Returns to Tenure or Seniority?

S. Buhai[1], M. Portela[2], C. Teulings[3] and A. van Vuuren[4]

UC Merced, Jan 7^{th} '09

[1] Aarhus School of Business, University of Aarhus
[2] University of Minho
[3] CPB Netherlands Bureau for Economic Policy Analysis and University of Amsterdam
[4] Free University Amsterdam

Outline

- Motivation/ Introduction / Intuition
- Theoretical model
- Data
- Empirical methodology and results
- Summary and concluding remarks

Introduction (1)

- Why does Jens earn more than Lars, when they do the same job, at the same firm and with equal skills?

Introduction (1)

- Why does Jens earn more than Lars, when they do the same job, at the same firm and with equal skills?
- Why is Pedro fired and his colleague Miguel is allowed to stay at the firm when the employer scales down employment, where again they do the same job, with the same skills?

Introduction (2)

- Simultaneous theoretical explanation and empirical evidence for these two phenomena

Introduction (2)

- Simultaneous theoretical explanation and empirical evidence for these two phenomena
- *Seniority* is different from *tenure*: measures the worker's tenure *relative* to the tenure of her colleagues.

Introduction (2)

- Simultaneous theoretical explanation and empirical evidence for these two phenomena
- *Seniority* is different from *tenure*: measures the worker's tenure *relative* to the tenure of her colleagues.
- Using matched worker-firm data for Denmark and Portugal, we show that a worker who is hired last, is likely to be fired first (Last In, First Out=LIFO)

Introduction (2)

- Simultaneous theoretical explanation and empirical evidence for these two phenomena
- *Seniority* is different from *tenure*: measures the worker's tenure *relative* to the tenure of her colleagues.
- Using matched worker-firm data for Denmark and Portugal, we show that a worker who is hired last, is likely to be fired first (Last In, First Out=LIFO)
    - on top of the negative duration dependence of the hazard rate, being a senior worker with many more junior colleagues has a further negative effect

Introduction (2)

- Simultaneous theoretical explanation and empirical evidence for these two phenomena
- *Seniority* is different from *tenure*: measures the worker's tenure *relative* to the tenure of her colleagues.
- Using matched worker-firm data for Denmark and Portugal, we show that a worker who is hired last, is likely to be fired first (Last In, First Out=LIFO)
  - on top of the negative duration dependence of the hazard rate, being a senior worker with many more junior colleagues has a further negative effect
- Analogously, we show that there is return to *seniority* in wages

Introduction (2)

- Simultaneous theoretical explanation and empirical evidence for these two phenomena
- *Seniority* is different from *tenure*: measures the worker's tenure *relative* to the tenure of her colleagues.
- Using matched worker-firm data for Denmark and Portugal, we show that a worker who is hired last, is likely to be fired first (Last In, First Out=LIFO)
    - on top of the negative duration dependence of the hazard rate, being a senior worker with many more junior colleagues has a further negative effect
- Analogously, we show that there is return to *seniority* in wages
    - on top of the return to tenure as usually measured, there is return to seniority

Introduction (3)

- Simple economic theory for why firms and workers would agree on applying a LIFO layoff rule and why that leads to a return to seniority in wages

Introduction (3)

- Simple economic theory for why firms and workers would agree on applying a LIFO layoff rule and why that leads to a return to seniority in wages
- Dynamic model of the firm with stochastic product demand and irreversible specific investments for each newly hired worker, e.g. Bentolila and Bertola (1990)=BB

Introduction (3)

- Simple economic theory for why firms and workers would agree on applying a LIFO layoff rule and why that leads to a return to seniority in wages
- Dynamic model of the firm with stochastic product demand and irreversible specific investments for each newly hired worker, e.g. Bentolila and Bertola (1990)=BB
  - labor demand follows a geometric random walk

Introduction (3)

- Simple economic theory for why firms and workers would agree on applying a LIFO layoff rule and why that leads to a return to seniority in wages
- Dynamic model of the firm with stochastic product demand and irreversible specific investments for each newly hired worker, e.g. Bentolila and Bertola (1990)=BB
    - labor demand follows a geometric random walk
    - hiring and firing of each worker can be considered separately of the hiring and firing of all other workers, transforming the firm level model into a model of an individual worker, e.g. Dixit (1989)

Introduction (3)

- While BB and Dixit take wages as given, we allow for wage bargaining over the surplus generated by the specific investment. We use ideas from the union frameworks in Kuhn (1988) and Kuhn and Robert (1989), but introduce them in a dynamic rather than their static framework:

Introduction (3)

- While BB and Dixit take wages as given, we allow for wage bargaining over the surplus generated by the specific investment. We use ideas from the union frameworks in Kuhn (1988) and Kuhn and Robert (1989), but introduce them in a dynamic rather than their static framework:
  - Incumbents bargain for a layoff order and for a wage schedule where inframarginal workers get higher wages than marginal workers

Introduction (3)

- While BB and Dixit take wages as given, we allow for wage bargaining over the surplus generated by the specific investment. We use ideas from the union frameworks in Kuhn (1988) and Kuhn and Robert (1989), but introduce them in a dynamic rather than their static framework:
  - Incumbents bargain for a layoff order and for a wage schedule where inframarginal workers get higher wages than marginal workers
  - firm cannot fire the expensive inframarginal workers without first firing the cost effective marginal workers– ie. Pedro and Miguel's situation

Introduction (3)

- While BB and Dixit take wages as given, we allow for wage bargaining over the surplus generated by the specific investment. We use ideas from the union frameworks in Kuhn (1988) and Kuhn and Robert (1989), but introduce them in a dynamic rather than their static framework:
  - Incumbents bargain for a layoff order and for a wage schedule where inframarginal workers get higher wages than marginal workers
  - firm cannot fire the expensive inframarginal workers without first firing the cost effective marginal workers– ie. Pedro and Miguel's situation
  - When this wage schedule is properly set, the firm will pick the efficient employment level

Introduction (3)

- While BB and Dixit take wages as given, we allow for wage bargaining over the surplus generated by the specific investment. We use ideas from the union frameworks in Kuhn (1988) and Kuhn and Robert (1989), but introduce them in a dynamic rather than their static framework:
    - Incumbents bargain for a layoff order and for a wage schedule where inframarginal workers get higher wages than marginal workers
    - firm cannot fire the expensive inframarginal workers without first firing the cost effective marginal workers– ie. Pedro and Miguel's situation
    - When this wage schedule is properly set, the firm will pick the efficient employment level
    - Then, equally productive workers receive different wages, based only on their position in the layoff order, ie. Lars and Jens's situation

Introduction (4)

- simple log linear sharing rule of the surplus of the specific investment

Introduction (4)

- simple log linear sharing rule of the surplus of the specific investment
  - with Nash bargaining feature, ie. efficient bargaining: as long as there is a surplus, the worker and the firm will agree on a distribution of that surplus that makes continuation of the relation mutually beneficial

Introduction (4)

- simple log linear sharing rule of the surplus of the specific investment
  - with Nash bargaining feature, ie. efficient bargaining: as long as there is a surplus, the worker and the firm will agree on a distribution of that surplus that makes continuation of the relation mutually beneficial
  - guarantees firing efficiency, however hiring decisions are efficient if and only if cost and revenues of the specific investment are shared in the same proportions

Introduction (4)

- simple log linear sharing rule of the surplus of the specific investment
  - with Nash bargaining feature, ie. efficient bargaining: as long as there is a surplus, the worker and the firm will agree on a distribution of that surplus that makes continuation of the relation mutually beneficial
  - guarantees firing efficiency, however hiring decisions are efficient if and only if cost and revenues of the specific investment are shared in the same proportions
  - elaborate our model under the assumption that the firm must pay for the full cost of the specific investment, so that any return to seniority implies sub-efficient hiring

Introduction (5)

- Discuss effect of firing cost: upward effect on wages, however they do not affect firing but further deteriorate hiring, given efficient bargaining

Introduction (5)

- Discuss effect of firing cost: upward effect on wages, however they do not affect firing but further deteriorate hiring, given efficient bargaining
- LIFO layoff rule allows for a decentralisation of the bargaining process –as required in the absence of a union– leading to higher wages for senior workers.

Introduction (5)

- Discuss effect of firing cost: upward effect on wages, however they do not affect firing but further deteriorate hiring, given efficient bargaining
- LIFO layoff rule allows for a decentralisation of the bargaining process –as required in the absence of a union– leading to higher wages for senior workers.
  - the political process within a union would lead to a more egalitarian distribution of the rents among the workers, that is, to higher wages but a lower wage return to seniority.

Model setup

- As in BB (1990), firms face a log demand curve (labor only factor of production)

$$n_t = z_t - \eta p_t$$

Model setup

- As in BB (1990), firms face a log demand curve (labor only factor of production)

$$n_t = z_t - \eta p_t$$

- $\eta > 1$ price elasticity of demand; N_t demand: production normalized to unity so output=employment; P_t is its price

Model setup

- As in BB (1990), firms face a log demand curve (labor only factor of production)

$$n_t = z_t - \eta p_t$$

- $\eta > 1$ price elasticity of demand; N_t demand: production normalized to unity so output=employment; P_t is its price
- z_t market index capturing the exogenous evolution of demand, $\Delta z \sim N\left(\mu, \sigma^2\right)$

Model setup

- As in BB (1990), firms face a log demand curve (labor only factor of production)

$$n_t = z_t - \eta p_t$$

- $\eta > 1$ price elasticity of demand; N_t demand: production normalized to unity so output=employment; P_t is its price
- z_t market index capturing the exogenous evolution of demand, $\Delta z \sim N\left(\mu, \sigma^2\right)$
- hiring cost I: specific investment that has to be made by the firm at the start of an employment relation

Model setup

- As in BB (1990), firms face a log demand curve (labor only factor of production)

$$n_t = z_t - \eta p_t$$

- $\eta > 1$ price elasticity of demand; N_t demand: production normalized to unity so output=employment; P_t is its price
- z_t market index capturing the exogenous evolution of demand, $\Delta z \sim N\left(\mu, \sigma^2\right)$
- hiring cost I: specific investment that has to be made by the firm at the start of an employment relation
  - irreversible: once made, the cost cannot be recouped by ending the employment relation

Model setup

- As in BB (1990), firms face a log demand curve (labor only factor of production)

$$n_t = z_t - \eta p_t$$

- $\eta > 1$ price elasticity of demand; N_t demand: production normalized to unity so output=employment; P_t is its price
- z_t market index capturing the exogenous evolution of demand, $\Delta z \sim N\left(\mu, \sigma^2\right)$
- hiring cost I: specific investment that has to be made by the firm at the start of an employment relation
  - irreversible: once made, the cost cannot be recouped by ending the employment relation
  - instantaneous

Model setup

- As in BB (1990), firms face a log demand curve (labor only factor of production)

$$n_t = z_t - \eta p_t$$

- $\eta > 1$ price elasticity of demand; N_t demand: production normalized to unity so output=employment; P_t is its price
- z_t market index capturing the exogenous evolution of demand, $\Delta z \sim N\left(\mu, \sigma^2\right)$
- hiring cost I: specific investment that has to be made by the firm at the start of an employment relation
  - irreversible: once made, the cost cannot be recouped by ending the employment relation
  - instantaneous
- worker reservation wage (eg. return to self-employment), constant, normalized to unity, in logs $w^r = 0$

Benchmark case: I=0

- labor demand can be adjusted costlessly at any time. Hence, subject to $n_t = z_t - \eta p_t$, maximize

$$\Pi_t = N_t P_t - N_t$$

Benchmark case: l=0

- labor demand can be adjusted costlessly at any time. Hence, subject to $n_t = z_t - \eta p_t$, maximize

$$\Pi_t = N_t P_t - N_t$$

- FOC:

$$\begin{aligned} p_t &= \pi, \\ n_t &= z_t - \eta \pi, \\ \pi &\equiv \ln \frac{\eta}{\eta - 1} > 0. \end{aligned}$$

Benchmark case: I=0

- labor demand can be adjusted costlessly at any time. Hence, subject to $n_t = z_t - \eta p_t$, maximize

$$\Pi_t = N_t P_t - N_t$$

- FOC:

$$\begin{aligned} p_t &= \pi, \\ n_t &= z_t - \eta \pi, \\ \pi &\equiv \ln \frac{\eta}{\eta - 1} > 0. \end{aligned}$$

- $\pi > 0$ due to monopoly power of the firm at the product market; firm's price is constant over time, while its labor demand follows a random walk, ie, Gibrat's law

Case I>0 (1)

- labor demand cannot be adjusted costlessly

Case I>0 (1)

- labor demand cannot be adjusted costlessly
  - hiring side: an additional worker requires a specific investment, which has to be recouped from future profits; investment is irreversible, so that delaying hiring has an option value

Case I>0 (1)

- labor demand cannot be adjusted costlessly
  - hiring side: an additional worker requires a specific investment, which has to be recouped from future profits; investment is irreversible, so that delaying hiring has an option value
  - firing side: although costless (so far), firing is irreversible: If demand surges after having fired the worker, the firm is unable to benefit from that demand without incurring the cost of the specific investment again. Hence option value of retaining the worker

Case I>0 (1)

- labor demand cannot be adjusted costlessly
  - hiring side: an additional worker requires a specific investment, which has to be recouped from future profits; investment is irreversible, so that delaying hiring has an option value
  - firing side: although costless (so far), firing is irreversible: If demand surges after having fired the worker, the firm is unable to benefit from that demand without incurring the cost of the specific investment again. Hence option value of retaining the worker
- optimal policy of a firm: hire workers whenever p_t reaches a constant upper bound $p^+ > \pi$ and to fire them whenever p_t reaches a lower bound $p^- < \pi$

Case I>0 (2)

- log marginal revenue $mr(\cdot)$

$$\ln\left[d\left(N \cdot P\right)/dN\right] \equiv mr\left(n, z\right) = \frac{1}{\eta}\left(z - n\right) - \pi$$

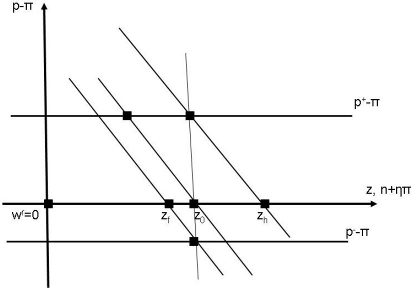

Figure: Firing-hiring boundaries with stochastic market index

LIFO and rent sharing (1)

- Index each worker by the log employment level of the firm at the date that the worker is hired: a worker hired at time h gets rank q, $q = n_h = z_h - \eta p^+$. Her seniority index at time t is defined as $n_t - q$.

LIFO and rent sharing (1)

- Index each worker by the log employment level of the firm at the date that the worker is hired: a worker hired at time h gets rank q, $q = n_h = z_h - \eta p^+$. Her seniority index at time t is defined as $n_t - q$.
  - Hence, the most senior worker has $q = 0$, and her seniority index is $n_t - q = n_t$, while the least senior worker at time t has $q = n_t$, and her seniority index is $n_t - q = 0$.

LIFO and rent sharing (1)

- Index each worker by the log employment level of the firm at the date that the worker is hired: a worker hired at time h gets rank q, $q = n_h = z_h - \eta p^+$. Her seniority index at time t is defined as $n_t - q$.
  - Hence, the most senior worker has $q = 0$, and her seniority index is $n_t - q = n_t$, while the least senior worker at time t has $q = n_t$, and her seniority index is $n_t - q = 0$.
  - LIFO layoff rule says that when a firm wants to fire a worker, it has to fire the worker with the lowest seniority $n_t - q$

LIFO and rent sharing (1)

- Index each worker by the log employment level of the firm at the date that the worker is hired: a worker hired at time h gets rank q, $q = n_h = z_h - \eta p^+$. Her seniority index at time t is defined as $n_t - q$.
  - Hence, the most senior worker has $q = 0$, and her seniority index is $n_t - q = n_t$, while the least senior worker at time t has $q = n_t$, and her seniority index is $n_t - q = 0$.
  - LIFO layoff rule says that when a firm wants to fire a worker, it has to fire the worker with the lowest seniority $n_t - q$
  - can characterize the distribution of completed spells under this separation rule

LIFO and rent sharing (1)

- Index each worker by the log employment level of the firm at the date that the worker is hired: a worker hired at time h gets rank q, $q = n_h = z_h - \eta p^+$. Her seniority index at time t is defined as $n_t - q$.
  - Hence, the most senior worker has $q = 0$, and her seniority index is $n_t - q = n_t$, while the least senior worker at time t has $q = n_t$, and her seniority index is $n_t - q = 0$.
  - LIFO layoff rule says that when a firm wants to fire a worker, it has to fire the worker with the lowest seniority $n_t - q$
  - can characterize the distribution of completed spells under this separation rule
- Bentolila and Bertola's (1990) model supplemented with a LIFO layoff rule corresponds therefore one-to-one with a simple model of individual job tenures: Buhai and Teulings (2006)

LIFO and rent sharing (2)

- Why would a firm commit to using a LIFO layoff rule?

LIFO and rent sharing (2)

- Why would a firm commit to using a LIFO layoff rule?
  - No reason if the firm pays the worker her individual wage

LIFO and rent sharing (2)

- Why would a firm commit to using a LIFO layoff rule?
  - No reason if the firm pays the worker her individual wage
  - However, if incumbents have some bargaining power: quasi rents of the specific investment might enable these workers to capture wages above the reservation wage

LIFO and rent sharing (2)

- Why would a firm commit to using a LIFO layoff rule?
  - No reason if the firm pays the worker her individual wage
  - However, if incumbents have some bargaining power: quasi rents of the specific investment might enable these workers to capture wages above the reservation wage
  - Following Kuhn and Robert, bargain simultaneously for a LIFO layoff rule and a wage schedule that grants higher wages to inframarginal workers

$$w(q, z_t) = \beta \cdot mr\,(q, z_t) + \omega = \frac{\beta}{\eta}\,(z_t - q) - \beta\pi + \omega$$

Lifo and rent sharing (3)

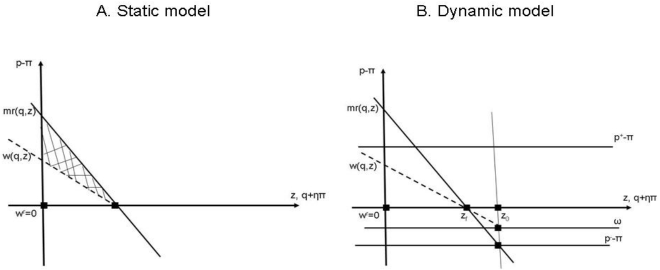

Figure: Static vs. dynamic framework

Worker's optimization problem (1)

- Using real option theory,eg. Dixit and Pindyck (1994) to derive the value of the parameter ω, the worker's reservation wage.

Worker's optimization problem (1)

- Using real option theory,eg. Dixit and Pindyck (1994) to derive the value of the parameter ω, the worker's reservation wage.
- $V(z_t - q)$ be the asset value of holding a job. The asset value equation is then:

$$\rho V(z_t - q) = \exp\left[w(z_t - q)\right] + \mu V'(z_t - q) + \frac{1}{2}\sigma^2 V''(z_t - q)$$

Worker's optimization problem (1)

- Using real option theory,eg. Dixit and Pindyck (1994) to derive the value of the parameter ω, the worker's reservation wage.
- $V(z_t - q)$ be the asset value of holding a job. The asset value equation is then:

$$\rho V(z_t - q) = \exp\left[w(z_t - q)\right] + \mu V'(z_t - q) + \frac{1}{2}\sigma^2 V''(z_t - q)$$

- We can solve this, given efficient bargaining: so it is optimal for a worker with rank q to separate when $z_t = q + \eta p^-$.

$$\begin{aligned} V(z_t - q) &= \frac{1}{r(\beta/\eta)} e^{\omega} + A^- e^{\lambda^- z} = \frac{1}{\rho}, \\ V'(z_t - q) &= \frac{\beta}{\eta r(\beta/\eta)} e^{\omega} + \lambda^- A^- e^{\lambda^- z} = 0. \end{aligned}$$

Worker's optimization problem (1)

- Using real option theory,eg. Dixit and Pindyck (1994) to derive the value of the parameter ω, the worker's reservation wage.
- $V(z_t - q)$ be the asset value of holding a job. The asset value equation is then:

$$\rho V(z_t - q) = \exp\left[w(z_t - q)\right] + \mu V'(z_t - q) + \frac{1}{2}\sigma^2 V''(z_t - q)$$

- We can solve this, given efficient bargaining: so it is optimal for a worker with rank q to separate when $z_t = q + \eta p^-$.

$$\begin{aligned} V(z_t - q) &= \frac{1}{r(\beta/\eta)} e^{\omega} + A^- e^{\lambda^- z} = \frac{1}{\rho}, \\ V'(z_t - q) &= \frac{\beta}{\eta r(\beta/\eta)} e^{\omega} + \lambda^- A^- e^{\lambda^- z} = 0. \end{aligned}$$

  - Value matching: asset value of holding the job should be equal to the asset value after separation, that is, the net discounted value of the reservation wage, ρ^{-1}

Worker's optimization problem (1)

- Using real option theory,eg. Dixit and Pindyck (1994) to derive the value of the parameter ω, the worker's reservation wage.
- $V(z_t - q)$ be the asset value of holding a job. The asset value equation is then:

$$\rho V(z_t - q) = \exp\left[w(z_t - q)\right] + \mu V'(z_t - q) + \frac{1}{2}\sigma^2 V''(z_t - q)$$

- We can solve this, given efficient bargaining: so it is optimal for a worker with rank q to separate when $z_t = q + \eta p^-$.

$$\begin{aligned} V(z_t - q) &= \frac{1}{r(\beta/\eta)} e^{\omega} + A^- e^{\lambda^- z} = \frac{1}{\rho}, \\ V'(z_t - q) &= \frac{\beta}{\eta r(\beta/\eta)} e^{\omega} + \lambda^- A^- e^{\lambda^- z} = 0. \end{aligned}$$

  - Value matching: asset value of holding the job should be equal to the asset value after separation, that is, the net discounted value of the reservation wage, ρ^{-1}
  - Smooth pasting: for small variations in z_t the worker remains

Worker's optimization problem (2)

- $$\omega = \ln r\left(\beta/\eta\right) - \ln \rho - \ln\left(1 - \frac{\beta}{\eta\lambda^{-}}\right)$$

Worker's optimization problem (2)

- $$\omega = \ln r\left(\beta/\eta\right) - \ln\rho - \ln\left(1 - \frac{\beta}{\eta\lambda^{-}}\right)$$
- $\omega \leq 0$: below the log reservation wage $w^r = 0$ since separation is an irreversible decision.

Worker's optimization problem (2)

- $$\omega = \ln r\left(\beta/\eta\right) - \ln \rho - \ln\left(1 - \frac{\beta}{\eta\lambda^{-}}\right)$$
- $\omega \leq 0$: below the log reservation wage $w^r = 0$ since separation is an irreversible decision.
- $\frac{\partial\omega}{\partial\beta} < 0$: the higher the worker's bargaining power β, the lower is ω, since expected future revenues are higher so that workers are prepared to accept greater losses before separation

Worker's optimization problem (2)

- $$\omega = \ln r\left(\beta/\eta\right) - \ln\rho - \ln\left(1 - \frac{\beta}{\eta\lambda^{-}}\right)$$
- $\omega \leq 0$: below the log reservation wage $w^r = 0$ since separation is an irreversible decision.
- $\frac{\partial\omega}{\partial\beta} < 0$: the higher the worker's bargaining power β, the lower is ω, since expected future revenues are higher so that workers are prepared to accept greater losses before separation
- $\frac{\partial\omega}{\partial\mu} < 0$: declining in the drift μ since a higher drift raises expected future revenues

Worker's optimization problem (2)

- $$\omega = \ln r\left(\beta/\eta\right) - \ln \rho - \ln\left(1 - \frac{\beta}{\eta\lambda^{-}}\right)$$
- $\omega \leq 0$: below the log reservation wage $w^r = 0$ since separation is an irreversible decision.
- $\frac{\partial\omega}{\partial\beta} < 0$: the higher the worker's bargaining power β, the lower is ω, since expected future revenues are higher so that workers are prepared to accept greater losses before separation
- $\frac{\partial\omega}{\partial\mu} < 0$: declining in the drift μ since a higher drift raises expected future revenues
- $\frac{\partial\omega}{\partial\sigma} < 0$: eDclining in the variability of demand σ^2, since a higher variability raises the option value of hoping for a future increase in the surplus

Firm's optimization problem (1)

- $F(n_t - z_t)$ be the asset value of the firm for the N_t-th worker

$$\begin{aligned}\rho F(n_t - z_t) &= \exp[mr(z_t - n_t)] - \exp[w(z_t - n_t)] \\ &\quad + \mu F'(n_t - z_t) + \frac{1}{2}\sigma^2 F''(n_t - z_t)\end{aligned}$$

Firm's optimization problem (1)

- $F(n_t - z_t)$ be the asset value of the firm for the N_t-th worker

$$\begin{aligned}\rho F(n_t - z_t) &= \exp[mr(z_t - n_t)] - \exp[w(z_t - n_t)] \\ &\quad + \mu F'(n_t - z_t) + \frac{1}{2}\sigma^2 F''(n_t - z_t)\end{aligned}$$

-

$$\begin{aligned}F(n_t - z_t) &= \frac{1}{r(\eta^{-1})}\exp\left[\frac{1}{\eta}(z_t - n_t) - \pi\right] - \frac{1}{r(\beta/\eta)}\exp[w(z_t - \\ &\quad + B^{-}\exp\left[\lambda^{-}(z_t - n_t)\right].\end{aligned}$$

Firm's optimization problem (1)

- $F(n_t - z_t)$ be the asset value of the firm for the N_t-th worker

$$\begin{aligned}\rho F(n_t - z_t) &= \exp[mr(z_t - n_t)] - \exp[w(z_t - n_t)] \\ &\quad + \mu F'(n_t - z_t) + \frac{1}{2}\sigma^2 F''(n_t - z_t)\end{aligned}$$

-

$$\begin{aligned}F(n_t - z_t) &= \frac{1}{r(\eta^{-1})}\exp\left[\frac{1}{\eta}(z_t - n_t) - \pi\right] - \frac{1}{r(\beta/\eta)}\exp[w(z_t - \\ &\quad + B^- \exp\left[\lambda^-(z_t - n_t)\right].\end{aligned}$$

- Option value of hiring the Nth worker at some future date:

$$G(n_t - z_t) = B^+ \exp\left[\lambda^+(z_t - n_t)\right]$$

Firm's optimization problem (2)

- Value matching and smooth pasting conditions:

$$
\begin{aligned}
F\left(z_t - \eta p^-, z_t\right) &= G\left(z_t - \eta p^-, z_t\right), \\
F'\left(z_t - \eta p^-, z_t\right) &= G'\left(z_t - \eta p^-, z_t\right), \\
F\left(z_t - \eta p^+, z_t\right) &= G\left(z_t - \eta p^+, z_t\right) + I, \\
F'\left(z_t - \eta p^+, z_t\right) &= G'\left(z_t - \eta p^+, z_t\right).
\end{aligned}
$$

Firm's optimization problem (2)

- Value matching and smooth pasting conditions:

$$\begin{aligned}
F\left(z_t-\eta p^-, z_t\right) &= G\left(z_t-\eta p^-, z_t\right),\\
F'\left(z_t-\eta p^-, z_t\right) &= G'\left(z_t-\eta p^-, z_t\right),\\
F\left(z_t-\eta p^+, z_t\right) &= G\left(z_t-\eta p^+, z_t\right)+I,\\
F'\left(z_t-\eta p^+, z_t\right) &= G'\left(z_t-\eta p^+, z_t\right).
\end{aligned}$$

- The system of equations has a unique solution for p^+, p^-, B^+, B^- for which (i) $p^+ - \pi > 0 > \omega > p^- - \pi$, $B^+ > 0$, $B^- > 0$; (ii) $\frac{\partial B^+}{\partial \beta} < 0$; (iii) $\frac{\partial p^+}{\partial \beta} > 0$; (iv) $\frac{\partial p^-}{\partial \beta} < 0$.

Unemployment and the welfare cost of hold-up

- Who gets hired by a firm and who does not?

Unemployment and the welfare cost of hold-up

- Who gets hired by a firm and who does not?
- Asset value of unemployment

$$\rho V^U = \frac{\lambda}{u}\left[V\left(\eta p^+\right) - V^U\right]$$

Unemployment and the welfare cost of hold-up

- Who gets hired by a firm and who does not?
- Asset value of unemployment

$$\rho V^U = \frac{\lambda}{u}\left[V\left(\eta p^+\right) - V^U\right]$$

- u is the unemployment rate. λ/u is the arrival rate of a new job for unemployed.

Unemployment and the welfare cost of hold-up

- Who gets hired by a firm and who does not?
- Asset value of unemployment

$$\rho V^U = \frac{\lambda}{u}\left[V\left(\eta p^+\right) - V^U\right]$$

- u is the unemployment rate. λ/u is the arrival rate of a new job for unemployed.
- Then, using $V^U = 1/\rho$, the asset value of self employment,

$$u = \lambda\left[V\left(\eta p^+\right) - \frac{1}{\rho}\right]$$

Unemployment and the welfare cost of hold-up

- Who gets hired by a firm and who does not?
- Asset value of unemployment

$$\rho V^U = \frac{\lambda}{u}\left[V\left(\eta p^+\right) - V^U\right]$$

- u is the unemployment rate. λ/u is the arrival rate of a new job for unemployed.
- Then, using $V^U = 1/\rho$, the asset value of self employment,

$$u = \lambda\left[V\left(\eta p^+\right) - \frac{1}{\rho}\right]$$

- Two types of inefficiency

Unemployment and the welfare cost of hold-up

- Who gets hired by a firm and who does not?
- Asset value of unemployment

$$\rho V^U = \frac{\lambda}{u}\left[V\left(\eta p^+\right) - V^U\right]$$

- u is the unemployment rate. λ / u is the arrival rate of a new job for unemployed.
- Then, using $V^U = 1/\rho$, the asset value of self employment,

$$u = \lambda\left[V\left(\eta p^+\right) - \frac{1}{\rho}\right]$$

- Two types of inefficiency
  - not all gains from trade between the worker and the firm are exploited. Firms would hire more workers if $\beta = 0$, since p^+ is an increasing function of β

Unemployment and the welfare cost of hold-up

- Who gets hired by a firm and who does not?
- Asset value of unemployment

$$\rho V^U = \frac{\lambda}{u}\left[V\left(\eta p^+\right) - V^U\right]$$

- u is the unemployment rate. λ/u is the arrival rate of a new job for unemployed.
- Then, using $V^U = 1/\rho$, the asset value of self employment,

$$u = \lambda\left[V\left(\eta p^+\right) - \frac{1}{\rho}\right]$$

- Two types of inefficiency
  - not all gains from trade between the worker and the firm are exploited. Firms would hire more workers if $\beta = 0$, since p^+ is an increasing function of β
  - cost of rationing that dissipate workers' surplus: workers as a group spoil their whole share in the quasi rents in wasteful unemployment.

Data (1)

- *Integrated Database for Labor Market Research* (IDA): Danish exhaustive, register matched employer-employee data, 1980-2001, eg. Mortensen (2003)

Data (1)

- *Integrated Database for Labor Market Research* (IDA): Danish exhaustive, register matched employer-employee data, 1980-2001, eg. Mortensen (2003)
- *Quadros de Pessoal*: Portuguese matched employer-employee compulsory survey (register quality), 1991-2000, eg. Cabral and Mata (2003)

Data (1)

- *Integrated Database for Labor Market Research* (IDA): Danish exhaustive, register matched employer-employee data, 1980-2001, eg. Mortensen (2003)
- *Quadros de Pessoal*: Portuguese matched employer-employee compulsory survey (register quality), 1991-2000, eg. Cabral and Mata (2003)
- Information on worker earnings, occupation, education, age; the firm's location, firm employment size, industry

Data (2)

- Tenure reported in Portugal, can be computed for everybody since 1964 in Denmark; we use potential experience (age-schooling-6)

Data (2)

- Tenure reported in Portugal, can be computed for everybody since 1964 in Denmark; we use potential experience (age-schooling-6)
- For both countries, for firm employment size: we count workers holding *main* or *primary* jobs, ie. full time workers in Portugal and workers with more than 50% of their working hours in the primary job for Denmark

Data (2)

- Tenure reported in Portugal, can be computed for everybody since 1964 in Denmark; we use potential experience (age-schooling-6)
- For both countries, for firm employment size: we count workers holding *main* or *primary* jobs, ie. full time workers in Portugal and workers with more than 50% of their working hours in the primary job for Denmark
- All private sector, except agriculture, fishing and mining; empirical analysis done at both economy level and industry level (broader categories and 2-digit level)

Data (2)

- Tenure reported in Portugal, can be computed for everybody since 1964 in Denmark; we use potential experience (age-schooling-6)
- For both countries, for firm employment size: we count workers holding *main* or *primary* jobs, ie. full time workers in Portugal and workers with more than 50% of their working hours in the primary job for Denmark
- All private sector, except agriculture, fishing and mining; empirical analysis done at both economy level and industry level (broader categories and 2-digit level)
- (DK vs. PT institutional framework)

Descriptive stats

Table: Descriptive Statistics Denmark 1980-2001, Portugal 1991-2000

	(1)	(2)	(3)	(4)	(5)	(6)
DK	22364083	2771627	6870869	301015	21.89	5.41
	.	.	.	.	(7.99)	(5.58)
PT	11420191	3211990	4268149	330270	3.68	8.43
	.	.	.	.	(2.52)	(8.61)

	(7)	(8)	(9)	(10)	(11)	(12)
DK	20.25	12.05	37.79	0.35	0.63	4.68
	(12.19)	(3.05)	(11.95)	.	(0.72)	(2.44)
PT	20.26	6.81	36.73	0.40	0.87	4.04
	(11.39)	(3.65)	(11.18)	.	(0.85)	(2.14)

(1) Observations, (2) Workers, (3) Spells, (4) Firms, (5) Average Real Hourly Wage (base year=2000, Euro echivalent), (6) Average Tenure, (7) Average Potential Experience, (8) Average Education, (9) Average Age, (10) Proportion of Women, (11) Average Relative Log Rank, (12) Average Log Firm Size

Empirical framework: Testable predictions

The model has three testable implications:

- Gibrat's law: log firm size follows a random walk, in particular for large firms.

Empirical framework: Testable predictions

The model has three testable implications:

- Gibrat's law: log firm size follows a random walk, in particular for large firms.
- Last-in-First-Out separation rule: the workers hired last, leave the firm first

Empirical framework: Testable predictions

The model has three testable implications:

- Gibrat's law: log firm size follows a random walk, in particular for large firms.
- Last-in-First-Out separation rule: the workers hired last, leave the firm first
- Return to seniority in wages: a worker's wages depends on her seniority in the firm, that is her tenure relative to that of her colleagues.

Testing Gibrat's law: Method

- Large literature on testing Gibrat's; the prediction not specific just to our model. Here we use two parsimonious methods.

Testing Gibrat's law: Method

- Large literature on testing Gibrat's; the prediction not specific just to our model. Here we use two parsimonious methods.
- First, construct and interpret the autocovariance matrix of residuals ε_{jt} from

$$\Delta n_{jt} = \delta_0 + \delta_1 Z_{jt} + \varepsilon_{jt}$$

Testing Gibrat's law: Method

- Large literature on testing Gibrat's; the prediction not specific just to our model. Here we use two parsimonious methods.
- First, construct and interpret the autocovariance matrix of residuals ε_{jt} from

$$\Delta n_{jt} = \delta_0 + \delta_1 Z_{jt} + \varepsilon_{jt}$$

- Second, following Bond et al (2005), use either OLS or the transformed Breitung and Meyer technique respectively:

$$n_{jt} = \beta n_{j,t-1} + u_{jt}$$

$$n_{jt} - n_{j1} = \beta(n_{j,t-1} - n_{j1}) + \varepsilon_{jt}$$

Testing Gibrat's law: Results (1)

Table: 1st Gibrat's Law Test: Residual Autocovariances

	Denmark		Portugal	
Lag	all firms	large firms	all firms	large firms
0	0.1587	0.0424	0.1162	0.0255
	(0.0005)	(0.0112)	(0.0005)	(0.0007)
1	-0.0030	-0.00003	0.0002	-0.0001
	(0.0002)	(0.0005)	(0.0002)	(0.0003)
2	-0.0094	-0.0008	-0.0024	0.0012
	(0.0002)	(0.0003)	(0.0002)	(0.0004)
3	-0.0020	-0.0002	-0.0013	0.0006
	(0.0002)	(0.0002)	(0.0002)	(0.0003)
4	-0.0016	-0.00004	-0.0008	0.0006
	(0.0002)	(0.0002)	(0.0003)	(0.0002)
N obs generating reg	1505926	79425	878919	66369

Testing Gibrat's law: Results (2)

Table: 2nd Gibrat's Law Test: Unit Root Type Regressions

	Denmark				Portugal			
	all firms		large firms		all firms		large firms	
Coef	OLS	BM	OLS	BM	OLS	BM	OLS	BM
β	.9361	.9208	.9755	.9806	.9594	.9537	.9791	1.043
	(.0003)	(.0006)	(.0012)	(.0030)	(.0004)	(.0009)	(.0011)	(.0030)
N obs	1505926		79425		878934		66340	
R^2	0.87	0.70	0.95	0.82	0.91	0.66	0.96	0.84
MSE	0.42	0.43	0.21	0.21	0.36	0.36	0.17	0.17

Testing LIFO: Method (1)

- Efficient bargaining model: quits and layoffs observationally equivalent, McLaughlin (1991)

Testing LIFO: Method (1)

- Efficient bargaining model: quits and layoffs observationally equivalent, McLaughlin (1991)
- Define *seniority index* r_{ijt}

$$r_{ijt} \equiv n_{jt} - q_{ijt}$$

Testing LIFO: Method (1)

- Efficient bargaining model: quits and layoffs observationally equivalent, McLaughlin (1991)
- Define *seniority index* r_{ijt}

$$r_{ijt} \equiv n_{jt} - q_{ijt}$$

- q_{ijt} is the 'seniority level, ie. log of number of workers employed in firm $j(i,t)$ at time t, for at least as long as worker i; for the most senior worker, $q_{ijt} = 0$, hence $r_{ijt} = n_{ijt}$

Testing LIFO: Method (1)

- Efficient bargaining model: quits and layoffs observationally equivalent, McLaughlin (1991)
- Define *seniority index* r_{ijt}

$$r_{ijt} \equiv n_{jt} - q_{ijt}$$

- q_{ijt} is the 'seniority level, ie. log of number of workers employed in firm $j(i,t)$ at time t, for at least as long as worker i; for the most senior worker, $q_{ijt} = 0$, hence $r_{ijt} = n_{ijt}$
- r_{ijt} reasonable proxy for $z_t - q$, since z_t is equal to n_t, up to a constant, ηp, and except for the insulation of n_t from shocks in z_t when $p^- < p_t < p^+$

Testing LIFO: Method (2)

- LIFO does not apply literally within the firm, eg. since the workforce not completely homogenous within the firm, or for other separation reasons such as exogenous individual worker shocks, retirement, learning about the quality of the job etc.

Testing LIFO: Method (2)

- LIFO does not apply literally within the firm, eg. since the workforce not completely homogenous within the firm, or for other separation reasons such as exogenous individual worker shocks, retirement, learning about the quality of the job etc.
- Hence: we want that r_{ijt} has, ceteris paribus, strong negative impact on the separation rate

Testing LIFO: Method (2)

- LIFO does not apply literally within the firm, eg. since the workforce not completely homogenous within the firm, or for other separation reasons such as exogenous individual worker shocks, retirement, learning about the quality of the job etc.
- Hence: we want that r_{ijt} has, ceteris paribus, strong negative impact on the separation rate
- Discrete-time mixed proportional hazard rate model

$$\theta(r_{ijt}, Z_{ijt}, T_{ijt}, v_i) = \frac{\exp\left(\beta r_{ijt} + \gamma Z_{ijt} + \psi_{T_{ijt}} + v_i\right)}{1 + \exp\left(\beta r_{ijt} + \gamma Z_{ijt} + \psi_{T_{ijt}} + v_i\right)}$$

Testing LIFO: Method (2)

- LIFO does not apply literally within the firm, eg. since the workforce not completely homogenous within the firm, or for other separation reasons such as exogenous individual worker shocks, retirement, learning about the quality of the job etc.
- Hence: we want that r_{ijt} has, ceteris paribus, strong negative impact on the separation rate
- Discrete-time mixed proportional hazard rate model

$$\theta(r_{ijt}, Z_{ijt}, T_{ijt}, v_i) = \frac{\exp\left(\beta r_{ijt} + \gamma Z_{ijt} + \psi_{T_{ijt}} + v_i\right)}{1 + \exp\left(\beta r_{ijt} + \gamma Z_{ijt} + \psi_{T_{ijt}} + v_i\right)}$$

- Fully flexible baseline hazard, by including a full set of dummies ψ_T for every tenure level; 2-mass point distribution for v_i

Testing LIFO: Method (2)

- LIFO does not apply literally within the firm, eg. since the workforce not completely homogenous within the firm, or for other separation reasons such as exogenous individual worker shocks, retirement, learning about the quality of the job etc.
- Hence: we want that r_{ijt} has, ceteris paribus, strong negative impact on the separation rate
- Discrete-time mixed proportional hazard rate model

$$\theta(r_{ijt}, Z_{ijt}, T_{ijt}, v_i) = \frac{\exp\left(\beta r_{ijt} + \gamma Z_{ijt} + \psi_{T_{ijt}} + v_i\right)}{1 + \exp\left(\beta r_{ijt} + \gamma Z_{ijt} + \psi_{T_{ijt}} + v_i\right)}$$

- Fully flexible baseline hazard, by including a full set of dummies ψ_T for every tenure level; 2-mass point distribution for v_i
- Z_{ijt} includes education, potential experience and indicators for region, industry and occupation.

Testing LIFO: Method (2)

- LIFO does not apply literally within the firm, eg. since the workforce not completely homogenous within the firm, or for other separation reasons such as exogenous individual worker shocks, retirement, learning about the quality of the job etc.
- Hence: we want that r_{ijt} has, ceteris paribus, strong negative impact on the separation rate
- Discrete-time mixed proportional hazard rate model

$$\theta(r_{ijt}, Z_{ijt}, T_{ijt}, v_i) = \frac{\exp\left(\beta r_{ijt} + \gamma Z_{ijt} + \psi_{T_{ijt}} + v_i\right)}{1 + \exp\left(\beta r_{ijt} + \gamma Z_{ijt} + \psi_{T_{ijt}} + v_i\right)}$$

- Fully flexible baseline hazard, by including a full set of dummies ψ_T for every tenure level; 2-mass point distribution for v_i
- Z_{ijt} includes education, potential experience and indicators for region, industry and occupation.
- We exclude workers above 55; report separately for men and women; delete left-censored spells

Testing LIFO: Results

Table: Main results LIFO test

	Denmark		Portugal	
	Males	Females	Males	Females
Logrank	-0.0577	-0.0357	-0.0549	-0.0669
	(0.0019)	(0.0025)	(0.0054)	(0.0065)
Education	-0.1169	-0.1267	-0.1204	-0.1446
	(0.0003)	(0.0005)	(0.0009)	(0.0012)
Experience	-0.0771	-0.0732	-0.0490	-0.0656
	(0.0001)	(0.0001)	(0.0003)	(0.0004)
N obs	10788368	5990891	2118405	1488687

Testing wage-seniority dependency (1)

- $$w_{ijt} = \alpha + \chi X_{ijt} + \gamma T_{ijt} + \delta r_{ijt} + \zeta n_{jt} + \varepsilon_{ijt}$$

Testing wage-seniority dependency (1)

- $$w_{ijt} = \alpha + \chi X_{ijt} + \gamma T_{ijt} + \delta r_{ijt} + \zeta n_{jt} + \varepsilon_{ijt}$$

- $$_{ijt} = \varphi_{ij} + \psi_j + \mu_i + \nu_{ijt}$$

Testing wage-seniority dependency (1)

- $$w_{ijt} = \alpha + \chi X_{ijt} + \gamma T_{ijt} + \delta r_{ijt} + \zeta n_{jt} + \varepsilon_{ijt}$$
- $$_{ijt} = \varphi_{ij} + \psi_j + \mu_i + \nu_{ijt}$$
- all kinds of reasons for ϕ_{ij}, ψ_j, and μ_i to be correlated to T_{ijt}, see eg. Topel (1991) or Altonji and Williams (2005)

Testing wage-seniority dependency (1)

- $$w_{ijt} = \alpha + \chi X_{ijt} + \gamma T_{ijt} + \delta r_{ijt} + \zeta n_{jt} + \varepsilon_{ijt}$$

- $${}_{ijt} = \varphi_{ij} + \psi_j + \mu_i + \nu_{ijt}$$

- all kinds of reasons for ϕ_{ij}, ψ_j, and μ_i to be correlated to T_{ijt}, see eg. Topel (1991) or Altonji and Williams (2005)
- solutions, if uninterested in the first order separate effect of T and X:

$$\text{FD: } \Delta w_{ijt} = \chi + \gamma + \delta \Delta r_{ijt} + \zeta \Delta n_{jt} + \Delta \nu_{ijt}$$

$$\text{FE: } \widetilde{w}_{ijt} = (\chi + \gamma)\, \widetilde{T}_{ijt} + \delta \widetilde{r}_{ijt} + \zeta \widetilde{n}_{jt} + \widetilde{\nu}$$

Testing wage-seniority dependency (2)

- Choosing FE vs. FD depends on the error structure of v_{ijt}.

Testing wage-seniority dependency (2)

- Choosing FE vs. FD depends on the error structure of v_{ijt}.
- The closer is v_{ijt} to a unit root, the more efficient is FD; the closer v_{ijt} to being serially uncorrelated, the more efficient estimation is FE

Testing wage-seniority dependency (2)

- Choosing FE vs. FD depends on the error structure of v_{ijt}.
- The closer is v_{ijt} to a unit root, the more efficient is FD; the closer v_{ijt} to being serially uncorrelated, the more efficient estimation is FE
- However, FE assumes the r_{ijt} and n_{jt} on w_{ijt} is immediate. Any lagged impact will not be captured after first differencing.

Testing wage-seniority dependency (2)

- Choosing FE vs. FD depends on the error structure of v_{ijt}.
- The closer is v_{ijt} to a unit root, the more efficient is FD; the closer v_{ijt} to being serially uncorrelated, the more efficient estimation is FE
- However, FE assumes the r_{ijt} and n_{jt} on w_{ijt} is immediate. Any lagged impact will not be captured after first differencing.
- Hence, we do both, and expect higher estimates for δ and ζ from using FE

Testing wage-seniority dependency (2)

- Choosing FE vs. FD depends on the error structure of v_{ijt}.
- The closer is v_{ijt} to a unit root, the more efficient is FD; the closer v_{ijt} to being serially uncorrelated, the more efficient estimation is FE
- However, FE assumes the r_{ijt} and n_{jt} on w_{ijt} is immediate. Any lagged impact will not be captured after first differencing.
- Hence, we do both, and expect higher estimates for δ and ζ from using FE
- *In a LIFO-perfect world r_{ijt} and n_{jt} perfectly correlated within a job spell. Happily, LIFO does not apply strictly in the real world, which allows us separate identification of δ and ζ with FE and FD*

Wage covariogram

Table: Residual Autocovariances for Within-Job LogWage Innovations

Lag	Denmark	Portugal
0	0.0231	0.0273
	(0.00002)	(0.00007)
1	-0.0043	-0.0082
	(0.00001)	(0.00006)
2	-0.0006	-0.0008
	(8.7e-06)	(0.00003)
3	-0.0003	-0.0004
	(9.0e-06)	(0.00003)
4	-0.0003	9.2e-06
	(9.5e-06)	(0.00003)
5	-0.00008	-0.00008
N obs generating reg	14907897	5758655

Wage covariogram: interpretation

- covariance of ν_{ijt} with its first lag is substantial, the covariance with higher lags is negligible

Wage covariogram: interpretation

- covariance of ν_{ijt} with its first lag is substantial, the covariance with higher lags is negligible
- process well approximated by an MA(1) process, made up of a mixture permanent and transitory shocks.

Wage covariogram: interpretation

- covariance of ν_{ijt} with its first lag is substantial, the covariance with higher lags is negligible
- process well approximated by an MA(1) process, made up of a mixture permanent and transitory shocks.
- let q_{ijt} and u_{ijt} be the transitory and permanent shock respectively

$$\Delta v_{ijt} = u_{ijt} + q_{ijt} - q_{ij,t-1}$$

Wage covariogram: interpretation

- covariance of ν_{ijt} with its first lag is substantial, the covariance with higher lags is negligible
- process well approximated by an MA(1) process, made up of a mixture permanent and transitory shocks.
- let q_{ijt} and u_{ijt} be the transitory and permanent shock respectively

$$\Delta v_{ijt} = u_{ijt} + q_{ijt} - q_{ij,t-1}$$

- hence, $\text{Var}(\Delta v_{ijt}) = \text{Var}(u_{ijt}) + 2\text{Var}(q_{ijt})$ and $\text{Cov}(\Delta v_{ijt}, \Delta v_{ij,t-1}) = -\text{Var}(q_{ijt})$, so that $\text{Var}(u_{ijt}) = \text{Var}(\Delta v_{ijt}) + 2\text{Cov}(\Delta v_{ijt}, \Delta v_{ij,t-1})$

Wage covariogram: interpretation

- covariance of ν_{ijt} with its first lag is substantial, the covariance with higher lags is negligible
- process well approximated by an MA(1) process, made up of a mixture permanent and transitory shocks.
- let q_{ijt} and u_{ijt} be the transitory and permanent shock respectively

$$\Delta v_{ijt} = u_{ijt} + q_{ijt} - q_{ij,t-1}$$

- hence, $\text{Var}(\Delta v_{ijt}) = \text{Var}(u_{ijt}) + 2\text{Var}(q_{ijt})$ and $\text{Cov}(\Delta v_{ijt}, \Delta v_{ij,t-1}) = -\text{Var}(q_{ijt})$, so that $\text{Var}(u_{ijt}) = \text{Var}(\Delta v_{ijt}) + 2\text{Cov}(\Delta v_{ijt}, \Delta v_{ij,t-1})$
- st. dev permanent shocks: 0.12 for DK and 0.10 for PT, in line with numbers found for US e.g. Buhai and Teulings (2006)

FD and FE wage regs

Table 6: FE and FD Wage Regressions for the Entire Private Sector in Denmark and Portugal

	Denmark				Portugal			
	FD1	FD2	FE1	FE2	FD1	FD2	FE1	FE2
logrank		.003***		.008***		.016***		.022***
		(.0003)		(.0003)		(.0005)		(.0005)
logfsize	.013***	.011***	.026***	.021***	.025***	.015***	.040***	.028***
	(.0002)	(.0003)	(.0003)	(.0003)	(.0004)	(.0005)	(.0004)	(.0004)
tenure+exper	.047***	.045***	.010***	.007***	.068***	.065***	.059***	.055***
	(.0003)	(.0003)	(.0001)	(.0002)	(.0005)	(.0005)	(.0003)	(.0003)
tenure^2	.191***	.199***	-.052***	-.036***	-.086***	-.069***	-.083***	-.067***
	(.002)	(.002)	(.002)	(.002)	(.003)	(.003)	(.002)	(.002)
tenure^3	-.101***	-.105***	.014***	.008***	.027***	.021***	.024***	.019***
	(.001)	(.001)	(.099)	(9.88e-07)	(.001)	(.001)	(.0007)	(.0007)
tenure^4	.002***	.002***	-.0009***	-.0002	-.003***	-.002***	-.003***	-.002***
	(.0002)	(.0002)	(.0002)	(.0002)	(.0002)	(.0002)	(.00009)	(.00009)
exper^2	-.224***	-.223***	.099***	.100***	-.204***	-.204***	-.149***	-.147***
	(.002)	(.002)	(.0006)	(.0006)	(.004)	(.004)	(.002)	(.002)
exper^3	.039***	.039***	-.039***	-.039***	.043***	.043***	.030***	.029***
	(.0007)	(.0007)	(.0002)	(.0002)	(.001)	(.001)	(.0007)	(.0007)
exper^4	-.003***	-.003***	.004***	.004***	-.003***	-.003***	-.002***	-.002***
	(.00007)	(.00007)	(.00003)	(00003)	(.0001)	(.0001)	(.00007)	(.00007)
N obs	14907897		22364083		5758655		10743244	
Workers	2116307		277162		1752000		3092329	
Spells	3745050		6870869		1965560		4053649	
Firms	221106		301015		206361		322502	

Returns to seniority within gender and education subgroups

Table 7: FE and FD Regressions by Gender and Education Rank Groups

	Denmark				Portugal			
Gender Categories								
	Females		Males		Females		Males	
	FD	FE	FD	FE	FD	FE	FD	FE
logrank	.005***	.005***	.005***	.010***	.015***	.019***	.014***	.019***
	(0.0004)	(0.0005)	(0.0004)	(0.0004)	(0.0007)	(0.0006)	(0.0007)	(0.0006)
logfsize	.002***	.014***	.014***	.025***	.015***	.028***	.019***	.031***
	(0.0005)	(0.0005)	(0.0004)	(0.0004)	(0.0007)	(0.0006)	(0.0006)	(0.0006)
ten+exp	.032***	.009***	.052***	.007***	.053***	.042***	.080***	.073***
	(0.0004)	(0.0002)	(0.0004)	(0.0002)	(0.0007)	(0.0005)	(0.0007)	(0.0005)
N obs	5049388	7745676	9858509	14618407	2300767	4353808	3457888	6389436
Education Categories								
	HighEduc		LowEduc		HighEduc		LowEduc	
	FD	FE	FD	FE	FD	FE	FD	FE
logrank	.010***	.020***	.002***	-.002***	.029***	.032***	.013***	.016***
	(.0003)	(.0004)	(.0004)	(.0004)	(.002)	(.002)	(.0005)	(.0005)
logfsize	.007***	.016***	.014***	.024***	.026***	.026***	.016***	.031***
	(.0004)	(.0004)	(.0005)	(.0005)	(.002)	(.002)	(.0005)	(.0004)
(ten+exp)	.040***	.006***	.031***	.006***	.116***	.099***	.056***	.049***
	(.0004)	(.0002)	(.0007)	(.0002)	(.002)	(.001)	(.0005)	(.0003)
N obs	9567345	14054988	5268672	8309095	259793	536920	5492034	10206324

Summary and conclusions (1)

- In both DK and PT, positive *return to seniority in wages*, with an elasticity in the order of magnitude of 0.01-0.02: a 1 % increase in the seniority hierarchy of the firm raises your wage by 0.01-0.02 %

Summary and conclusions (1)

- In both DK and PT, positive *return to seniority in wages*, with an elasticity in the order of magnitude of 0.01-0.02: a 1 % increase in the seniority hierarchy of the firm raises your wage by 0.01-0.02 %
- twice as high for higher educated workers, and is twice as high in Portugal as it is in Denmark

Summary and conclusions (1)

- In both DK and PT, positive *return to seniority in wages*, with an elasticity in the order of magnitude of 0.01-0.02: a 1 % increase in the seniority hierarchy of the firm raises your wage by 0.01-0.02 %
- twice as high for higher educated workers, and is twice as high in Portugal as it is in Denmark
- 5-30 % of what has been know as the return to tenure and to firmsize is in fact a return to seniority

Summary and conclusions (1)

- In both DK and PT, positive *return to seniority in wages*, with an elasticity in the order of magnitude of 0.01-0.02: a 1 % increase in the seniority hierarchy of the firm raises your wage by 0.01-0.02 %
- twice as high for higher educated workers, and is twice as high in Portugal as it is in Denmark
- 5-30 % of what has been know as the return to tenure and to firmsize is in fact a return to seniority
- Learning or standard search models explanations focus solely on the features of the worker herself (in case of learning, her ability; in case of search, her job offer history)

Summary and conclusions (1)

- In both DK and PT, positive *return to seniority in wages*, with an elasticity in the order of magnitude of 0.01-0.02: a 1 % increase in the seniority hierarchy of the firm raises your wage by 0.01-0.02 %
- twice as high for higher educated workers, and is twice as high in Portugal as it is in Denmark
- 5-30 % of what has been know as the return to tenure and to firmsize is in fact a return to seniority
- Learning or standard search models explanations focus solely on the features of the worker herself (in case of learning, her ability; in case of search, her job offer history)
- *A return to seniority implies that a worker is to some extent shareholder in her own firm. Hence, it makes the link between labor economics and finance.*

Summary and conclusions (2)

- The model interprets the return to seniority due to a hold up problem, where firms pay the full cost of the specific investment, while workers capture part of the return. Inneficiently low hiring is obtained

Summary and conclusions (2)

- The model interprets the return to seniority due to a hold up problem, where firms pay the full cost of the specific investment, while workers capture part of the return. Inneficiently low hiring is obtained
- With risk neutral workers and either investment or wages are contractible, efficient hiring can be obtained by using the sharing rule of the costs for the one, to mirror the sharing rule for the other, thereby satisfying the Hosios (1990) condition

Summary and conclusions (2)

- The model interprets the return to seniority due to a hold up problem, where firms pay the full cost of the specific investment, while workers capture part of the return. Inneficiently low hiring is obtained
- With risk neutral workers and either investment or wages are contractible, efficient hiring can be obtained by using the sharing rule of the costs for the one, to mirror the sharing rule for the other, thereby satisfying the Hosios (1990) condition
- With risk averse workers, efficiency can only be obtained when both investment and wages are contractible, such that the costs of investment are fully attributed to the firm and there is no seniority profile.

Summary and conclusions (2)

- The model interprets the return to seniority due to a hold up problem, where firms pay the full cost of the specific investment, while workers capture part of the return. Inneficiently low hiring is obtained
- With risk neutral workers and either investment or wages are contractible, efficient hiring can be obtained by using the sharing rule of the costs for the one, to mirror the sharing rule for the other, thereby satisfying the Hosios (1990) condition
- With risk averse workers, efficiency can only be obtained when both investment and wages are contractible, such that the costs of investment are fully attributed to the firm and there is no seniority profile.
  - Other allocations assign part of the risky return to the risk averse player. In that sense, our estimation results indicate incompleteness in the insurance market.

Summary and conclusions (3)

- LIFO layoff rules are not bad per se

Summary and conclusions (3)

- LIFO layoff rules are not bad per se
    - offer protection to "property rights" of incumbents on their share of the specific investment, thereby helping the firm to solve a commitment problem

Summary and conclusions (3)

- LIFO layoff rules are not bad per se
    - offer protection to "property rights" of incumbents on their share of the specific investment, thereby helping the firm to solve a commitment problem
    - else, incumbents would have all reasons not to cooperate in the transfer of tacit knowledge to newly hired workers.

Further research (1)

- Return to seniority in other countries? Empirical question, however bet it does, notwithstanding difefrences in institutional frameworks

Further research (1)

- Return to seniority in other countries? Empirical question, however bet it does, notwithstanding difefrences in institutional frameworks
  - economic mechanisms for having a LIFO layoff exist everywhere,and legal institutions might very well just be a formalisation of rules of conduct and implicit contracts that would have emerged anyway.

Further research (1)

- Return to seniority in other countries? Empirical question, however bet it does, notwithstanding difefrences in institutional frameworks
  - economic mechanisms for having a LIFO layoff exist everywhere,and legal institutions might very well just be a formalisation of rules of conduct and implicit contracts that would have emerged anyway.
- Hold up problems reduce turnover, and thereby specific investment, since turnover requires new specific investment to be made

Further research (1)

- Return to seniority in other countries? Empirical question, however bet it does, notwithstanding difefrences in institutional frameworks
  - economic mechanisms for having a LIFO layoff exist everywhere,and legal institutions might very well just be a formalisation of rules of conduct and implicit contracts that would have emerged anyway.
- Hold up problems reduce turnover, and thereby specific investment, since turnover requires new specific investment to be made
  - contingent on our assumption that investment modelled as fixed amount and in one shot, at the begining of the worker-firm relationship

Further research (2)

- *What happens if the amount of investment can vary both in size and timing?*

Further research (2)

- *What happens if the amount of investment can vary both in size and timing?*
    - longer expected job duration might invoke more specific investment, which in turn would lengthen the expected job duration since the productivity at the job is raised relative to the productivity at the outside market etc.

Further research (2)

- *What happens if the amount of investment can vary both in size and timing?*
  - longer expected job duration might invoke more specific investment, which in turn would lengthen the expected job duration since the productivity at the job is raised relative to the productivity at the outside market etc.
  - firm responds along two margins of adjustment, when the demand for its product goes up: first, it hires additional workers, and second, it expands the specific investment in its incumbent workforce

Further research (2)

- *What happens if the amount of investment can vary both in size and timing?*
    - longer expected job duration might invoke more specific investment, which in turn would lengthen the expected job duration since the productivity at the job is raised relative to the productivity at the outside market etc.
    - firm responds along two margins of adjustment, when the demand for its product goes up: first, it hires additional workers, and second, it expands the specific investment in its incumbent workforce
    - further legitimation for a LIFO rule, not as legal constraint, but as an efficient economic institution