

Supplementary Information

SI 1. Descriptive statistics of of the transaction and ownership networks

Table 1 illustrates the number of nodes and edges in the co-ownership network, in the original transaction network, and in the “limited” transaction network, after dropping firms that did not have any ownership connections. In general, the transaction network is larger and denser than the co-ownership network. However, limiting the transaction network to the set of nodes observed in the ownership network results in a smaller and less dense subgraph of the transactions network.

Table 1 Descriptives of the networks

	Number of nodes	Number of edges
Co-ownership network, 2016	27,671	21,193
Co-ownership network, 2017	33,919	26,581
Full transaction network, 2016	93,555	222,395
Full transaction network, 2017	112,278	254,881
Limited transaction network, 2016	5,441	6,308
Limited transaction network, 2017	5,488	6,516







Notes: Full transaction network refers to the entire network based on VAT return data. Limited transaction network is the subgraph of the entire transaction network between nodes observed in the ownership network in 2016 or in 2017.

Table 2 presents the persistence of interfirm links over time in the two networks and their overlap. We observe more ownership ties in 2017 than in 2016 and that no such connection disappeared over the observed year. Business transactions between the same set of companies are less stable as only about half of them appear in both years. The overlap of connections in the two different interfirm networks is relatively small as only around 5% of company pairs have both co-ownership ties and business transaction ties.

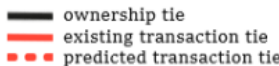
Table 2 Overlap and stability of co-ownership and transaction ties

	Number of ties		
	Co-ownership	Business transactions	Overlap
2016	21,139	6,308	1,313
2017	26,581	6,516	1,461
2016-2017 overlap	21,139	3,090	-

SI2 Multi-level motifs on the full sample of all firms

2016	2017	Motif name	Observed	Relative frequency
Motifs behind tie creation				
		Direct ownership	19,826	0.00015%
		Indirect ownership	9,572	0.00007%
		Indirect transaction	21,793,021	0.168%
		Indirect mixed	104,002	0.00080%
Motifs behind tie persistence				
		Direct ownership	1313	0.59%
		Indirect ownership	230	0.11%
		Indirect transaction	81,956	36.85%
		Indirect mixed	4,247	1.91%

Notes: The panel “behind tie creation” counts the motifs for all possible pairs of nodes where no transaction edge was observed in 2016, and relative frequency compares these figures to the number of possible pairs of nodes where no transaction edge was observed. The panel “behind tie persistence” counts motifs for dyads with an existing business edge in 2016, and relative frequency compares this number to the number of existing transactions in 2016.



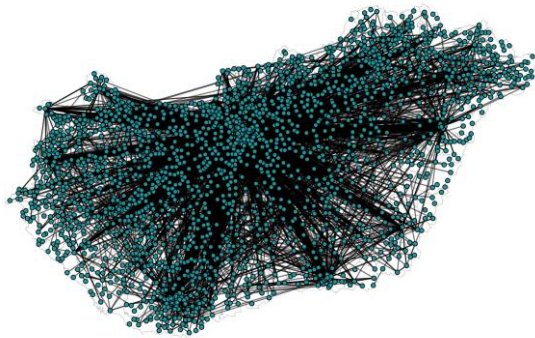
 — ownership tie
 — existing transaction tie
 - - - predicted transaction tie

SI3. Geographical distribution of firms

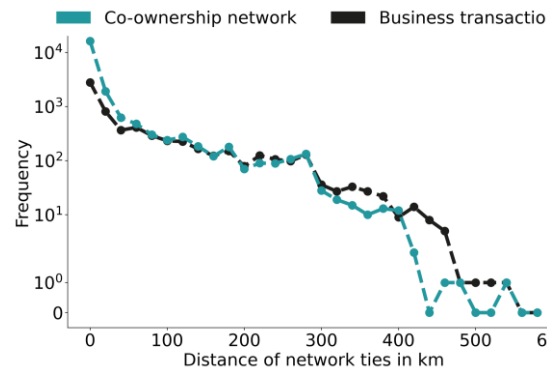
Figure 1 illustrates that ties in the co-ownership network and in the business transaction network have different geographic patterns. There are more co-ownership ties that cover short distances, but over 100 kilometers we observe more business relationships than ownership-based connections.

Figure 1 Geographic dimension of the network

(a)



(b)



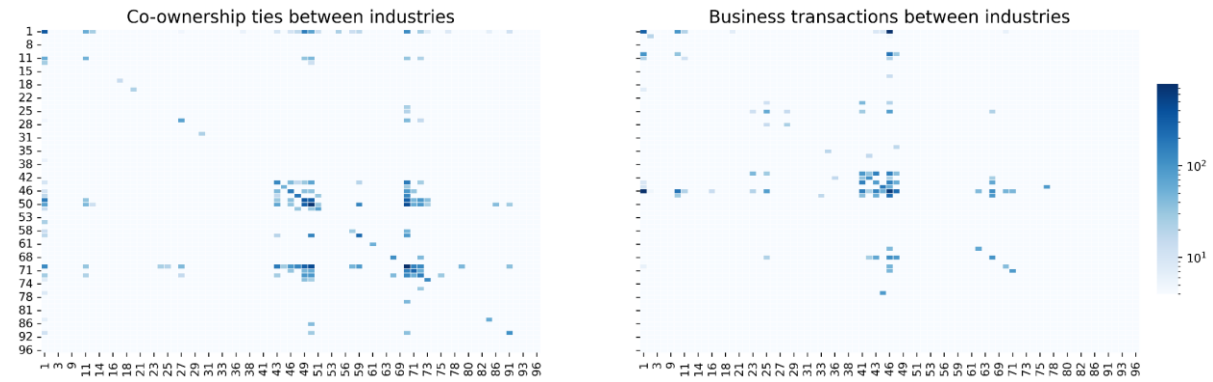
Source: Authors' own construction

Note: Figure 1a maps the co-ownership network of companies from 2016. Figure 1b illustrates the distance of ties in the co-ownership and business transaction networks of 2016.

SI4. Co-ownership ties and business transactions across industries

Figure 2 visualizes the density of co-ownership ties and business transactions between industries identified by 2-digit NACE codes. The diagonal is somewhat emphasized on both heatmaps, but the different network ties clearly follow different patterns.

Figure 2 Co-ownership ties and business transactions between 2-digit NACE codes



SI5. Logistic regressions on the creation of business ties

	Dependent variable: creation of transaction tie			
	Model 1	Model 2	Model 3	Model 4
Same city	4.630 ^{***} (0.158)	3.234 ^{***} (0.294)	2.335 ^{***} (0.279)	2.380 ^{**} (0.278)
Related industry	1.046 ^{***} (0.284)	0.787 ^{***} (0.292)	0.609 [*] (0.312)	0.897 ^{***} (0.311)
Same industry	1.158 ^{***} (0.364)	0.189 (0.379)	-0.115 (0.448)	0.300 (0.438)
Direct ownership		6.028 ^{***} (0.339)	4.598 ^{***} (0.337)	5.537 ^{***} (0.340)
Indirect ownership			1.168 ^{**} (0.526)	2.107 ^{***} (0.527)
Indirect transaction			6.439 ^{***} (0.150)	3.976 ^{***} (0.165)
Indirect mixed			2.484 ^{***} (0.278)	2.631 ^{***} (0.263)
Size (emp) (i+j)				1.392 ^{***} (0.058)
Size difference (i-j)				0.156 [*] (0.090)
Labor productivity (i+j)				0.182 ^{***} (0.052)
Ownership homophily (both MNE or local)				-0.182 (0.183)
Constant	-13.004 ^{***} (0.062)	-12.967 ^{***} (0.061)	-13.222 ^{***} (0.069)	-16.529 ^{***} (0.407)
Model statistics				
Observations	115,045,823	115,045,823	115,045,823	105,146,136
Log likelihood	-4,261	-4,113	-3,5540	-3,158
AIC	8,531	8,237	7,124	6,340

Notes: log-odds parameters, standard errors in parentheses. Run on a 10% random sample of all potential dyads. * p<0.1, ** p<0.05, *** p<0.01

SI6. Key coefficients of log-linear models on new business tie creation on the sample of all firms

	Model (1)	Model (2)	Model (3)	Model (4)
Business tie creation x				
Same city	3.141 ^{***}	2.397 ^{***}	2.099 ^{***}	2.566 ^{***}
	(0.038)	(0.055)	(0.063)	(0.056)
Related industry	0.361 ^{***}	0.310 ^{***}	0.143 ^{***}	-0.025
	(0.043)	(0.043)	(0.045)	(0.057)
Same industry	0.992 ^{***}	0.652 ^{***}	0.357 ^{***}	0.810 ^{***}
	(0.059)	(0.061)	(0.063)	(0.081)
Direct ownership		5.022 ^{***}	1.620 ^{***}	6.772 ^{***}
		(0.076)	(0.105)	(0.108)
Indirect ownership			-0.411 ^{***}	5.631 ^{***}
			(0.156)	(0.267)
Indirect transaction			4.694 ^{***}	4.706 ^{***}
			(0.007)	(0.007)
Indirect mixed			2.709 ^{***}	6.111 ^{***}
			(0.039)	(0.056)
Model statistics				
Deviance	2.1E+09	1.76E+09	6362.0	173.0
d.f.	134	129	109	65
p value (LR test)		0.000	0.000	0.000
p value (Chi2 test)	0.000	0.000	0.000	0.000

Source: Authors' own construction

Notes: Parameters of loglinear models, standard errors in parentheses, * p<0.1, ** p<0.05, *** p<0.01

SI7. Selected coefficients of the three-way interaction model on tie creation

	Same city	Related industry	Same industry	Direct ownership	Indirect ownership	Indirect transaction	Indirect mixed
Same city	3.452 ^{***}	0.030	-0.267	-2.584 ^{***}	-2.441 ^{***}	-1.292 ^{***}	-0.980 ^{***}
Related industry		0.322 ^{***}	NA	-0.144	0.308	-0.257	0.215
Same industry			0.777 ^{***}	-0.573 [*]	-2.382 [*]	-0.385	0.093
Direct ownership				7.795 ^{***}	NA	-2.946 ^{***}	-4.261 ^{***}
Indirect ownership					6.197 ^{***}	-2.339 ^{***}	-3.945 ^{***}
Indirect transaction						6.343 ^{***}	-3.572 ^{***}
Indirect mixed							6.224 ^{***}

Notes: The underlying model is presented in Table 5 model 4. * p<0.1, ** p<0.05, *** p<0.01

SI8 Key coefficients of log-linear models on new business tie creation when direct holdings are excluded from the sample

	Model (1)	Model (2)	Model (3)	Model (4)
Business tie creation x				
Same city	4.426***	2.721***	2.404***	3.758***
	(0.060)	(0.119)	(0.129)	(0.099)
Related industry	1.127***	0.948***	0.681***	0.814***
	(0.085)	(0.086)	(0.088)	(0.121)
Same industry	1.145***	0.282**	-0.023	0.746***
	(0.106)	(0.112)	(0.113)	(0.168)
Direct ownership		5.996***	5.862***	8.218***
		(0.131)	(0.147)	(0.141)
Indirect ownership			5.286***	7.186***
			(0.319)	(0.520)
Indirect transaction			5.711***	6.245***
			(0.070)	(0.076)
Indirect mixed			-2.483***	6.362***
			(0.129)	(0.286)
Model statistics				
Deviance	2.1E+09	1.76E+09	6362.0	173.0
d.f.	134	129	109	65
p value (LR test)		0.000	0.000	0.000
p value (Chi2 test)	0.000	0.000	0.000	0.000

Source: Authors' own construction

Notes: Parameters of loglinear models, standard errors in parentheses, * p<0.1, ** p<0.05, *** p<0.01

SI9. Logistic regressions on the persistence of business ties

	Dependent variable: persistence of transaction tie			
	(5)	(6)	(7)	(8)
Same city	0.558*** (0.061)	0.281*** (0.070)	0.223*** (0.074)	0.393*** (0.076)
Related industry	0.245** (0.081)	0.227** (0.082)	0.106 (0.084)	0.227*** (0.086)
Same industry	0.135 (0.103)	0.098 (0.103)	0.105 (0.105)	0.146 (0.108)
Direct ownership		0.592** (0.074)	0.699** (0.078)	0.964** (0.082)
Indirect ownership			0.569** (0.152)	0.659** (0.156)
Indirect transaction			0.655** (0.055)	0.418** (0.058)
Indirect mixed			0.283** (0.075)	0.310** (0.078)
Size (emp) (i+j)				0.398** (0.027)
Size difference (i-j)				0.121** (0.043)
Labor productivity (i+j)				0.068** (0.017)
Ownership homophily (both MNE or local)				-0.135 (0.087)
Constant	-0.254*** (0.030)	-0.199*** (0.033)	-0.641*** (0.041)	-2.257*** (0.174)
Model statistics				
Observations	6,308	6,308	6,308	6,287
Log likelihood	-4,305	-4,273	-4,162	-4,010
AIC	8,619	8,557	8,340	8,045

Note: log-odds parameters, standard errors in parentheses, * p<0.1, ** p<0.05, *** p<0.01

SI10. Key coefficients of log-linear models on tie business tie persistence when direct holdings are excluded from the ownership network

	Model (5)	Model (6)	Model (7)	Model (8)
Business tie x				
Same city	0.621***	0.261***	0.262***	0.677***
	(0.082)	(0.098)	(0.100)	(0.170)
Related industry	0.277**	0.272**	0.155	0.169
	(0.119)	(0.120)	(0.123)	(0.201)
Same industry	0.179	0.111	0.123	0.222
	(0.145)	(0.147)	(0.149)	(0.260)
Direct ownership		0.665***	0.677***	0.726***
		(0.098)	(0.101)	(0.174)
Indirect ownership			0.408	0.864
			(0.332)	(0.687)
Indirect transaction			0.591***	0.687***
			(0.082)	(0.117)
Indirect mixed			0.335***	0.605***
			(0.107)	(0.228)
Model statistics				
Deviance	5501	4514	186.5	100.9
d.f.	134	129	109	65
p value (LR test)	0.000	0.000	0.000	0.000
p value (Chi2 test)	0.000	0.000	0.000	0.003

Notes: Parameters of loglinear models, standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

SI11. Key coefficients of log-linear models on maintenance of business ties on the sample of all firms

	Model (1)	Model (2)	Model (3)	Model (4)
Business tie x				
Same city	0.716 ^{***}	0.488 ^{***}	0.440 ^{***}	0.663 ^{***}
	(0.049)	(0.055)	(0.058)	(0.086)
Related industry	0.368 ^{***}	0.335 ^{***}	0.161 ^{***}	0.217 ^{**}
	(0.059)	(0.059)	(0.061)	(0.098)
Same industry	0.193 ^{**}	0.167 ^{**}	0.185 ^{**}	0.344 ^{**}
	(0.080)	(0.081)	(0.083)	(0.134)
Direct ownership		0.591 ^{***}	0.617 ^{***}	0.671 ^{***}
		(0.067)	(0.069)	(0.124)
Indirect ownership			0.457 ^{***}	1.030 ^{***}
			(0.149)	(0.337)
Indirect transaction			0.747 ^{***}	0.751 ^{***}
			(0.009)	(0.009)
Indirect mixed			0.351 ^{***}	0.370 ^{***}
			(0.033)	(0.067)
Model statistics				
Deviance	773453.3	600229.3	1519.712	118.4944
d.f.	134	129	109	65
p value (LR test)		0.000	0.000	0.000
p value (Chi2 test)	0.000	0.000	0.000	0.000

Source: Authors' own construction

Notes: Parameters of loglinear models, standard errors in parentheses, * p<0.1, ** p<0.05, *** p<0.01

SI12. Selected coefficients of the three-way interaction model on tie persistence

	Same city	Related industry	Same industry	Direct ownership	Indirect ownership	Indirect transaction	Indirect mixed
Same city	0.507 ^{***}	-0.181	0.128	-0.279 [*]	0.122	-0.138	-0.420 ^{**}
Related industry		0.151	NA	0.286	-0.292	-0.126	0.062
Same industry			0.173	-0.355	-0.507	-0.020	0.099
Direct ownership				0.740 ^{***}	NA	0.152	0.197
Indirect ownership					0.920 ^{***}	-0.950 ^{***}	0.424
Indirect transaction						0.760 ^{***}	-0.195
Indirect mixed							-0.197

Source: Authors' own construction

Notes: The underlying model is presented in Table 5 model 4. * p<0.1, ** p<0.05, *** p<0.01