Unreliable Firms: Evidence from Rwanda

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Reliability as a firm characteristic

- Enormous measured productivity differences across firms, esp. in developing world (Hsieh and Klenow 2009)

- Many dimensions: cost, quality, reliability
  - Bad management, transport delays, electricity blackouts, broken contracts all inhibit fulfillment of orders
  - Increasingly relevant in era of global supply chains
  - Hard to observe

$\rightarrow$ This paper: measure reliability in a developing country (Rwanda) and understand role in firm performance

Project goals

1. Measure reliability using Rwandan firm-to-firm transactions
2. Identify characteristics of reliable firms
3. Document linkages: reliable firms trade with each other
4. Show entry of multinationals (MNCs) may increase reliability
5. Rationalize patterns using stylized model

Measuring reliability

- **Data:** universe of VAT transactions between formal Rwandan firms for 2015-17
  - Machine-recorded: seller, buyer, value, *timing (exact date)* by transaction
  - From tax filings: industry, corporate accounts, import/export history, foreign ownership, location by firm

- **Metric of (un)reliability:** coefficient of variation (CV) of time between consecutive shipments

  If supplier i and buyer j transact on dates $\{d_{ij}^1, d_{ij}^2, ...d_{ij}^n\}$:

$$Diff_{ij} = \{d_{ij}^2 - d_{ij}^1, d_{ij}^3 - d_{ij}^2, ...d_{ij}^n - d_{ij}^{n-1}\}$$

$$CV_{ij} = \frac{\sqrt{Var(Diff_{ij})}}{\mathbb{E}[Diff_{ij}]}$$

Intuition for reliability metric

$$CV_{ij} = \frac{\sqrt{Var(Diff_{ij})}}{\mathbb{E}[Diff_{ij}]}$$

- A supplier i that sells every Monday to its buyer j is perfectly reliable ($CV_{ij} = 0$)
- Missing some week, or selling with a delay, increases the CV
- Technically this is 'regularity', with reliability interpretation if firms want regular input supply

▸ Summary statistics

Characteristics of reliable firms: regression

For supplier i in sector $s(i)$ and buyer j, we estimate:

$$CV_{ij} = \beta X_i + \gamma_{s(i)} + \delta_j + \epsilon_{ij} \tag{1}$$

where:

- CV is computed over all transactions from 1/2015 to 12/2017
- X are seller characteristics: firm size, MNC and exporter status, and supplier status
- γ accounts for sectoral transaction patterns (ex: monthly power bills)
- δ is a unique buyer FE capturing any *demand-side* variation in CV

'Good' firms are more reliable

Dependent Variable:	CV of Time Between Shipments			
Model:	(1)	(2)	(3)	(4)
Variables				
Log Formal Sales	-0.010***			-0.008***
	(0.002)			(0.002)
Exporter		-0.037***		-0.033***
		(0.006)		(0.006)
MNC			-0.043***	-0.029**
			(0.011)	(0.012)
Log Informal Sales Control	Yes	Yes	Yes	Yes
Fixed-effects				
Buyer ID	Yes	Yes	Yes	Yes
Seller Industry	Yes	Yes	Yes	Yes
Transaction Count	Yes	Yes	Yes	Yes
Fit statistics				
Observations	73,295	73,295	73,295	73,295
R^2	0.29258	0.29281	0.29246	0.29306
Within R^2	0.00176	0.00209	0.00159	0.00243

One-way (Buyer ID) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

▸ Seller Ind x Buyer ID FE ▸ Food wholesalers only

Linked reliability across firms

Are firms 'near' good firms in the trading network also reliable?

- Suggestive of complementarities
- A few bad firms can constrain development, as in an O-Ring model (Kremer 1993)

Two ways to test:

- **Transparent:** check reliability of direct suppliers to MNCs and exporters

$$CV_{ij} = \beta X_i + \gamma_{s(i)} + \delta_j + \epsilon_{ij} \tag{2}$$

- **Nonparametric:** estimate reliability fixed effect, examine sorting

$$CV_{ij} = \alpha_i + \eta_{s(i)s(j)} + \delta_j + \epsilon_{ij} \tag{3}$$

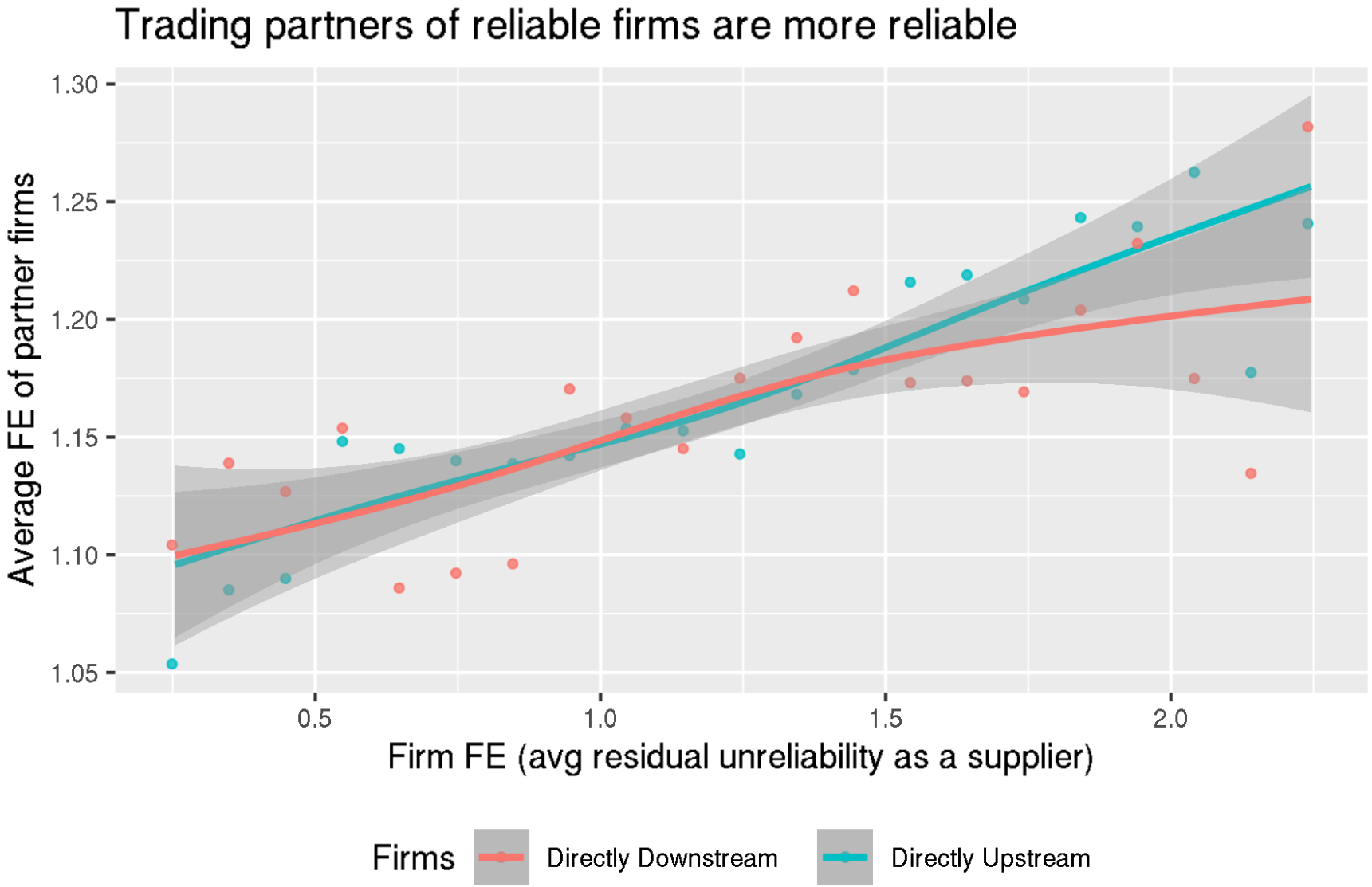
Firms that sell to MNCs/exporters are more reliable

Dependent Variable:	CV of Time Between Shipments		
	All buyers		
Model:	(1)	(2)	(3)
Variables			
MNC Sales Share	-0.231***		-0.125***
	(0.041)		(0.046)
Exporter Sales Share		-0.152***	-0.122***
		(0.021)	(0.024)
Log Informal Sales Control	Yes	Yes	Yes
Fixed-effects			
Buyer ID	Yes	Yes	Yes
Seller Industry	Yes	Yes	Yes
Transaction Count	Yes	Yes	Yes
Fit statistics			
Observations	69,732	69,732	69,732
R^2	0.29992	0.30012	0.30020
Within R^2	0.00202	0.00230	0.00242

One-way (Buyer ID) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

▸ Supplier Ind x Buyer ID FE ▸ Food wholesalers only

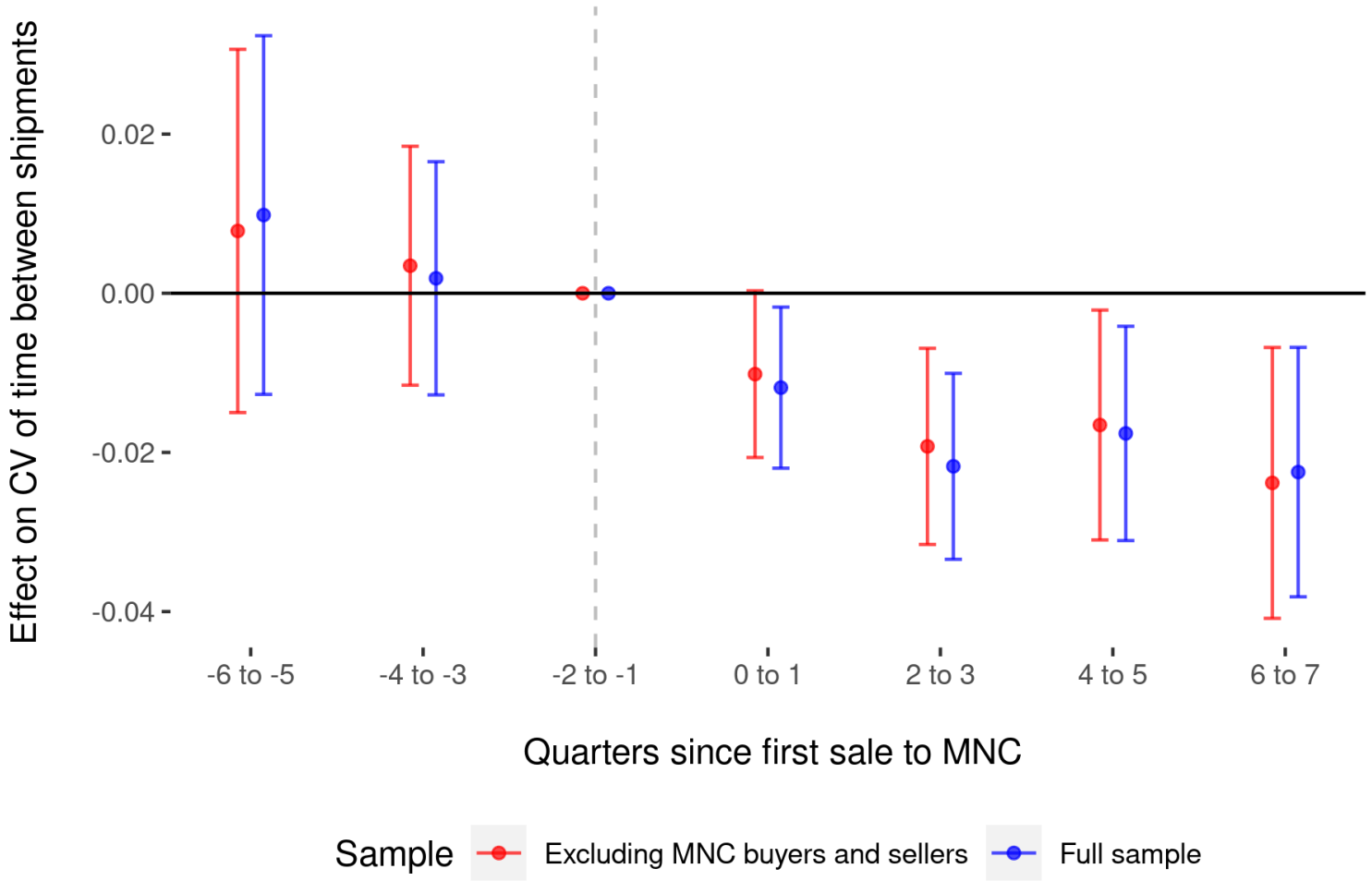
Reliable firms have reliable suppliers (AKM)



$$CV_{ij} = \alpha_i + \eta_{s(i)s(j)} + \delta_j + \epsilon_{ij} \quad (4)$$

First-time suppliers to MNCs improve reliability in *existing* relationships

$$CV_{ijt} = \beta SuppliesMNC_{it} + \gamma_{ij} + \delta_{jt} + \epsilon_{ijt} \quad (5)$$



Model with complementarities can rationalize patterns

Suppose a firm chooses reliability r (which earns p_r per unit) and picks a supplier with level s (at cost p_s per unit).

$$\pi = \max_{r,s} p_r r - c(r,s) - p_s s \tag{6}$$

If $c(r,s)$ has *decreasing differences* then:

- Higher $p_r \rightarrow$ higher $r \rightarrow$ higher s
- Lower $p_s \rightarrow$ higher $s \rightarrow$ higher r

Intuition: to rationalize sorting, a better supplier s must reduce the *marginal* cost of additional $r' > r$:

Devt implications:

- Downstream cannot take advantage of 'reliability premia' in global supply chains without reliable upstream suppliers
- More reliable transport or electricity upstream will change production processes downstream

Recap and next steps

- We construct metric of supplier reliability based on transaction timing for universe of Rwandan formal firms
- 'Good firms' on many dimensions are more reliable, as are their suppliers. Suggestive of complementarities.
- Next steps:
  - Examine responses to common shocks (power outages, transport improvements)
  - Quantify aggregate productivity implications for Rwanda in a model

Thank you!

Summary statistics

Table: Summary Statistics by Seller (s) x Buyer (b) pair

Statistic	N	Mean	St. Dev.	Min	Max
Total Transactions from 2015-17 (s to b)	252,359	16.491	38.104	3	971
Total Value (s to b, bn Rwf)	252,359	0.027	1.886	0.000	884.174
CV of Time Between Shipments (s to b)	252,359	1.006	0.538	0.000	10.541
Total Sales (s, bn Rwf)	252,359	164.076	6,403.156	0.0002	356,965.600
Total Sales to Formal Firms (s, bn Rwf)	252,359	5.027	23.060	0.00000	884.991
Firm Age (s, years)	252,359	6.088	3.435	0.049	16.011
=1 if MNC (s)	252,359	0.068	0.251	0	1
Share of (s) Sales to MNCs	252,359	0.031	0.078	0.000	1.000
=1 if Importer (s)	252,359	0.739	0.439	0	1
=1 if Exporter (s)	252,359	0.255	0.436	0	1
Share of (s) sales to exporters	252,359	0.071	0.111	0.000	1.000

Notes: Unit of observation is buyer x seller pair. Sample consists of all VAT transactions in Rwanda from 2015-17. CV is the coefficient of variation (SD/mean) of the time between consecutive shipments within a buyer x seller pair. Formal firms are other firms in the sample.

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'Good' firms are more reliable (restrictive FE)

Dependent Variable:	CV of Time Between Shipments			
Model:	(1)	(2)	(3)	(4)
Variables				
Log Formal Sales	-0.012***			-0.009***
	(0.003)			(0.003)
Exporter		-0.056***		-0.050***
		(0.007)		(0.007)
MNC			-0.058***	-0.033**
			(0.015)	(0.015)
Log Informal Sales Control	Yes	Yes	Yes	Yes
Fixed-effects				
Seller Ind x Buyer ID	Yes	Yes	Yes	Yes
Transaction Count	Yes	Yes	Yes	Yes
Fit statistics				
Observations	76,769	76,769	76,769	76,769
R^2	0.69570	0.69607	0.69566	0.69624
Within R^2	0.00207	0.00330	0.00193	0.00383

One-way (Seller Ind x Buyer ID) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

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'Good' firms are more reliable (food only)

Dependent Variable:	CV of Time Between Shipments			
Model:	(1)	(2)	(3)	(4)
Variables				
Log Formal Sales	-0.027**			-0.026**
	(0.011)			(0.011)
Exporter		-0.083***		-0.082***
		(0.025)		(0.025)
MNC			0.078	0.015
			(0.081)	(0.084)
Log Informal Sales Control	Yes	Yes	Yes	Yes
Fixed-effects				
Buyer ID	Yes	Yes	Yes	Yes
Seller Industry	Yes	Yes	Yes	Yes
Transaction Count	Yes	Yes	Yes	Yes
Fit statistics				
Observations	5,593	5,593	5,593	5,593
R^2	0.63854	0.63893	0.63786	0.63967
Within R^2	0.01305	0.01412	0.01121	0.01614

One-way (Buyer ID) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

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CV vs. sales to MNCs/exporters (restrictive FE)

Dependent Variable:	CV of Time Between Shipments		
	All buyers		
Model:	(1)	(2)	(3)
Variables			
MNC Sales Share	-0.428***		-0.325***
	(0.056)		(0.063)
Exporter Sales Share		-0.193***	-0.120***
		(0.030)	(0.034)
Log Informal Sales Control	Yes	Yes	Yes
Fixed-effects			
Seller Ind x Buyer ID	Yes	Yes	Yes
Transaction Count	Yes	Yes	Yes
Fit statistics			
Observations	73,123	73,123	73,123
R^2	0.70440	0.70428	0.70453
Within R^2	0.00365	0.00325	0.00409

One-way (Seller Ind x Buyer ID) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

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CV vs. sales to MNCs/exporters (food only)

Dependent Variable:	CV of Time Between Shipments		
	All buyers		
Model:	(1)	(2)	(3)
Variables			
MNC Sales Share	-1.04***		-0.922**
	(0.355)		(0.395)
Exporter Sales Share		-0.356**	-0.114
		(0.179)	(0.208)
Log Informal Sales Control	Yes	Yes	Yes
Fixed-effects			
Buyer ID	Yes	Yes	Yes
Seller Industry	Yes	Yes	Yes
Transaction Count	Yes	Yes	Yes
Fit statistics			
Observations	5,487	5,487	5,487
R^2	0.64520	0.64450	0.64524
Within R^2	0.01406	0.01214	0.01418

One-way (Buyer ID) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*