Business Groups as Knowledge-based Hierarchies of Firms

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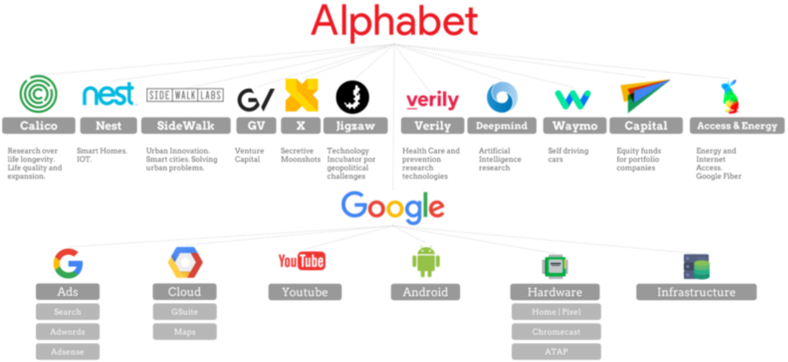
What are Business Groups ?



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- Key players of globalization: multinational enterprises are (international) business groups
- "*The economics literature has not had much to say about non-standard organizational forms [...] now much discussed in the business and organizational literatures, including joint ventures, strategic alliances, networks, business groups.*" (Baker, Gibbons and Murphy, QJE 2002)

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  - one firm organized in ≥ 2 plants: one HQ and ≥ 1 legally independent 'affiliate' (f) => BG, domestic or foreign (MNE)
- Why these different organizational forms / firm boundaries? Would a change in institutions (eg IPR) drive the choice? Is it relevant how the VI firm organizes its $d/b/f$ (eg hierarchy)?

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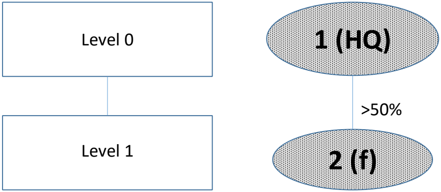
  - the average hierarchical depth of the largest MNEs is 7 levels
- BGs (either parent or affiliates in host countries) account for some 75% of US trade flows (BEA, 2012) or around 65% of French trade (Altomonte et al., 2013)

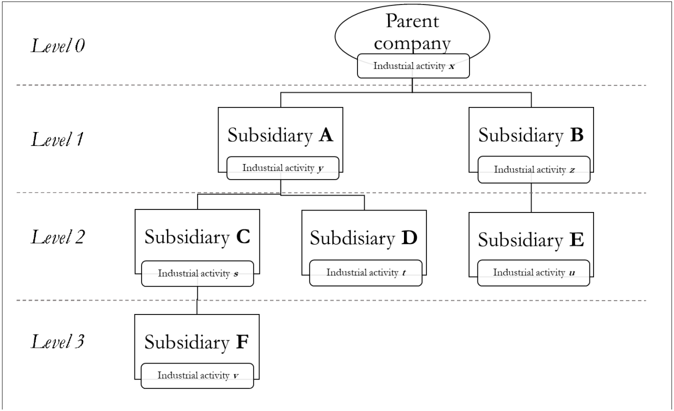
Business Groups as Hierarchies of Firms

- Business Groups (BGs) as a set of at least two *legally autonomous* firms that function as a single economic entity through a common source of *hierarchical control* via equity stakes
- The simplest (1 HQ - 1 affiliate) BG



Business Groups as Hierarchies of Firms

- A complex BG identified as a hierarchical graph through the notion of *control*



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- Empirically tests the key predictions of the model

The dataset

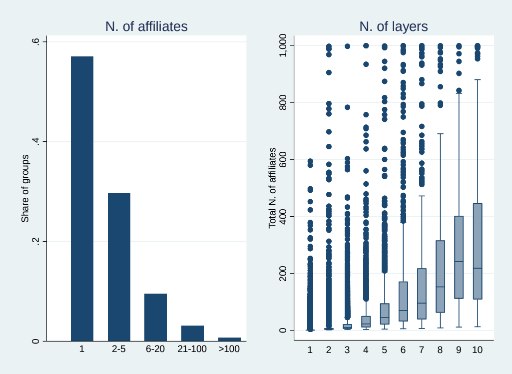
- Sample of 270,374 headquarters controlling 1,519,588 affiliates in 207 countries for the year 2010 from Orbis. OECD sample available for 178,190 HQ controlling 1,154,138 subsidiaries world wide, with no particular selection bias. Control group of independent firms for OECD sample

	Total sample	OECD sample
N. of parents	270,374	178,190
of which:		
- Multinational HQ	49,897	36,314
HQ main activity:		
- Agric. & Mining	6,840	3,467
- Manufacturing	25,718	14,634
- Services	237,816	160,089
HQ controlling:		
Subsidiaries	1,519,588	1,154,138
Independent firms (control group)	-	4,160,047

Validation

Stylized facts - 1

- World sample



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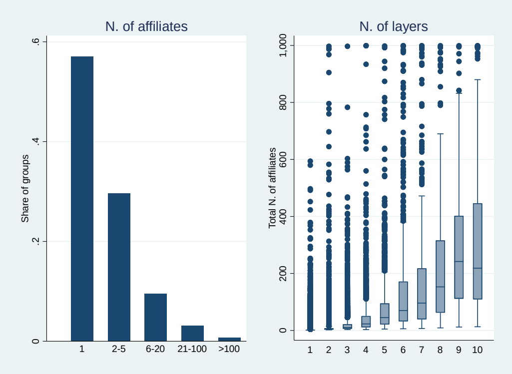

- OECD sample: 55% of parents = 1 affiliate (vs. 57% in world sample); 80% of BGs = 1 layer of control (vs. 82% in the world sample); 146 BGs (out of 165 in total) $\geq$ 10 layers

Stylized facts - 1

- Number of affiliates per layer (World sample)

	BG with: 10 layers	7 layers	4 layers	3 layers	2 layers
1	62.6	64.8	19.5	11.1	5.8
2	51.8	41.6	14.0	7.4	2.5
3	42.7	34.0	8.5	2.8	
4	40.9	24.2	3.2		
5	30.8	15.0			
6	29.5	7.8			
7	23.9	3.0			
8	21.6				
9	15.7				
10	12.6				
N. of BGs	165	347	3,068	8,697	32,823

Note: Average number of affiliates per layer, for different sized BGs

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- Figures for the OECD sample are entirely similar

The HQ organizational decisions

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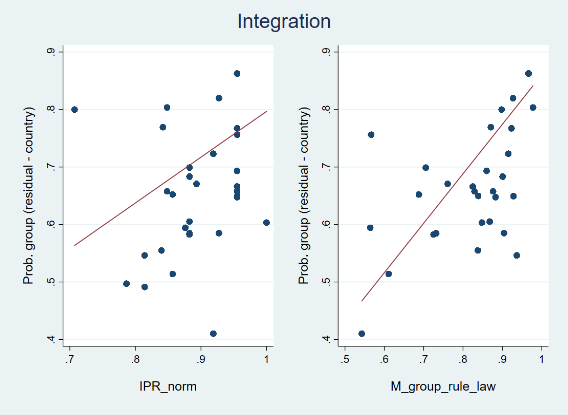
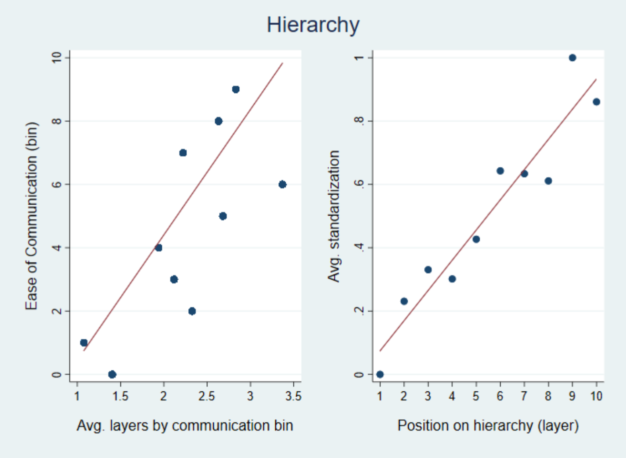
- The distinct features of BGs are driven by the *integration* and *hierarchy* decisions: BGs as "knowledge-based hierarchies" (Garicano and Rossi-Hansberg, 2015) of firms in a world of "incomplete contracts" (Antràs and Rossi-Hansberg, 2009)

Stylized facts - 2



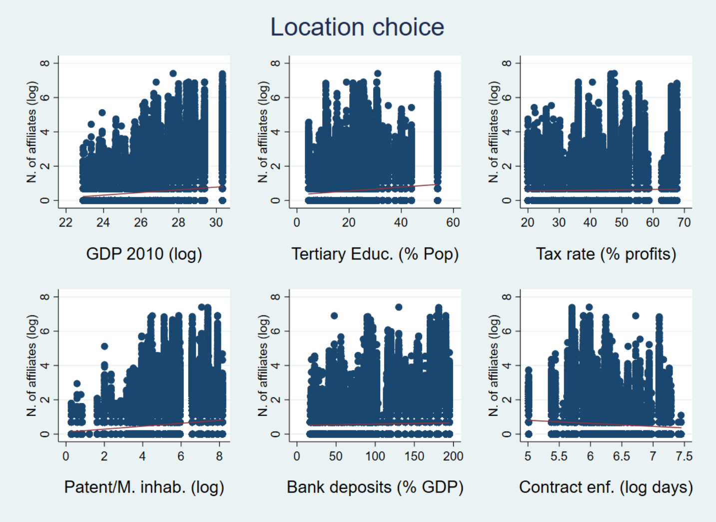
- Consistent with Biancini & Bombarda (2017); Eppinger and Kukharskyy (2017)

Stylized facts - 3



- Consistent with Garicano & Rossi-Hansberg (QJE, 2006); Caliendo & Rossi-Hansberg (QJE, 2012); Caliendo, Monte & Rossi-Hansberg (JPE, 2015)

Location controls



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- Recent evidence in US (Ramondo et al. - JIE, 2015; Atalay et al. - AER, 2014): no intra-group trade of median foreign affiliates and no trade between upstream and downstream plants within US firm

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- Recent evidence in US (Ramondo et al. - JIE, 2015; Atalay et al. - AER, 2014): no intra-group trade of median foreign affiliates and no trade between upstream and downstream plants within US firm
- Firm's boundaries not only driven by the ability to transfer goods within the firm, but also capabilities / intangible inputs / knowledge ('knowledge capital' of MNC, Markusen 1984)

Setup

- The HQ owns 'blueprints' of a large number of M differentiated products and knows their production possibilities. To turn the production possibilities of a product into actual production, a problem has to be solved.
- The HQ knows how to solve the problem but this requires time which the HQ has only in limited amount. The problem comes in different versions, indexed $\wp = 1, ..., P$ in decreasing order of difficulty, and the HQ decides which version to tackle.
- Solving a more difficult version of the problem is harder (requires higher skills) but allows for production at lower marginal cost than solving an easier version.
- The HQ has to decide how many products to make and how to organize their production. Each product faces isoelastic demand $y = Ap^{-\sigma}$ with $\sigma > 1$ and $A > 0$.

Setup

- Production units composed of a 'manager' and an endogenous number of 'workers' (normalized wages) supply an intermediate input, solve the problem and produce output.
- The manager receives the blueprint from the HQ and solves the assigned version $\wp$ of the problem $=>$ production at productivity $\theta_{\wp} = e^{-\theta\wp}$ with $\theta \geq 0$, i.e. solving more difficult versions of the problem (lower $\wp$) entails higher productivity (lower marginal costs).
- Solving a version $\wp$ requires managerial skills $\wp$. The ability differential of managers is reflected in different hiring costs $w\theta_{\wp}$
- At $w\theta_{\wp}$ the supply of managers of ability $\wp$ is infinitely elastic. Contracts signed by the HQ with managers and workers are incomplete.

Setup

- On top of adequate skills, solving a given version $\wp$ of a problem by the manager also requires supervision in implementing the blueprint.
- Supervision by the HQ can be direct (one degree of hierarchical separation) or indirect (more than one degree of hierarchical separation).
- In the latter case, supervision can be performed through managers of higher ability, i.e. at least equal to $\wp - 1$.
- Supervision entails a communication cost for the supervisor, captured by a parameter $\varphi_{\wp}$, with $\varphi_{\wp} = e^{\varphi \wp}$ and $\varphi > 0$, i.e. the higher the skill of the supervised manager (lower $\wp$), the lower the communication costs associated to its supervision.

Setup

- Managers and HQ can devote to supervision only a limited amount of time $\tau_{\wp} = e^{\tau}$ with $\tau > 0$ for all $\wp$.
- In order to solve a problem with productivity $\theta_{\wp}$, a manager of ability $\wp$ requires $\varphi_{\wp}\theta_{\wp}$ units of supervision time (directly from HQ or indirectly through managers of ability $\wp - 1$).
- Recursive time constraint:

$$\tau_{\wp-1} n_{\wp-1} = \varphi_{\wp}\theta_{\wp} n_{\wp} \tag{1}$$

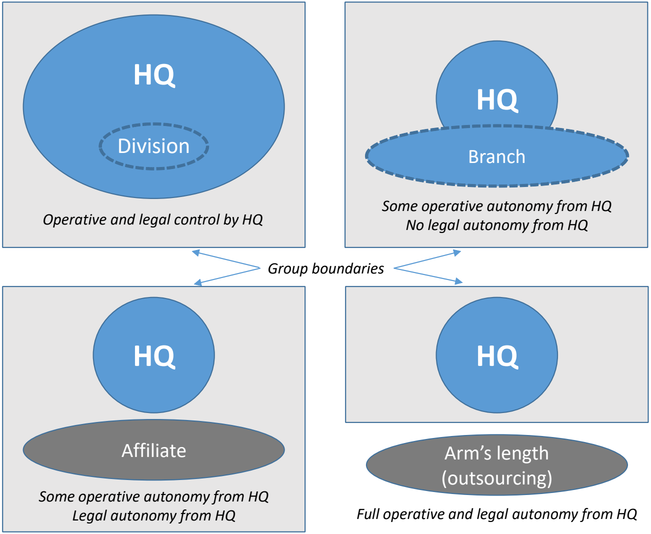
where $n_{\wp}$ is the number of managers of ability $\wp$ hired by the HQ, with $\wp = 0$ referring to the HQ, in which case $n_0 = 1$.

- Solving under assumed functional forms for $\tau_{\wp}$, $\varphi_{\wp}$ and $\theta_{\wp}$ yields

$$n_{\wp} = \prod_{s=1}^{\wp} \frac{\tau_{s-1}}{\varphi_s \theta_s} = e^{\tau + \sum_{s=1}^{\wp}(\theta-\varphi)s} = e^{\tau + \frac{1}{2}\wp(\wp+1)(\theta-\varphi)} \tag{2}$$

Note that $n_{\wp}$ can be increasing (decreasing) in $\wp$ for $\theta > (<)\varphi$.

Integration decision



Integration decision

- Affiliates f have a comparative advantage in production vs. divisions d. But:
  - traditional quality holdup due to imperfect monitoring (not relevant for d) => Nash-bargaining and no outside option after intermediate is produced
  - *knowledge holdup*: the HQ has to reveal the 'blueprints' to the (legally autonomous) units when solving problems => positive outside option for the manager's affiliate (although less efficient than under the HQ)
- The trade-off between comparative advantage in production and (double) holdup determines the integration decision
- Boundaries of the BG defined by those cases in which the (higher) comparative advantage of arm's length suppliers is not strong enough to compensate for their (bigger) holdup problem

Integration decision
Division

- One unit of intermediate input = one unit of final output; the number of units of labor needed to produce a unit of that input are $\delta/\theta_{\wp}$, no holdup problem (perfect monitoring)
- The division maximizes profit $\pi_d = p_d y_d - (\delta/\theta_{\wp}) x_d$, where x_d is the amount of the intermediate input produced, $y_d = x_d$ is the final output and p_d is its price.
- Maximized HQ profit $\pi_d(\theta_{\wp})$ under our isoelastic demand is

$$\pi_d(\theta_{\wp}) = \frac{A}{\sigma}\left(\frac{\sigma}{\sigma-1}\frac{\delta}{\theta_{\wp}}\right)^{1-\sigma} = \theta_{\wp}^{\sigma-1}\ \bar{\pi}$$

with $\bar{\pi} \equiv \frac{A}{\sigma}\left(\frac{\sigma}{\sigma-1}\delta\right)^{1-\sigma}$

Integration decision
Affiliate

- Comparative advantage in marginal costs $\kappa/\theta_{\wp} < \delta/\theta_{\wp}$ but double holdup:
- Quality holdup: Nash-bargaining on surplus share, with bargaining weights $1-\omega$ (HQ) and ω (affiliate), $\omega \in (0,1)$
- Knowledge holdup: positive outside option with independent production by affiliate, though less efficient than within the BG as $\rho > 1$ units of inputs required to produce a unit of final output (proxy for strength of property rights)
- Optimal quantity of input chosen by the affiliate under quality holdup and outside option

$$x_f(\theta_{\wp}) = A\left\{\frac{\sigma-1}{\sigma}\frac{\theta_{\wp}}{\kappa}\left[\omega+(1-\omega)\,\rho^{\frac{1-\sigma}{\sigma}}\right]\right\}^{\sigma}$$

Integration decision

Affiliate

- HQ profit $\pi_f\left(\theta_\wp\right)$

$$\pi_f\left(\theta_\wp\right) = \Omega\left(\frac{\kappa}{\delta}\right)^{1-\sigma}\theta_\wp^{\sigma-1}\;\bar{\pi} \tag{3}$$

with $\Omega \equiv \sigma\left(1-\omega\right)\left(1-\rho^{\frac{1-\sigma}{\sigma}}\right)\left[\omega+\left(1-\omega\right)\rho^{\frac{1-\sigma}{\sigma}}\right]^{\sigma-1}$

- $\pi_f(\theta_\wp) \neq \pi_d(\theta_\wp)$ due to holdup Ω and comparative advantage $\left(\kappa/\delta\right)^{1-\sigma}$

- As $\rho \to 1$, $\pi_f(\theta_\wp) \to 0$ as HQ's knowledge is fully dissipated. As $\rho \to \infty$ then f outside option vanishes and $\pi_f(\theta_\wp)$ tends to standard (quality) holdup case (branch)

Integration condition

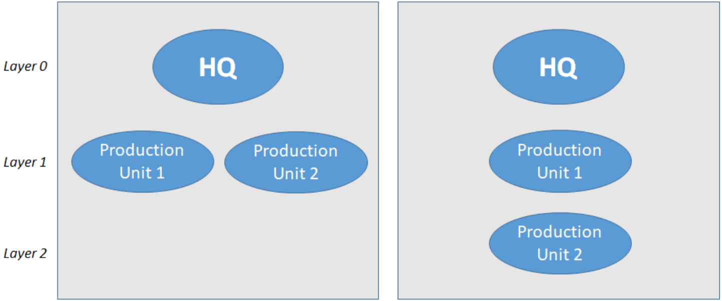
- The HQ prefers to run teams as affiliates rather than divisionswhenever $\pi_f(\theta_{\wp}) \geq \pi_d(\theta_{\wp})$.
- A necessary and sufficient condition for a BG to be the profit maximizing integration choice by the HQ is

$$\Omega\left(\frac{\kappa}{\delta}\right)^{1-\sigma} \geq 1 \qquad (4)$$

i.e. the efficiency gains from comparative advantage dominate the efficiency losses from holdup.

Hierarchy decision

- Flat organization: production units placed on layer $\ell = 1$ work in parallel under *direct* supervision of the HQ placed on layer $\ell = 0$
- Hierarchical organization: production units work in sequence on layers $\ell = 1, 2, \ldots$ under *indirect* supervision of the HQ



Flat organization *Hierarchical organization*

Hierarchy decision

Affiliate

- At layer $\ell = 0$ there is only the HQ and no operating profit.
- HQ operating profits $\pi_f(\theta_\wp)$ generated by affiliates placed at layer $\ell = 1$ increase with ability of managers $\wp$ => incentive to appoint managers with highest ability $\wp = 1$ at that layer, given HQ time constraint
- Hence $\ell = \wp = 1$, with HQ receiving profits from each affiliate equal to

$$\Pi_f(\theta_1) = \left[\Omega \left(\frac{\kappa}{\delta}\right)^{1-\sigma} e^{-\theta(\sigma-2)} \bar{\pi} - w\right] e^{-\theta}$$

Hierarchy decision
Affiliate

- Due to the time constraint, the number of affilates that can be opened at layer $\ell = 1$ equals

$$n_1 = \frac{\tau_0 n_0}{\varphi_1 \theta_1} = e^{\tau + (\theta - \varphi)}$$

- Total profits received by the HQ from $\ell = 1$ are

$$\Pi_f(\theta_1) n_1 - F = \left[\Omega \left(\frac{\kappa}{\delta} \right)^{1-\sigma} e^{-\theta(\sigma - 2)} \; \bar{\pi} - w \right] e^{\tau - \varphi} - F$$

- Production on $\ell = 1$ will thus be activated at all if and only if

$$\Pi_f(\theta_1) n_1 - F \geq 0$$

with $F > 0$ being the fixed (organizational) cost of activating a layer

Hierarchy decision

Affiliate

- A generic layer $\ell = \wp$ will be activated if $\ell = \wp - 1$ is activated, with

$$\Pi_f(\theta_\wp) = \left[\Omega\left(\frac{\kappa}{\delta}\right)^{1-\sigma} e^{-\wp\theta(\sigma-2)}\ \bar{\pi} - w\right] e^{-\wp\theta}$$

- Given the time constraint, the number of affilates will be

$$n_\wp = e^{\tau+\frac{1}{2}\wp(\wp+1)(\theta-\varphi)}$$

- with total profit accruing to the HQ

$$\Pi_f(\theta_\wp) n_\wp - F = \left[\Omega\left(\frac{\kappa}{\delta}\right)^{1-\sigma} e^{-\wp\theta(\sigma-2)}\ \bar{\pi} - w\right] e^{\tau+\frac{1}{2}\wp(\wp+1)(\theta-\varphi)-\wp\theta} - F$$

Hierarchy decision
Affiliate

- The hierarchy stops at layer $\ell = \wp^*$ where $\wp^*$ is the largest integer $\wp$ compatible with

$$\Pi_f(\theta_{\wp^*})n_{\wp^*} - F \geq 0$$

- At that layer there are

$$n_{\wp^*} = e^{\tau + \frac{1}{2}\wp^*(\wp^*+1)(\theta - \varphi)}$$

affiliates.

- Note that if $\theta < \varphi \Rightarrow n_{\wp-1} < n_{\wp}$ (inverted pyramid) which ensures that the hierarchical structure is contiguous, i.e. $\Pi_f(\theta_{\wp-1})n_{\wp-1} > \Pi_f(\theta_{\wp})n_{\wp}$

Optimal organization choice

Proposition: *A BG arises in equilibrium iff*

$$\Omega \left(\frac{\kappa}{\delta}\right)^{1-\sigma} > 1$$

When this condition holds the BG is organized as a hierarchy of $\wp^*$ layers of affiliates, where $\wp^*$ is the largest integer $\wp$ such that the profit of the BG at layer $\wp$ is larger than the fixed costs of activating the layer, i.e.

$$\left[\Omega \left(\frac{\kappa}{\delta}\right)^{1-\sigma} e^{-\wp\theta(\sigma-2)} \; \bar{\pi} - w\right] e^{\tau+\frac{1}{2}\wp(\wp+1)(\theta-\varphi)-\wp\theta} - F \geq 0$$

Optimal organization choice

With $\wp^*$ layers of affiliates we have that:

1. the total number of affiliates of the BG is

$$M^* = \sum_{\wp=1}^{\wp^*} n_\wp = \sum_{\wp=1}^{\wp^*} e^{\tau + \frac{1}{2}\wp(\wp+1)(\theta-\varphi)}$$

2. the number of affiliates assigned to layer $\wp$ of the BG is

$$n_\wp = e^{\tau + \frac{1}{2}\wp(\wp+1)(\theta-\varphi)}$$

3. the total profit of the BG is

$$\sum_{\wp=1}^{\wp^*} \left[\Omega \left(\frac{\kappa}{\delta} \right)^{1-\sigma} e^{-\wp\theta(\sigma-2)} \bar{\pi} - w \right] e^{\tau + \frac{1}{2}\wp(\wp+1)(\theta-\varphi) - \wp\theta} - F\wp^*$$

Comparative statics

- Controlling for the parameters that drive the integration condition $\Omega\left(\frac{\kappa}{\delta}\right)^{1-\sigma} > 1$, we have that:
  - higher communication costs (higher φ) are associated on average with a smaller number of group affiliates M^* and lower profits per layer => less hierarchical layers likely to be activated
  - more standardized production processes (lower productivity $\theta_\wp$) should characterize BGs with a lower number of subsidiaries, and flatter hierarchies
  - an increase in the cost of managers (higher w), higher fixed costs per layer (higher F) or a reduction of the time available for supervision (lower τ) will all be associated to flatter hierarchies

Testing the model

- Model setup

$$group_{isj} = \alpha + \beta\ \rho_j + \Gamma\ X_{i,s,j} + \varepsilon_{isj} \qquad \text{(Integration regr.)}$$

$$H_{g(i)sj} = \alpha + \Lambda\ Z_g + \Gamma\ X_{i,s,j} + \Phi\ Y_{g(j)} + \varepsilon_{g(i)sj} \qquad \text{(Hierarchy reg)}$$

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- Eq. (Integration regr.): probability of a firm i operating in an industry s in a country j to establish a BG group by integrating affiliates, based on covariates in our Integration Eq.
- Eq. (Hierarchy reg): hierarchical choice of a group $g(i)$ having firm i as a parent, operating in an industry s in a country j as a function of covariates in our Hierarchy Eq.

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    - no changes in key underlying distributions

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- Average standardization of tasks (Blinder and Krueger, 2013) of the industries in which the group is operating (dummy vs. sample mean) [−]

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- Vertical integration choice (Acemoglu et al., 2009; Alfaro et al., 2016) VI; multinational group dummy.

Dep Var	(1) Group	(2) Group	(3) Group	(4) Group	(5) Group
IPR	0.280**	0.309**	0.285**	0.441***	0.335**
	[0.143]	[0.140]	[0.115]	[0.157]	[0.140]
Capital Intensity		0.031**	-0.145	0.029*	0.027*
		[0.015]	[0.103]	[0.015]	[0.014]
Cost of startup	-0.000	-0.000	-0.001	0.001	0.002*
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Total tax rate	-0.001***	-0.002***	-0.001**	-0.001*	-0.001*
	[0.000]	[0.000]	[0.001]	[0.001]	[0.000]
GDP Growth	-0.003	-0.003	-0.001	-0.001	-0.002
	[0.004]	[0.005]	[0.005]	[0.005]	[0.005]
Population	-0.007	-0.007	-0.001	0.007	0.006
	[0.006]	[0.007]	[0.006]	[0.009]	[0.008]
Patent / inhabitant	-0.006	-0.006	-0.011	-0.007	-0.005
	[0.007]	[0.008]	[0.008]	[0.008]	[0.007]
Age	0.003	0.004*	0.004**	0.004*	0.003*
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Financial development					0.021***
					[0.008]
Inverse Mills Ratio				-0.143**	-0.163***
				[0.054]	[0.053]
Constant	-0.027	-0.042	-0.101	-0.393**	-0.335*
	[0.103]	[0.151]	[0.154]	[0.178]	[0.192]
Size HQ (dummy)	YES	YES	YES	YES	YES
Industry FE (3-digit)	YES	YES	YES	YES	YES
First-stage selection eq.	NO	NO	NO	YES	YES
Observations	4,273,058	3,737,847	458,154	3,737,847	3,736,256
R-squared	0.273	0.285	0.408	0.288	0.282

Standard errors clustered at the country level in brackets
*** p<0.01, ** p<0.05, * p<0.1

Dep Var	(1) Ssubsidiaries	(2) Subsidiaries	(3) Layers	(4) Layers
Estimation method	OLS	OLS	O. Probit	O. Probit
Ease of communication	0.084***	0.083***	0.151***	0.153***
	[0.009]	[0.009]	[0.018]	[0.018]
Standardization	-0.152***	-0.151***	-0.029**	-0.029**
	[0.009]	[0.008]	[0.013]	[0.013]
Skill premium			-0.097***	-0.088***
			[0.016]	[0.018]
N. of subsidiaries			1.143***	1.148***
			[0.010]	[0.010]
Fin. Development (group)		-0.001		0.022
		[0.008]		[0.015]
Tax rate (group)		0.011***		-0.004***
		[0.001]		[0.001]
Patent (group)		-0.089***		0.020*
		[0.008]		[0.011]
Contract enforcem.t (group)		-0.288***		0.112***
		[0.026]		[0.038]
IPR index (HQ)	2.505***	3.238***	0.738***	0.416**
	[0.111]	[0.143]	[0.180]	[0.205]
Age (HQ)	0.055***	0.049***	-0.123***	-0.120***
	[0.004]	[0.004]	[0.006]	[0.006]
Constant	-2.130***	-0.980***	-	-
	[0.113]	[0.201]	-	-
Size HQ (dummy)	YES	YES	YES	YES
Industry FE (3-digit)	YES	YES	YES	YES
Observations	59,269	59,269	59,269	59,269
R-squared	0.441	0.448	-	-

Robust standard errors in brackets

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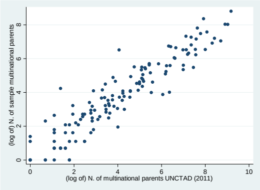
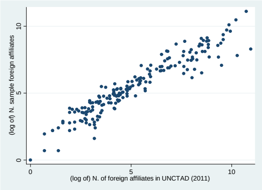
- In line with our theory, significant and robust evidence that firms (in a given industry and of a given size) are more likely to set up subsidiaries when operating in countries characterized by better institutions.
- Conditional on this result, BGs are more likely to be structured across several layers of hierarchy when communication costs between parents and affiliates are easier, the skill premia for good managers are smaller, and problem solving is more challenging.

[SUPPLEMENTARY MATERIAL]

Data validation

- Fortune 500 companies, Top 2,000 R&D firms (IRI), Top 100 largest MNEs (UNCTAD) all listed in our sample.
- Match (MNEs' parents / affiliates) by country with UNCTAD data





- 0.7% of BGs with >100 affiliates responsible for >70% of value added in our data: closely matches UNCTAD (2016) distribution
- Indirect validation in Altomonte et al. (2013): a proxy for intra-firm and arm's length flows obtained merging French firm-level trade with these ownership data closely matches US BEA official figures.

Back

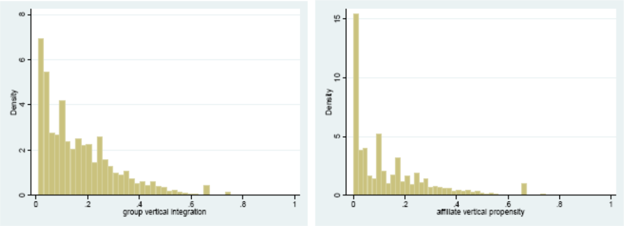
GIC index in BGs

- Most BGs (up to the 7th decile) have a GIC equal to zero, that is they have a very simple 1-1 structure
- The top 1% of complex BGs has $>$900 affiliates and $>$10 levels of control, with a GIC > 4.7 (max GIC > 19) $=>$ Pareto distribution

Statistics	N	H(G)	GIC
Mean	5.62	0.18	0.35
standard deviation	32.62	0.43	1.02
Skewness	28.59	2.43	5.34
50th percentile	1	0	0
75th percentile	3	0	0
90th percentile	8	0.92	1.45
95th percentile	16	1	1.88
99th percentile	74	1.83	4.7
Maximum	1000*	3.27	19.47

Vertical integration index in BGs

Figure: Group and Affiliate Vertical Integration indexes



Density calculated on a sample of 228,927 groups of firms. Mean: .062; standard deviation: .122; skewness: 2.723.

Density calculated on a sample of 1,056,806 affiliates; Mean: .049; standard deviation: .114; skewness: 3.189.

- Average integration across BGs in our data =.062; Alfaro et al. (2016) for manufacturing industries on a different dataset (D&B) with a threshold >20 employees: average integration =.063; Acemoglu et al. (2009) =.0487