The Globalization of Farmland: Theory and Empirical Evidence

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Overview

Outline

Introduction

- Booming interest in the direct acquisition of farmland in land-abundant developing countries post 2007-2008.
  - agricultural trade from $200 billion to almost $1100 billion between 1980-2010.
- Polarized debate between those who see land acquisitions as a means to increase yields and alleviate poverty, and those who see it as a 'land grab' (Financial Times, 2016 and Bloomberg, 2017).
  - Acquisitions have often involved multinational companies (profits?) and foreign governments (food independence?)
- This paper: are land acquisitions a type of platform FDI? or are they motivated by food-independence?
  - Theory: model that encapsulates technology, endowments and geography as push and pull factors.
  - Empirics: explaining land acquisitions between 2000-2016.

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model basics

- The world consists of N countries, $i = 1...N$. Each country i produces an agricultural good (A) and a manufactured good (M) using labor (L) and land (T).
- Factors of production are available in quantities L_i and T_i
  - Labor used in both sectors, land only for agricultural goods.
- Agricultural (and manufacturing) goods differentiated by country of origin a la Armington (1969).
  - different crop (varieties) due to country-specific climatic/soil conditions as in Costinot et al. (2014)
- Constant return to scale Cobb-Douglas production functions and perfect competition in all markets.

model basics & Production

1. Producers from country i can produce a variety in country l (*multinational production*).
   - agricultural technology as a vector of TFP terms, $Z_i \equiv \{Z_{li}, l = 1...N\}$.
   - The unit cost of (multinational) agricultural production

$$c_{li}^{A} = \frac{(w_l)^{\alpha}(f_l)^{1-\alpha}}{Z_{li}}$$

   -*vertical* motive (low local wages w_l and land prices f_l).
   -*horizontal* motive (save on iceberg trade costs, $t_{nl} > 1$).
2. Agricultural varieties also differentiated by investor country i (double Armington layer).

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Preferences and consumption

- Cobb-Douglas utility for representative consumer in country n:

$$u_n = \left(Q_n^A\right)^{\gamma} \left(Q_n^M\right)^{1-\gamma} \tag{1}$$

- Aggregate consumption Q_n^A (and Q_n^M) as CES aggregates over N differentiated varieties:

$$Q_n^A = \left(\sum_{l=1}^{N} \left(q_{nl}^A\right)^{\frac{\varepsilon_A - 1}{\varepsilon_A}}\right)^{\frac{\varepsilon_A}{\varepsilon_A - 1}}, \ \varepsilon_A > 1 \tag{2}$$

- Consumption/import q_{nl}^A as a CES aggregate over the N number of discrete varieties from different investor countries:

$$q_{nl}^A = \left(\sum_{i=1}^{N} \left(q_{nli}^A\right)^{\frac{\sigma - 1}{\sigma}}\right)^{\frac{\sigma}{\sigma - 1}}, \ \sigma > 1 \tag{3}$$

Demand for agricultural goods

- Country n consumption of the variety produced in country l by an investors from country i, is:

$$X_{nli}^{A} = \left(\frac{c_{li}^{A}}{p_{l}^{A}}\right)^{1-\sigma} \left(\frac{t_{nl} p_{l}^{A}}{P_{n}^{A}}\right)^{1-\varepsilon_{A}} \gamma I_{n} \tag{4}$$

with

$$p_{l}^{A} \equiv \left(\sum_{j=1}^{N} \left(c_{lj}^{A}\right)^{1-\sigma}\right) \tag{5}$$

$$c_{li}^{A} = \frac{(w_{l})^{\alpha}(f_{l})^{1-\alpha}}{Z_{li}} \tag{6}$$

- and where $I_{n} = w_{n} L_{n} + f_{n} T_{n}^{A}$ is national income.

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Trade flows and nominal output

- Sector revenues $V_l^A \equiv \sum_{n=1}^{N} X_{nl}^A = \sum_{n=1}^{N} \left(\sum_{i=1}^{N} X_{nli}^A \right)$ in country l from summing over all importers n,

$$V_l^A = (p_l^A \Omega_l^A)^{1-\varepsilon_A} V^A \tag{7}$$

where $V^A \equiv \sum_{l=1}^{N} V_l^A$.

- The term Ω_l^A measures remoteness from agricultural importers,

$$\Omega_l^A \equiv \left[\sum_{n=1}^{n=N} \left(\frac{t_{nl}}{P_n^A} \right)^{1-\varepsilon_A} \frac{\gamma I_n}{V^A} \right]^{1/(1-\varepsilon_A)} \tag{8}$$

Market equilibrium and trade balance

- Excess demand system $G(w, T_I^A)$:

$$G_I^L(w, T_I^A) = \frac{\alpha}{w_I}\left(p_I^A \Omega_I^A\right)^{1-\varepsilon_A} V^A + \frac{1}{w_I}(p_I^M \Omega_I^M)^{1-\varepsilon_M} V^M - L_I \quad (9)$$

$$G_I^T(w, T_I^A) = \frac{1-\alpha}{T_I^A}\left(p_I^A \Omega_I^A\right)^{1-\varepsilon_A} V^A - f_I \quad (10)$$

- Balanced trade (BT) condition results from adding up excess demand equations:

$$I_I = \left(p_I^A \Omega_I^A\right)^{1-\varepsilon_A} V^A + \left(p_I^M \Omega_I^M\right)^{1-\varepsilon_M} V^M \quad (11)$$

Equilibrium definition and existence

Definition 1.

An equilibrium is a vector $\langle w, T^A \rangle \in \mathbb{R}^{2n}_{++}$ such that $G_l^L = 0$ and $G_l^T = 0$ for $l = 1, ..., N$.

Proposition 1.

There is at least one vector of wages and quantities of agricultural land, $\langle w, T^A \rangle \in \mathbb{R}^{2n}_{++}$, *such that the markets for agricultural land and labour clear in every country,* $G = 0$.

Proof.

See Appendix A.

Demand for land under Platform FDI

Land demanded by agricultural investor i in country l,

$$T_{li}^{A} = \frac{(1-\alpha)X_{li}^{A}}{f_l} = \frac{(1-\alpha)\left(c_{li}^{A}\Omega_l^{A}\right)^{1-\varepsilon_A} V^{A}}{f_l} \tag{12}$$

where Ω_l^A measures remoteness from agricultural importers,

$$\Omega_l^{A} \equiv \left[\sum_{n=1}^{n=N}\left(\frac{t_{nl}}{P_n^{A}}\right)^{1-\varepsilon_A}\frac{\gamma I_n}{V^{A}}\right]^{1/(1-\varepsilon_A)} \tag{13}$$

Proposition 2.

Under the platform FDI motive, the quantity of land leased by investor-country i in host-country l is decreasing in host-country remoteness from agricultural consumer markets Ω_l^A, decreasing in the return to labor w_l and land price f_l in host-country l (via c_{li}^A), and increasing in the agricultural productivity of the investor-country, Z_{li} (via c_{li}^A).

Demand for land under Food Independence

- A1. $\sigma \to \infty$.
- A2. Each country holds absolute advantage in supplying its home market.
- Land demanded by agricultural investor n in country l,

$$T_{ln}^{A} = \left(\frac{\frac{t_{nl}^{A}}{Z_{ln}}}{\widetilde{\Omega_{l}^{A}} \widetilde{P_{n}^{A}}} \right)^{1-\varepsilon_{A}} \frac{\gamma I_{n} T_{l}^{A}}{V^{A}}$$

where $\widetilde{\Omega_{l}^{A}}$ and $\widetilde{P_{n}^{A}}$ measures investor-country and host-country remoteness from agricultural producers and consumers respectively.

Proposition 3.

Under the food independence motive, the quantity of land leased is increasing in host-country remoteness Ω_{l}^{A}, investor-country remoteness $\widetilde{P_{n}^{A}}$, agricultural productivity of the investor-country Z_{ln}, expenditures on agricultural goods γI_{n}, agricultural land T_{l}^{A}, and decreasing in bilateral trade costs t_{nl}^{A}.

Outline

Bilateral specification

- Based on our model of trade and land acquisitions, the following specification is put forward:

$$T_{li}^{A} = \gamma_0 + \gamma_1 ln(t_{li}) + \gamma_2 ln(T_l) + \gamma_3 ln(w_l) + \gamma_4 ln(q_l)$$

$$+\gamma_5 ln(Z_i) + \gamma_6 ln(I_i) + \gamma_7 ln(\Omega_l^A) + \gamma_8 ln(\widetilde{P_i^A}) + \varepsilon_{li}$$

- Hypothesis. food-independence vs. platform FDI.
  - H1. Endowments, technology and institutions: $\gamma_2, \gamma_3 > 0$, $\gamma_4 < 0$.
  - H2. Food independence vs. platform FDI: $\gamma_7, \gamma_8 > 0$ vs. $\gamma_7 < 0, \gamma_8 = 0$

Estimation

- Poisson Pseudo-Maximum Likelihood as the new gravity standard (see Silva and Tenreyro 2006).
- How to deal with multilateral resistance terms ("remoteness"):
  - linear approximations a la Baier and Bergstrand (2009), $\Omega_l^A = \prod_{n=1}^{N} t_{nl}^{\theta_n}$ with $\theta_n \equiv I_n / \sum I_j$.
  - instrumented (agricultural) trade a la Frankel and Romer (1999), $\log\left(\sum_{n=1, n\neq l}^{n=N} \hat{X}_{nl}^{A}\right)$
  - Obtain bilateral trade cost estimates from observed agricultural trade flows.

Estimation

- Obtain estimates of bilateral fixed effects for agricultural trade 1995-2005 a la Anderson and Yotov (2016) and Anderson et al. (2015):

stage 1.

$$X^A_{nl,t} = exp\left[\pi_{l,t} + \chi_{n,t} + \mu_{nl} + \beta_1 RTA_{ij,t}\right] \times \varepsilon_{nl,t}$$

stage 2.

$$exp\left[\hat{\mu}_{nl}\right] = exp\left[\pi_l + \chi_n + \eta_1 lnDIST_{nl} + \eta_2 CONTIG_{nl} + \eta_1 COMLANG_{nl} + \eta_1 COL_{nl}\right] \times \varepsilon_r$$

stage 3.

$$\hat{t}^{1-\sigma}_{nl} = exp\left[\hat{\pi}_l + \hat{\chi}_n + \hat{\eta}_1 lnDIST_{nl} + \hat{\eta}_2 CONTIG_{nl} + \hat{\eta}_1 COMLANG_{nl} + \hat{\eta}_1 COL_{nl}\right]$$

- Estimates $\hat{t}^{1-\sigma}_{nl}$ and $\hat{\mu}_{nl}$ give full bilateral trade cost matrix used to construct Ω^A_l and P^A_n.

Data

- Country-level variables:
  - large-scale land acquisitions (Land Matrix), 2000-2016.
  - agricultural value added per worker, GDP per capita (World Bank WDI).
  - distance, common language etc. (CEPII GeoDist database).
  - amount of suitable land (FAO GAEZ).
  - Agricultural imports and agricultural production from CEPII TradeProd dataset.
  - RTA dummy variable from Egger and Larch (2008).
  - land tenure security index from Arezki et al. (2013).

Table 1 : Key characteristics of land projects by region (2000 - 2016).

	All	MENA	SSA	LAC	ECA	EAP	SA	NAM
Size of projects								
Host countries (#)	88	6	38	18	9	13	4	N/A
Total area (mn ha)	58.9	0.9	23.7	10.2	10.6	13.4	0.1	N/A
Projects >= 1 mn ha (#)	3	0	2	0	0	1	0	N/A
Projects >= 250k ha and < 1mn ha (#)	49	1	18	9	15	6	0	N/A
Projects >=10k ha and <250k ha (#)	675	4	284	144	54	188	1	N/A
Projects<10k ha (#)	1,425	16	580	215	97	416	101	N/A
Total # projects	2,152	21	884	368	166	611	102	N/A
Intended use (percent)								
Agriculture	62.3	96.2	59.8	55.8	89.9	65.9	13.9	N/A
Biofuels	14.2	0.0	19.3	12.3	2.1	13.0	7.0	N/A
Forestry, Industry and Other	14.3	3.8	8.5	17.1	6.3	16.7	73.0	N/A
"Green"	7.3	0.0	10.8	9.6	1.7	3.1	6.1	N/A
Unknown	1.9	0.0	1.6	5.2	0.0	1.3	0.0	N/A

Source: Land Matrix; and author's calculations.

Notes: The category 'Agriculture' groups the Land Matrix categories 'Food Crops', 'Livestock', 'Agriculture Unspecified', 'Non-food Agriculture Commodities'; 'Forestry, Industry and Other' refers to 'Wood and Fibers', 'Forest Unspecified', and 'Other'; 'Green' includes 'Carbon Sequestration/REDD', 'Conservation', 'Renewable Energy' and 'Tourism'.

World Map of Deals by Target Country

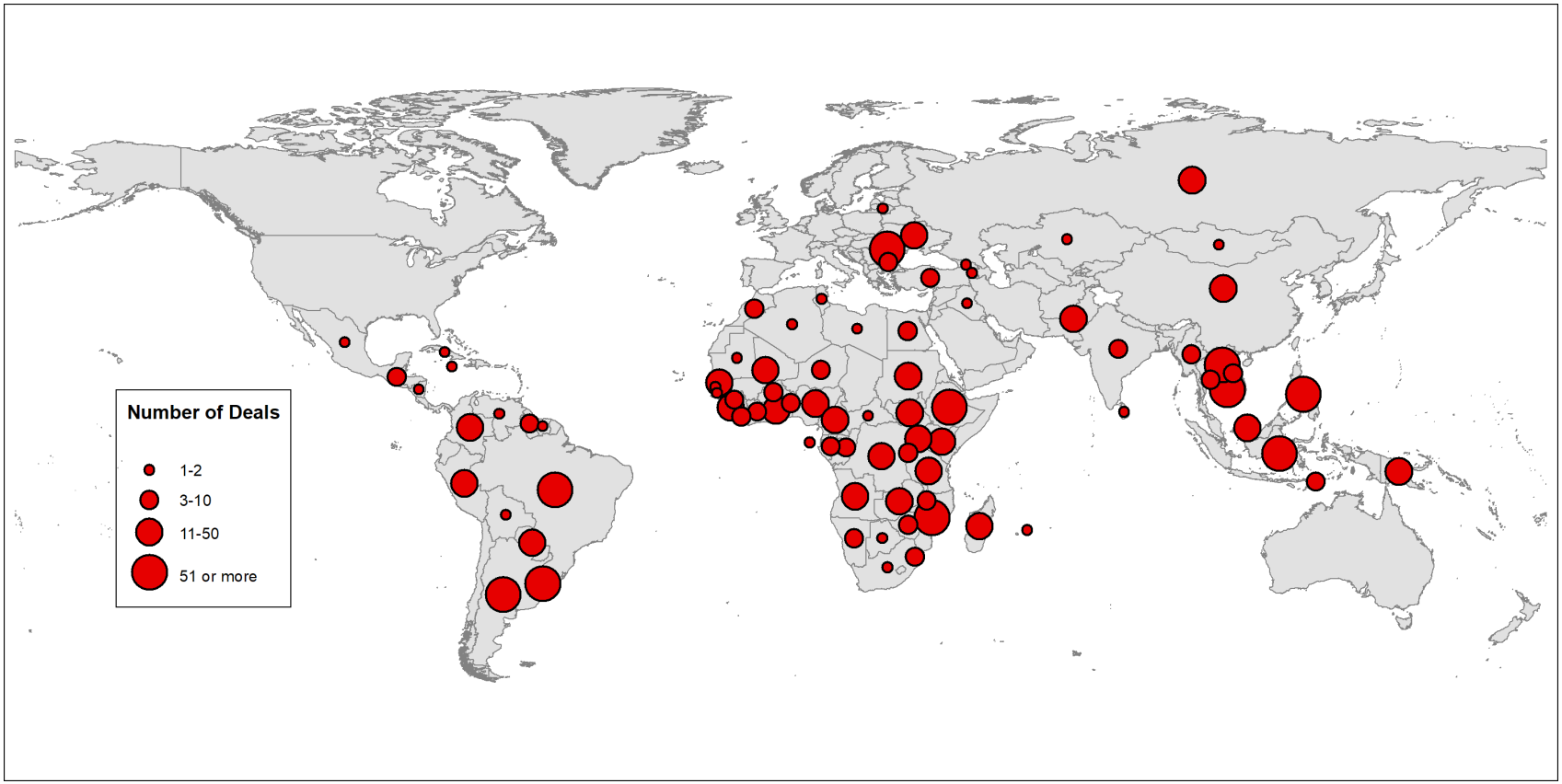

Figure 1 : Number of deals by target country

Outline

Bilateral regressions of deals by country pair

VARIABLES	(1) project_b	(2) project_b	(3) project_b	(4) project_b	(5) project_b	(6) project_b	(7) project_b
dist_1_log	-0.983***	-2.011***	-1.429***	-1.361***	-0.938***	-1.237***	-1.070***
	(0.137)	(0.164)	(0.124)	(0.144)	(0.134)	(0.144)	(0.134)
colony_b	0.686**	0.845***	0.910***	1.063***	0.939***	0.970***	0.689***
	(0.268)	(0.256)	(0.348)	(0.278)	(0.234)	(0.325)	(0.259)
agri_va_o_log	0.411***			0.521***	0.468***	0.476***	0.333***
	(0.0542)			(0.0512)	(0.0783)	(0.0548)	(0.0569)
population_o_log	0.748***			0.740***	0.751***	0.670***	0.651***
	(0.0646)			(0.0485)	(0.0694)	(0.0572)	(0.0560)
gdp_cap_log	-0.559***		-0.628***		-0.357***	-0.702***	-0.839***
	(0.106)		(0.0897)		(0.0899)	(0.0841)	(0.107)
suitable_nf_np_log	0.346***		0.472***		0.221***	0.272***	0.341***
	(0.0656)		(0.0535)		(0.0617)	(0.0456)	(0.0580
land_governance	0.00483		-0.0381		1.77e-05	-0.0258	0.0720
	(0.0734)		(0.0632)		(0.0642)	(0.0740)	(0.0711)
P_n^A (BB)					-0.158		
					(0.165)		
Ω_l^A(BB)					3.332***		
					(0.465)		
$log\left(\sum_{n=1,n\neq l}^{n=N} \hat{X}_{nl}^A\right)$						-0.382***	
						(0.138)	
$log\left(\sum_{l=1,l\neq n}^{l=N} \hat{X}_{nl}^A\right)$						-1.846***	
						(0.218)	
P_n^A (AY)							-0.829***
							(0.179)
Ω_l^A(AY)							1.997***
							(0.276)
RESET	3.143	0.0612	16.72	0.231	5.554	2.951	0.816
N	15960	15960	15960	15960	15960	15960	15960
r2_p	0.404	0.745	0.578	0.628	0.458	0.477	0.433
Investor FE		YES	YES				
Host FE		YES		YES			

Notes: the dependent variable project_b measures the number of deals concluded per investor-host country pair between 2006-2013. Estimates are obtained with the PPML estimator. Constant and fixed effects are included but not reported. Robust standard errors, clustered by country-pair, are reported in parentheses. *** p<0.01; ** p<0.05; * p<0.1

Bilateral regressions: intensive margin only

VARIABLES	(1) project_b	(2) project_b	(3) project_b	(4) project_b	(5) project_b	(6) project_b	(7) project_b
dist_1_log	-0.293**	-0.411**	-0.172	-0.438***	-0.225*	-0.347***	-0.292**
	(0.122)	(0.178)	(0.152)	(0.123)	(0.119)	(0.120)	(0.122)
colony_b	-0.188	0.159	0.00307	0.279	-0.0387	0.0357	-0.157
	(0.239)	(0.212)	(0.243)	(0.215)	(0.220)	(0.213)	(0.225)
agri_va_o_log	-0.00766			0.0172	0.0318	0.0226	-0.0593
	(0.0474)			(0.0425)	(0.0601)	(0.0474)	(0.0518)
population_o_log	0.189***			0.198***	0.224***	0.188***	0.134***
	(0.0463)			(0.0344)	(0.0524)	(0.0417)	(0.0490)
gdp_cap_log	0.0462		0.0275		0.154**	-0.0861	-0.0191
	(0.0776)		(0.0699)		(0.0765)	(0.0659)	(0.0842)
suitable_nf_np_log	0.0499		0.155***		0.0297	0.0386	0.0570
	(0.0358)		(0.0493)		(0.0315)	(0.0291)	(0.0355)
land_governance	-0.0207		0.0143		-0.0478	-0.0249	-0.00643
	(0.0536)		(0.0445)		(0.0493)	(0.0514)	(0.0551)
P_n^A (BB)					-0.0121		
					(0.130)		
Ω_l^A (BB)					1.766***		
					(0.348)		
$log\left(\Sigma_{n=1,n\neq l}^{n=N} \hat{X}_{nl}^A\right)$						-0.00914	
						(0.107)	
$log\left(\Sigma_{l=1,l\neq n}^{l=N} \hat{X}_{nl}^A\right)$						-1.191***	
						(0.182)	
P_n^A (AY)							-0.343*
							(0.177)
Ω_l^A(AY)							0.476
							(0.297)
RESET	8.204	53.21	27.73	10.48	14.05	9.391	8.766
N	409	409	409	409	409	409	409
r2_p	0.162	0.483	0.365	0.404	0.226	0.253	0.171
Investor FE		YES	YES				
Host FE		YES		YES			

Notes: the dependent variable project_b measures the number of deals concluded per investor-host country pair between 2006-2013. Estimates are obtained with the PPML estimator. Constant and fixed effects are included but not reported. Robust standard errors, clustered by country-pair, are reported in parentheses. *** p<0.01; ** p<0.05; * p<0.1

Conclusion

- Theory allows differentiation between platform FDI and food-independence motive, and shows how geography, endowments and technology drive land acquisitions.
- Empirical evidence suggests that remoteness (or "trade") was positively (negatively) related to bilateral investment: acquisitions targetted countries that until recently were characterized by limited participation in the global food trading system.
  - Consistent with our model, specifically the food independence version
  - Lends support to the notion that foreign acquisitions may hurt domestic food security.