APPENDIX 5

The LPI methodology

Because logistics has many dimensions, measuring and summarizing performance across countries are challenging. Examining the time and costs associated with logistics processes—port processing, customs clearance, transport, and the like—is a good start, and in many cases this information is readily available. But even when complete, this information cannot be easily aggregated into a single, consistent, cross-country dataset, because of structural differences in countries' supply chains. Even more important, many critical elements of good logistics—such as process transparency and service quality, predictability, and reliability—cannot be assessed using only time and cost information.

Constructing the international LPI

The main part of the Logistics Performance Index (LPI) survey (questions 4 to 9 in the 2023 edition) provides the raw data for the international LPI. Each survey respondent rates up to eight overseas markets on six core components of logistics performance. The eight countries are chosen based on the most important export and import markets of the country where the respondent is located, on random selection, and—for landlocked countries—on neighboring countries that form part of the land bridge connecting them with international markets (table A5.1).

Respondents take the survey online. The survey for this edition was open from September 6

Table A5.1 Methodology for selecting country groups for survey respondents

	Respondents from low-income countries	Respondents from middle-income countries	Respondents from high-income countries
Respondents from coastal countries	Five most important export partner countries + Three most important import partner countries	Three most important export partner countries + The most important import partner country + Four random countries, one from each country group: a. Africa b. East Asia and Central Asia c. Latin America d. Europe less Central Asia and OECD	Two random countries from a list of the five most important export partner countries and five most important import partner countries + Four random countries, one from each country group: a. Africa b. East Asia and Central Asia c. Latin America d. Europe less Central Asia and OECD + Two random countries from the combined country groups a, b, c, and d
Respondents from landlocked countries	Four most important export partner countries + Two most important import partner countries + Two land-bridge countries	Three most important export partner countries + One most important import partner country + Two land-bridge countries + Two countries randomly, one from each country group: a. Africa, East Asia and Central Asia, and Latin America b. Europe less Central Asia and OECD	

Source: 2023 LPI team.

to November 5, 2022. The web engine for the survey underlying the 2023 LPI was the same as the engine put in place in 2012 (and used in subsequent editions). It incorporates the uniform sampling randomized approach to gain the most possible responses from underrepresented countries. Because the survey engine relies on a specialized country selection methodology for survey respondents based on high trade volume between countries, the uniform sampling randomized approach can help countries with lower trade volumes rise to the top during country selection.

The survey engine builds a set of eight countries for the survey respondents (see table A5.1). After 200 surveys, the uniform sampling randomized approach is introduced into the engine's process for country selection. For each new survey respondent, the approach solicits a response from a country chosen at random but with nonuniform probability—with weights chosen to evolve the sampling toward uniform probability. Specifically, a country i is chosen with a probability $(N–n_i) / 2N$, where n_i is the sample size of country i so far, and N is the total sample size. As country sample sizes grew above 100, the country selection engine excluded oversampled countries from the pool to increase responses from underrepresented countries.

The international LPI is a summary indicator of logistics sector performance, combining data on six core performance components into a single aggregate measure. Some respondents did not provide information for all six components, so interpolation was used to fill in missing values. The missing values were replaced with the country mean response for each question, adjusted by the respondent's average deviation from the country mean in the answered questions.

The six core components are:

- The efficiency of customs and border management clearance, rated from very low (1) to very high (5) in survey question 4.
- The quality of trade and transport infrastructure, rated from very low (1) to very high (5) in survey question 5.
- The ease of arranging competitively priced shipments, rated from very difficult (1) to very easy (5) in survey question 6.
- The competence and quality of logistics services, rated from very low (1) to very high (5) in survey question 7.
- The ability to track and trace consignments, rated from very low (1) to very high (5) in survey question 8.
- The frequency with which shipments reach consignees within scheduled or expected delivery times, rated from hardly ever (1) to nearly always (5) in survey question 9.

The overall LPI score is constructed from these six indicators using principal component analysis, a standard statistical technique used to reduce the dimensionality of a dataset. In the LPI, the inputs for principal component analysis are country scores on questions 4–9, averaged across all respondents providing data on a given overseas market. Scores are normalized by subtracting the sample mean and dividing by the standard deviation before conducting the principal component analysis. The output from the analysis is a single indicator—the LPI score—which is a weighted average of those scores. The weights are chosen to maximize the percentage of variation in the LPI's original six indicators that is accounted for by the summary indicator.

The first (principal) eigenvalue of the correlation matrix of the six core indicators is greater than 1—and much larger than any other eigenvalue (see the first line of table A5.2). Standard statistical tests, such as the Kaiser Criterion and the eigenvalue scree plot, suggest that a single principal component be retained to summarize the underlying data. This principal component is the international LPI score. The international LPI accounts for 91 percent of the variation in the six components.

Table A5.2 Results of principal component analysis for the 2023 international LPI score

Component	Eigenvalue	Difference	Proportion	Cumulative
1	5.47139	5.27856	0.9119	0.9119
2	0.192832	0.034632	0.0321	0.9440
3	0.1582	0.0797762	0.0264	0.9704
4	0.0784234	0.0263933	0.0131	0.9835
5	0.0520301	0.00490627	0.0087	0.9921
6	0.0471239	na	0.0079	1.0000

Source: 2023 LPI team.
Note: na is not applicable.

Table A5.3 Component loadings for the 2023 international LPI score

Component	Weight
Customs	0.4105
Infrastructure	0.4133
International shipments	0.3931
Logistics quality and competence	0.4168
Tracking and tracing	0.4133
Timeliness	0.4021

Source: 2023 LPI team.
Note: na is not applicable.

To construct the international LPI score, normalized scores for each of the six original indicators are multiplied by their component loadings (table A5.3) and then summed. The component loadings represent the weight given to each original indicator in constructing the international LPI score. Since the loadings are similar for all six, the international LPI score is close to a simple average of the indicators. Although principal component analysis is rerun for each version of the LPI, the weights remain steady from year to year. There is thus a high degree of comparability across LPI editions.

Constructing the confidence intervals

To account for the sampling error created by the LPI's survey-based methodology, LPI scores are presented with approximate 80 percent confidence intervals. These intervals make it possible to provide upper and lower bounds for a country's LPI score. To determine whether a difference between two scores is statistically significant, confidence intervals must be examined carefully. For example, a statistically significant improvement in a country's performance should not be concluded unless the lower bound of the country's 2023 LPI score exceeds the upper bound of its 2018 score.

To calculate the confidence interval, the standard error of LPI scores across all respondents is estimated for a country. The upper and lower bounds of the confidence interval are then

$$LPI \pm \frac{t_{(0.1,\,N-1)}S}{\sqrt{N}},$$

where LPI is a country's LPI score, N is the number of survey respondents for that country, s is the estimated standard error of each country's LPI score, and t is Student's t-distribution. As a result of this approach, confidence intervals and low-high ranges for scores are larger for small markets with few respondents, since these estimates are less certain. The average confidence interval on the 1–5 scale is 0.25, or about 8 percent of the average country's LPI score. Hence, caution must be taken when interpreting small differences in LPI scores.

LPI scores have two limitations. First, the experience of international freight forwarders might not represent the broader logistics environment in poor countries, which often relies on traditional operators. And international and traditional operators might differ in their interactions with government agencies—and in their service levels. Second, for landlocked countries and small island states, the LPI might reflect access problems outside the country assessed, such as transit difficulties. The low rating of a landlocked country might not adequately reflect its trade facilitation efforts, which depend on the workings of complex international transit systems. Landlocked countries cannot eliminate transit inefficiencies with domestic reforms.