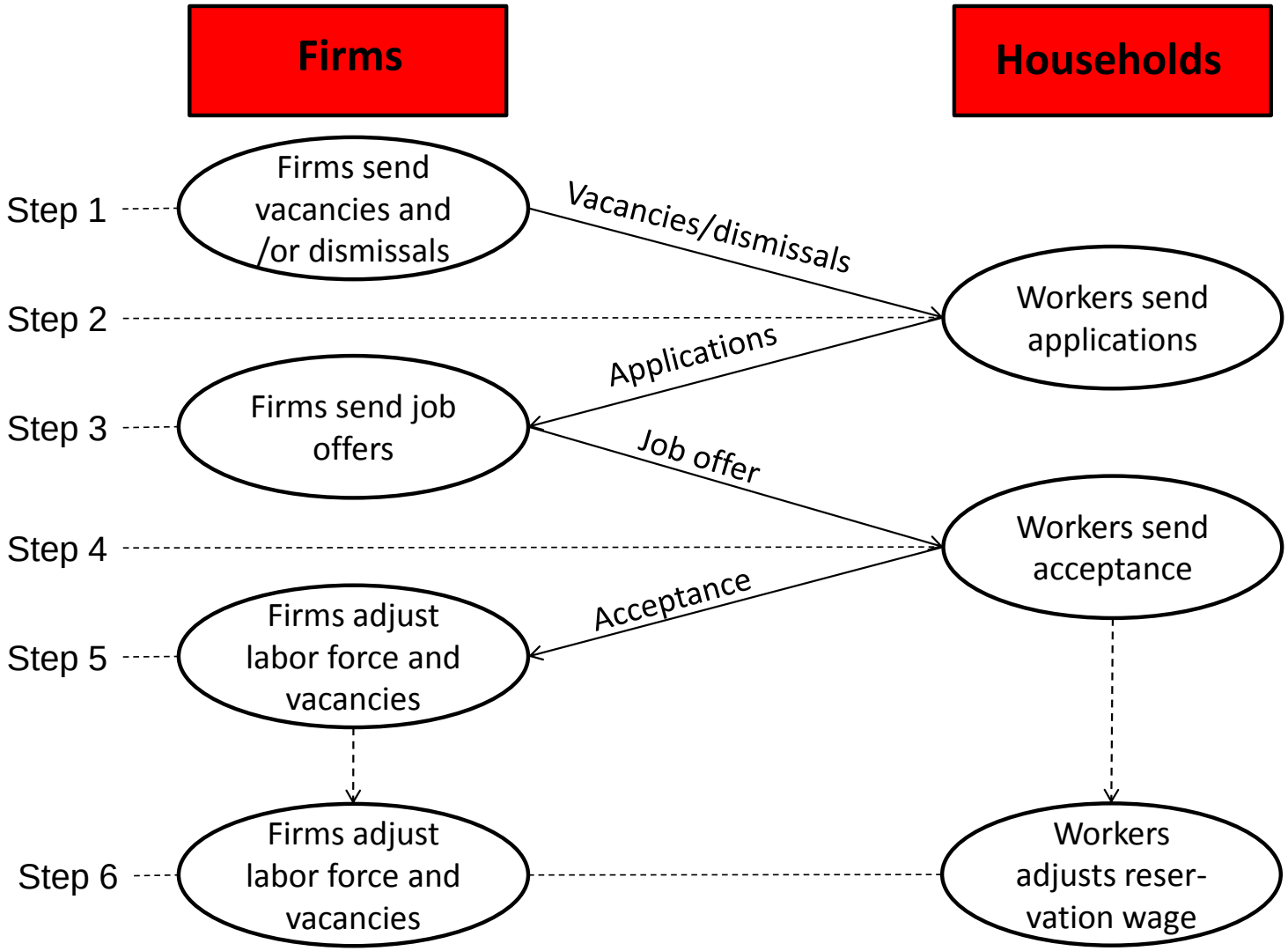
Embedment of the labor market in the EURACE model



Labor Demand and Labor supply

- Labor demand:
  - The labor demand is generated on the consumption goods market.
  - If the demand for consumption goods of one firm increases (decreases) the labor demand for production increases (decreases).
  - Firms enter the labor market once a month. This day is heterogenous across firms.
- Labor supply:
  - Unemployed generate the labor supply.
  - Labor supply is differentiated due to general and specific skills.
  - Unemployed enter the labor market every day as long as they are unemployed.

Sequence of action: Matching algorithm



Sequence of action: Matching algorithm

- Step 1: Firms send dismissals and /or firms post vacancies including wage offers for each general skill level.
- Step 2: Workers/job seekers extract from the list of vacancies those postings to which they fit in terms of their reservation wage and send applications.
- Step 3: Firms read the incoming applications and send as many job offers as they have vacancies to fill.
- Step 4: Workers rank the incoming job offers according to the wages net of commuting costs and accept the highest ranked job offer.
- Step 5: Firms adjust their work force and their vacancies.
- Step 6: If the number of vacancies not filled exceeds some threshold firms raise the base wage offer. If an unemployed job seeker did not find a job he reduces his reservation wage.

- The labor market loop is repeated one time if one or more firms did not fill their vacancies during the first loop.

Step 1: Labor demand driven dismissals

- If firms want to decrease the production quantity they have to dismiss employees.

  $\Rightarrow$ Connection between production level and unemployment rate.

- Three different rules:

  1. Random firing: Firms randomly choose which employees will be dismissed.
  2. Lowest general skills first: Firms dismiss employees with low general skill.
  3. Lowest specific skills first: Firms dismiss employees with low specific skills.

Step 1: Random dismissals

- Firms dismiss a randomly determined fraction γ_t of the employees in each period.
  - $\gamma_t \in [lowerbound, upperbound]$, for example $\gamma_t \in [0, 10]$
  - The boundaries are exogenously given.
- The idea: We combine several reasons for a job separation.
  1. Employees quit because they found a better job (on-the-job-search).
  2. Employees quit because they moved or were not satisfied with their actual job.
  3. Firms dismiss workers because they were not satisfied with the performance.

Step 1: Vacancies

- If firms want to raise the production they have to increase the number of employees and to post vacancies.

  $\Rightarrow$ Connection between production level and unemployment rate.

- Two important characteristics of vacancies:

  1. Wage offers for each general skill group.

  2. The region_id of the firm: Job seekers who want to work in a foreign region have to bear commuting costs (optional).

Step 1: Vacancies Determination of the wage offer

- Firm i determines the wage offer $w^O_{i,t,g}$ in period t for each general skill level g where $g \in [1,5]$

$$\Rightarrow w^O_{i,t,g} = w^b_{i,t} \times \bar{B}_{i,t,g}.$$

- The offered wage $w^O_{i,t,g}$ consists of two parts:

1. Base wage offer $w^{\boldsymbol{b}}_{\boldsymbol{i,t}}$ which is paid for one unit of specific skills.
   - $w^{\boldsymbol{b}}_{\boldsymbol{i,t}}$ will be increased in the second loop if the number of unfilled vacancies exceeded an exogenously given threshold ν.
   - The base wage offer is market driven and an increase is not price neutral.
2. Average specific skill level $\bar{B}_{\boldsymbol{i,t,g}}$ of employees with general skill level g in firm i.
   - The wage offer will be increased (decreased) if the productivity of workers increased (decreased).
   - This increase is price neutral.

Step 1: Wage offer

- Via this wage offer determination the model produces different wage offers for different general skills.

  $\Rightarrow$ Connection of wage offers to the productivity of workers.

  $\Rightarrow$ Wage dispersion across and within skill groups.

Step 2: Applications

- Workers/job seekers extract from the list of vacancies those postings to which they fit in terms of their reservation wage.

$$w^O_{i,t,g} \geq w^R_{w,t}$$

- If the wage offer $w^O_{i,t,g}$ is lower than the reservation wage $w^R_{w,t}$ of job seeker w in period t then the job seeker will ignore this posted vacancy.

- If the vacancy is posted by firm j from a foreign region the job seeker has to take commuting costs *comm* (optional) into account.

$$w^O_{j,t,g} - comm \geq w^R_{w,t}$$

$\Rightarrow$ Voluntary unemployment.

Step 2: Applications

- The job seeker sends applications to z randomly chosen firms.
  - The exogenously given parameter z is the number of applications a job seeker can send where $z \in [0, \mathit{NumberFirms}]$.
  - The job seeker chooses the firms randomly because we want to avoid that all job seekers apply to the same firm, i.e. the firm with the highest wage offer.

$\longrightarrow$ Imperfect Information

Step 3: Job offers

- Two possible cases:

1. Case: The number of applicants is $\leq$ than the number of vacancies.
   - Firms send job offers to all applicants.

2. Case: The number of applicants is $>$ than the number of vacancies.
   - Logit model: General skills of applicants are translated into an employment probability.
   - Higher general skills lead to higher employment probabilities.

Step 3: Job offers - More applicants than vacancies

- Firms store the incoming applications in a list.
- We use a logit model to translate the general skills of an applicant a into an employment probability $prob_{a,t}$.

$$prob_{a,t} = \frac{\exp^{\lambda b_a^{gen}}}{\sum_{a=1}^{A} \exp^{\lambda b_a^{gen}}}$$

  - The exogenously given parameter λ measures the sensitivity of employment probabilities with respect to the general skill levels and A is the number of applicants on the list.
- Firms randomly choose as many applicants as they have vacancies to fill and send job offers.

Step 3: Job offers - Employment probabilities

- The influence of λ on the employment probabilities.
  - $\lambda = 0$: Applicants are chosen equally likely.
  - $\lambda > 0$: As λ increases, applicants with higher general skills are chosen more likely.
  - $\lambda \to -\infty$: Employment probability for applicants with the highest general skill level ($g = 5$) converges to 1.
  - Higher general skills lead to higher employment probabilities.

$\Rightarrow$ Basis for different unemployment rates across the general skill groups.

Step 4: Job acceptance and refusal

- If households receive one or more job offers they rank the incoming job offers.
  1. The job offer with the highest wage net of commuting costs is ranked first.
  2. If the offered wages of two job offers are equal they are ranked randomly.
- Households accept the highest ranked job offer.
- Households adjust the reservation wage to the new wage net commuting costs that is

$$w^R_{w,t} = w^O_{i,t,g} \text{ or } w^R_{w,t} = w^O_{j,t,g} - comm.$$

- The other job offers are refused.

$\Rightarrow$ Frictions: Vacancies remain unfilled.

$\Rightarrow$ Frictions: Some unemployed do not get a job offer.

Step 5: Work force and vacancies adjustment

- If firms receive one or more job acceptances:

1. The applicant is added to the work force and his ID, wage, general skill level and specific skills are stored.

2. The number of vacancies is decreased by the number of job acceptances.

Step 6: Wage offer adjustment

- If the number of vacancies not filled exceeds an exogenously given threshold ν firms raise the base wage offer $w^b_{i,t}$ by an exogenously determined fraction φ.

$$w^b_{i,t+\tau} = (1+\varphi) w^b_{i,t}$$

$$\Rightarrow w^O_{i,t+\tau,g} = w^b_{i,t+\tau} \times \bar{B}_{i,t,g}$$

- The market driven wage increase should attract more (high skilled) workers to fill the unfilled vacancies.

- The base wage offer is increased only after the first loop on the labor market and not after the second loop.

Step 6: Wage offer adjustment

- Base wage offer adjustments lead to:

  $\Rightarrow$ Wage competition between firms.

  $\Rightarrow$ Connection between consumption goods demand and wages.

  $\Rightarrow$ Different wages across firms for the same general skill group.

  $\Rightarrow$ Wage dispersion within the general skill groups and across firms.

Step 6: Reservation wage adjustment

- If a job seeker did not find a job he reduces his reservation wage by a fraction ϕ.

$$w^R_{w,t+\tau} = (1-\phi) w^R_{w,t}$$

- In the next round or period the job offer will also extract posted vacancies with a lower wage offer.
- There exists a lower bound for the reservation wage w^R_{min}.
  - The lower bound is determined by the unemployment benefit.

Wage increase due to productivity increase

- The wage of employee i in period $t+1$ will be increased if the productivity increased.

$$w_{i,t+1} = w_{i,t}(1 + P_{r,t})$$

  - $P_{r,t}$ is the average productivity increase in region r in period t.

- Interpretation: Simplified version of a wage bargaining agreement.

$\Rightarrow$ Connection between wages and productivity progress.

Unemployment benefit

- Unemployed receive unemployment benefits UB.
- Unemployment benefits are based on an exogenously given regional unemployment benefit rate u_r of their last net wage.

$$UB_{i,t+1} = u_r(w_{i,t}(1 - taxrate))$$

- The lower bound of unemployment benefits is 50% of the average net wage in the economy.

Spatial structure

- The EURACE model allows to have more than one region which can be calibrated differently, e.g. Germany and Poland.
- Implications for the labor market:
  1. Regional labor market with different properties.
  2. Commuting of workers between the regions.

Spatial structure - Different properties

- Regions can be calibrated differently regarding the labor market (and other markets).

1. Different general skill distributions.
2. Different specific skills.
3. Different unemployment benefit rates.
4. Different (base) wage offers.

Spatial structure - Different properties

- Calibration: Germany vs. Poland

General skill level	Germany	Poland
1	10%	42%
2	30%	33%
3	40%	20%
4	15%	4%
5	5%	1%

Variable	Germany	Poland
Specific skills	1.5	1.0
Base wage offer	1.5	1.0
Wage offer	2.25	1.0
Unemployment benefit rate	0.7	0.6

Spatial structure - Commuting of workers

- The parameter commuting costs *comm* steers the flow of commuters.
- Job seekers only apply for a job in a foreign region if

$$w^{O}_{j,t,g} - comm \geq w^{R}_{w,t}.$$

- If commuting costs are high

$$\lim_{comm \to \infty} (w^{O}_{j,t,g} - comm) = -\infty. \Rightarrow w^{O}_{j,t,g} - comm < w^{R}_{w,t}$$

  - No commuting between regions.
  - Interpretation: Labor markets are closed.

$\Rightarrow$ Two or more separated labor markets.

Spatial structure - Commuting of workers

- If commuting costs are low

$$\lim_{comm \to 0}(w^O_{j,t,g} - comm) = w^O_{j,t,g} \Rightarrow w^O_{j,t,g} - comm \lessgtr w^R_{w,t}.$$

- Commuting between regions.
- Interpretation: Labor markets are completely open.

  $\Rightarrow$ One completely integrated labor market.

Spatial structure - Commuting of workers

- There is a range of commuting costs $comm \in [\underline{comm}, \overline{comm}]$ where

  $w^O_{j,t,g} - comm < w^R_{w,t}$ for some job seekers and

  $$w^O_{j,t,g} - comm \geq w^R_{w,t} \text{ for others.}$$

- If additionally the wage offer by a firm j from a foreign region is higher than the wage offer by firm i from the domestic region some workers might commute and some not.

  $$\Rightarrow w^O_{j,t,g} - comm > w^O_{i,t,g}$$

- Interpretation: Two or more open labor markets with spatial frictions.

Spatial structure - Commuting costs

- Interpretation of commuting costs:

1. Monetary costs for traveling.
2. Opportunity costs: forgone leisure.
3. Regulations by law: employment permit.