

# 14

## Consistency of Original and Re-Simulation Performance of LINKS Simulations Firms

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Revised August 31, 2020

A re-simulation of a completed LINKS simulation industry provides an overall test of the internal validity of the LINKS software architecture.

- ✓ A re-simulation re-uses all firms' decisions and simulation parameters from a completed industry in their original time sequencing and re-simulates (re-runs) the industry from beginning to end.
- ✓ Since the firms' decisions don't change from the original to the re-simulation, it's only the inherent randomness built into the LINKS software architecture that differs.
- ✓ Internal validity requires a high correspondence (correlation) between the performance of firms in the original and re-simulated LINKS industries.

But, of course, the question remains: "how high is 'up'?" ... how high is the correspondence (correlation) between the performance of LINKS firms in original and re-simulated industries?

Six recent multi-industry LINKS events each included multiple industries with the same LINKS simulation variant and the same underlying scenario/parameter file. These six multi-industry events included 24 industries with a total of 147 LINKS firms with LINKS enterprise management, marketing, services, and supply chain management simulations. Collectively, these multi-industry replications of six different LINKS simulations provide a rich empirical basis to examine the consistency of original and re-simulation performance of LINKS firms.

For overall firm performance within a LINKS event, two within-simulation performance metrics were examined:

1. **Retained Earnings** (cumulative after-tax earnings of a firm throughout a LINKS simulation event).
2. **Within-Simulation Grade** (a percentage grade scaled to a mean of 85% and the 70%-100% range within each LINKS industry, based on a quantitative multi-factor balanced scorecard performance evaluation system described in the LINKS student manual; the LINKS multi-factor balanced scorecard performance evaluation system includes multiple within-industry financial, operational and customer-facing key performance indicators).

Re-simulation results<sup>1</sup> are reported in Table 1. As may be noted, 41 of the 48 re-simulation correlations are 0.95 or larger. Only two of the 48 re-simulation correlations are less than 0.90, and these two re-simulation correlations are in the 0.82 to 0.85 range.

The very high correlations between the original and re-simulated industries for the two overall firm performance metrics, retained earnings and within-simulation grade, across the 24 industries in these

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<sup>1</sup> These LINKS industries were re-simulated from their original round-3 position, the point at which LINKS student teams assumed managerial control of their firms. In the standard LINKS setup, all firms have identical decisions and market positions as LINKS begins and there's no randomness in the initial round-1 results. In advancing LINKS to round 3, randomness exists in the round-2 and round-3 results. In beginning LINKS events with available round-3 results, student teams have some meaningful sales history when they begin their LINKS work.

six multi-industry LINKS events provide reassuring evidence of the robustness and internal validity of the LINKS software architecture.

For LINKS instructors and students, these results provide strong support for the summary statement:

*“It’s not the LINKS simulation’s inherent randomness that determines your performance and results; it’s the quality of your firm’s decisions relative to your competitors’ decisions.”*

**Table 1: Re-Simulation Correlations**

Data Source	Original LINKS Industry Code	Correlations Between Original and Re-Simulation Firm Performance	
		Retained Earnings	Grade
LINKS Enterprise Management Simulation <ul style="list-style-type: none"> <li>• 23 firms in 3 industries</li> <li>• 10-round events</li> <li>• LINKS @ Pennsylvania State University</li> </ul>	GEA	0.996	0.980
	GEB	0.996	0.987
	GEC	0.959	0.976
LINKS Marketing Simulation <ul style="list-style-type: none"> <li>• 16 firms in 4 industries</li> <li>• 10-round events</li> <li>• LINKS @ University of Arizona</li> </ul>	UAA	0.996	0.934
	UAB	0.997	0.996
	UAC	1.000	0.985
	UAD	0.999	0.987
LINKS Marketing Strategy Simulation <ul style="list-style-type: none"> <li>• 30 firms in 5 industries</li> <li>• 12-round events</li> <li>• LINKS @ Hogeschool Utrecht</li> </ul>	HUA	0.985	0.986
	HUB	0.965	0.972
	HUC	0.994	0.995
	HUD	0.993	0.964
	HUE	0.846	0.935
LINKS Services Marketing Simulation <ul style="list-style-type: none"> <li>• 24 firms in 4 industries</li> <li>• 9-round events</li> <li>• LINKS @ IIM – Lucknow</li> </ul>	RKA	0.951	0.822
	RKB	0.983	0.981
	RKC	0.976	0.906
	RKD	0.971	0.928
LINKS Services Management Simulation <ul style="list-style-type: none"> <li>• 12 firms in 2 industries</li> <li>• 11-round events</li> <li>• LINKS @ Katholische Universitaet Eichstaett-Ingolstadt and University of Paderborn (two-university competition)</li> </ul>	AAA	0.994	0.939
	BBB	0.996	0.994
LINKS Supply Chain Management Simulation <ul style="list-style-type: none"> <li>• 42 firms in 6 industries</li> <li>• 12-round events</li> <li>• LINKS Global SCM Competition</li> </ul>	SC1	0.986	0.959
	SC2	0.985	0.963
	SC3	0.950	0.957
	SC4	0.988	0.974
	SC5	0.972	0.964
	SC6	0.980	0.977