Online Supplement for
Offshoring and the Onshore Composition of Tasks and Skills*

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Online Supplement

I Corporate Ownership and FDI Exposure

Prior to our shift-share analysis and estimation, we inferred the economically relevant ownership share of a German firm in any other German firm (also see Becker and Muendler 2008). The relevant ownership share can differ from the recorded share in a firm's equity for two reasons. First, a firm may hold indirect shares in an affiliate via investments in third firms who in turn control a share of the affiliate. We call ownership shares that sum all direct and indirect shares *cumulated* ownership shares. Second, corporate structures may exhibit cross ownership of a firm in itself via affiliates who in turn are parents of the firm itself. We call ownership shares that remove such circular ownership relations *consolidated* ownership shares. This appendix describes the procedure in intuitive terms; graph-theoretic proofs are available from the authors upon request.

Consolidation removes the degree of self-ownership (α) from affiliates, or intermediate firms between parents and affiliates, and rescales the ultimate ownership share of the parent to account for the increased control in partly self-owning affiliates or intermediate firms (with a factor of $1/(1-\alpha)$). Investors know that their share in a firm, which partly owns itself through cross ownership, in fact controls a larger part of the firm's assets and its affiliates' assets than the recorded share would indicate. In this regard, cross ownership is like self-ownership. Just as stock buy-backs increase the value of the stocks because investors' de facto equity share rises, so do cross-ownership relations raise the de facto level of control of the parents outside the cross-ownership circle.

We are interested in *ultimate* parents that are not owned by other German firms, and want to infer their *cumulated and consolidated* ownership in all affiliates. Consider the following example of interlocking (Example 2 in Figure I.1). The ultimate parent with firm ID 101 holds 90 percent in firm 201, which is also owned by firm 202 for the remaining 10 percent. However, firm 201 itself holds a 25 percent stake in firm 202—via its holdings of 50 percent of 301, which has a 50 percent stake in 201. Firms 201 and 202 hold 60 percent and 40 percent of firm 909. Our cumulation and consolidation procedure infers the ultimate ownership of 101 in all other firms.

We assemble the corporate ownership data in a three-column matrix:[27] the first column takes the affiliate ID, the second column the parent ID, and the third column the effective ownership share. Table I.1 shows this matrix for Example 2 in Figure I.1 (the third column with the direct ownership share is labeled 1, representing the single iteration 1).

On the basis of this ownership matrix, our inference procedure walks through the corporate labyrinth for a prescribed number of steps (or iterations). The procedure multiplies the ownership shares along the edges of the walk, and cumulates multiple walks from a given affiliate to a given ultimate parent. Say, we prescribe that the algorithm take all walks of length two between every possible affiliate-parent pair (in business terms: two firm levels up in the group's corporate hierarchy; in mathematical terms: walks from any vertex to another vertex that is two edges away in the directed graph).

We choose the following treatment to infer the *cumulated and consolidated* ownership for ultimate parents: We assign every ultimate parent a 100 percent ownership of itself. This causes

[27]We assemble cleared ownership data by first removing one-to-one reverse ownerships and self-ownerships in nested legal forms (such as *Gmbh & Co. KG*).

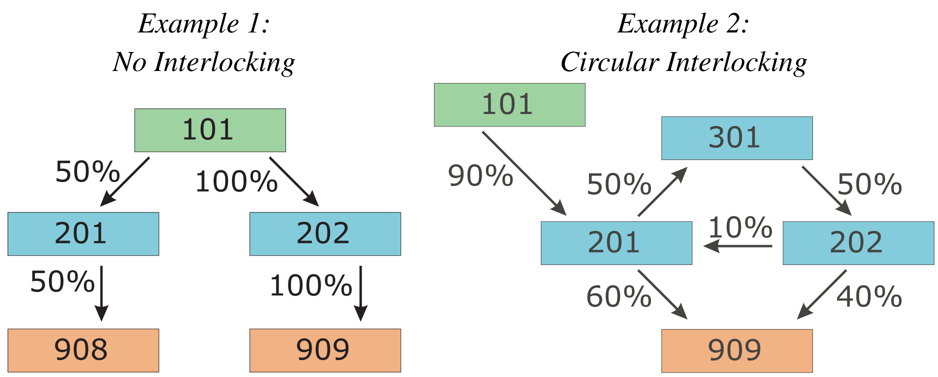

Figure I.1: Examples of Corporate Groups

the procedure to *cumulate and consolidate* the effective ownership share for all affiliates of ultimate parents, at any length of walks. There are seven distinct possibilities in the example to move in two steps through the corporate labyrinth. Table I.1 lists these possibilities as iteration 2 (all entries in or below the second row). With our treatment, there is now an eighth possibility to move from affiliate 201 to parent 101 in two steps because we have added the 101-101 loop with 100-percent ownership. As a result, our procedure cumulates ownerships of ultimate parents for all walks that are of length two or shorter. The procedure starts to consolidate shares as the length of the walk increases. Iteration 3 in Table I.1 shows the cumulated and partially consolidated ownership of ultimate parent 101 in affiliate 201, for all three-step walks, including the first cycle from 201 through 202 and 301 back to 201 and then to 101.

In 2000, the maximum length of direct (non-circular) walks from any firm to another firm is 21. So, for all ultimate parents, the *cumulated and consolidated* ownership shares are reported correctly from a sufficiently large number of iterations on. Table I.1 shows iteration 100. The ownership share of 101 in 201 has converged to the exact measure $(.9/(1-.1\cdot.5\cdot.5) = .\overline{923076})$ at five-digit precision. Firm 101 controls 92.3 percent of firm 201's assets, among them firm 201's offshore affiliates.

To calculate the FDI exposure at any hierarchy level in the corporate group, we use a single-weighting scheme with ownership shares. The economic rationale behind single-weighting is that ultimate parents are more likely to be the corporate decision units (whereas FDI conducting and reporting firms in the group may be created for tax and liability purposes). We first assign FDI exposure measures (offshore affiliate employment by world region) from onshore affiliates to their ultimate German parents. Suppose firm 201 in Example 2 of Figure I.1 conducts FDI in the corporate group. We assign 92.3 percent of 201's FDI exposure to firm 101, the ultimate German parent. We then assign the same 92.3 percent of 201's FDI exposure to all affiliates of 101 (201 itself, 202, 301, 909). Therefore jobs throughout the group (including those at 201 itself) are only affected to the degree that the ultimate parents can control offshore affiliate employment (or sales). We assign only 92.3 percent of 201's FDI exposure to 201 itself because the ultimate parent only has 92.3 percent of the control over employment at 201.[28]

[28] An alternative assignment scheme would be double-weighting, first weighting FDI exposure by ownership and then assigning the FDI exposure to jobs throughout the corporate group using ownership weights again. We de-

Table I.1: Ownership Inference

Affiliate-parent pair	Iteration (Length of Walk) 1	2	3	5	9	100
201-101	.9	.90	.900	.92250	.92306	.92308
201-202	.1					
201-301		.05		.00125		
202-101			.225	.22500	.23077	.23077
202-201		.25		.00625		
202-301	.5					
301-101		.45	.450	.46125	.46153	.46154
301-201	.5					
301-202		.05		.00125		
909-101		.54	.540	.64350	.64609	.64615
909-201	.6		.100		.00006	
909-202	.4	.06		.00150		
909-301		.20	.030	.00500	.00001	

Because we choose single-weighting in the onshore branches of the MNE, we also single-weight offshore affiliate employment by the ownership share of the German parent in its offshore affiliates. Mirroring the minimal ownership threshold of 10 percent in the MIDI data on offshore affiliates, we also discard the FDI exposure of onshore affiliates with ownership shares of less than 10 percent in our single-weighting assignment of FDI exposure to onshore jobs throughout the corporate group.

II Regional Aggregates

We lump host countries into four broad regions: CEE (Central and Eastern Europe), DEV (Developing countries), OIN (Overseas Industrialized countries), and WEU (Western Europe), beyond the home location Germany. We list the regional definitions in Table II.1. The broad regions share geographic characteristics, and contain countries with relatively similar endowments and institutional characteristics. CEE and WEU share borders with Germany and are geographically contiguous, whereas OIN includes non-European industrialized countries, and DEV spans the remaining developing countries throughout Africa, Latin America and the Asia-Pacific region.

cide against double-weighting. Any weighting scheme results in exposure measures that are weakly monotonically decreasing as one moves upwards in the corporate hierarchy because ownership shares are weakly less than one. Double-weighting aggravates this property. Revisit Example 1 in Figure I.1 and suppose firm 201 conducts FDI. Single-weighting assigns 50 percent of 201's exposure to affiliate 908, double-weighting only 12.5 percent. If 908 itself conducts the FDI, single-weighting assigns 25 percent of its own FDI exposure to 908, double-weighting only 6.25 percent. In economic terms, double-weighting downplays the decision power of intermediate hierarchies in the corporate group further than single-weighting so that we favor single-weighting. Recall that purely laterally related firms (sisters, aunts and nieces) are excluded from our offshore-expansion group so that firms 202 and 909 in Example 1 of Figure I.1 are not relevant for the choice of weighting scheme.

Table II.1: AGGREGATE LOCATIONS

Locations	Countries
WEU	Western European countries (EU 15 plus Norway and Switzerland)
OIN	Overseas Industrialized countries including Australia, Canada, Japan, New Zealand, USA as well as Iceland and Greenland
CEE	Central and Eastern European countries including accession countries and candidates for EU membership as well as Balkan countries, Belarus, Turkey, and Ukraine
DEV	Developing countries including Russia and Central Asian economies as well as dominions of Western European countries and of the USA

III Robustness to Alternative Task Measures

As a robustness check to our classification of tasks, we reuse a classification by Spitz-Oener (2006) for information technology and labor demand. The Spitz-Oener (2006) mapping is based on a set of 15 job descriptions, also in the BIBB-IAB work survey. Table III.1 lists those job descriptions. Spitz-Oener (2006) classifies job descriptions with codes v192 and v200 as (manual) routine tasks, we take the complementary 13 job descriptions to imply non-routine tasks. Following Spitz-Oener (2006), we take job descriptions v189, v190, v194, v195, and v198 to imply interactive tasks. For the mapping from tasks to occupations, we proceed similar to our own task classifications and compute the task intensity of occupations as described in Subsection 2.2 in the text.

Table III.2 presents results from re-estimating the two main specifications of Table 6 in the text for alternative task measures in the all-sector sample. Columns 1 and 2 repeat the estimates from Table 6 (columns 2 and 7) to facilitate comparisons. Columns 3 and 4 in Table III.2 show results under the lenient task definitions (Table A.1) and columns 5 and 6 report results under the complementary task definitions by Spitz-Oener (Table III.1). The magnitudes of the association between *OE* and non-routine or interactive tasks are similar across the three different task measures, although statistical significance is somewhat weaker for both the lenient definition and the Spitz-Oener definition. A similar pattern can be observed for manufacturing and services separately (not reported).

Table III.3 presents results from estimating the relationship between offshoring and the task composition with additional controls at the sector level. Tasks are classified according to the stricter definition and the controls are similar to the ones used in Table 9. To facilitate comparison, we also include the results from regressions without the additional controls in Table 6 (Columns 2 and 7). The relationship between overall offshoring and the wage-bill shares of non-routine and interactive tasks is strikingly robust in magnitude and coefficient remain significant when introducing these controls.

Table III.1: NON-ROUTINE AND INTERACTIVE TASKS BY SPITZ-OENER

Code	Task	non-routine	interactive
v189	Training, teaching, instructing	x	x
v190	Consulting, informing others	x	x
v191	Measuring, testing, quality controlling	x	
v192	Surveillance, operating machinery, plants, or processes		
v193	Repairing, renovating	x	
v194	Purchasing, procuring, selling	x	x
v195	Organizing, planning	x	x
v196	Advertising, public relations, marketing, promoting business	x	
v197	Information acquisition and analysis, investigations	x	
v198	Conducting negotiations	x	x
v199	Development, research	x	
v200	Manufacture or production of merchandize		
v201	Providing for, waiting on, caring for people	x	
v223	Practicing labor law	x	
v224	Practicing other forms of law	x	

Source: BIBB-IAB Qualification and Career Survey 1998/1999.
Note: Classification of non-routine or interactive tasks by Spitz-Oener (2006). v189-v224 codes are variable abbreviations in the BIBB-IAB data.

IV Instrumental Variables Regressions

A cause of concern is that simultaneity problems may affect equation (5). If *OE* at ℓ and onshore demand for work type i are simultaneously determined, then γ_ℓ may be biased. Instrumenting for *OE* helps assess this problem if a valid and strong instrument for *OE* can be found. We report estimation results from using the two-year lag of *OE* as instrument. Using the two-year lag of foreign labor input in our cost function estimation follows an identification strategy similar to Blundell and Bond (2000) who use lagged factor inputs as instruments for present factor inputs to estimate production functions.[29] Our instruments are valid if current home employment is not related to past *OE* other than through current *OE* itself, conditional on other MNE-level performance variables in equation (5). While we consider this assumption plausible for the operation of MNEs, we do not want to overly stress the results. Much of our emphasis is on the predicted relationship between *OE* and the onshore workforce composition, and we largely interpret this relationship as an informative correlation for theory and further empirical work rather than a causal one.

Table IV.4 shows the results for all four advanced work types from two-stage least squares regressions using the all-sector sample. The lower panel reports results from the first-stage regression corresponding to the second-stage regression in the upper panel. Past offshore employment is a highly significant predictor of current offshore employment, and thus a strong instrument.[30]

[29] Blundell and Bond (2000) estimate a GMM production function for first-differenced variables. We use a conventional ordinary least-squares approach for comparability to the existing literature on MNEs and allow for plant effects. Alternative instruments at the industry level, such as *OE* by Swedish MNEs and exports and imports by Germany's trading partners, have not proven to be sufficiently strong instruments in first-stage specifications.

[30] One might prefer an 'independent' source of variation to a lagged endogenous variable as an instrumental variable,

Table III.2: Offshoring and Tasks for Alternative Task Measures

	Strict def.		Lenient def.		Spitz-Oener def.	
Task:	Non-rout.	Interact.	Non-rout.	Interact.	Non-rout.	Interact.
	(1)	(2)	(3)	(4)	(5)	(6)
Offshore empl. share	2.505	1.653	2.217	1.280	2.946	3.150
	(.585)***	(.293)***	(.564)***	(.338)***	(.376)***	(.440)***
Log Cap./Val. add.	.524	.042	.545	.289	-.490	-.729
	(.144)***	(.072)	(.138)***	(.083)***	(.092)***	(.107)***
Log Value added	.322	-.072	.153	.164	-1.165	-1.281
	(.102)***	(.051)	(.099)	(.059)***	(.067)***	(.078)***
Obs.	5,008	5,008	5,008	5,008	5,008	5,008
R^2 (within)	.004	.005	.005	.005	.054	.037
R^2 (between)	.069	.024	.057	.040	.154	.202
R^2 (overall)	.064	.023	.053	.038	.150	.196

Sources: Linked STATISTIK-BA/MIDI data 1998-2001 and BIBB-IAB worker survey 1998/99, balanced panel of MNE plants.
Notes: Estimators are plant random effects, conditional on year effects (not reported). Standard errors in parentheses: * significance at ten, ** five, *** one percent.

In the second stage, the estimated coefficients for worldwide offshoring (columns 1 to 4) are all positive and statistically significant, except for white-collar occupations.[31] So, overall, the instrumental variable regressions never overturn any of our findings and confirm our earlier results when statistically significant.

but such variables aren't readily available.

[31] In the second-stage regressions, we control for plant random effects. Results from fixed-effect estimations are qualitatively similar, but the point estimates are larger in absolute magnitude at the same time as they have larger standard errors, rendering them statistically insignificant.

Table III.3: OFFSHORING AND TASKS: SECTOR-LEVEL CONTROLS

	Non-routine tasks		Interactive tasks	
	(1)	(2)	(3)	(4)
Offshore empl.	2.505 (.585)***	2.499 (.572)***	1.653 (.293)***	1.706 (.288)***
Log Capital/Value added	.524 (.144)***	.333 (.142)**	.042 (.072)	-.007 (.072)
Log Value added	.322 (.102)***	.105 (.102)	-.072 (.051)	-.101 (.052)**
Industry-level controls				
Offshoring (narrow)		9.453 (4.875)*		3.360 (2.485)
R&D share in production		22.041 (17.812)		33.665 (8.958)***
Import penetration share in absorption		-1.496 (2.036)		-9.078 (1.027)***
Wage-bill share of non-routine tasks in non-MNEs		36.423 (2.754)***		
Wage-bill share of interactive tasks in non-MNEs				14.365 (1.801)***
Obs.	5008	5002	5008	5002
R^2 (within)	.004	.006	.005	.002
R^2 (between)	.069	.199	.024	.157
R^2 (overall)	.064	.197	.023	.149

Sources: Linked STATISTIK-BA/MIDI data 1998-2001 and BIBB-IAB worker survey 1998/99, balanced panel of MNE plants.
Notes: Estimators are plant random effects, conditional on year effects. Robust standard errors, clustered at the two-digit industry level, in parentheses: * significance at ten, ** five, *** one percent.

Table IV.4: OFFSHORING, TASKS AND SKILLS: IV ESTIMATES

	Non-routine tasks	Inter-active tasks	Highly educ. (Abitur+)	White-collar occup.
	(1)	(2)	(3)	(4)
Offshore empl. share	4.760	3.136	6.607	4.153
	(1.463)***	(.680)***	(2.439)***	(3.604)
Log Cap./Val. add.	.653	.024	.786	-1.440
	(.165)***	(.081)	(.320)**	(.371)***
Log Value added	.461	-.110	.920	-2.704
	(.102)***	(.050)**	(.200)***	(.223)***
Year 1999	.154	.079	.516	1.442
	(.133)	(.068)	(.280)*	(.281)***
Year 2000	.171	.053	.581	2.050
	(.137)	(.070)	(.285)**	(.292)***
Year 2001	.096	-.071	.495	1.840
	(.142)	(.072)	(.293)*	(.305)***
First stage estimates for offshore employment share				
Offshore empl. share $(t-2)$	.872	.872	.875	.872
	(.007)***	(.007)***	(.007)***	(.007)***
Obs.	4900	4900	4815	4900
R^2 (within)	.005	.005	.008	.032
R^2 (between)	.067	.023	.060	.092
R^2 (overall)	.061	.020	.052	.091

Sources: Linked STATISTIK-BA/MIDI data 1998-2001 and BIBB-IAB worker survey 1998/99, MNE plants only, all sectors.
Notes: Two-period lag of offshore employment serves as instrument for current offshore employment. Estimators are plant random effects. Robust standard errors, clustered at the MNE level, in parentheses: * significance at ten, ** five, *** one percent.

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