Firm Dynamics, Job Turnover, and Wage Distributions in an Open Economy

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Motivation

- Labor market effects of openness?
  - less job security
  - increased wage inequality
- Many liberalizing countries also experienced:
  - technological change
  - macro shocks
  - labor market reforms
  - privatization
- This paper
  - develops a dynamic structural model in which openness can lead to all of the consequences above
  - fits the model to Colombian micro data and quantifies the linkages

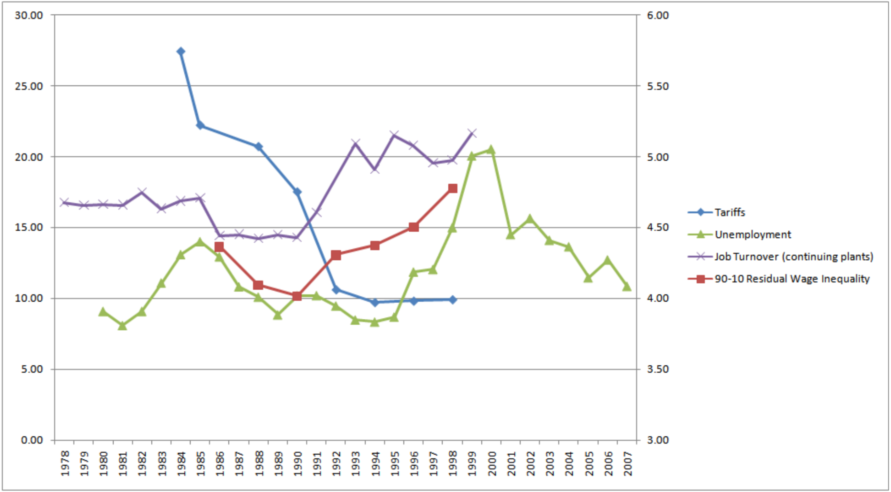

FIGURE: Colombian Experience

Evidence regarding job turnover:

- Openness is correlated with increased job turnover mainly due to greater *intra-sectoral* labor movements rather than *inter-sectoral* labor reallocation.

Hence:

- Use a Melitz (2003) model in which relatively efficient firms self-select into exporting.
- Allow ongoing idiosyncratic productivity shocks and endogenous entry/exit, as in Hopenhayn and Rogerson (1993).

Evidence regarding wage inequality:

- Wage inequality has increased partly because of a rising skill premium (Goldberg and Pavcnik (2007)), *but:*
  - we present evidence for increased (residual) wage dispersion by controlling for worker characteristics,
  - "Within industries, plants that receive greater inducements to export . . . raise wages relative to those that do not" (Verhoogen (2008), Amiti and Davis (2008))." Adjustments mainly reflect changes in worker rents (Frias et al. (2009)).

Hence

- Ex-ante homogeneous workers search and randomly match with heterogenous firms
- rent sharing

As trade costs decrease:

- job turnover
  - elasticity of profit functions wrt productivity increases $\Rightarrow$higher turnover
  - firm size distribution shifts towards larger firms which have lower turnover
- wage inequality
  - openness creates additional rents for large firms
  - squeezes rents out of small firms $\Rightarrow$fatter tails in the wage distribution.

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- The model generates considerable frictional wage dispersion (Hornstein, Krusell and Violante (2009))
- Openness can account for around 40% of the increase in residual wage inequality, but does not generate higher (steady state) job turnover.
- Not yet finished: dismissal costs and variable mark-ups

Some Related GE Trade and Labor Models

- **Unemployment and trade with labor market frictions**:
  - *Melitz with Search*: Felbermayr et al (2007), Helpman and Itskhoki (2010), Helpman et al (2009a, 2009b),
  - *Melitz with Efficiency wages*: Egger and Kreikemeier (2007), Amiti and Davis (2008), Davis and Harrigan (2008).
  - *Competitive product markets with search*: Albrecht and Vroman (2002), Davidson et al (1999, 2008)
  - *Competitive product markets with other labor market frictions*: Artuc, Chaudhuri and McClaren (2008), Kambourov (2006)
- **Trade and wage dispersion**
  - *Skill premia models*: Albrecht and Vroman (2002), Yeaple (2005), Davidson et al (2008), Helpman et al (2009a, 2009b)
  - *Efficiency wage models*: Davis and Harrigan (2008)
- **Novel features of our model:**
  - Ongoing idiosyncratic productivity shocks
  - Endogenous entry/exit

- Differentiated good (Q-sector) production:

$$q(z,l) = zl^{\alpha}, \quad \alpha > 0,$$

- firms are distributed across states (z,l) with $f(z,l)$
- homogeneous non-traded good (S-sector) production:

$$S = L_S + bL_u, \quad 0 < b < 1.$$

- Infinitely lived, ex-ante homogenous, risk-neutral worker-consumers of measure one. For worker i,

$$U_i = \sum_{t=1}^{\infty} \left(\frac{1}{1+r} \right)^t S_i^{1-\gamma} Q_i^{\gamma},$$

where $Q_i = \left(\int \int q_{Hi}(z,l)^{\frac{\sigma-1}{\sigma}} f(z,l) dz dl + q_{Fi} \right)^{\frac{\sigma}{\sigma-1}}$.

- Budget constraint (no saving):

$$I_i = S_i + \int \int p_H(z,l) q_{Hi}(z,l) f(z,l) dz dl + (\tau_m \tau_c k)\, q_{Fi}$$

- Iceberg trade costs: $\tau_c - 1$; Import tariffs: $\tau_m - 1$; Pesos per dollar exchange rate: k.

- Aggregating over consumers yields home demand for domestic goods and imports:

$$
\begin{aligned}
q_H(z,l) &= D_H \cdot p_H(z,l)^{-\sigma} \\
q_F &= D_H \cdot [\tau_m \tau_c k]^{-\sigma}
\end{aligned}
$$

where $D_H = \gamma I P^{\sigma-1}$ with the price index

$$
P = \left(\int \int p_H(z,l)^{1-\sigma} f(z,l) dz dl + [\tau_m \tau_c k]^{1-\sigma} \right)^{\frac{1}{1-\sigma}}
$$

- If a fraction $(1-\eta)$ output is sold domestically:

$$
r_H(z,l,\eta) = D_H^{\frac{1}{\sigma}} [(1-\eta) z l^{\alpha}]^{\frac{\sigma-1}{\sigma}}
$$

- exogenous foreign demand level D_F
- fixed costs of exporting $c_x > 0$

$$\begin{aligned} r(z,l) &= \max_{\eta \in [0,1]} \{ r_H(z,l,\eta) + r_x(z,l,\eta) - c_x \mathcal{I}^x \} \\ &= \max \left\{ \begin{array}{c} \left[D_H^{\frac{1}{\sigma}} (1-\eta^o)^{\frac{\sigma-1}{\sigma}} + k D_F^{\frac{1}{\sigma}} \left(\frac{\eta^o}{\tau_c} \right)^{\frac{\sigma-1}{\sigma}} \right] (z l^\alpha)^{\frac{\sigma-1}{\sigma}} - c_x \\ D_H^{\frac{1}{\sigma}} (z l^\alpha)^{\frac{\sigma-1}{\sigma}} \end{array} \right. . \end{aligned}$$

where $\eta^o = 1 / \left(1 + \frac{\tau_c^{\sigma-1} D_H}{k^\sigma D_F} \right)$ and $\mathcal{I}^x = 1_{\eta > 0}$ is an indicator function for exporting.

Timing of Firm's Problem

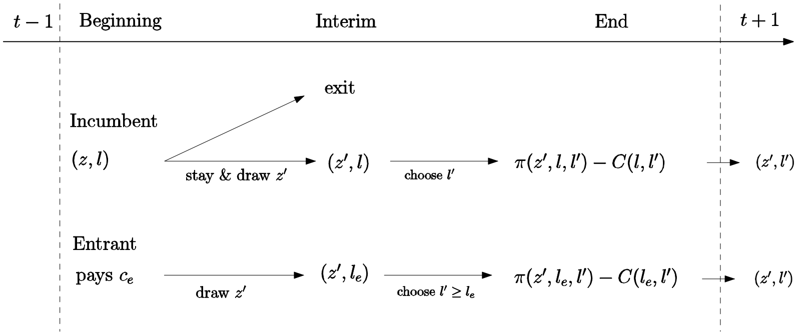

FIGURE: Within-period Sequencing of Events for Firms

Timing of Worker's Problem

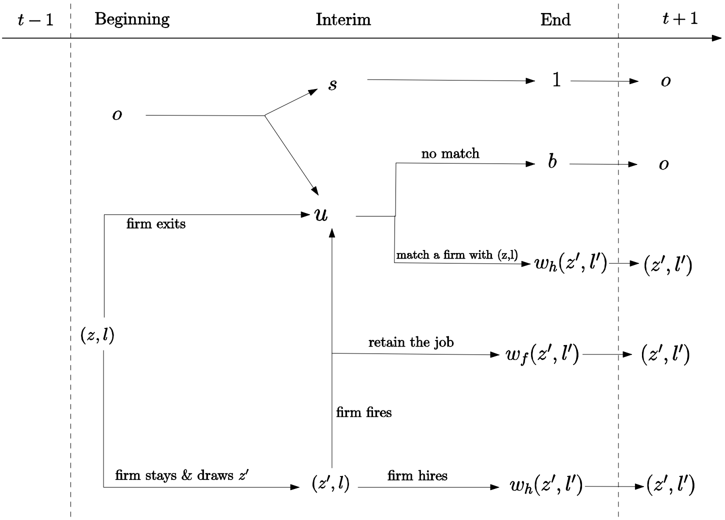

FIGURE: Within-period Sequencing of Events for Workers

- New matches, given measure L_u of unemployed workers are searching for jobs in the Q-sector and measure V of vacancies:

$$M(V, L_u) = \frac{V \cdot L_u}{(V^\theta + L_u^\theta)^{1/\theta}}$$

- Vacancy filling and job finding probabilities:

$$\phi_f(V, L_u) = \frac{M(V, L_u)}{V} = \frac{L_u}{(V^\theta + L_u^\theta)^{1/\theta}}$$

$$\phi_w(V, L_u) = \frac{M(V, L_u)}{L_u} = \frac{V}{(V^\theta + L_u^\theta)^{1/\theta}}.$$

- Cost of posting v vacancies for a firm of size l:

$$C_h(l, v) = \left(\frac{c_h}{\lambda_1}\right)\left(\frac{v}{l^{\lambda_2}}\right)^{\lambda_1}$$

where $\lambda_1 > 1$ (convexity), $\lambda_2 > 0$ (scale economies)

- Convex hiring costs deliver realistic firm dynamics in a large firm setup- Yashiv (2000), Bertola and Caballero (1994), Bertola and Girabaldi (2001)

- Firms are large, so employment at the i^{th} firm evolves according to $l_i' = l_i + \phi_f v_i$,

$$v_i = \frac{l_i' - l_i}{\phi_f}.$$

- The total number of vacancies is: $V = \sum v_i$.

- Firms bargain with all workers individually, and they do so each period (Stole and Zwiebel, 1996).

- In hiring firms $(l' > l)$, rents are split by Nash bargaining

  $\Rightarrow$hiring wages $w_h(z, l)$,
- In firing firms $(l' \leq l)$, no rents

  $\Rightarrow$resevation wages $w_f(z, l)$.

- Current profits

$$\pi(z, l, l') = \begin{cases} r(z, l') - w_h(z, l')l' - c_p & \text{if } l' > l \\ r(z, l') - w_f(z, l')l' - c_p & \text{otherwise.} \end{cases}$$

- Firm's value in the interim state:

$$\widetilde{\mathcal{V}}(z',l) = \max_{l'} \frac{1}{1+r}\{\pi(z',l,l') - C(l,l') + \mathcal{V}(z',l')\}$$

where

$$C(l,l') = \begin{cases} C_h\left(l,l'\right), \text{ if } l' > l, \\ c_f(l-l'), \text{ otherwise.} \end{cases}$$

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- The implied policy functions:

$$\begin{aligned} l' &= L(z',l), \\ \mathcal{I}^h(z',l) &= \begin{cases} 1, \text{ if } L(z',l) > l, \\ 0, \text{ otherwise.} \end{cases}, \\ \mathcal{I}^c(z,l) &= \begin{cases} 1 \text{ if } E_{z'}[\widetilde{\mathcal{V}}(z',l)|z] > 0 \\ 0 \text{ otherwise.} \end{cases} \end{aligned}$$

- Entry occurs until the value of an additional firm no longer exceeds the sunk entry cost, c_e:

$$\mathcal{V}_e = \int_{\underline{z}}^{\bar{z}} \widetilde{\mathcal{V}}(z, l_e) f_e(z) dz \leq c_e,$$

where $f_e(z)$ is the distribution of initial productivity levels.

- Interim value of S-sector employment:

$$J^s = \frac{1}{1+r}\left(1 + J^o\right)$$

- Interim value of searching for a Q-sector job:

$$J^u = \frac{1}{1+r}\left[(1-\phi_w)(b + J^o) + \phi_w E J_h^e\right]$$

where EJ_h^e is the expected value of being employed in a hiring firm.

- The value of the sectoral choice is

$$J^o = \max\{J^s, J^u\} = J^s = J^u$$

- The value of being in a hiring firm at the interim stage:

$$\widetilde{J}_h^e(z', l) = \frac{1}{1+r}\left[w_h(z', l') + J^e(z', l')\right]$$

- The value of being in a firing firm before firing takes place:

$$\widetilde{J}_f^e(z', l) = P_f(z', l)J^u + (1 - P_f(z', l))\frac{w_f(z', l') + J^e(z', l')}{1+r}$$

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- The value of starting the period employed at a (z,l) firm:

$$J^e(z,l) = (1-\mathcal{I}^c(z,l))J^u +$$
$$\mathcal{I}^c(z,l)\int_{z'}\left[\widetilde{J}_h^e(z',l)\mathcal{I}^h(z',l') + \widetilde{J}_f^e(z',l)(1-\mathcal{I}^h(z',l'))\right]h(z'|z)dz'$$

- At the time of hiring, firm rents from the marginal worker are:

$$\Pi^{firm}(z,l) = \frac{1}{1+r}\left[\frac{\partial \pi(z,l)}{\partial l} + \int_{z'} \frac{\partial \mathcal{V}(z',l)}{\partial l} h(z'|z)dz'\right]$$

- Worker rents are:

$$\Pi^{work}(z,l) = \frac{1}{1+r}\left[w_h(z,l) + J^e(z,l)\right] - \frac{b+J^o}{1+r}$$

- The bargaining condition:

$$\beta\Pi^{firm}(z,l) = (1-\beta)\Pi^{work}(z,l)$$

- Implied hiring wage:

$$w_h(z,l) = (1-\beta)r\left(\frac{b+J^o}{1+r}\right) + \Gamma(\alpha,\beta,\sigma)D^{\frac{1}{\sigma}} z^{\frac{\sigma-1}{\sigma}} l^{-\left[\frac{\alpha}{\sigma}+(1-\alpha)\right]} - \beta P_f(z,l)c_f$$

- Firm leaves workers indifferent between staying and leaving,

$$\frac{w_f(z', l') + J^e(z', l')}{1 + r} = J^u,$$

which delivers:

$$w_f(z', l') = rJ^u - \left[J^e(z', l') - J^u\right].$$

- A distribution $f(z, l)$ of firms that reproduces itself through $h(z'|z)$, firms' policy functions and the initial productivity draws of entrants from $f_e(z)$,
- Workers are indifferent between working in the service sector or searching,
- Supply matches demand for services and each differentiated good,
- Flow of workers into and out of unemployment match each other,
- Aggregate income matches aggregate expenditure,
- Trade balance holds.

Annual Industrial Survey, 1982-91

- All Colombian manufacturing plants with more than 10 workers, collected by the Colombian National Statistical Agency (DANE)
- 44,023 plant-year observations
- Average firm size: 69

- Log revenue function (gross of fixed exporting costs):

$$\ln r_{it} = d_H + \mathcal{I}_{it}^x d_F + \frac{\sigma - 1}{\sigma} \ln z_{it} + \alpha \frac{\sigma - 1}{\sigma} \ln l_{it}$$

- Productivity process

$$\ln z_{it} = \rho \ln z_{it-1} + \epsilon_{it},$$

- Estimated equation

$$\begin{aligned} \ln r_{it} \quad = \quad & (d_H + \mathcal{I}_{it}^x \cdot d_F) - \rho \left(d_H + \mathcal{I}_{it-1}^x d_F\right) + \rho \ln r_{it-1} \\ & - \alpha\rho \left(\frac{\sigma - 1}{\sigma}\right) \ln l_{it-1} + \alpha \left(\frac{\sigma - 1}{\sigma}\right) \ln l_{it} + \frac{\sigma - 1}{\sigma} \epsilon_{it}, \end{aligned}$$

- GMM estimator deals with selection bias and simultaneity.

	GMM Estimates with $\sigma = 5$		
parameter	estimate	std. error	z-ratio
α	0.592	0.057	10.41
ρ	0.848	0.007	118.73
σ_{ε}^2	1.668	0.042	39.54
d_H	1.682	0.047	35.78
d_F	0.213	0.004	51.31

PARAMETERS SET BEFORE SIMULATIONS

Parameter	Value	Description	Source
$k^{\sigma} D_F$	3482.1	foreign demand	from GMM estimates
τ_c	2.837	iceberg trade costs	from GMM estimates
c_e	329.4	entry costs	from GMM estimates
σ	5	elas. of substitution	Anderson&van Wincoop(2004)
r	0.15	discount rate	Bond et al. (2008)
γ	0.4	Q goods in utility	World Bank (2005)
l_e	10	size of entrants	assumed
β	0.5	bargaining power	assumed
θ	1.27	elas. of matching fnc.	den Haan et al. (2000)

Remaining parameters: $(c_p, c_h, c_x, b, \lambda_1, \lambda_2)$

Data vs. Model

Industry-wide Statistics	Data	Model	**Emp. Growth Rates, by Quintile**	Data	Model
Exit rate	0.091	0.083	<20th percentile	0.319	0.341
Job turnover	0.211	0.226	20th-40th percentile	0.218	0.248
Export rate	0.120	0.122	40th-60th percentile	0.191	0.209
Unemployment	0.086	0.100	60th-80th percentile	0.183	0.168
$corr(l, l')$	0.95	0.83	>80th percentile	0.157	0.145
$corr(z, l')$	0.59	0.66			
$corr(z, l)$	0.57	0.74			

Second Stage: Calibration

Parameter	In model units	In US$	Description
c_p	19.0	$85,946	fixed cost of operation
c_h	5.31	$24,020	vacancy posting cost scalar
c_x	8.57	$38,766	fixed cost of exporting
b	0.12	$542	value of home production
λ_1	1.68		convexity, vacancy cost function
λ_2	0.30		scale effect, vacancy cost function

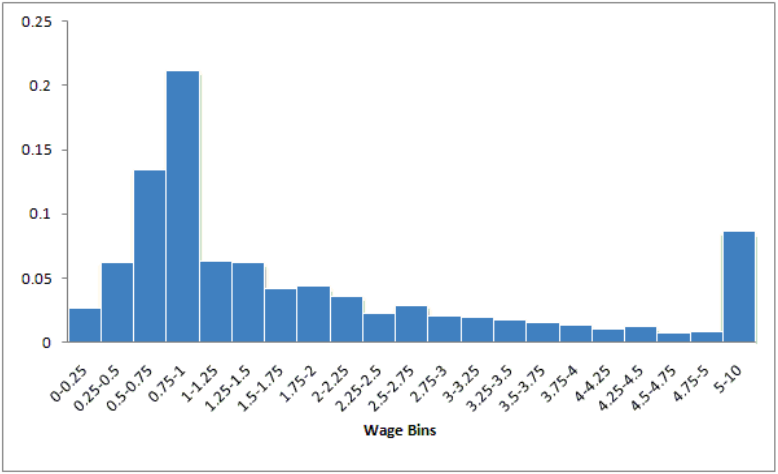

FIGURE: Histogram of Wages

Experiments: Decrease in Trade Costs

Variable	base case $\tau_m = 1.21$ $\tau_c = 2.84$	tariff reductions $\tau_m = 1.11$ $\tau_c = 2.84$	15% drop in trade costs $\tau_m = 1.21$ $\tau_c = 2.55$	45% drop in trade costs $\tau_m = 1.21$ $\tau_c = 2$
Export rate	0.122	0.140	0.158	0.264
Job turnover	0.226	0.222	0.224	0.224
Unemployment	0.100	0.100	0.098	0.094
$\log(w_{90}/w_{10})$	2.035	2.047	2.049	2.070
Std. dev. log wages	0.775	0.776	0.778	0.781
Ave. ind. utility, $IP^{-\gamma}$	0.772	0.771	0.781	0.829

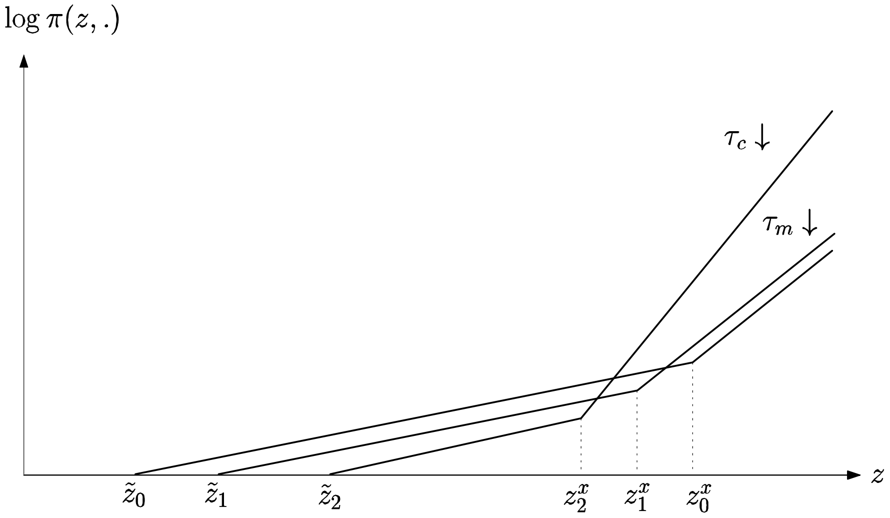

FIGURE: Response of Profits to Import Tariffs and Trade Costs

Summary

- No evidence on openness leading to increased job turnover
  - flexible wages absorb most of the shock
  - exporter effect and shift in size distribution offset each other

- Residual wage inequality increases

- Work in progress: JT quite responsive to labor market reforms (drop in c_f)