Barriers to Reallocation and Economic Growth: the Effects of Firing Costs

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Background

- Large scale gross reallocation of inputs across firms: the U.S. annual job creation/destruction rate of over 10%.
- In general, the loss of aggregate productivity from misallocation of inputs can be large: Restuccia and Rogerson (2008) and Hsieh and Klenow (2009).

Background

- Firing costs (employment protections) can act as barriers to reallocation.
  - Micco and Pagés (2007) and Haltiwanger, Scarpetta, and Schweiger (2014): restrictions on hiring and firing reduce the pace of job creation and job destruction in the cross-country context.
  - Davis and Haltiwanger (2014): Limiting the firms' ability to fire at will has a negative impact on job reallocation in the U.S. context.

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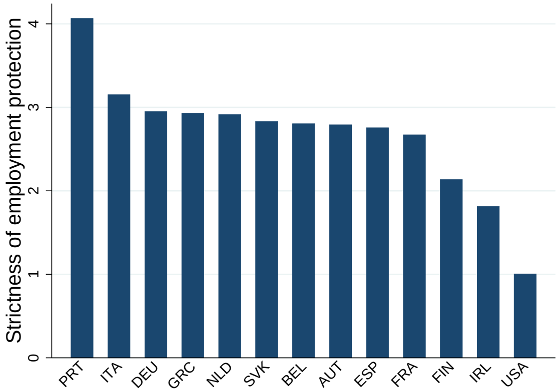
  - Davis and Haltiwanger (2014): Limiting the firms' ability to fire at will has a negative impact on job reallocation in the U.S. context.
- Firing costs can also reduce employment and productivity.
  - Autor, Donohue, and Schwab (2006): The U.S. states that adopted common-law restrictions reduced employment.
  - Autor, Kerr, and Kugler (2007): A particular form of protection (the "good faith exception") had a detrimental effect on state total factor productivity.
  - Bassanini, Nunziata, and Venn (2009): Across OECD countries, employment protection has a negative impact on TFP growth in industries where layoff regulations are more likely to be binding.

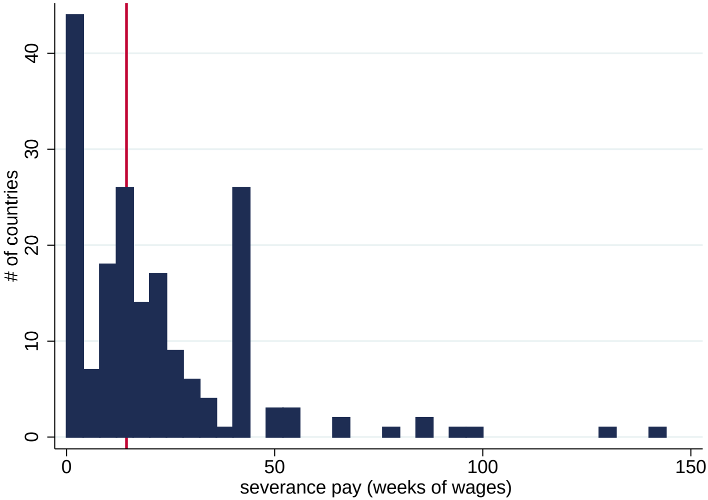
Firing costs: Europe vs United states



Source: OECD, average 1995-2005

Firing costs: severance payments, conditions for fair dismissal, notification procedures

Firing costs around the world



Source: World Bank, Doing Business Database 2015

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  - Creative destruction by new entrants
  - Innovation by both entrants and incumbents
- The model is calibrated using labor market data.

Related literature

- Firing costs, misallocation and aggregate productivity
  - Hopenhayn and Rogerson (1993), Moscoso Boedo and Mukoyama (2012)
  - Poschke (2009), Samaniego (2006)
- Firm dynamics and endogenous innovation
  - Klette and Kortum (2004), Acemoglu, Akcigit, Bloom, and Kerr (2013), Akcigit and Kerr (2015), Acemoglu and Cao (2015)

Model: the representative consumer

- Utility:

$$\mathbf{U} = \sum_{t=0}^{\infty} \beta^t [\log(C_t) - \xi L_t],$$

  where $\beta \in (0, 1)$ and $\xi > 0$.
- The consumer works, owns firms, and consumes. Labor is the only production factor.

Model: final-good firms (perfect competition)

- Final good (used for consumption and R&D):

$$Y_t = \left(\int_{\mathcal{N}_t} {\mathbf{q}_{jt}}^{\psi} {y_{jt}}^{1-\psi} dj \right)^{\frac{1}{1-\psi}} .$$

- y_{jt} is the quantity of intermediate good j.
- $\mathbf{q}_{jt} = \alpha_{jt} q_{jt}$: α_{jt} is an exogenous temporary shock, and q_{jt} is the underlying quality of intermediate good j.
- $\mathcal{N}_t \subset [0, 1]$: set of active products.
- Aggregate quality (productivity) index: $Q_t \equiv \bar{q}_t^{\frac{\psi}{1-\psi}}$.

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  - the firm enter/exit

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- Gross job flows are observed when:
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  - the firm enter/exit
- Firing costs
  - Tax for each worker fired τw.
  - The tax is transferred lump-sum to the consumer.

Model: innovation

- Incumbents can innovate on their own products.
- Entrants innovate randomly across different products.
- Innovation is stochastic.

$$q_{jt} = \begin{cases} (1+\lambda_i) q_{j,t-1} & \text{if innovates} \\ q_{j,t-1} & \text{if does not innovate} \end{cases}$$

  where $i = I, E$.
- Later we set $\lambda_E > \lambda_I$ to capture the idea that the entrants' innovation is more radical.

Model: innovation

Incumbents

- Improves the quality of its own product by R&D (in final goods).
- Probability of successful innovation: x_{Ijt}
- Innovation cost:

$$\mathbf{r}_{Ijt} = \theta_I Q_t \frac{q_{jt}}{\bar{q}_t} x_{Ijt}{}^{\gamma}.$$

  - Cost is increasing in the aggregate productivity Q_t.
  - Cost is increasing in the relative productivity $q_{jt}/\bar{q}_t$.

Model: innovation

Entrants

- Improves the quality of an incumbent's product or of an inactive product. Innovation is undirected.
- First pay the entry cost ϕQ_t (become a potential entrant) and then conduct R&D
- Probability of successful innovation: x_{Et}
- Innovation cost:

$$\mathbf{r}_{Et} = \theta_E Q_t {x_{Et}}^{\gamma}.$$

- Cost is increasing in the aggregate productivity Q_t.
- Creative destruction rate: $\mu = m x_E$, where m is the number of potential entrants.

Model solution and frictionless benchmark

The balanced-growth equilibrium is solved with normalizations:
$\hat{Y} \equiv Y_t/Q_t$, $\hat{w} \equiv w_t/Q_t$, $\hat{q} \equiv q_t/\bar{q}_t$,....

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Analytical characterizations of the frictionless case:

- The value function is linear in productivity q.
- The innovation decision is independent of q ($\rightarrow$ Gibrat's law).
- The right tail of the productivity distribution is Pareto.
- The growth rate of $\bar{q}$ can be derived analytically.
- Note: the normalized productivity next period is $(1+\lambda_I)\hat{q}/(1+g_q)$ with successful innovation, but without innovation $\hat{q}/(1+g_q) < \hat{q}$. $\rightarrow$ the firm has to contract if it does not innovate.

Calibration

One period = one year

Innovation step

- Innovation steps are $\lambda_E = 1.50$ and $\lambda_I = 0.25$ (Bena, Garlappi and Grüning (2015)). Entrants' innovations are more radical.
- $\theta_E/\theta_I = \lambda_E/\lambda_I$

Parameters $\xi, \theta_I, \epsilon, \phi, \delta$ are chosen to match

- Employment-population ratio of 61.3%
- Average growth rate of output per worker 1.48%
- Job creation rate 17.0%
- Job creation by entrants 6.4%
- Tail index of firm size distribution 1.06

Baseline model statistics

Table : Model vs Data (in percents)

	Data	Model
Growth rate g	1.48	1.48
Employment L	0.613	0.613
Job creation rate	17.0	17.0
Job creation rate from entry	6.4	6.4
Tail index	1.06	1.06
Job destruction rate	15.0	17.0
Job destruction from exit	5.3	2.8
R&D ratio R/Y		11.5

Notes: Job flows data from Business Dynamics Statistics (Census) establishment statistics.

Results: firing costs

Experiment: $\tau = 0.3$ (3.6 months of wages = median of severance payments)

(1) Decline in job flows

	Baseline	$\tau = 0.3$
Job creation rate (%)	17.0	4.9
Job creation from entry (%)	6.4	4.4
Job destruction rate (%)	17.0	4.9
Job destruction from exit (%)	2.8	2.4

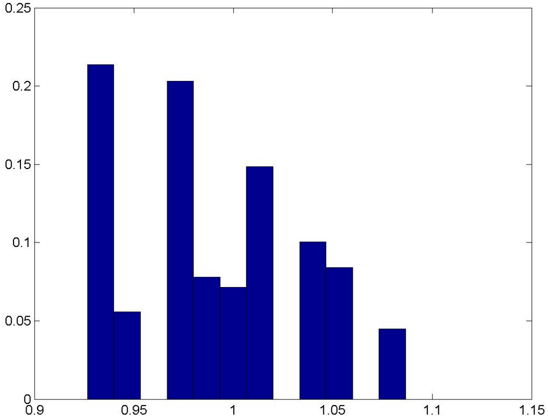
Results: firing costs

(2) Level effects

	$\tau = 0$	$\tau = 0.3$
Employment L	100	98.7
Normalized output $\hat{Y}$	100	98.1
Normalized average productivity $\hat{Y}/L$	100	99.3
Number of active products N	0.96	0.95

- As in standard firm dynamics models, both employment and output fall.
- Labor productivity also falls, because of misallocation of resources.

Results: firing costs



- Dispersion in the Marginal product of labor (would be equal across firms if no frictions).

Results: firing costs

(3) Growth effects

	$\tau = 0$	$\tau = 0.3$
Growth rate of output g (%)	1.48	1.40
Average innovation prob by incumbents x_I	0.084	0.090
Creative destruction rate $\mu = mx_E$ (%)	2.65	2.34

- The total growth effect is negative: firing taxes reduce productivity growth.
- Opposite effect on incumbents and entrants.

Results: firing costs

Innovation rate of entrants is lower.

- period profit (tax payment/distortion/wages) ($-$)

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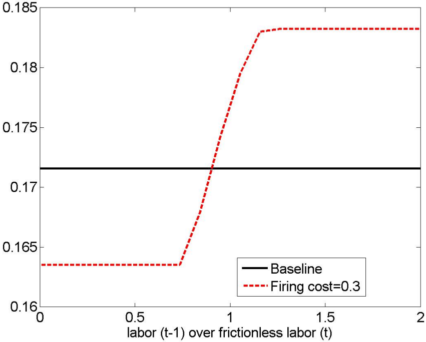
Innovation rate of incumbents can be higher or lower.

- period profit (tax payment/distortion/wages) ($-$)
- creative destruction effect (lower μ) ($+$)
- tax-escaping effect (escape tax payment by innovating) ($+$)

Results: holding μ constant

Figure : Incumbent's innovation probability (x_I)



- The tax escaping effect dominates for firms that are 'too big'.

Conclusion

- We constructed a model to study the effect of barriers to reallocation on aggregate productivity growth.
- The baseline case can be characterized analytically, and the general model can be computed similarly to popular heterogeneous-agent models.
- The model is calibrated using the labor market data.
- In our baseline calibration, the firing tax
  - reduces gross job flows
  - reduces employment, output, and average labor productivity (level effects)
  - reduces aggregate productivity growth (growth effects)
- The growth effect is the outcome of two conflicting forces:
  - Entrants' innovation declines.
  - Incumbents' innovation increases.

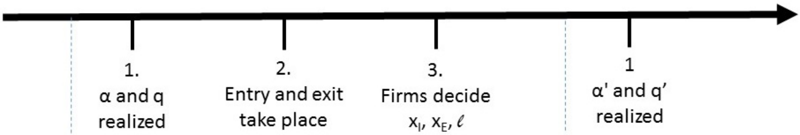
APPENDIX

Model: timing

1. Innovation occurs based on the previous period's R&D. Transitory shock realizes.

2. Incumbent firm exits if an entrant has innovated on its product line; Incumbents and new entrants exit if hit by exogenous exit shock.

3. Incumbents and entrants decide R&D investment, incumbents decide hiring/firing and pay the firing cost. Production.



Model: firm's problem

$$
\begin{aligned}
V_t(q_t, \alpha_t, \ell_{t-1}) & \\
= \max_{\ell_t, x_{It}} \quad & \Pi_t(q_t, \alpha_t, \ell_{t-1}, \ell_t, x_{It}) \\
& + \frac{1}{1+r} \Bigg\{ (1-\mu_t) \left[(1 - x_{It}) E Z_{t+1}(q_t, \alpha_{t+1}, \ell_t) \right. \\
& \qquad \left. + x_{It} E Z_{t+1}((1+\lambda_I) q_t, \alpha_{t+1}, \ell_t) \right] \\
& \qquad - \mu_t \tau w_{t+1} \ell_t \Bigg\}
\end{aligned}
$$

where

$$
Z_t(q_t, \alpha_t, \ell_{t-1}) = (1-\delta) V_t(q_t, \alpha_t, \ell_{t-1}) - \delta \tau w_t \ell_{t-1}
$$

and

$$
\begin{aligned}
\Pi_t & (q_t, \alpha_t, \ell_{t-1}, \ell_t, x_{It}) \\
& = (p_t - w_t) \ell_t - \theta_I Q_t \frac{q_t}{\bar{q}_t} {x_{It}}^{\gamma} - \tau w_t \max\langle 0, \ell_{t-1} - \ell_t \rangle,
\end{aligned}
$$

with $p_t = (\alpha_t q_t)^{\psi} {y_{jt}}^{-\psi} {Y_t}^{\psi}$.

Model: entry

- Free-entry condition

$$\max_{x_{E_t}} \left\{ -\theta_E Q_t {x_{Et}}^{\gamma} - \phi Q_t + \frac{1}{1+r} x_{Et} \bar{V}_{E,t+1} \right\} = 0,$$

- $\bar{V}_E$, the expected value of entry (depends on the number of potential entrants m)

- Creative destruction rate $\mu = m x_E$

Model: period profit

$$\Pi_t(q_t, \alpha_t, \ell_{t-1}, \ell_t, x_{It})$$
$$= (p_t - w_t)\ell_t - \theta_I Q_t \frac{q_t}{\bar{q}_t} {x_{It}}^{\gamma} - \tau w_t \max\langle 0, \ell_{t-1} - \ell_t \rangle,$$

with $p_t = (\alpha_t q_t)^{\psi} {y_{jt}}^{-\psi} {Y_t}^{\psi}$.

Model: balanced growth

The Euler equation:

$$\beta(1 + r_{t+1}) = \frac{C_{t+1}}{C_t}(\equiv 1 + g)$$

where g is the growth rate. The labor-leisure choice:

$$\frac{w_t}{C_t} = \xi.$$

Model: stationarized problem

$$\hat{V}(\hat{q},\ell) = \max_{\ell' \geq 0, x_I} \hat{\Pi}(\hat{q},\alpha,\ell,\ell',x_I) + \beta\left((1-\mu)\hat{S}(x_I,\hat{q}/(1+g_q),\ell') - \mu\tau\hat{w}\ell'\right),$$

where

$$\hat{S}(x_I,\hat{q}/(1+g_q),\ell') = (1-x_I)E_{\alpha'}\hat{Z}(\hat{q}/(1+g_q),\alpha',\ell') + x_I E_{\alpha'}\hat{Z}((1+\lambda)\hat{q}/(1+g_q),\alpha',\ell').$$

$$\hat{\Pi}(q,\alpha,\ell,\ell',x_I) = ([\alpha\hat{q}]^{\psi}\ell'^{-\psi}\hat{Y}^{\psi} - \hat{w})\ell' - \theta_I\hat{q}{x_I}^{\gamma} - \tau\hat{w}\max\langle 0,\ell-\ell'\rangle.$$

Model: value from entry

$$\hat{\hat{V}}_E = \int\int \hat{Z}((1+\lambda)\hat{q}/(1+g_q), \alpha, 0)(\bar{f}(\hat{q})+(1-N)h(\hat{q}))\omega(\alpha)d\hat{q}d\alpha.$$

Parameter values

	Parameter	Value
Discount rate	β	0.947
Disutility of labor	ξ	1.475
Demand elasticity	ψ	1/5
Innovation step: entrants	λ_E	1.5
Innovation step: incumbents	λ_I	0.25
Innovation curvature	γ	2.00
Innovation cost	θ_E	7.998
Innovation cost	θ_I	1.333
Entry cost	ϕ	0.1643
Exogenous exit rate	δ	0.001
Transitory shock	ϵ	0.267
Inactive lines	h mean	0.976
Firing tax	τ	0

Model: solving for the stationary equilibrium

1. Normalized model: $\hat{Y} \equiv Y_t/Q_t$, $\hat{w} \equiv w_t/Q_t$, $\hat{q} \equiv q_t/\bar{q}_t$,....

2. Given g_q, μ, $\hat{Y}$, $\hat{w}$
   - Compute value functions and decision functions
   - Stationary distribution of firms over $\hat{q}$, α and ℓ_{-1}

3. Stationary GE conditions: find g_q, μ, $\hat{Y}$, $\hat{w}$ such that
   (i) $\hat{Y}$ consistent with firms' output decision
   (ii) $\hat{\hat{V}}_E$ satisfies the free entry condition
   (iii) $\hat{Y} = \hat{C} + \hat{R}$
   (iv) $\frac{1}{N} \int \int \int \hat{q} f(\hat{q}, \alpha, \ell) d\alpha d\ell dq = 1$

The steps are very similar to the standard firm dynamics model (Hopenhayn (1992), Hopenhayn and Rogerson (1993)) and the standard heterogeneous-agent models (Bewley-Huggett-Aiyagari)

Model: frictionless benchmark

- The value function is linear in productivity q

$$\hat{Z}(\hat{q}, \alpha) = \mathcal{A}\alpha\hat{q} + \mathcal{B}\hat{q},$$

- The innovation decision is independent of q ($\rightarrow$ Gibrat's law)

$$\gamma\theta_I \hat{q} {x_I}^{\gamma-1} = \beta(1-\mu)E\left[\hat{Z}\left(\frac{(1+\lambda_I)\hat{q}}{1+g_q}, \alpha'\right) - \hat{Z}\left(\frac{\hat{q}}{1+g_q}, \alpha'\right)\right]$$

- Note: the normalized productivity next period is $(1+\lambda_I)\hat{q}/(1+g_q)$ with successful innovation, but without innovation $\hat{q}/(1+g_q) < \hat{q}$. $\rightarrow$ the firm has to contract if it does not innovate.

Model: frictionless benchmark

- Right tail of the productivity distribution is Pareto

$$F(\hat{q} > u) \propto u^{-\kappa},$$

where κ is the solution to:

$$1 = (1-\delta)\left[(\mu + (1-\mu)x_I)\gamma_i^{\kappa} + (1-\mu-(1-\mu)x_I)\gamma_n^{\kappa}\right].$$

- Growth rate of $\bar{q}$:

$$1 + g_q = (1-\delta)[(1+\lambda_I x_I)(1-\mu) + (1+\lambda_E)\mu] + \delta(1+\lambda_E)\bar{q}^h$$

Extensions

Two extensions of the model:

- Persistent exogenous shocks
  - Assume that α can be persistent;
  - The variance and the persistence of α is calibrated to match the variance and the autocovariance of employment growth. The data is taken from Longitudinal Business Database (through Synthetic LBD).
- Modifying innovation process
  - Entry more likely for low-q products $\rightarrow$ smaller entrants.
  - Low-q firms have lower θ_I $\rightarrow$ depart from Gibrat's law.

The main results are robust to these extensions.

Results for extension I: persistent exogenous shock

	Baseline		Persistent α	
	$\tau = 0.0$	$\tau = 0.3$	$\tau = 0.0$	$\tau = 0.3$
Growth rate of output g (%)	1.48	1.40	1.48	1.39
Innovation probability: incumbents $\bar{x}_I$	0.084	0.090	0.084	0.089
Innovation probability: entrants x_E	0.143	0.143	0.143	0.143
Creative destruction rate μ (%)	2.65	2.34	2.66	2.33
Employment L	100	98.7	100	98.0
Normalized output $\hat{Y}$	100	98.1	100	96.8
Normalized average productivity $\hat{Y}/L$	100	99.3	100	98.8
Number of active products N	0.964	0.959	0.964	0.959
Job creation rate (%)	17.0	4.9	17.0	7.0
Job creation rate from entry (%)	6.4	4.5	6.4	4.4
Job destruction rate (%)	17.0	4.9	17.0	7.0
Job destruction rate from exit (%)	2.8	2.4	2.8	2.4
R&D ratio R/Y (%)	11.5	10.7	11.5	10.8

Results for extension II: smaller entrants and deviation from Gibrat's law

	Baseline		Extension	
	$\tau = 0.0$	$\tau = 0.3$	$\tau = 0.0$	$\tau = 0.3$
Growth rate of output g (%)	1.48	1.40	1.48	1.45
Innovation probability: incumbents $\bar{x}_I$	0.084	0.090	0.055	0.057
Innovation probability: entrants x_E	0.143	0.143	0.042	0.042
Creative destruction rate μ (%)	2.65	2.34	6.29	5.81
Employment L	100	98.7	100	98.8
Normalized output $\hat{Y}$	100	98.1	100	98.3
Normalized average productivity $\hat{Y}/L$	100	99.3	100	99.4
Number of active products N	0.964	0.959	0.984	0.983
Job creation rate (%)	17.0	4.9	17.2	5.8
Job creation rate from entry (%)	6.4	4.5	7.5	5.5
Job destruction rate (%)	17.0	4.9	17.2	5.9
Job destruction rate from exit (%)	2.8	2.4	3.2	3.1
Entry rate(%)	2.8	2.4	6.4	6.2
R&D ratio R/Y (%)	11.5	10.7	11.9	11.3

Some empirical analysis

- Our model results indicate that the firing tax reduces total R&D, and consequently, productivity growth.
- Bassanini, Nunziata, and Venn (2000) find that firing costs tends to reduce TFP growth in industries where firing costs are more likely to be binding.
- We repeat the exercise with R&D spending as the dependent variable:

$$\text{R\&D}_{jct} = \beta_0 + \beta_1 \ \text{EPL}_{ct} \times \text{layoff}_j + \gamma_j + \lambda_{ct} + \varepsilon_{jct},$$

- The theoretical prediction: $\beta_1 < 0$.

Empirical results

	[1]	[2]	[3]
$\text{EPL}_{ct} \times \text{layoff}_j$	-0.0393**	-0.0380***	-0.0335
	(0.0135)	(0.0106)	(0.0352)
R-squared	0.352	0.588	0.598
N	5993	3201	359

[1] non-balanced panel [2] balanced panel [3] year=2005.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.