The Network Origins of Firm Dynamics

Contracting Frictions and Dynamism with Long-Term Relationships

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Research on Trade Networks in the Past, Present, and Future

New quantitative methods to study the formation & role of trade networks

- Informed by (and applied to) new empirical results

How does trade shape growth and development?

Applications in a range of different settings/fields:

(a) Quantify trade and growth in historical episodes (the *past*)

(b) Role of trade and firm networks in present-day industrial development (the *present*)

(c) Adaptation of economic systems to environmental risk & climatic change (the *future*)

Common theoretical foundations, very different applications.

Back-and-forth between theory and empirics.

The Past: Quantifying trade and its role in historical episodes

1. "Trade and the End of Antiquity" (with T. Chaney, r&r Econometrica)
    - 4th-10th century: use data on coin finds to recover trade shares → trade shares are informative about relative productivity → recover (and decompose) relative growth of ancient economies

2. "Trade and the Origins of the Territorial State" (work in progress)
    - 8th-10th century: trade flows were an important tax base for early states (Poland, Volga Bulgaria). Estimate trade flows → estimate tax base → study how trade contributes to state formation

The Future: Adaptation of economic systems to environmental risk & climatic change

1. "Firm Adaptation in Production Netowrks" (with C. Balboni, M. Waseem, cond. accept. AER)
    - Climate change increases frequency of extreme weather events. Show evidence that following extreme weather events (floods) in Pakistan, firms *persistently* change their sourcing strategies $\Rightarrow$ Adaptation! Quantification via trade model.

2. "Clearing the Air on the Costs and Benefits of Road Infrastructure" (with C. Balboni, A. Berman, L. Marzano, M. Waseem, work in progress)
    - Urban setting: compare benefits from roads (market integration: trade, commuting) with local environmental externality (air pollution). Integrate atmospheric dispersion model into quant. spatial model.

The Present: Trade Networks in Industrial Development

Two old papers on quantification of contracting frictions

1. "The Impact of Contract Enforcement Costs on Value Chains and Aggregate Productivity" (JMP, ReStat 2022)
2. "Misallocation in the Market for Inputs" (with E. Oberfield, QJE 2020)
    - Static distortions from imperfect contract enforcement lead to welfare losses of 0% - 10%.
3. "The Network Origins of Firm Dynamics: Contracting Frictions and Dynamism with Long-Term Relationships" (with E. Oberfield, R. South, M. Waseem, work in progress)

Also old (JPE 2022) and ongoing work (with E. Oberfield) on firms' product portfolios and economies of scope.

The Network Origins of Firm Dynamics

Motivation: Firms and Aggregate Productivity

Large literature, starting with Hopenhayn, that considers firm dynamics — and the process of reallocation across firms — as underpinning aggregate productivity:

- Entry, exit
- Growth, decline

Reallocation: most productive firms should "rise to the top"

But: many productive firms struggle to scale up, large unproductive firms stay in the market etc

- Foster et al. (2008): TFPQ only weakly correlated with exit
- Hsieh and Klenow (2014), Verhoogen (2023), Bassi et al. (2022, 2025)

How does this process of "rising to the top" happen? What shapes firm's demand and dynamics?

This paper: firm-to-firm relationships and firm dynamics

This paper: study the role that firm-to-firm relationships play in shaping firm dynamics and allocative efficiency.

... and study one institutional determinant of dynamism.

1. Motivational facts (Pakistan) point to important role of extensive margin of sales relationships for explaining firm growth and decline:
   Firms grow/shrink largely by gaining/losing important buyers
   $\Rightarrow$ allocative efficiency will be improved when productive firms are able to establish lasting relationships with important buyers
2. Show that **one determinant of relationship churning is contract enforcement**:
   When courts are slow (contract enforcement is poor): relationship churning is slower, firm growth volatility is lower, exit rates are lower.
   cf. Johnson, McMillan, Woodruff (2002), Monarch (2010).
   Plausible mechanism: firms use relational contracts to overcome enforcement frictions, at the cost of higher relationship churning

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3. Quantitative model with firm dynamics built on firm-to-firm trade
    - Stochastic arrival of new potential matches; new relationship replace existing ones when new supplier is better than old one $\Rightarrow$ new supplier scales up, old supplier sees reduction in demand
    - Aggregate productivity is shaped by the process of match formation
4. Calibrate multi-sector version of model to Indian/Pakistani setting
    - Compare firm dynamics in model to data
5. Study role of contracting frictions in shaping relationships, firm dynamics, and aggregate productivity
    - In data & model: contracting frictions make relationships stickier
    - Results in dynamic losses $\approx$ 3x static losses from increased transaction costs (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)
  - 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: Nunn (2007), Boehm (2022), Amirapu (2021), Boehm Oberfield (2020)
- Relational contracts: Kranton (1996), McMillan Woodruff (1999), Hemous, Olsen (2018), Macchiavello Morjaria (2015,2021)

Data

- **Pakistan Value Added Tax** data 2011-2019
  - Monthly Firm-to-Firm sales transactions, aggregated to annual level
  - 4-digit industry codes
- For contracting frictions questions, supplement with **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

Sales growth rates of firms

Davis-Haltiwanger-Schuh (DHS) sales growth rate of firms:

$$g_{it} = \frac{\text{Sales}_{i,t+1} - \text{Sales}_{i,t}}{0.5(\text{Sales}_{i,t+1} + \text{Sales}_{i,t})}$$

- Firm entry (sales from 0 to > 0): $g_i = +2$
- Firm exit (sales from > 0 to 0): $g_i = -2$
- Firm growth/decline (sales from > 0 to > 0): $g_i \in (-2, +2)$

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Decomposition:

$$g_{it} = EXT_{it} + INT_{it}$$

$$EXT_{it} = \frac{\sum_{j \in B_{it}^{\text{new}}} S_{ijt+1} - \sum_{j \in B_{it}^{\text{old}}} S_{ijt}}{0.5(S_{it+1} + S_{it})}, \qquad INT_{it} = \frac{\sum_{j \in B_{it}^{\text{cont}}} (S_{ijt+1} - S_{ijt})}{0.5(S_{it+1} + S_{it})} \tag{1}$$

where $B_{it}^{\text{new}} = B_{it+1} \setminus B_{it}$, $B_{it}^{\text{old}} = B_{it} \setminus B_{it+1}$, and $B_{it}^{\text{cont}} = B_{it} \cap B_{it+1}$

Fraction of variancs of DHS sales growth accounted for by EXT

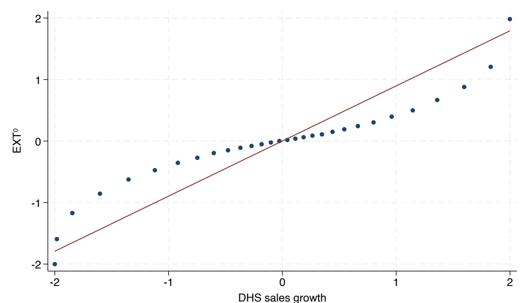
Most of sales growth variance coming from extensive margin changes:

Frequency	Incumbents	Small Firms	Large Firms	With Entrants
Annual	0.79	0.81	0.74	0.90
Quarterly	0.78	0.78	0.78	0.89
Biennial	0.82	0.85	0.74	0.91

⇒ Firms grow and shrink mostly by establishing new or losing buyer relationships.

Association with extensive margin changes is strongest for large growth/decline episodes

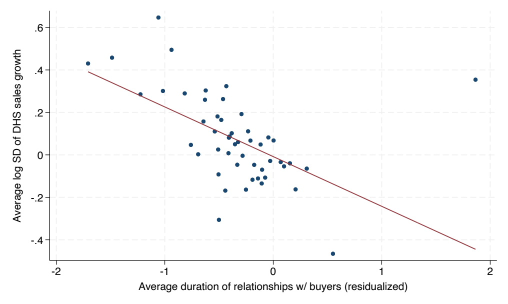
Higher order



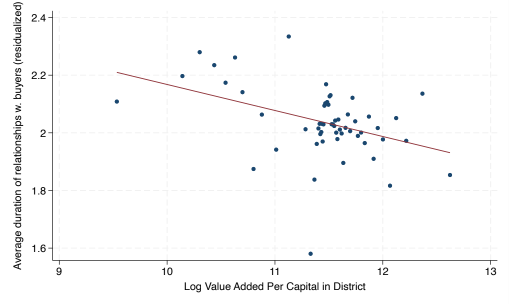
Relationship churning varies across space (districts)

- Average of firm log SD of DHS sales growth
- Average of firm's duration of relationships with buyers

de-mean by industry(-pair), and take average average within districts:



(a) Growth Volatility vs. Duration of Relationships



(b) Relationship length and Log GDP per capita

$\Rightarrow$ sales growth is more volatile whenever relationships are on average shorter

$\Rightarrow$ relationships are shorter in richer districts of Pakistan

Contracting frictions and relationship churning

One determinant of relationship length is the presence of contracting frictions:

Johnson, McMillan, Woodruff (2002):

- Survey of firms in Eastern Europe, Belief in court quality 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?"*
  - Relationship-specific inputs: less confidence in courts $\implies$ more likely to reject new offer
  - Homogeneous inputs: little difference

Approach: (Nunn, 2007) 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), 4-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) Correlation with GDP/capita

Details

Contracting frictions in output markets ⇒ longer relationships (Pak)

	Dependent variable: Length of Relationship (in Years)				
	(1)	(2)	(3)	(4)	(5)
Age of pending cases (S) × RelSpec_S	0.206*		0.172*		
	(0.086)		(0.076)		
Age of pending cases (B) × RelSpec_S		0.187*	0.146*		
		(0.083)	(0.071)		
Age of pending cases (Min(B,S)) × RelSpec_S				0.296**	0.301**
				(0.038)	(0.039)
B × S 4-digit Industry FE	Yes	Yes	Yes	Yes	Yes
B District FE	Yes	Yes	Yes	Yes	
S District FE	Yes	Yes	Yes	Yes	
S District × S 4-digit Industry FE					Yes
B District × B 4-digit Industry FE					Yes
R^2	0.119	0.119	0.119	0.120	0.162
Observations	1628710	1628182	1627686	1629206	1627434

Standard errors in parentheses, clustered at the origin-destination district level.

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

Contracting friction in output markets ⇒ lower SD of sales growth

	$\log \sigma(\Delta \log \text{Sales}_{i,t+1})$					
	(1)	(2)	(3)	(4)	(5)	(6)
Avg age of civil cases × Rel. spec.	-0.173**	-0.173**	-0.0388*	-0.0391*	-0.0759**	-0.0794**
	(0.050)	(0.050)	(0.017)	(0.017)	(0.029)	(0.029)
Log Sales	-0.149**	-0.149**	-0.0952**	-0.0937**	-0.0954**	-0.0939**
	(0.0053)	(0.0050)	(0.0034)	(0.0034)	(0.0034)	(0.0034)
$\overline{(\Delta \log \text{Sales})_{i,t+1}}$		-0.00474		-0.244**		-0.244**
		(0.020)		(0.029)		(0.029)
Data	Pakistan	Pakistan	India	India	India	India
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Estimator	OLS	OLS	OLS	OLS	IV	IV
R^2	0.242	0.242	0.194	0.201	0.0471	0.0544
Observations	36637	36637	27930	27930	27930	27930

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

	Dependent variable: P(exit)		
	(1)	(2)	(3)
Q1 Dummy	0.0739**		
	(0.0018)		
Q2 Dummy	0.0253**	-0.0510**	-0.0493**
	(0.0016)	(0.0042)	(0.0046)
Q3 Dummy	0.0131**	-0.0611**	-0.0636**
	(0.00091)	(0.0046)	(0.0053)
Q4 Dummy	0.00789**	-0.0715**	-0.0770**
	(0.00062)	(0.0045)	(0.0053)
Q1 × Relspec × AvgAgeCourts		-0.00621**	-0.00552*
		(0.0024)	(0.0023)
Q2 × Relspec × AvgAgeCourts		-0.00384*	-0.00422**
		(0.0015)	(0.0015)
Q3 × Relspec × AvgAgeCourts		-0.00469**	-0.00367**
		(0.0013)	(0.0011)
Q4 × Relspec × AvgAgeCourts		-0.00162	
		(0.0014)	
4-digit Industry × Year FE		Yes	Yes
District × Year FE			Yes
4-digit Industry × District FE			Yes
R^2	0.0522	0.0536	0.0764
Observations	407189	300384	299802

(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)
  - Household 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)

$$c_b = \left(\frac{c_s}{z_{bs}}\right)^{\alpha} w^{1-\alpha} \qquad \text{or} \qquad c_b = w/q$$

  where $q \equiv z_0 z_1^{\alpha} z_2^{\alpha^2} \ldots$ is productivity delivered by current chain, $z_0, z_1, z_2, \ldots$ are firm's own, its supplier's, its supplier's supplier's...

  - Many ways to split surplus...Focus on eqm 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

- 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

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

- Under these assumptions: MGF of change in log $\frac{w}{cost}$ over interval with length τ

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

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

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

One shock, many subtle firm dynamics patterns

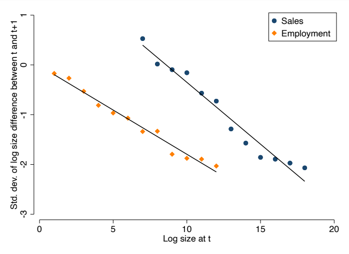
Firm size depends on fundamentals (cost) but also on demand (number & size of customers)

Model explains key firm dynamics facts:

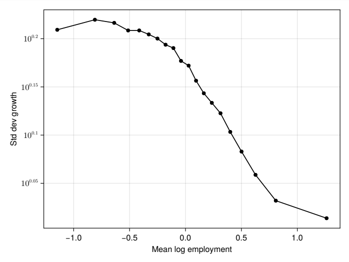
- Size-variance relationship
- Fat tails in firm growth rates
- Exit rates declining in size
- Existence of “gazelles”

Standard Deviation of Growth Rates by Size

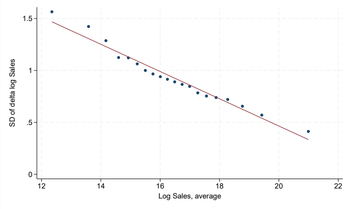
Data (US, Factset):



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

Determinants of Firm Growth Volatility

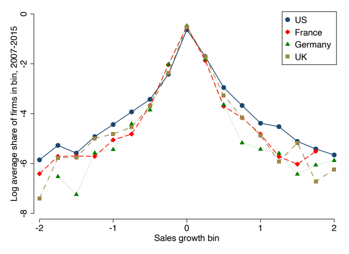
	Data (Pakistan)					Simulation				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\overline{\log(\text{Sales})}$	-0.138		-0.092	-0.105	-0.103	-0.3021		-0.2424	-0.2259	-0.2256
	(0.0018)		(0.0025)	(0.0022)	(0.0022)	(0.0007)		(0.0009)	(0.0008)	(0.0008)
$\overline{\log(\text{Buyers})}$		-0.217	-0.111				-0.4962	-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 $\log \text{sales}_{t+1} - \log \text{sales}_t$.

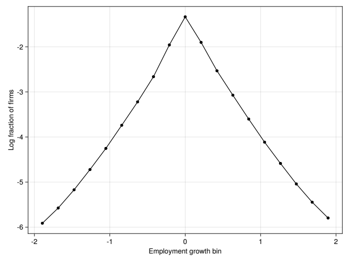
Back

Distribution of Growth Rates has Fat Tails

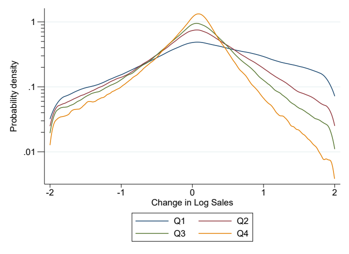
Data (Factset):



Simulation:

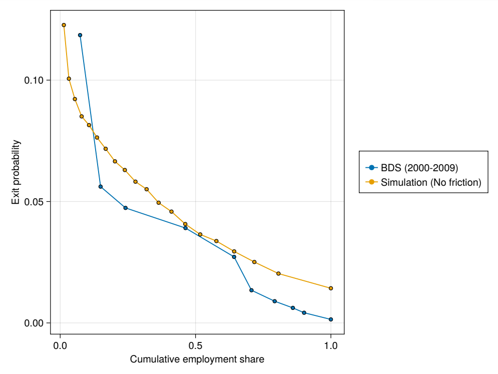


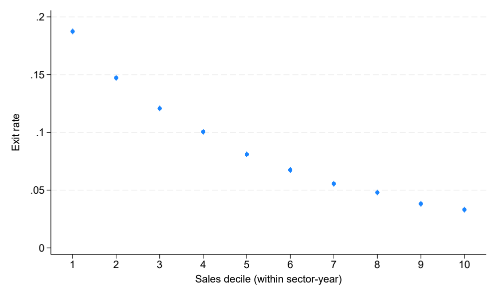
Data (Pakistan):



- 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





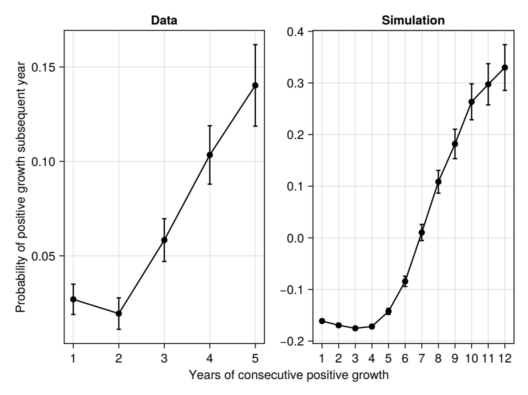
- Firms exit when they lose last customer
- Large firms can have one large customer
- Number of buyers is a good predictor of exit

"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 $\Longrightarrow$ persistent growth until inflows equals outflows
- Cost evolves over time



Quantification of Contracting Frictions

Contracting Frictions

Contracting frictions make firm-to-firm relationships stickier (see beginning of the talk)

When formal enforcement through courts is slow/costly, firms use relational contracts:

- firms can sustain long-term contract iff continuation value δV is sufficiently high
- if buyers' search effort is observable, relational contract may feature buyer searching less for alternative suppliers to keep continuation value high (increases effective discount factor)

Multiple possible underlying frictions (repeated moral hazard, adverse selection of suppliers) that end up decreasing the effective arrival rate of new matches ϕ

Microfoundation: Repeated Moral Hazard with Punishment

Calibrate multi-sector version of model

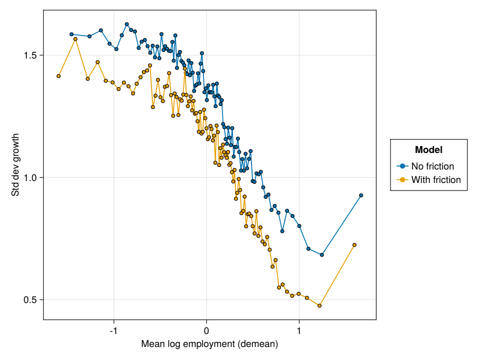
- Firm b in industry ω

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

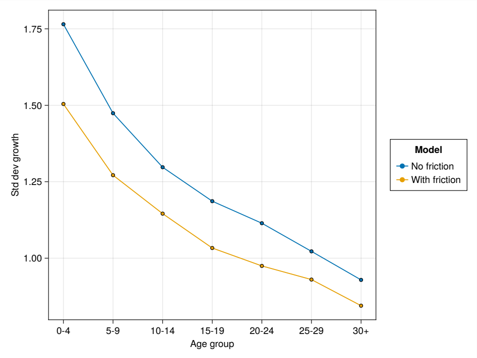
- Calibrate to Indian data on 5-digit industries
- Some industries ω produce relationship specific goods
  - Less efficient courts $\Rightarrow$ lower arrival rate κ for relationship-specific inputs

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)	0.37	Mean rel. survival prob.	0.69 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	$\beta + 1$		

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



(c) Volatility by Size

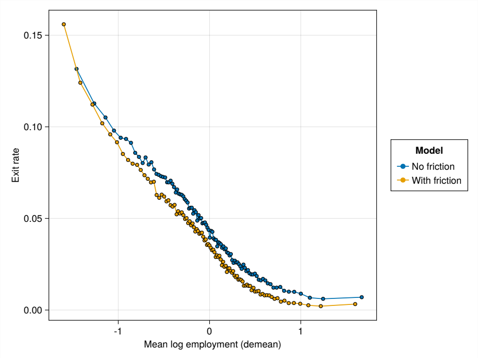


(d) Volatility by Age

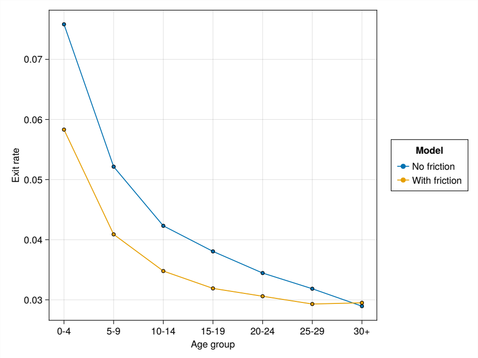
Lower arrival rate of shocks ⇒ lower variance of growth rates

Empirical evidence: $sd(\Delta logSales_{it})$ table in the beginning

Exit Rates: Frictions vs No Frictions (Model)



(e) Exit Rates By Size

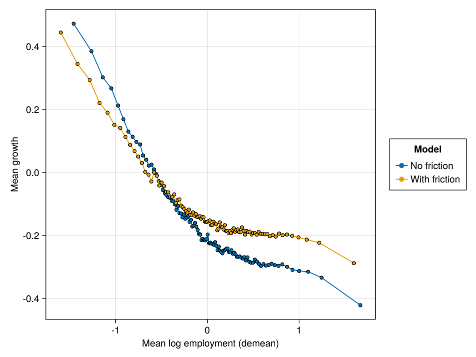


(f) Exit Rates by Age

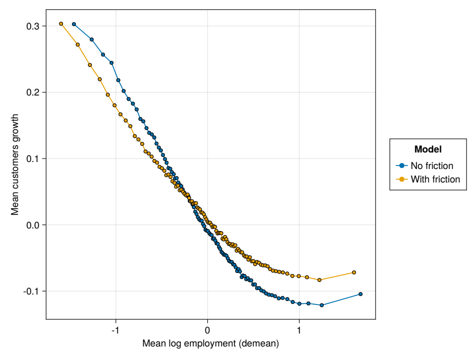
Lower arrival rate of shocks ⇒ lower probability of losing last customer

Empirical evidence: exit rates table in the beginning

Mean Reversion: Frictions vs No Frictions (Model)



(g) Sales



(h) 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

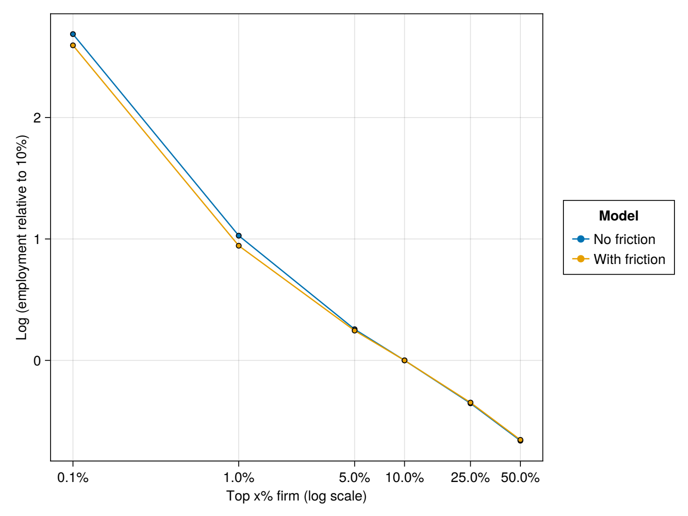
	Dependent variable: Change in log Sales					
	(1)	(2)	(3)	(4)	(5)	(6)
$\log \text{Sales}_{t-1}$	-0.403**	-0.427**	-0.555**	-0.403**	-0.436**	-0.583**
	(0.011)	(0.025)	(0.037)	(0.012)	(0.028)	(0.038)
$\log \text{Sales}_{t-1} \times$ Age civ. cases $\times$ relspec	0.00709^{+}	0.0206*	0.0249^{+}	0.00687	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

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

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

Similar with Pakistan data Pakistan

Counterfactual: reduce contracting frictions (note: preliminary!)

Reducing average age of pending court cases by 1 year

$\Rightarrow$ 0.3 years longer relationships on average (for rel-spec. industries)

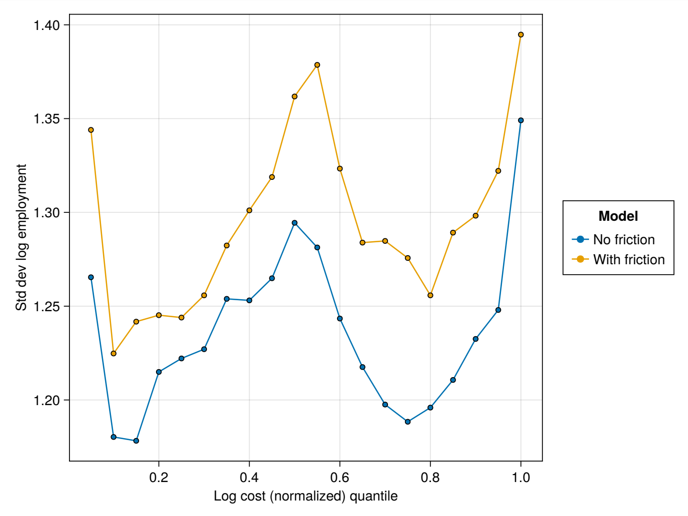
Counterfactual: change arrival rate of new suppliers κ (or ϕ) accordingly, to move from average age of pending cases of 4 years to 1 year

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!

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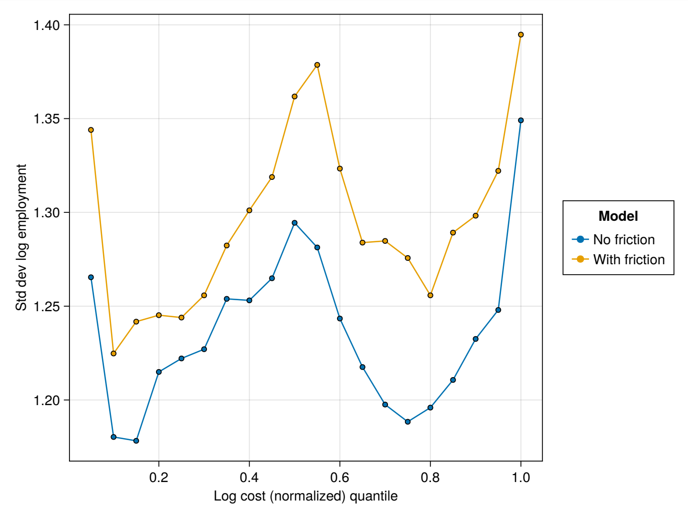
Implications for Aggregate Productivity

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

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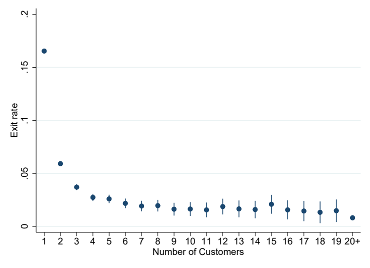

	Dependent variable: P(exit)			
	(1)	(2)	(3)	(4)
Constant	0.0878**	0.0879**	0.0878**	0.0879**
	(0.00039)	(0.00038)	(0.00038)	(0.00038)
Fixed Effects	Year	Year, #Buyers	Year, Sales vingtiles	Year, #Buyers, Sales vingtiles
R^2	0.0293	0.0889	0.0976	0.112
Observations	501828	501431	501828	501431

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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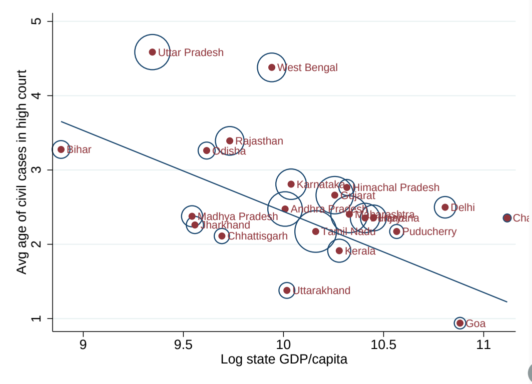
Slow Courts

- 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)
$\log \text{Sales}_{t-1}$	-0.310**	-0.347**	-0.359**
	(0.0053)	(0.018)	(0.022)
$\log \text{Sales}_{t-1} \times$ Age civ. cases $\times$ rel.spec.		0.0191*	0.0216*
		(0.0082)	(0.0095)
Firm $\times$ 4-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	0.368	0.370	0.432
Observations	214380	164552	154912

Standard errors clustered at the district $\times$ industry level. Conditions on $|\Delta \log \text{Sales}| < 1$.

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Skewness of Size Distribution: Pakistan

	Dependent variable: Skewness of log Sales		
	(1)	(2)	(3)
Avg age of civil cases × Rel. spec.	-1.627*	-2.347**	-2.603*
	(0.795)	(0.798)	(1.240)
District FE	Yes	Yes	Yes
4-digit Industry FE	Yes	Yes	Yes
Statistic	25-75	25-90	50-90
R^2	0.540	0.623	0.546
Observations	854	653	653

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

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

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

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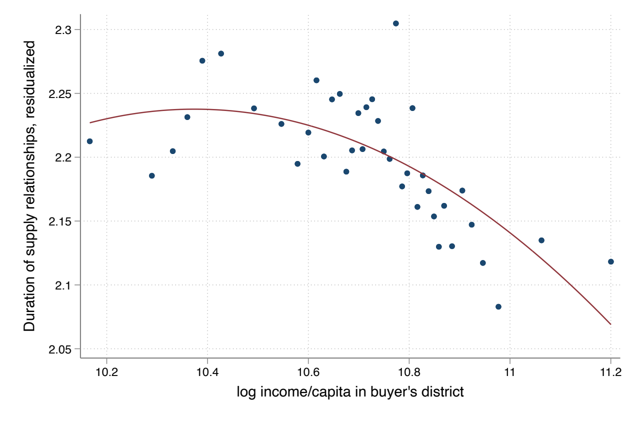
Motivation: Dynamism and Development

Richer districts (Pakistan) on average have *shorter* firm-to-firm relationships

- y-axis: duration of firms' relationships with supplier
- x-axis: log district income/capita from Pakistan LFS

Regression conditions on industry pair fixed effects



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Notes on Pakistan

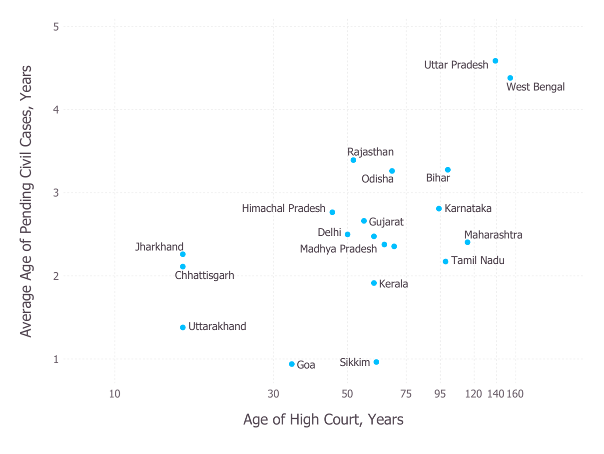
- 7 states, almost all economic activity is in two states, Sindh and Punjab
- All of our data is in district courts
- VAT data: Size threshold: varies across years. 2-3k per year - 15k per year
- Can still register for VAT
- Small firms effectively face sales tax
- Some sectors (notably agriculture, 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

$\Rightarrow$ backlogs have accumulated over time

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



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Aggregate Output along BGP

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

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

back

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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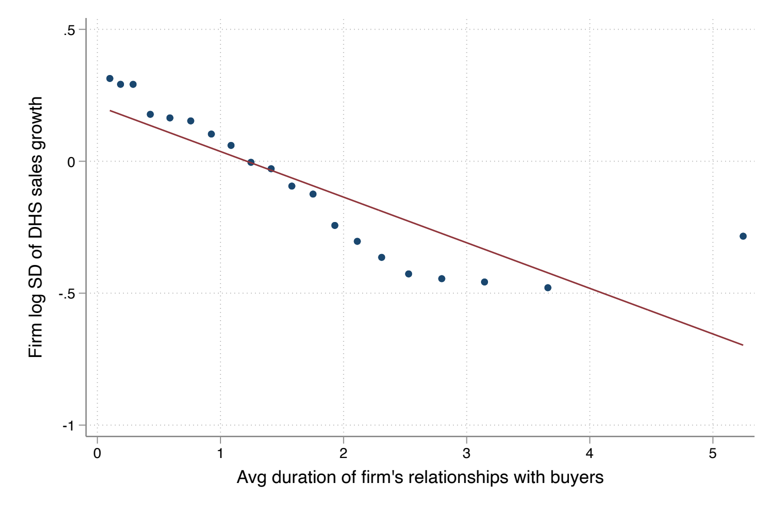
Firm volatility is lower when buyer-seller relationships last longer



Data from Pakistan. Back

Contracting frictions

Approach: Contracting frictions in output market present when:

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

Standardized vs. Relationship-specific (Rauch)

- Standardized $\approx$ sold on an organized exchange, ref. price in trade pub.
- Relationship-specific $\approx$ everything else
- India: $\sim$ 70% of sales are rel-spec
- Pakistan: $\sim$ 60% of sales is rel-spec

Contract enforcement quality: Average age of pending cases

- India: High courts. Range of avg age: 1-4.5 years.
  IV: age of court (Boehm-Oberfield 2020) story
- Pakistan: District courts. Range: 1-3 years

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Higher-order sales growth decomposition

Table 1: Sales growth decomposition

	Contribution of extensive margin changes to firm sales volatility, by time aggregation								
	Quarterly			Annual			Biennial		
Order	All	Small	Large	All	Small	Large	All	Small	Large
0	0.744	0.752	0.731	0.792	0.813	0.734	0.832	0.858	0.788
1	0.741	0.748	0.73	0.79	0.814	0.731	0.839	0.867	0.794
2	0.736	0.745	0.725	0.787	0.813	0.725	0.842	0.871	0.796

Table shows coefficient in regression of EXT^k on g, where:

$$g_i = \frac{\text{Sales}_{i,t+1} - \text{Sales}_{i,t}}{(\text{Sales}_{i,t+1} + \text{Sales}_{i,t})/2}$$

$$EXT_i^0 = \frac{\sum_{\text{J} \in B_{i,t+1}^{\text{new}}} \text{Sales}_{i,t+1} - \sum_{\text{J} \in B_{i,t}^{\text{old}}} \text{Sales}_{i,t}}{(\text{Sales}_{i,t+1} + \text{Sales}_{i,t})/2}, \qquad EXT^{k+1} = \sum_{n=0}^{k} \Omega^n EXT^0$$

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Assumptions

Players. Buyer and supplier, discrete time, discount factor e^{-r}. CES demand ($\varepsilon > 1$), Cobb-Douglas production (input share α). Supplier cost c follows random walk.

Per-period payoffs (proportional to $Dc^{1-\varepsilon}$). Supplier chooses $\delta \in \{0, 1\}$ (observed).

- $\delta = 0$: buyer earns $\frac{1-\alpha}{\varepsilon}$, supplier earns $\pi_H = \frac{\alpha}{\varepsilon}$.
- $\delta = 1$: cost falls by η, product fails with prob. ξ. Court awards damages discounted by $(1 - \mathfrak{q})$. Supplier earns $\pi_L = \pi_H + \Delta$.

One-period temptation: $\Delta \equiv \alpha\eta\frac{\varepsilon-1}{\varepsilon} - \xi(1 - \mathfrak{q}) > 0$ (assumed).

Search. Better supplier arrives with prob. $1 - e^{-\phi}$, $\phi \in [0, \bar{\phi}]$. Cost improvement Pareto(β), so $\Omega \equiv E[x^{\varepsilon-1}] = \frac{\beta}{\beta-(\varepsilon-1)} > 1$.

Relational contract. On path: $\delta = 0$, $\phi = \phi^*$. Grim trigger: deviation $\rightarrow$ Nash ($\delta = 1$, $\phi = \bar{\phi}$) forever. New matches start in cooperation.

Equilibrium and IC constraint

Define $\rho \equiv e^{-r} E[(c'/c)^{1-\varepsilon}]$ (adjustment for effective discount factor).

Supplier value functions (normalized: $V(c) = v \cdot Dc^{1-\varepsilon}$):

$$v_S^{RC} = \frac{\pi_H}{1 - \rho\, e^{-\phi^*}} \qquad\qquad v_S^{N} = \frac{\pi_H + \Delta}{1 - \rho\, e^{-\bar{\phi}}}$$

Supplier IC. Deviation: earn $\pi_H + \Delta$ for one period, then Nash forever.

$$\underbrace{\rho\, e^{-\phi^*}}_{\substack{\text{eff. discount} \\ \times \text{ survival}}} \cdot \underbrace{\left(v_S^{RC} - v_S^{N}\right)}_{\text{value of cooperation}} \geq \underbrace{\Delta}_{\substack{\text{one-period} \\ \text{temptation}}}$$

Buyer value: $v_B^{RC} = \dfrac{\frac{1-\alpha}{\varepsilon}}{1 - \rho[e^{-\phi^*} + (1 - e^{-\phi^*})\Omega]}$, increasing in ϕ^* $\Rightarrow$ supplier IC binds.

Comparative Statics and Intuition

Formal result. At the binding IC, $da/d\Delta > 0$, so ϕ^* is *decreasing* in Δ:

$$\frac{da}{d\Delta} = \frac{(1-b)\,\pi_H/\pi_L}{(2a-b)\,\pi_L} > 0$$

Comparative statics (all operate through $\Delta = \alpha\eta\frac{\varepsilon-1}{\varepsilon} - \xi(1-\mathfrak{q})$).

- Higher $\mathfrak{q}$ (court delay) $\rightarrow \Delta\uparrow$ (weaker penalty) $\rightarrow$ IC tighter $\rightarrow \phi^*\downarrow$.
- Higher η (cost saving from cheating) $\rightarrow \Delta\uparrow \rightarrow \phi^*\downarrow$.
- Higher ξ (detection prob.) $\rightarrow \Delta\downarrow$ (stronger penalty) $\rightarrow \phi^*\uparrow$.
- $\Delta \rightarrow 0$: $\phi^* \rightarrow \bar{\phi}$ (no friction needed).

Intuition. Buyer sacrifices search speed ($\phi^* < \bar{\phi}$) in exchange for zero-defect inputs. Lower ϕ^* lengthens the relationship, raising v_S^{RC} until cooperation dominates deviation. Court delay $\mathfrak{q}$ weakens formal enforcement, widening the residual temptation Δ that the relational contract must deter $\Rightarrow$ stickier relationships.

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