The Network Origins of Firm Dynamics

Contracting Frictions and Dynamism with Long-Term Relationships

Johannes Boehm [1] Ezra Oberfield [2] Ruairidh South [3] Mazhar Waseem [4]

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[1]Sciences Po [2]Cornell [3]Princeton [4]Manchester

Weak Contract Enforcement and Long Term Relationships

Systematic differences in firm dynamics across countries (Hsieh-Klenow 2014)

Long term relationships can substitute for formal contract enforcement

- static benefit: helps incentives $\rightarrow$ lower transaction costs
- potential cost: less likely to switch to better supplier

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Johnson, McMillan, Woodruff (JLEO 2002):

- Survey of firms in Eastern Europe
- Belief in quality of courts varies across countries
- *"If another firm you have never purchased from offered to supply this input for a price 10% lower than this supplier, would you purchase from the new firm instead of this supplier?"*
    - Custom inputs: less confidence in courts $\implies$ more likely to reject new offer
    - Standard inputs: little difference

Monarch (2020): US imports from China

- Firms in more contract intensive industries stay with suppliers for longer

What is the role of relationships in firm dynamics and allocative efficiency?

This paper

1. Motivational evidence from India/Pakistan, that contracting frictions increase relationship stickiness and reduce dynamism
2. Quantitative model with firm dynamics built on firm-to-firm trade
   - Contracting frictions induce relational contracting which leads to more stickiness in firm-to-firm relationships
   - Productive firms are chosen less often as suppliers $\Rightarrow$ aggregate productivity loss
3. Calibrate multi-sector version of model to Indian/Pakistani setting
   - Compare firm dynamics in model to data
   - See how firm dynamics change with contracting frictions (in model & data)
4. Perform counterfactuals where we reduce contracting frictions
   - Reduces dynamic losses from misallocation
   - Dynamic losses $\approx$ 3x static losses (Boehm-Oberfield, 2020)

Literature

- Firm Dynamics:
  - Customer Capital: Luttmer (2011), Gourio Rudanko (2014) , Afrouzi Drenik Kim, Argente Fitzgerald Moreira Priolo, Einav Klenow Levin Murciano-Goroff, Foster Haltiwanger Syverson (2016)
  - Input-Switching: Gopinath Neiman (2014), Lu Mariscal Mejia (2024), Damijan Konings Polanec (2014), Monarch (2022) Baqaee Burstein Duprez Farhi (2023)
  - Kortum-Klette: Lentz Mortensen (2008), Akcigit Kerr (2018), Garcia-Macia Hsieh Klenow (2019)
- Firm-to-firm trade
  - Firm heterogeneity, static: Oberfield (2018), Bernard Moxnes Ultveit-Moe (2018), Eaton Kortum Kramarz (2024), Bernard Dhyne Magerman Manova Moxnes (2022)
  - Deterministic Life Cycle: Chaney (2014) and Aekka Khanna
  - Dynamics with Frictions: Huneeus, Miyauchi, Martin Mejean Parenti (2023) and Fontaine Martin Mejean (2023)
- Frictions and Dynamism: Hopenhayn, Rogerson (1993), Hsieh, Klenow (2014), Akcigit Alp Peters (2021)
- Contracting frictions: Boehm (2022), Amirapu (2021), Boehm Oberfield (2020)
- Relational contracts: Kranton (1996), Hemous, Olsen (2018), Macchiavello Morjaria (2015,2021)

Data

- **Indian Annual Survey of Industries**, 1989/90-2014/15 (with gaps)
  - Plant-level panel survey of manufacturing plants
  - Sales/purchases by 5-digit outputs and inputs
- Supplement with **Pakistan Value Added Tax** data 2011-2019
  - Monthly Firm-to-Firm sales transactions, aggregated to annual level
  - Only have 2-digit industry of firm, do not see products traded

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Contracting frictions in output market present when:

firms output is relationship-specific AND firm located in region with poor contract enforcement

- **Relationship-specificity:** Rauch '99, by 5-digit product (India), 2-digit industry (Pak.)
- **Poor contr. enforecement:** Avg. age of pending cases in states (India), districts (Pak.) For India, also use age of court as IV (Boehm & Oberfield, 2020)

Contracting friction in output markets ⇒ longer relationships (Pak)

	Dep. var.: Length of Relationship (in Years)				
	(1)	(2)	(3)	(4)	(5)
Age of pending cases (S) × RelSpec_S	0.225**				
	(0.045)				
Age of pending cases (B) × RelSpec_S	0.0638				
	(0.045)				
Age of pending cases (Min(B,S)) × RelSpec_S		0.281**	0.264**		
		(0.032)	(0.041)		
Age of pending cases (Min(B,S)) × $\text{EnforcementIntensity}_{b,s}$				0.0228*	0.0258*
				(0.011)	(0.013)
B × S Industry FE	Yes	Yes	Yes	Yes	Yes
B District FE	Yes	Yes		Yes	
S District FE	Yes	Yes		Yes	
S District × S Industry FE			Yes		Yes
B District × B Industry FE			Yes		Yes
R^2	0.0630	0.0636	0.0929	0.0625	0.0922
Observations	2140189	2142616	2141943	2142616	2141943

Standard errors in parentheses, clustered at the origin-destination district level.
$^+$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Contracting frictions in output markets $\Rightarrow$ lower variance of sales growth

	Dependent variable: $\sigma(\Delta \log \text{Sales})_{d\omega}$			
	(1)	(2)	(3)	(4)
Avg age of civil cases × Rel. spec.	-0.0177*	-0.0187*	-0.0401*	-0.0385*
	(0.0089)	(0.0088)	(0.016)	(0.016)
$\overline{(\Delta \log \text{Sales})_{d\omega}}$		-0.273**		-0.273**
		(0.024)		(0.024)
State FE	Yes	Yes	Yes	Yes
5-digit Industry FE	Yes	Yes	Yes	Yes
Estimator	OLS	OLS	IV	IV
R^2	0.287	0.302	-0.000369	0.0207
Observations	7574	7574	7574	7574

Regression at the state × industry level. Only state-industry cells with more than 5 observations used.

Dependent variable: standard deviation of residualized (by age, year, state and industry) annualized sales growth in each state-industry cell

Data from ASI, India

Contracting frictions in output markets ⇒ lower exit rates (across all size bins)

	Dependent variable: P(exit)			
	(1)	(2)	(3)	(4)
Q1 Dummy	0.0738***	0.0717***		
	(0.0023)	(0.0057)		
Q2 Dummy	0.0255***	0.0208***	-0.0460***	-0.0469***
	(0.0018)	(0.0033)	(0.0013)	(0.0042)
Q3 Dummy	0.0131***	0.00979***	-0.0576***	-0.0567***
	(0.00099)	(0.0016)	(0.0016)	(0.0043)
Q4 Dummy	0.00800***	0.00677***	-0.0611***	-0.0586***
	(0.00071)	(0.0011)	(0.0018)	(0.0044)
Q1 × Relspec × AvgAgeCourts		0.00129		-0.00539*
		(0.0026)		(0.0025)
Q2 × Relspec × AvgAgeCourts		0.00299*		-0.00501**
		(0.0014)		(0.0019)
Q3 × Relspec × AvgAgeCourts		0.00221*		-0.00627***
		(0.00099)		(0.0016)
Q4 × Relspec × AvgAgeCourts		0.000871		-0.00755***
		(0.00087)		(0.0016)
Industry × Year FE			Yes	Yes
R^2	0.0525	0.0526	0.0460	0.0462
Observations	417711	411541	417698	411528

Standard errors in parentheses, clustered at the industry-region level.
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Data from Pakistan

Model: Single Industry

- Growing industry with many firms. Two types of firms: manufacturers, retailers

- Each firm produces using labor and one input:

$$y_b = A(z_{bs}x_s)^{\alpha} l^{1-\alpha}, \qquad A \equiv \alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}$$

- Single shocks process: new potential buyer-supplier matches arrive via Poisson process
  - Each new potential match: random supplier s, random match-specific productivity z_{bs}
  - Buyer's decision: switch or not

- Large number of retailers
  - Same production function & supplier arrival process as manufacturers
  - Sell output to household (but not to other manufacturers or retailers)
    - Manufacturers sell to other firms and to retailers, but not to household

Static Equilibrium

- Representative Household
  - Dixit-stiglitz preferences across varieties sold by retailers (elast. ε)
  - Households inelastically supplies a growing quantity of labor L (growth rate γ)
    - Labor used for production or to create new manufacturers and retailers

- Market structure
  - Monopolistic Competition across retailers
  - Bilateral contracts in firm-to-firm trade (quantity, transfer)
  - Countably stable: no countable coalition wants to alter/drop contracts

  $\Rightarrow$ Efficient production within supply chains (quantities)

$$c_b = \left(\frac{c_s}{z_{bs}}\right)^{\alpha} w^{1-\alpha}$$

  - Many ways to split surplus
    - Focus on equilibrium in which surplus split according to cost shares

Keeping the model tractable

- State variable for a firm is, in principle, very large

- We focus on one economic decision:
  - New supplier comes along: switch or not
  - Easy if each supplier's (log) cost is random walk with the same distribution of increments: lower cost now $\implies$ better distribution of future cost (FOSD)

- Key characteristic: no mean reversion in cost

  What makes this work?
  - Productivity of new potential match inspired by current supply chain
  - No option to go back to old supplier
  - No supplier death

Productivity of new potential match inspired by current supply chain

- Productivity delivered by current chain is

$$q \equiv z_0 z_1^{\alpha} z_2^{\alpha^2} \dots$$

where $z_0, z_1, z_2, \dots$ are firm's own, its supplier's, its supplier's supplier's...

- match-specific prod. with new potential supplier:

$$z = \underbrace{b}_{\text{original component}} \quad \underbrace{q}_{\text{spillover from current chain}}$$

- The arrival rate of new suppliers with original component larger than b is

$$\kappa b^{-\beta}$$

$\implies$ Arrival rate of supplier that delivers cost reduction larger than x is

$$\phi x^{-\beta}, \qquad \phi \equiv \kappa \int (c_s/w)^{-\beta} dF(c_s)$$

Entry and Exit

To have an ergodic distribution for cost, assume a growing mass of entrants

- Population grows at rate γ, $L_t = L_0 e^{\gamma t}$
- Entry
  - Free entry: unit of labor $\implies$ flow χ of manufacturers and χ_R of retailers
  - $\implies$ Along BGP, flow of entrants grows at population growth rate, γ
  - Each entrant draws potential suppliers:
    The number of draws of techniques with match-specific component larger than z is Poisson with mean $\kappa_0 z^{-\beta}$
- Exit
  - Firms never die. But if no customers, output is zero
  - A firm "exits" when it loses its last customer
    - May gain customers later, still draws new suppliers, etc
- Under these assumptions: MGF of change in log $\frac{w}{cost}$ over interval with length τ

$$\mathbb{E}\left[\left(\frac{cost_{j,t}}{cost_{j,t+\tau}}\right)^s\right] = e^{-\tau\phi\sum_{k=1}^{\infty}\frac{s}{\beta\alpha^{-k}+s}}$$

Aggregate Output along BGP

Aggregate output is

$$Y_t = \left(|R_t| \int_0^\infty c^{1-\varepsilon} dF(c) \right)^{\frac{1}{\varepsilon - 1}} (1-\eta) L_t$$

In special case where $\beta = \varepsilon - 1$, output per capita is

$$\frac{Y_t}{L_t} = (1-\eta) \left(\frac{\eta \chi_R}{\gamma} L_0 \right)^{\frac{1}{\beta}} \left[\frac{\kappa_0^\alpha \Gamma(1-\alpha)}{1 + \frac{\phi}{\gamma} \sum_{k=1}^\infty \frac{1}{1-\alpha^{-k}}} \right]^{\frac{1}{1-\alpha} \frac{1}{\beta}} e^{\frac{\gamma}{\beta} t}$$

$\rightarrow$ Semi-endogenous growth

- Distribution of cost in cross section is constant over time
- Growth from gains from variety
- Firm-level dynamics matter for level of output along BGP

General formula

Calibrate multi-sector version of model

- Firm b in industry ω

$$y_b = A_\omega l^{\alpha_{\omega l}} \prod_{\omega'} (z_{bs'} x_{s'})^{\alpha_{\omega\omega'}} \qquad \text{with} \qquad \begin{array}{c} \alpha_{\omega l} + \sum_{\omega'} \alpha_{\omega\omega'} = 1 \\ A_\omega \equiv \alpha_{\omega l}^{-\alpha_{\omega l}} \prod_{\omega'} \alpha_{\omega\omega'}^{-\alpha_{\omega\omega'}} \end{array}$$

- Calibrate to Indian data on 5-digit industries
- Some industries ω produce relationship specific goods
  - Less efficient courts $\Rightarrow$ lower arrival rate κ for relationship-specific inputs
  - For now behavioral assumption, microfoundation is work-in-progress

Parameter	Value	**Target**	**Target value**	**Data source**
Population growth (γ)	0.04	Employment share by age		Hsieh & Klenow (2014)
New technique shape (β)	3.52	Δ cost from new suppliers	-0.284	Baqaee et al. (2023)
New supplier arrival rate (ϕ)	0.58	Mean relationship length	1.72 years	Pakistan data
Observation threshold	varies	$\frac{\text{Median sales above threshold}}{\text{Threshold}}$	6.36	Pakistan data
Number of retailer firms ratio	60	Annual exit probability	0.05	
Household EoS (ε)	4.52	$\beta + 1$		

One shock, many subtle firm dynamics patterns

Firm size depends on fundamentals (cost) but also on demand (number & size of customers)

Model explains key firm dynamics facts:

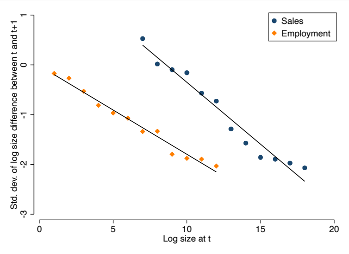
- Size-variance relationship
- Fat tails in firm growth rates
- Exit rates declining in size
- Existence of "gazelles"

When enforcement is worse:

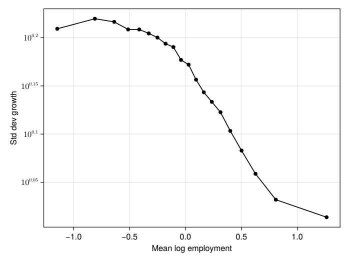
- Lower variance of firm growth $\rightarrow$ evidence: see earlier results
- Less mean reversion in firm size
- Less skewed size distribution
- Lower exit rate $\rightarrow$ evidence: see earlier results

Standard Deviation of Growth Rates by Size

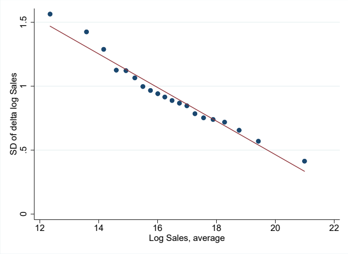
Data (US, Factset):



Simulation:

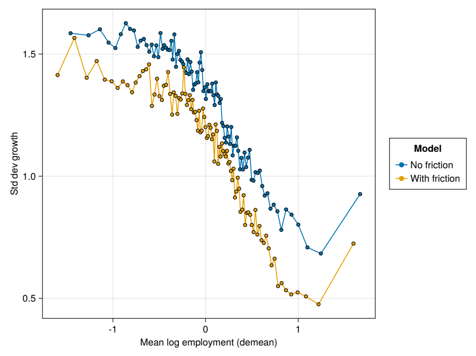


Data (Pakistan):

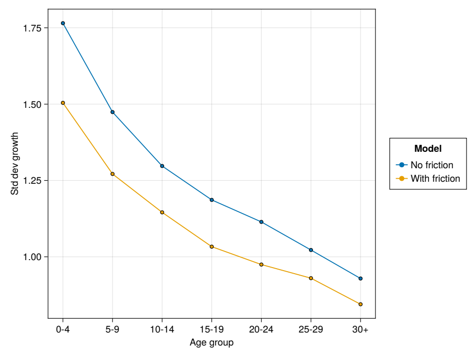


- Larger $\implies$ lower standard deviation of growth rates (Hymer and Pashigian, 1962)
  - Usual mechanism: Large firms composed of more subunits $\implies$ diversification
  - Here: Large firm tends to have more customers
- Declines more slowly than $\sqrt{\text{size}}$
  - Usual mechanism: correlation across subunits, granular subunits
  - Here: granular customers (also some correlation from cost changes) ▸ Comparison

Standard Deviation of Growth Rates: Frictions vs No Frictions (Model)



(a) Volatility by Size



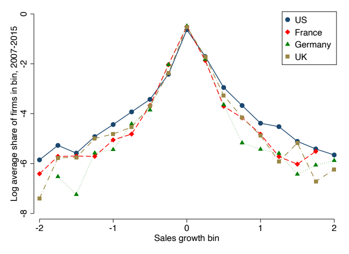
(b) Volatility by Age

Lower arrival rate of shocks $\Rightarrow$ lower variance of growth rates

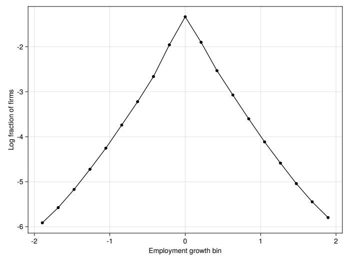
Empirical Evidence: see table at beginning of talk

Distribution of Growth Rates has Fat Tails

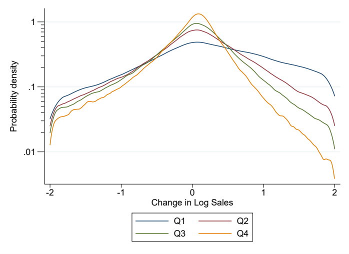
Data (Factset):



Simulation:

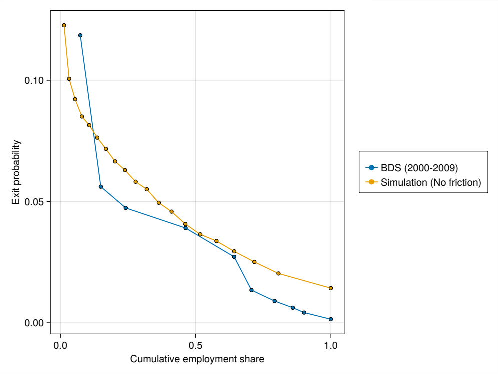


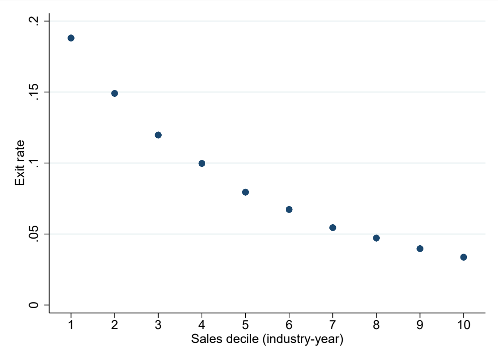
Data (Pakistan):



- Fat tails: Ashton, 1926, Laplace dist: Stanley, et al. (1996)
- Here: Mixture of getting one large customer, many small customers

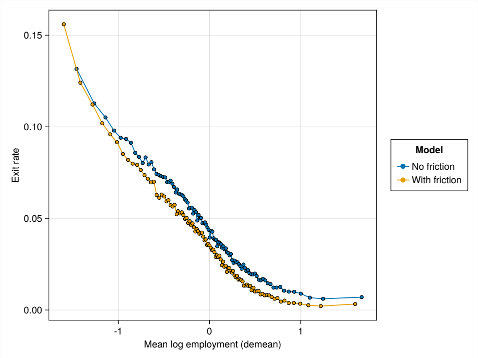
Exit rates decline with size



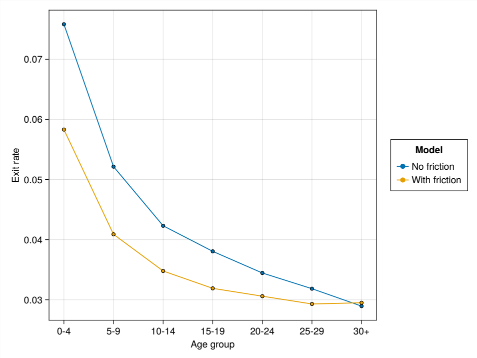


- Firms exit when they lose last customer
- Large firms can have one large customer
- Number of buyers is a good predictor of exit

Exit Rates: Frictions vs No Frictions (Model)



(c) Exit Rates By Size

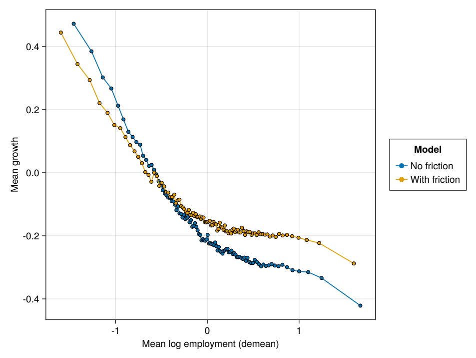


(d) Exit Rates by Age

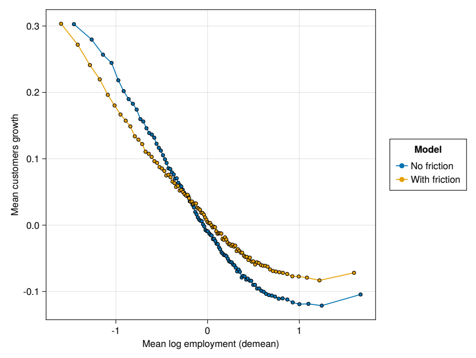
Lower arrival rate of shocks $\Rightarrow$ lower probability of losing last customer

Empirical Evidence: see table at beginning of talk

Mean Reversion: Frictions vs No Frictions (Model)



(e) Sales



(f) Number of Customers

According to the model, no mean reversion in *cost*

But: mean reversion in *sales* towards a long-run level commensurate with costs

With fictions ($\rightarrow$ less turnover) slower mean-reversion in sales

Mean reversion in firm size: slower with frictions

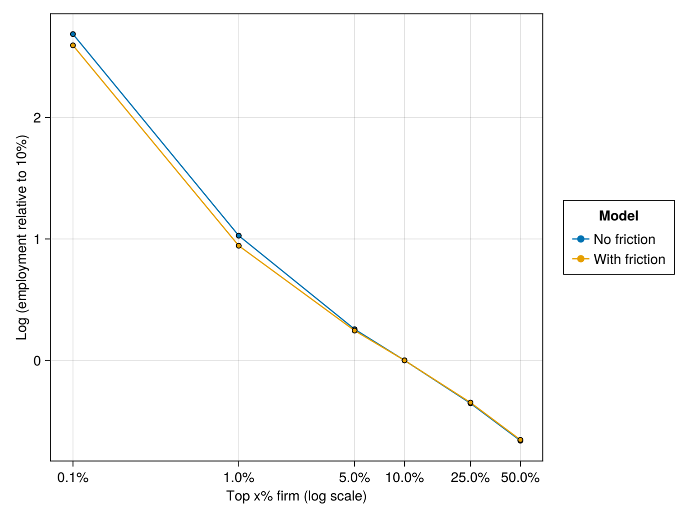
	Dependent variable: Change in log Sales					
	(1)	(2)	(3)	(4)	(5)	(6)
log Sales_{t-1}	-0.403**	-0.427**	-0.555**	-0.403**	-0.436**	-0.583**
	(0.011)	(0.025)	(0.037)	(0.012)	(0.028)	(0.038)
log $\text{Sales}_{t-1} \times$ Age civ. cases $\times$ relspec	0.00709+	0.0206*	0.0249+	0.00687	0.0256*	0.0405*
	(0.0037)	(0.0096)	(0.015)	(0.0044)	(0.012)	(0.019)
Plant $\times$ 5-digit Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes			Yes		
Year $\times$ Previous Year FE	Yes			Yes		
Age FE		Yes	Yes		Yes	Yes
Industry $\times$ District $\times$ Year FE		Yes			Yes	
Industry $\times$ District $\times (t, t-1)$ FE			Yes			Yes
Method	OLS	OLS	OLS	IV	IV	IV
R^2	0.457	0.636	0.671	0.256	0.250	0.278
Observations	204518	78053	51401	204518	78053	51401

Standard errors in parentheses, clustered at the state $\times$ industry level.

Similar with Pakistan data ▸ Pakistan

Size Distribution: less fat tails with frictions

Model simulation:



Contracting frictions in output markets ⇒ lower skewness in size distribution

	Dependent variable: Skewness of log Sales					
	(1)	(2)	(3)	(4)	(5)	(6)
Relspec x Court Congestion	-0.360*	-0.671*	-0.799**	-0.624^{+}	-1.312*	-0.905
	(0.168)	(0.287)	(0.294)	(0.349)	(0.598)	(0.578)
R^2	0.540	0.435	0.554	0.001	0.000	0.007
State FE	Yes	Yes	Yes	Yes	Yes	Yes
5-digit Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Estimator	OLS	OLS	OLS	IV	IV	IV
Statistic	25-75	50-75	50-90	25-75	50-75	50-90
Observations	3008	3008	1448	3008	3008	1448

$$\text{Skewness}_{s\omega} = \frac{\log\left(\text{Share of plants above } S_1\right) - \log\left(\text{Share of plants above } S_0\right)}{\log S_1 - \log S_0}$$

S_0 and S_1 are different quantiles of overall plant size distribution (25th, 50th, and 75th, 90th)

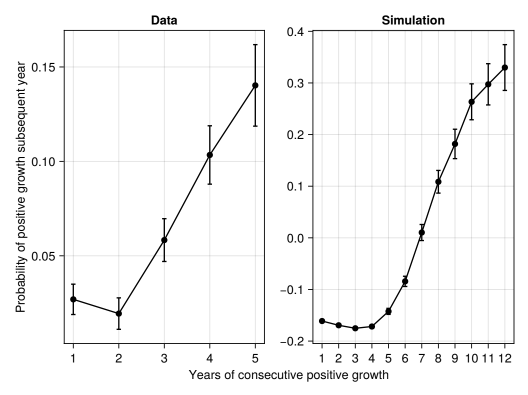
Similar with Pakistan data ▸ Pakistan

“Gazelles” / “rockets” / type dependence / ex ante heterogeneity

- Luttmer (2011): Need “rockets” that eventually slow to explain why largest firms are not so old
- Sedlacek, Sterk, Pugsley (2021): Hidden “ex ante heterogeneity” explains most of size dispersion at young ages, almost half of size dispersion at twenty
- Coad, Daunfeldt, Halvarsson (2018): autocorrelation of growth rates is positive for young firms and negative for older firms

Here: cost is hidden type

- Cost determines inflow of customers
- Low cost at birth $\implies$ persistent growth until inflows equals outflows
- Cost evolves over time



Counterfactual: reduce contracting frictions

Reducing average age of pending court cases by 1 year

$\Rightarrow$ 0.26 years longer relationships on average (for rel-spec. industries)

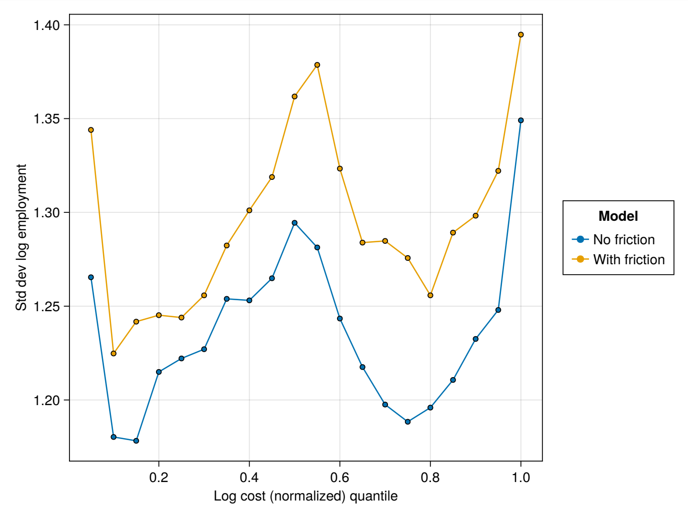
Counterfactual: change arrival rate of new suppliers κ (or ϕ) accordingly, to move from average age of pending cases of 4 years to 1 year

Reduces misallocation: firms with low cost get drawn as suppliers more often, large but unproductive firms shrink

	No friction	**With friction**
Mean income growth	0.015	0.015
Log real income difference	0.000	-0.162

Agg. productivity loss from dynamic misallocation $\approx$ 3x static loss (Boehm & Oberfield, 2020)

Reducing friction ⇒ reduce size dispersion within each cost quantile



Thank you!

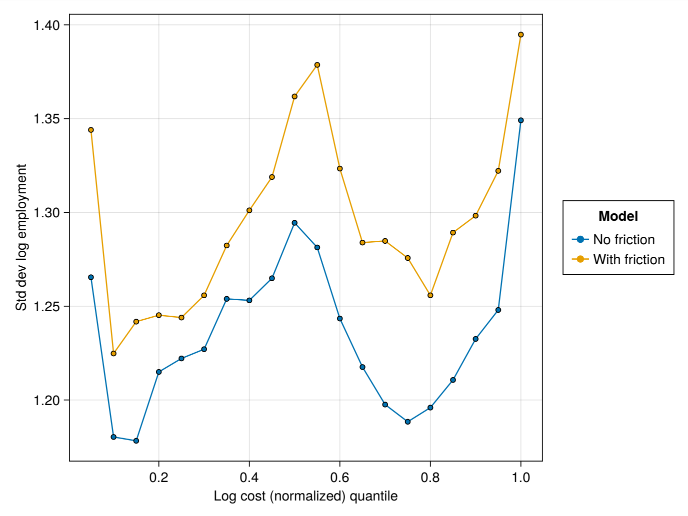
johannes.boehm@sciencespo.fr

Implications for Aggregate Productivity

Productivity

- Productivity growth is $\frac{\gamma}{\varepsilon-1}$
  - Gains from variety/Population growth
- Weak enforcement affects level of productivity
- Misallocation: Firms use worse suppliers than they would with better enforcement

Misallocation: Dispersion in Size



Misallocation: Correlation of Log Cost and Log Employment

Model	Correlation (demeaned)	Correlation (normalized)
No friction	-0.281	-0.370
With friction	-0.260	-0.340

Aggregate Productivity

	No friction	With friction
Mean income growth	0.015	0.015
Log real income difference	0.000	-0.162

- Note: In counterfactuals, entry rate held fixed
- More severe contracting frictions $\implies$ lower entry (impact on welfare not obvious)

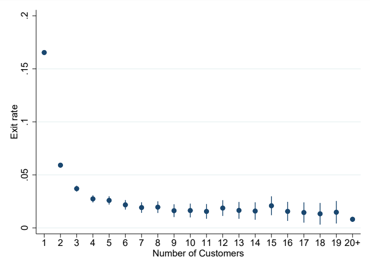
Conclusion

- One response to weak contract enforcement is to use relational contracts
- Static benefits, but less switching
  - $\Rightarrow$ Slower firm dynamics
  - $\Rightarrow$ Cost penalty builds up over time
  - Not switching in past $\implies$ large impact on current aggregate productivity
- Dynamic costs of bad enforcement are $\sim$3 times the size of static costs

Appendix

Number of Buyers is Good Predictor of Exit

Back



	Dependent variable: P(exit)			
	(1)	(2)	(3)	(4)
Constant	0.0878**	0.0879**	0.0878**	0.0879**
	(0.00039)	(0.00038)	(0.00038)	(0.00038)
Fixed Effects	Year	Year, #Buyers	Year, Sales vingtiles	Year, #Buyers, Sales vingtiles
R^2	0.0293	0.0889	0.0976	0.112
Observations	501828	501431	501828	501431

Standard errors in parentheses, clustered at the industry-region level.

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Determinants of Firm Growth Volatility

	Data (Pakistan)					Simulation				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\overline{\log(\text{Sales})}$	-0.138		-0.092	-0.105	-0.103	-0.3021		-0.2424	-0.2259	-0.2256
	(0.0018)		(0.0025)	(0.0022)	(0.0022)	(0.0007)		(0.0009)	(0.0008)	(0.0008)
$\overline{\log(\text{Buyers})}$		-0.217	-0.111				-0.4962	-0.1845		
		(0.0031)	(0.0042)				(0.0014)	(0.0018)		
$\overline{\log(\text{HHI})}$				0.152	0.202				0.3179	0.4224
				(0.0055)	(0.0067)				(0.0017)	(0.0112)
$\overline{\log(\text{HHI (weighted)})}$					-0.051					-0.1058
					(0.0037)					(0.0112)
Fixed Effects										
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Statistics										
R^2	0.263	0.244	0.286	0.287	0.289	0.7667	0.7393	0.7713	0.781	0.781
R^2-within	0.197	0.175	0.221	0.223	0.225	0.2674	0.1814	0.282	0.3123	0.3124
Observations	23,034	23,034	23,034	23,034	22,552	538,784	538,784	538,784	538,784	538,784

Standard errors in parentheses. The dependent variable is the log standard deviation of $\log \text{sales}_{t+1} - \log \text{sales}_t$.

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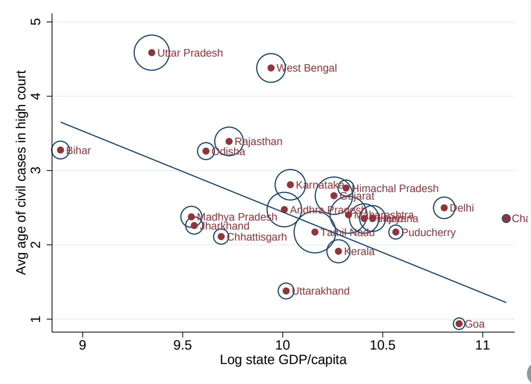
Slow Courts

- Contract disputes between buyers and sellers
- District courts can de-facto be bypassed, cases would be filed in high courts
- Court quality measure: average age of pending civil cases in high court



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Mean Reversion: Pakistan

	Dependent variable: Change in log Sales		
	(1)	(2)	(3)
$\log \text{Sales}_{t-1}$	-0.146**	-0.163**	-0.163**
	(0.0051)	(0.010)	(0.011)
$\log \text{Sales}_{t-1} \times$ Age civ. cases $\times$ relspec		0.0114^{+}	0.0128*
		(0.0060)	(0.0062)
Firm $\times$ 2-digit Industry FE	Yes	Yes	Yes
District FE	Yes	Yes	
Year FE	Yes	Yes	
Age FE			Yes
Industry $\times$ District $\times$ Year FE			Yes
R^2	0.218	0.218	0.249
Observations	205351	205254	201931

Standard errors in parentheses, clustered at the district $\times$ industry level.

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Skewness of Size Distribution: Pakistan

	Dependent variable: Skewness of log Sales		
	(1)	(2)	(3)
Relspec x Court Congestion	-0.914	-1.053^{+}	-1.465^{+}
	(0.593)	(0.562)	(0.831)
District FE	Yes	Yes	Yes
2-digit Industry FE	Yes	Yes	Yes
Statistic	25-75	25-90	50-90
R^2	0.424	0.598	0.547
Observations	935	688	688

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

$$\text{Skewness}_{s\omega} = \frac{\log(\text{Share of plants above } S_1) - \log(\text{Share of plants above } S_0)}{\log S_1 - \log S_0}$$

S_0 and S_1 are different quantiles of overall plant size distribution (25th, 50th, and 75th, 90th)

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Notes on Pakistan

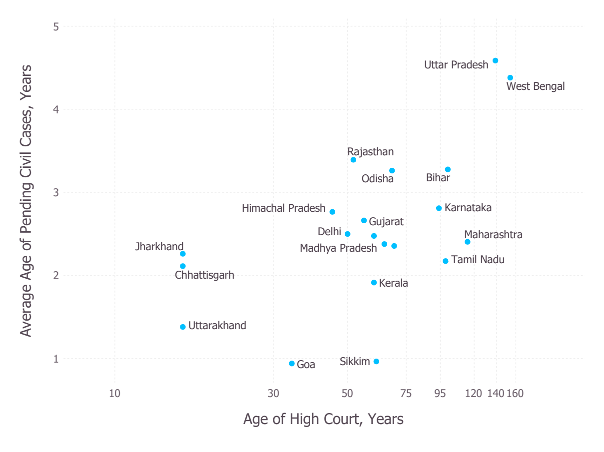
- 7 states, almost all economic activity is in two states, Sindh and Punjab
- All of our data is in district courts
- VAT data: Size threshold: varies across years. 2-3k per year - 15k per year
- Can still register for VAT
- Small firms effectively face sales tax
- Some sectors (notably agriculture, some services, companies owned by army) excluded from VAT
- For manufacturing, sum across firms of reported VA in data of firms represents 89% manufacturing VA as reported by National Accounts (for whole economy, much lower 30-40%)
- Currently use all transactions, whether reported by one or both parties. If parties disagree on value, use geometric mean of reported transactions
- Firms reports total sales separately from transactions For size, use declared sales of firm, not sum of transactions
- Remove invoice mills
- For firm: age (date registered), two digit industry codes (sometimes there is a product

Endogeneity: IV

- Since independence: # judges based on state population

⇒ backlogs have accumulated over time

- But: new states have been created, with new high courts and clean slate



Aggregate Output along BGP

Output per capita along the BGP when $\beta \neq \varepsilon - 1$ is

$$\frac{Y_t}{L_t} = (1-\eta)^{\frac{\beta}{\varepsilon-1}} \left(\frac{\eta \chi_R}{\gamma} L_0\right)^{\frac{1}{\varepsilon-1}} \left[\frac{\Gamma\left(1-\frac{\alpha}{\beta}(\varepsilon-1)\right)}{1+\frac{\phi}{\gamma}\sum_{k=1}^{\infty}\frac{\varepsilon-1}{\varepsilon-1-\beta\alpha^{-k}}}\right]^{\frac{1}{\varepsilon-1}} \left[\frac{\kappa_0 \Gamma(1-\alpha)}{1+\frac{\phi}{\gamma}\sum_{k=1}^{\infty}\frac{1}{1-\alpha^{-k}}}\right]^{\frac{\alpha}{1-\alpha}\frac{1}{\beta}} e^{\frac{\gamma}{\varepsilon-1}t}$$

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Weak Enforcement and Relational Contracts

- Contract specifies level of defectiveness $\delta \in [0, 1]$. Surplus maximized at $\delta = 0$.
  - Supplier can produce defective input. Saves in cost, but possibility output will be defective.
  - Claim can be enforced in court.
    - But delay in court reduces value of payment
    - Cost proportional to value of transaction
- Static Nash: Supplier makes defective input, court. Priced in, but static surplus $\downarrow$
- Relational contract
  - Supplier chooses $\delta = 0$
  - Buyer chooses lower arrival rate of new suppliers (observable to supplier, not court)
    - Backloads payoff, raises surplus of the relationship
  - Enforcement: Trigger strategies
    - If supplier does not customize, buyer does not reduce arrival of new suppliers
    - Punishment for defective inputs: **Relationship ends faster + enforcement in court**
    - If buyer does not reduce arrival rate, supplier stops customizing

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