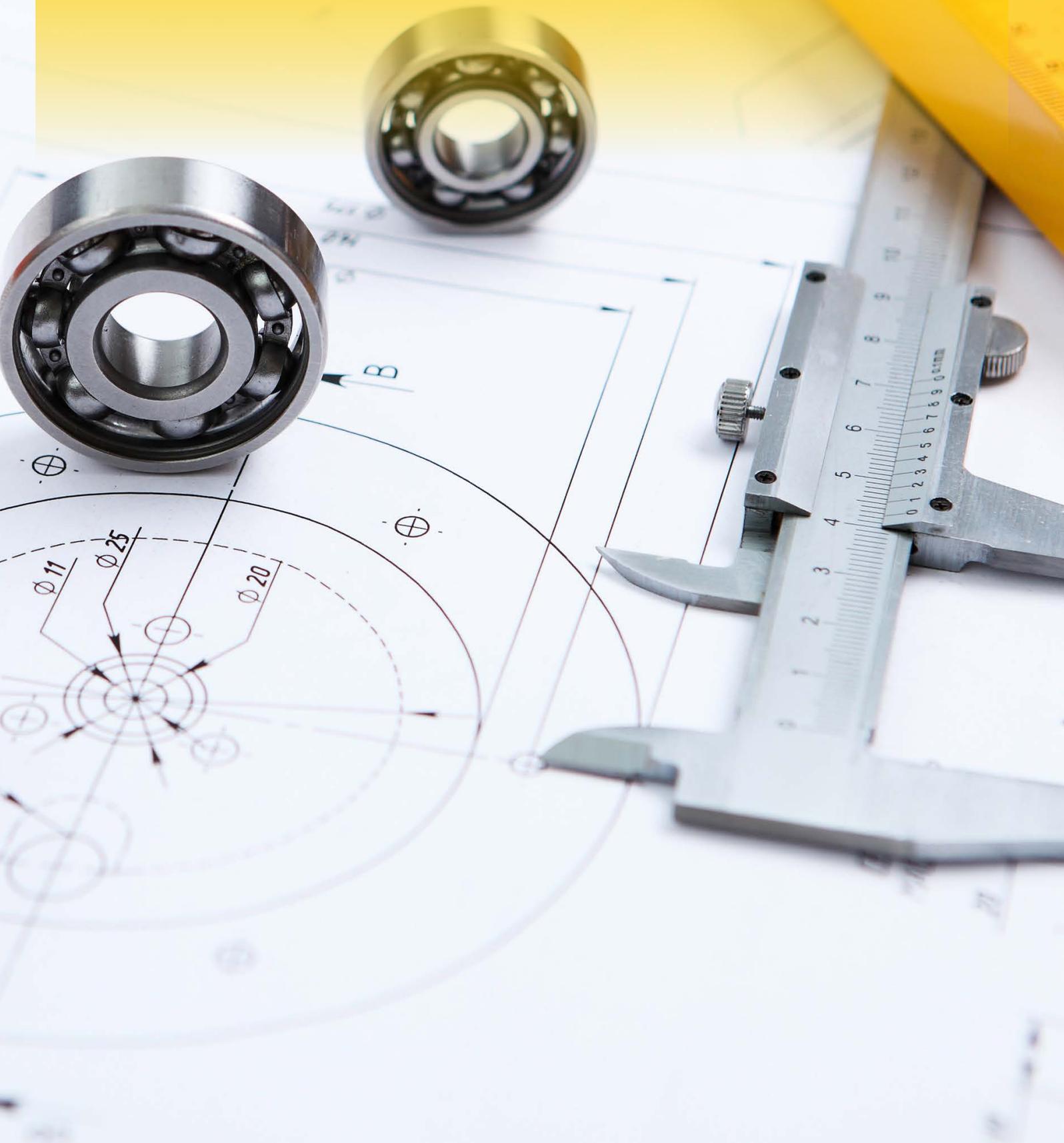CHAPTER 3
DHL GLOBAL CONNECTEDNESS INDEX METHODOLOGY

This chapter explains how the DHL Global Connectedness Index was constructed and describes the rationale for key methodological decisions.[1] For a list of data sources employed and additional technical notes, please refer to Appendix B.

This explanation proceeds in five parts. First, it describes the selection of a set of specific aspects of the broad phenomenon of global connectedness that are covered in the index. Second, it defines quantitative metrics for the measurement of each of these aspects of connectedness. Third, it identifies gaps in the availability of the data required to calculate those metrics, and discusses how such gaps were addressed. Fourth, it describes how these diverse metrics were made comparable before they were combined into the index ("normalization"). Fifth, it explains the aggregation and weighting mechanisms via which the metrics were finally combined into the index. Throughout this chapter, the example of the Netherlands (the top ranked country on the 2018 DHL Global Connectedness Index) will be used to illustrate the calculations that were performed to generate the index.

The methodology used to calculate the 2018 DHL Global Connectedness Index remains largely the same as in previous editions of the index. Where methodological changes have been introduced in this edition, such adjustments and the rationales for them are described in the sections that follow. The data used to compute the index have been completely updated both to extend the results up to 2017 as well as to incorporate revised source data for prior years.

1. Selecting Aspects of Connectedness to Measure

Global connectedness is a multifaceted phenomenon incorporating many types of connections, so its measurement necessarily requires one to proceed from a specific definition of the phenomenon to the selection of a set of underlying metrics that will be included in its assessment.

For the purpose of constructing the DHL Global Connectedness Index, the starting point is the following definition of global connectedness: Global Connectedness Refers to the *depth* and *breadth* of a country's integration with the rest of the world, as manifested by its participation in international flows of *products and services, capital, information, and people.*

As this definition implies, connectedness is measured here based on actual flows that take place between and among countries. Depending on relevant time frames and data availability, some flows are measured directly in the current year while others are measured based on stocks cumulated from prior year flows. The focus on actual flows is motivated by the sense that, while connectivity or the technical potential for connectedness has improved a great deal thanks to changes in transportation and communications technologies, actual levels of flows significantly lag that potential. This focus also allows the index to be generated based on hard data, which makes it ideal for dispelling myths about globalization ("globaloney").[2]

Furthermore, by focusing the index itself on actual flows, enablers of connectedness (such as the political variables covering tariffs, embassies, and so on, included in other globalization indexes) may be analyzed separately in relation to the index (since they are not mixed into the index along with the actual flows). This is intended to make the index more useful for policymakers seeking insight into how to foster the aspects of connectedness that they deem most constructive for their countries, a topic that was examined at some length in Chapters 4 and 5 of the 2011 edition and Chapter 4 of the 2012 edition of this report.

The definition of global connectedness used here also identifies four specific categories of flows that are covered as the

TABLE 3.1 //
PILLARS AND COMPONENTS

Pillar	Component
1. Trade	1.1. Merchandise Trade
	1.2. Services Trade
2. Capital	2.1. Foreign Direct Investment (FDI) Stocks
	2.2. Foreign Direct Investment (FDI) Flows
	2.3. Portfolio Equity Stocks
	2.4. Portfolio Equity Flows
3. Information	3.1. International Internet Bandwidth
	3.2. Telephone Call Minutes*
	3.3. Trade in Printed Publications
4. People	4.1. Migrants (foreign born population)
	4.2. Tourists (departures and arrivals)
	4.3. Students

*In this edition of the index, we have added to our telephone calls depth ratios rough estimates of call minutes between users of internet-based calling applications (Skype, WeChat, WhatsApp, etc.). In prior editions, calls placed via such applications were only included if they were terminated on fixed or mobile phones. To facilitate this adjustment, we have changed from separately reporting outbound and inbound telephone calls depth to simply reporting overall telephone calls depth (i.e. without directionality). For consistency, we now also report telephone calls breadth without directionality (even though calls between users of internet-based calling applications could not be incorporated into the breadth analysis at this time due to data limitations). We are comfortable removing directionality from the telephone calls component of the index because the actual exchange of information on a telephone call does not depend on which party placed the call. In this sense, phone calls are different from all other variables for which we continue to report directional results. The distinction between inbound and outbound calls is, for example, less relevant than the distinction between exports and imports or between emigrants and immigrants.

four pillars of the index. These are: trade flows (products and services), investment flows (capital), information flows, and people flows. While the selection of these categories of flows was ultimately a subjective choice, they seem to encompass broadly the aspects of international connectedness that have maximum relevance for business people, policymakers, and ordinary citizens concerned with the impact of globalization on their life opportunities.[3]

Within these four pillars, individual types of flows are the component building blocks from which the index is built. These were selected via an extensive search for data on actual flows corresponding to each of the four pillars, followed by the choice of a small set of flows within each based on their importance to the overall phenomenon of connectedness as well as the availability of data on which they could be measured. The 12 components that were ultimately selected across the four pillars are shown in **Table 3.1**.

A few points merit elaboration regarding the selection of aspects of connectedness for measurement. First are the cases where stocks cumulated from prior flows are utilized. In the capital pillar, flows are paired with stocks. Foreign investment stocks (the result of flows accumulated over

time, as well as reinvested earnings and changes in the valuation of assets) are an important indicator of enduring connections between countries, which have ongoing effects via corporate governance, and in the case of FDI, through managerial control. Investment stocks also help balance out the high year-to-year volatility of capital flows. On the people pillar, migration and international students are also measured using stocks (the number of people abroad at a given time rather than those who moved in a given year). This aligns with the long-term and medium-term nature of these interactions (which have multi-year time horizons), and complements the short-term nature of tourism, which rounds out the people pillar and is measured based on annual flows. The links that migrants and students retain to their countries of origin reflect aspects of connectedness that persist beyond the years when they relocated.

The second departure from the standard focus on flows is the inclusion of international internet bandwidth, which is used as a proxy for international internet traffic because of the lack of sufficient data on the latter.[4]

Additionally, some aspects of connectedness were excluded due to normative considerations. Because the index has been designed to help countries identify and pursue opportunities to capture more of the potential benefits of connectedness, flows that are generally viewed as primarily harmful (especially on a net global basis) are not covered in the index.[5] For example, an index focused on harms might include international transmission of diseases and cross-border environmental pollution, but these are not covered here.[6]

Somewhat more controversially, the coverage of capital flows in this index focuses on equity capital, and excludes all forms of cross-border debt except debt that is part of foreign direct investment. This reflects research indicating the more favorable impact of international equity investment (especially foreign direct investment but also portfolio equity) relative to debt investment. The financial crisis that began in 2007-08 provided an illustration of some of the risks associated with high levels of international indebtedness.

2. Defining Metrics
Having identified the set of component flows based on which to measure global connectedness, the next step is to identify appropriate metrics for each of these flows. Building on our definition of global connectedness, these metrics should capture each flow's depth as well as its breadth. Consider each of these aspects in turn.

TABLE 3.2 //
DEPTH METRICS BY COMPONENT

Pillar	Component	Domestic Comparison for Depth
1. Trade	1.1. Merchandise Trade	GDP
	1.2. Services Trade (Commercial Services Only)	GDP
2. Capital	2.1. Foreign Direct Investment (FDI) Stocks	GDP
	2.2. Foreign Direct Investment (FDI) Flows (moving average of last 3 years)	Gross Fixed Capital Formation (GFCF)
	2.3. Portfolio Equity Stocks	Stock Market Capitalization
	2.4. Portfolio Equity Flows (moving average of last 3 years)	Stock Market Capitalization
3. Information	3.1. International Internet Bandwidth	Internet Users
	3.2. Telephone Call Minutes	Population
	3.3. Trade in Printed Publications (H.S. Code 49 covering printed books, newspapers, pictures, etc.)	Population
4. People	4.1. Migrants (foreign born population)	Population
	4.2. Tourists (departures and arrivals of overnight tourists)	Population
	4.3. Students	Tertiary Education Enrollment

DEPTH refers to the size of a country's international flows as compared to a relevant measure of the size of its domestic economy. It reflects in simple terms how important or pervasive interactions with the rest of the world are in the context of business or life in a particular country.

For the merchandise trade component, depth is measured by comparing the value of each country's merchandise exports and imports to its GDP, yielding the metrics merchandise exports and merchandise imports as percent of GDP. Thus, in 2017, the Netherlands' merchandise exports were 79% of its GDP and merchandise imports 70%.

A comparison of the Netherlands versus the United States illustrates the importance of scaling depth metrics based on the size of each country's national economy. US exports were more than twice as large as the Netherlands' exports in 2017, but the US economy was roughly 23 times larger. Thus, even though the United States was a much larger exporter, the Netherlands was far more connected than the United States internationally with respect to merchandise exports, as reflected by its exports as percent of GDP ratio of 79% versus only 8% for the United States. As tends to be the case, the vast majority of economic activity in a large country such as the US takes place within the country's borders, whereas smaller countries tend to have a much higher proportion of their business activity involving foreign buyers or sellers.

To implement these depth metrics, a relevant measure of a country's domestic economy must be selected as the basis

of comparison for each type of international flow. Such measures are identified in **Table 3.2**, which also provides additional details about the flow metrics used for assessing depth.

Foreign direct investment (FDI) flows are compared with gross fixed capital formation (GFCF). This measure is a more precise match for FDI flows than GDP, allowing the metric to characterize the percentage of a country's fixed capital investment that takes place across versus within international borders.[7] For portfolio equity flows and stocks, stock market capitalization is used as the domestic comparison, as a large proportion of portfolio equity investment takes place on public stock markets.

FDI and portfolio equity flows are measured using a three year moving average because these flows tend to be especially volatile. Year-to-year fluctuations in such metrics tend to reflect macroeconomic conditions and merger waves more than long-lived changes in levels of connectedness.

Information and people flows are measured on a per-capita basis. Total population is used across all of these metrics except international internet bandwidth (where internet users is a more precise match) and international university students (where total tertiary education enrollment is the best match).

FIGURE 3.1 // COUNTRY MERCHANDISE EXPORTS VERSUS REST OF WORLD IMPORTS (%)
### TOP 40 IMPORTING COUNTRIES ONLY
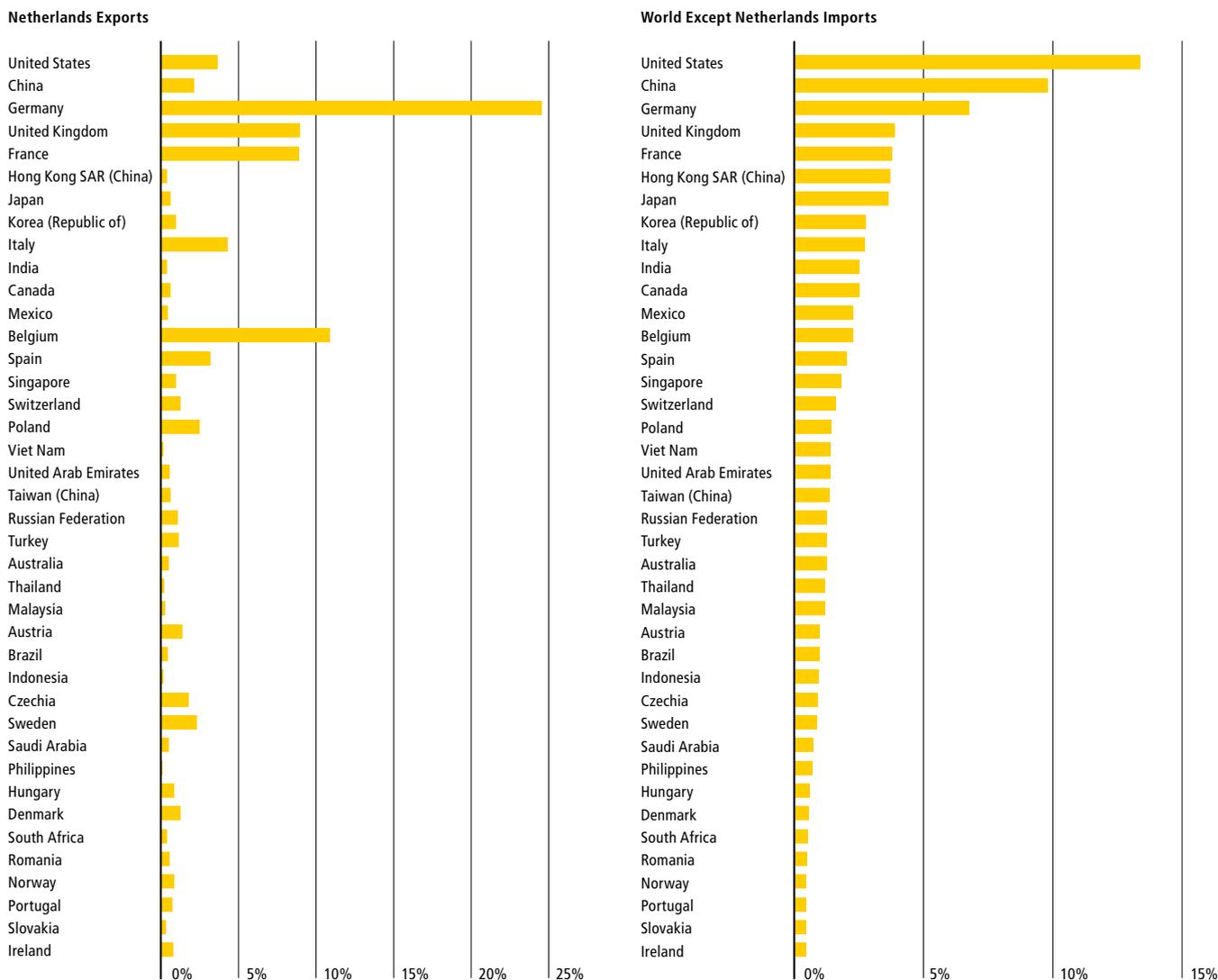
For the measurement of the depth of services trade, only commercial services are included; government services are excluded.

BREADTH measures how closely a country's distribution of international flows across its partner countries matches the global distribution of the same flows in the opposite direction. The breadth of a country's merchandise exports, for example, is measured based on the difference between the distribution of its exports across destination countries versus the rest of the world's distribution of merchandise imports.

To elaborate how this metric works, compare the breadth of the Netherlands' merchandise exports versus those of Switzerland and Eswatini (Swaziland). The Netherlands

ranks 39th globally on this metric, and Switzerland and Eswatini are the top and bottom ranked countries on this metric respectively. **Figure 3.1** juxtaposes each of these countries' distributions of merchandise exports by destination against the distribution of the rest of the world's merchandise imports. To make the charts easier to read, only the top 40 importers are shown in each pair. Notice how Switzerland's exports most closely resemble world imports, the Netherlands' bear moderately close resemblance, and Eswatini's bear almost no resemblance at all (85% of Eswatini's exports go to just one country, South Africa). Thus, Switzerland's exports have the highest breadth, the Netherlands' are fairly close behind, and Eswatini's have very low breadth.

FIGURE 3.1 // COUNTRY MERCHANDISE EXPORTS VERSUS REST OF WORLD IMPORTS (%)
TOP 40 IMPORTING COUNTRIES ONLY (CONTINUED)

Switzerland Exports

World Except Switzerland Imports
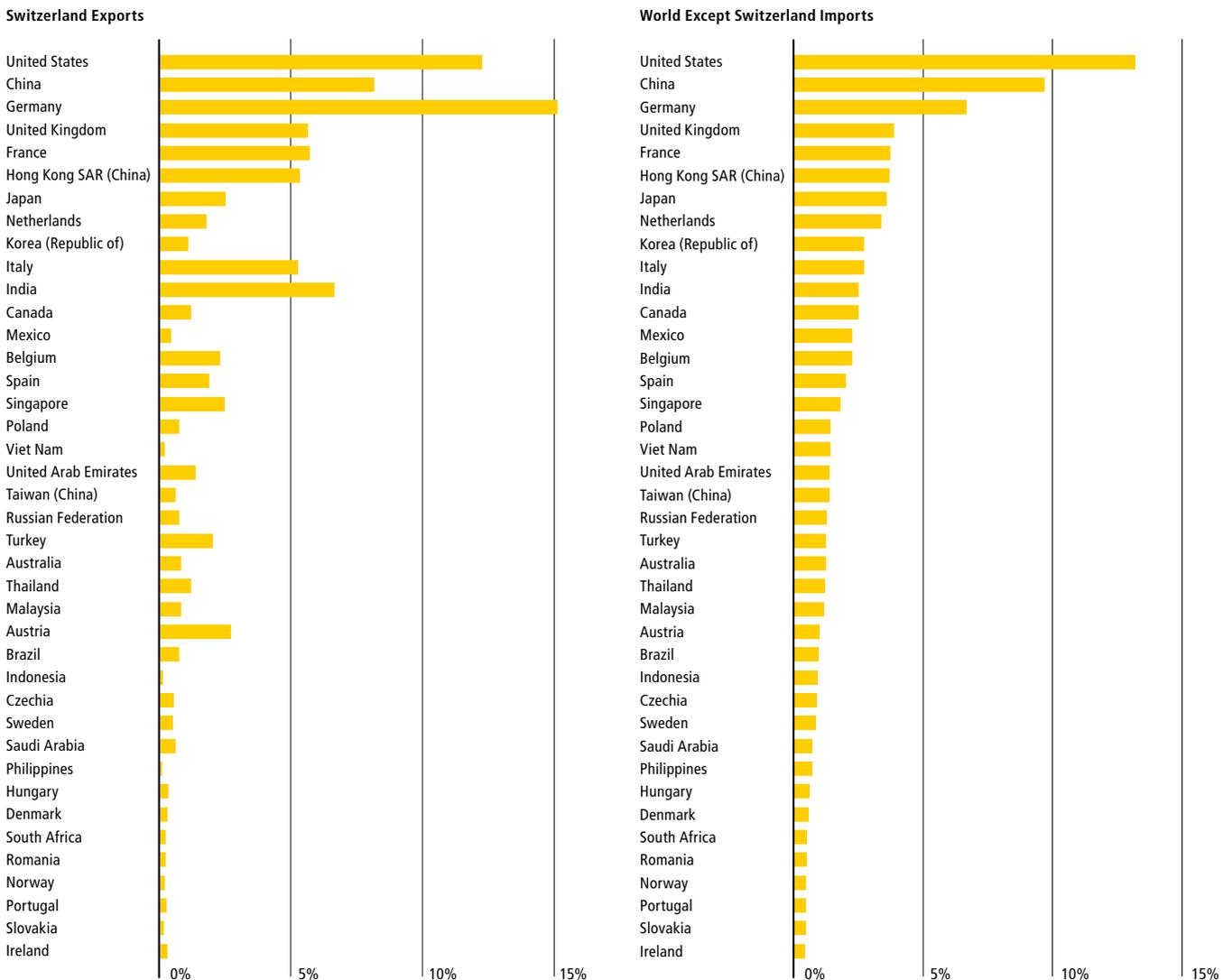
To convert the graphical pattern exhibited on these charts into a numerical metric, the absolute value of the difference between each bar on the right and left charts in each set (exports minus world except focal country imports) is computed, and then these values are summed vertically across all of the bars (partner countries). The scores are then re-scaled between 0 and 1 and subtracted from the number 1 in order to reverse the order, so that the country with the highest breadth score (lowest sum of the absolute values) is the country whose exports best match world imports and the country with the lowest score (highest sum of the absolute values) has the least close match between its exports and world imports.

To summarize mathematically (using exports as an example), breadth is calculated for a Country A by finding the sum across all partner countries of [Absolute Value of (Partner Country's % Share of Country A's Exports minus Partner Country's % Share of World Imports Excluding Country A's Imports)]. These results are re-scaled between 0 and 1 and then subtracted from the number 1 for convenience.

As the focus in breadth is on the geographical distribution of the flows, the absolute value of capital flows is considered when calculating breadth. This eliminates the possibility of there being anomalous results for some countries due, for example, to a large negative value caused by a repatriation of capital, which is better captured in depth than breadth.

In this edition of the index, we have refined how we construct the global distributions of opposite direction flows

FIGURE 3.1 // COUNTRY MERCHANDISE EXPORTS VERSUS REST OF WORLD IMPORTS (%)
TOP 40 IMPORTING COUNTRIES ONLY (CONTINUED)

Eswatini (Swaziland) Exports

World Except Eswatini (Swaziland) Imports
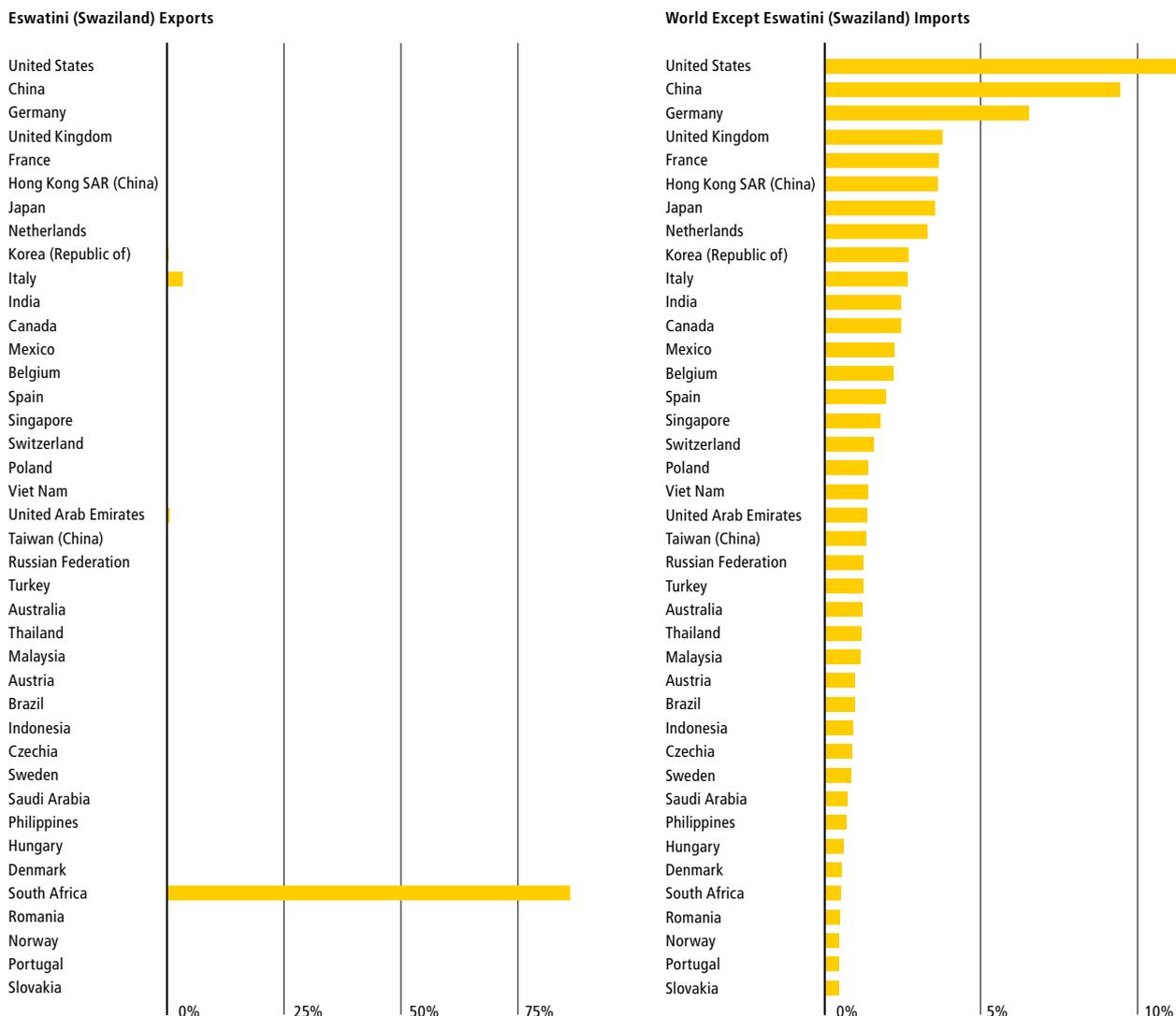
used in breadth calculations in order to better handle gaps and inconsistencies in the reported data. In prior editions of the index, we have used sums across partner country data for the flow direction being analyzed to calculate the implied global distributions (e.g. sums across export destinations to calculate the implied global distribution of imports). An alternative method is to use the reported totals of flows in the opposite direction (e.g. the values reported by the importing countries). Since both types of data can be incomplete, neither method alone results in an ideal comparison. Therefore, in this edition, we combine both methods. We rely primarily on directly reported world totals for opposite direction flows, but in cases where those are not available, we employ sums across partner countries to add in implied opposite direction flows.[8]

3. Addressing Data Gaps

Given the very large data requirements of an analysis such as the DHL Global Connectedness Index (more than 3 million data points were used to produce the index over a 17-year period), there are many cases where the targeted data are unavailable. Data availability constraints are especially severe for breadth and for smaller and less developed countries. Therefore, five methods are employed to generate the index in spite of missing data: exclusion of some components from the breadth analysis, incorporation of data from alternative sources, filling gaps via interpolation and repetition, checking breadth data to ensure adequate coverage across partner countries, and adoption of minimum data availability thresholds to determine whether scores generated based on partial data are reportable.

TABLE 3.3 //
BREADTH COVERAGE BY COMPONENT

Pillar	Component	Covered in Breadth?
1. Trade	1.1. Merchandise Trade	Yes
	1.2. Services Trade	No
2. Capital	2.1. Foreign Direct Investment (FDI) Stocks	Yes
	2.2. Foreign Direct Investment (FDI) Flows (average of last 3 years)	Yes
	2.3. Portfolio Equity Stocks	Yes (Outward Only)
	2.4. Portfolio Equity Flows (average of last 3 years)	No
3. Information	3.1. International Internet Bandwidth	No
	3.2. Telephone Call Minutes	Yes
	3.3. Trade in Printed Publications (H.S. Code 49 covering printed books, newspapers, pictures, etc.)	Yes
4. People	4.1. Migrants (foreign born population)	Yes
	4.2. Tourists (departures and arrivals of overnight tourists)	Yes (Inbound Only)
	4.3. Students	Yes (Inbound Only)

First, it is not possible to cover all of the same component flows in breadth as in depth, because for many countries data are only available on the total magnitude of the flows in question, not how they are distributed by origin and destination. Therefore, some components that are included in depth are excluded from breadth, as shown in **Table 3.3**.

Second, we incorporate data from alternative sources to improve the coverage of the index across countries, components, and years. Whereas prior editions of the index relied almost exclusively on a single data source for each component metric, we now incorporate multiple sources, wherever it is useful to do so. The primary motivation for the introduction of this enhancement was the lack of a single data source for FDI flows breadth that would provide adequate coverage across countries and years for this edition of the index.[9]

For the depth dimension of the index, we designate a primary source for each metric, as shown in Appendix B, Table B.1. If that source is not available, a secondary source (also listed in the same appendix table) is used. For the breadth dimension, when multiple data sources are available for a given component, we choose sources to employ on a country-by-country basis. We start by identifying sources with adequate coverage across partner countries (as described later in this section) in the most recent year. If more than one source is available in the most recent year, we select the one with the longest available time series, and that source is used in all available years. Then, if other sources are available for years that are not covered by the

selected source, they are prioritized based on how similar their values are to those in the selected source, as measured by median ratios across data points available in both sources.

We have also expanded the breadth data employed in this edition of the index by filling gaps with "mirror data." Where data for a particular flow are not reported by a given country, the flows in the opposite direction, as reported by the partner countries, are used in the breadth calculation, subject to the requirement that they meet our coverage standards. Several of our data sources, such as the IMF Direction of Trade Statistics and the UNCTAD Bilateral FDI Database, already include mirror data, so this methodological enhancement simply extends the use of mirror data across all of the breadth datasets.

Third, for both depth and breadth, there are cases where the required data for one or more countries are available in some but not all of the years for which the index is to be calculated. The 2018 DHL Global Connectedness Index is based primarily on 2017 data, but where 2017 data are unavailable, the most recent available data are used.

When there are gaps in the available data in the middle of a data series (e.g. data are available for 2007 and 2009 but not 2008), constant growth rate interpolation is used to fill the gaps. When data gaps lie before or after all of the available data, they are filled by repeating the values for the closest available year (with a given value repeated a maximum of five times). For example, if the latest data available are from

TABLE 3.4 // MISSING COMPONENTS IN DEPTH (DATA MISSING FOR FULL OR CLOSE TO FULL COMPONENT IN AT LEAST ONE YEAR)

Component	Data Gap	Remedy
3.2. Telephone Call Minutes	No country-level 2017 data for TDM calls and VoIP calls terminated on fixed and mobile phones; no country-level OTT VoIP data for 2001-2012	For TDM calls and VoIP calls terminated on fixed and mobile phones in 2017, reported world total is distributed across countries according to the 2016 distribution; For OTT VoIP calls 2005–2012, estimated world totals distributed across countries according to the 2013 distribution; OTT VoIP calls assumed to be negligible before 2005
4.1. Migrants	Data available only for 2000, 2005, 2010, 2015 and 2017	Interpolation employed over 2001–2004, 2006–2009, 2011–2014 and 2016
4.2. Tourists	No 2017 data	2016 data repeated in 2017
4.3. Students	No 2017 data for most countries	2016 data repeated in 2017 where missing

TABLE 3.5 // MISSING COMPONENTS IN BREADTH (DATA MISSING FOR FULL OR CLOSE TO FULL COMPONENT IN AT LEAST ONE YEAR)

Component	Data Gap	Remedy
2.1. FDI Stocks	No 2017 data for most countries	2016 data repeated in 2017 where missing
2.2. FDI Flows	No 2017 data for most countries	2016 data (3 year averages) repeated in 2017 where missing
3.2. Telephone Call Minutes	No 2017 data	2016 data repeated in 2017
4.1. Migrants	Data available only for 2000, 2005, 2010, 2015 and 2017	Interpolation employed over 2001–2004, 2006–2009, 2011–2014, and 2016
4.2. Tourists	No 2017 data	2016 data repeated in 2017
4.3. Students	No 2017 data available for most countries	2016 data repeated in 2017 where missing

2013 (no data are available for 2014–2017), the 2013 value will be repeated over the period 2014–2017. If the most recent available data pertain to 2011, the 2011 value would be repeated over the period 2012–2016, and the value would be treated as missing (and not reported) in 2017.[10]

The use of constant growth rate interpolation is an enhancement introduced in this edition of the index. Prior editions employed linear interpolation to fill gaps in the middle of data series. This change has little impact on the index results, but it represents a methodological improvement because economic and demographic data tend to conform better to constant growth models rather than linear growth models. The numerical effect of this adjustment is that more of the change over time in an interpolated data series is now estimated to take place in later years than in earlier years. In cases where constant growth rate interpolation is not possible due to zero values or a change from positive to negative, linear interpolation is used instead.

In most cases, data gaps affect only a subset of the countries on any given component in any given year. However, there are some components where most or all countries have missing data for at least one year. Those cases and the remedies employed are described in **Tables 3.4 and 3.5.** Note that the data gaps are especially severe in 2017 for breadth, owing to much more limited and slower reporting of flows by partner country as compared to aggregate flows.

Fourth, because a country may report breadth data, but those data may only cover a subset of partner (origin and destination) countries, we screen the breadth data to ensure adequate coverage across partners. Breadth scores for a given country in a given year are only deemed reportable if the sum of that country's flows (or stocks) add up to between 80% and 110% of that country's reported world total flows (or stocks) within the same breadth data source.[11] When a country's data fail to meet these coverage criteria in a given year but are available in at least one other year, its breadth score is replaced with one generated based on interpolation or repetition according to the rules described above. If a country's data fail to meet the coverage criteria in any year, no breadth score is reported for that country for that component.

The use of a uniform coverage requirement across all breadth components enables uniform treatment of missing values across breadth datasets. Countries may report interactions with only a subset of their partners for a variety of reasons: unreported flows may reflect negligible values, lack of data availability, confidential data, or other reporting preferences on the part of the data source. Having restricted the analysis to data with coverage ratios between 80% and 110%, all breadth data gaps are filled with zeros.

Fifth, after employing the various techniques to address data gaps described in this section, many countries will still have some component metrics missing in some years. Therefore, we must specify thresholds below which a given country's data are deemed insufficient to calculate and report global connectedness scores. To address such cases the following rules are applied:[12]

- At the pillar level, if more than 30% of the depth components (by weight) or if more than 50% of the breadth components (by weight) are missing, then the pillar score is not reported.

- For the overall index, if more than 33% of the depth components (by weight) or if more than 50% of the breadth components (by weight) are missing, the overall index is not computed, and the country is dropped from the analysis.

Why the stricter rules for depth than for breadth and the acceptance of only a subset of components for the latter? This reflects both the challenge entailed with producing breadth measures (which require hundreds of data points per country covered for each component versus only two for depth) and their importance and novelty.

Furthermore, the differences in coverage may also be justified in part by the fact that the unavailable data are unlikely to be distributed randomly. The countries that are missing data, especially in the capital pillar, tend to have more limited levels of capital market integration (lower depth). When a country has a very low level of depth on a given component, its score on breadth for that component is less relevant for the assessment of its overall level of global connectedness.

4. Making Metrics Comparable (Normalization)
After computing the metrics and filling in the data gaps as described above, the results must be made comparable or "normalized" before they can be combined into the index.

This is necessary because the various metrics have different units and distributions.

The simple method employed in the DHL Global Connectedness Index to make all of the diverse metrics comparable is to convert each distribution into its corresponding percentile ranks, over the period from 2001 to 2017. Thus, rather than comparing the different metrics directly, instead, each country's rank position on each of the metrics' distributions is compared.

For example the Netherlands' merchandise exports as percentage of GDP ratio (the metric employed to measure the depth of its merchandise exports), was 79% in 2017. 97% of the scores across all countries on this metric over the period from 2001 to 2017 were lower than 79%. Thus, the Netherlands' raw score of 79% converts to a normalized score of 0.97. The United States' score of 8% converts to a normalized score of 0.09, because only 9% of all of the scores observed on that metric were less than 8%.

Note that the normalization calculations are performed over the period 2001 to 2017 rather than year-by-year. This method, called "panel normalization," was selected because it permits the comparison of global connectedness scores across this period to spot trends in levels of connectedness. Because this method requires re-normalizing the data each time the index is updated, scores should only be compared across years within a single edition of the index. Readers should, for example, assess changes from 2013 to 2017 by comparing 2013 versus 2017 scores in this edition of the index rather than by comparing 2017 scores from this edition with 2013 scores from the 2014 edition.

5. Aggregation and Weights
The overall index is built up from its constituent components via three steps, as illustrated in **Figure 3.2**. First, the individual components are aggregated into pillars, resulting in the computation of distinct pillars of the same type for depth and breadth. Then, overall depth and breadth scores are computed. Finally, these two dimensions of the analysis are combined to produce the DHL Global Connectedness Index.

At each stage of the aggregation process, the constituent components are added together as weighted sums, according to the weights shown in **Table 3.6**. These weights reflect the authors' judgment of the relative importance and value of each pillar and component to the overall evaluation of global connectedness, based on the rationales described below.

AGGREGATION STRUCTURE
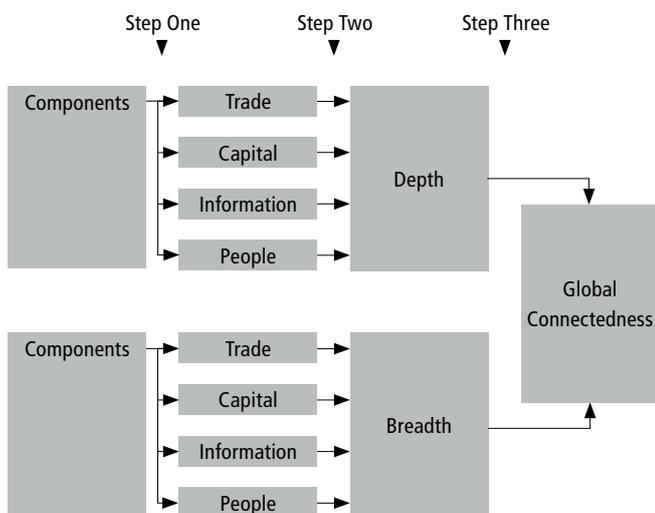
The trade and capital pillars are each assigned higher weights (35% each) than the information and people pillars (15% each). These pillar weights reflect our sense of the relative priorities business and economics audiences place on aspects to consider when measuring globalization.

Within the trade pillar, 75% of the weight is assigned to merchandise trade and 25% is assigned to services trade. Over the past decade, merchandise trade on average has been roughly four times larger than services trade. However, the growth rate of services trade has tended to be higher. Thus, in 2017, merchandise trade was only 3.5 times larger than services trade. Reflecting this long term trend, we assign three times higher weight to merchandise versus services trade.

In the capital pillar, equal weights are assigned to FDI and portfolio equity. The relative magnitudes of FDI versus portfolio equity investment stocks vary year-to-year, without one consistently far outstripping the other, as was the case in the trade pillar. Furthermore, within FDI, equal weights are assigned to both stocks and flows because they each measure distinct and important aspects of connectedness: flows indicating a country's current participation in cross-border investment activity and stocks indicating its participation in another country's economy via the exercise of its rights as a shareholder (and manager in the case of FDI).

Among the information components, telephone calls and international internet bandwidth are both assigned 40%

each, double the weight assigned to trade in books and other printed publications (20%). This reflects the imperfection of the latter indicator (publications are often printed in multiple locations rather than traded across borders in physical form) and the trend toward more information flows taking place digitally rather than via physical trade in printed publications.

Within the people pillar, equal weights are assigned to migration, tourism, and student mobility. Each of these components reflects a distinct aspect of connectedness and spawns distinct effects that span across the other components (e.g. students serving as conduits of information and migrants promoting trade). Without a logical basis for assigning different weights, they are treated as having equal importance.

In cases when a country has sufficient data to report an index score but one or more component metrics are missing, weights must be adjusted to address the data gap(s). When a country is missing component metrics in the most recent year (2017 for this edition of the index), the weights for calculating its pillar and index scores are adjusted so that the weight that would normally be applied to a missing component is redistributed proportionally across the available components.

In this edition of the index, we introduce a new method for handling missing values and their weights prior to the most recent year. The motivation for this change is the longer time series that the index now covers. In the original (2011) edition, the index was calculated for only six years and we did not impose a limit on the use of repetition to fill data gaps, so the available component metrics for a given country did not change over time. Now that the index covers a 17-year span and we impose a five-year limit on repetition to fill data gaps, changes in data availability over time could, under our original methodology, cause countries' connectedness scores to change even when no actual changes in connectedness have occurred. Under our original methodology, we calculated scores year-by-year and adjusted weights proportionally in each year to handle data gaps.

To ensure that such changes in data availability do not result in misleading connectedness trend results, we now calculate scores for years prior to the most recent one based on changes in the available component scores, working backwards from the most recent year. For each year, scores for that year (e.g. 2016) and the next year (e.g. 2017) are calculated using only the component metrics that are

TABLE 3.6 //
WEIGHTS

Pillar (Weight % of Total)	Depth Component (Weight % of Pillar)	Breadth Component (Weight % of Pillar)
1. Trade (35%)	1.1 Merchandise Trade (75%)	1.1 Merchandise Trade (100%)
	1.2 Services Trade (25%)	–
2. Capital (35%)	2.1. FDI Stocks (25%)	2.1. FDI Stocks (25%)
	2.2. FDI Flows (25%)	2.2. FDI Flows (25%)
	2.3. Portfolio Equity Stocks (25%)	2.3. Portfolio Equity Stocks (50%)
	2.4. Portfolio Equity Flows (25%)	–
3. Information (15%)	3.1. International Internet Bandwidth (40%)	–
	3.2. Telephone Call Minutes (40%)	3.2. Telephone Call Minutes (67%)
	3.3. Trade in Printed Publications (20%)	3.3. Trade in Printed Publications (33%)
4. People (15%)	4.1. Migrants (33%)	4.1. Migrants (33%)
	4.2. Tourists (33%)	4.2. Tourists (33%)
	4.3. Students (33%)	4.3. Students (33%)

available in both years. Then, the percent change between the two years is applied to the next year's score (calculated separately using all available components) to determine the score for the year in question. This method ensures that trends across years with differing data availability are consistent with actual changes in measured components' scores, and scores cannot rise or fall because of changes in data availability.[13]

Finally, to return to our example, in Step 1, the Netherlands' trade pillar score for depth is computed as follows. The Netherlands' normalized scores for each of the trade components are: merchandise exports 0.97, merchandise imports 0.94, services exports 0.88, and services imports 0.95. Within each type of flow, the weights are divided equally among the directional flows. Thus, the 75% weight assigned to merchandise trade becomes 37.5% each for merchandise exports and merchandise imports, and the 25% weight assigned to services trade becomes 12.5% each for services exports and services imports. Multiplying the normalized scores times the corresponding weights and then adding up the products, the Netherlands receives a score of 0.94 for the trade pillar for depth.

Step 2 proceeds in the same fashion as Step 1, but includes all of the components across the four pillars to generate overall results for the depth and breadth dimensions. Even if the rules for dealing with missing data outlined above do not allow a given pillar for a particular country to be displayed, the available components from that pillar are still used to generate the depth and breadth results, if missing data rules allow those aggregate results to be shown.

Finally in Step 3, the depth and breadth scores are combined, applying equal weights to both. However, to ensure that the different shapes of their distributions do not interfere with equal weighting at this step, and to make the results more intuitively understandable for readers, both depth and breadth scores are re-scaled between 0 and 50, taking all years into account. Then, they are simply added together, producing the final Global Connectedness Index, with possible scores ranging from 0 to 100.

Thus, the Netherlands' original depth and breadth scores of 0.87 and 0.92 respectively were rescaled to become 46 and 47. The sum of these scores, 93, is the Netherlands' overall 2017 score on the 2018 DHL Global Connectedness Index.

3. DHL GLOBAL CONNECTEDNESS INDEX METHODOLOGY
NOTES

1 For a more academically oriented discussion of how to measure globalization, drawing extensively on the research behind the DHL Global Connectedness Index, refer to Pankaj Ghemawat and Steven A. Altman, "Defining and Measuring Globalization," Chapter 1 in Pankaj Ghemawat, *The Laws of Globalization and Business Applications*, Cambridge University Press, 2017.

2 The term "globaloney" was coined by the late American politician Clare Booth Luce. See Albin Krebs, Clare Boothe Luce Dies at 84: Playwright, Politician, Envoy," *The New York Times*, October 10, 1987. "Globaloney" and associated problems are discussed in Pankaj Ghemawat and Steven A. Altman, "Is America enriching the world at its own expense? That's globaloney," *Washington Post*, February 3, 2017.

3 The selection of these four categories also draws support from definitions of globalization drawn from various research fields. Thus, for example, writings about globalization by economist Michael Mussa cite "trade, factor movements (of capital and people) and communication of economically useful knowledge and technology" while those by anthropologist Arjun Appadurai mention "ideas and ideologies, people and goods, images and messages, technologies and techniques." See Michael Mussa, "Factors driving global economic integration," paper presented at Global economic integration: Opportunities and challenges conference, Jackson Hole, Wyoming, USA, August 25, 2000, and Arjun Appadurai, "Grassroots globalization and the research imagination," Public Culture 12 (1):1–19, 2000.

4 Where available, we employ data on "used international internet bandwidth" to best proxy international internet traffic. Otherwise, "international internet bandwidth" is employed. Among the 103 countries with data available on both variables in 2016 in the International Telecommunication Union's World Telecommunication/ICT Indicators database (July 2018 edition), the values reported were the same for 87 countries and the correlation between the two variables was 0.999.

5 For an extended discussion of potential harms associated with globalization, refer to chapters 5–11 of Pankaj Ghemawat, *World 3.0: Global Prosperity and How to Achieve It*, Harvard Business Review Press, 2011.

6 The Maastricht Globalization Index does seek to incorporate analysis of harms associated with globalization. See Lukas Figge and Pim Martens, "Globalisation Continues: The Maastricht Globalisation Index Revisited and Updated," Globalizations, 2014. http://dx.doi.org/10.1080/14747731.2014.887389.

7 No similarly precise match is available for FDI stocks, so GDP is retained as the domestic comparison for FDI stocks.

8 We chose to make the directly reported world totals for the opposite direction flows our primary source because these values, subject to worldwide reporting standards, should be more consistent across countries. There remains, however, some inconsistency due to differences in reporting standards across flow directions. For example, merchandise exports are reported using the free-on-board (FOB) standard, whereas imports include cost, insurance and freight (CIF). The impact of such inconsistencies on the breadth scores, however, appears to be very small, prompting us to conclude that the method employed in this edition of the index makes the best use of the presently available data.

9 The compilation of breadth data pertaining to FDI imposed special challenges for this edition of the index, due to changes in source data availability prompted mainly by revisions to international reporting standards (transition to the IMF's 6th edition of its Balance of Payments and International Investment Position Manual and the OECD's 4th edition of its Benchmark Definition of FDI). There was no single source that provided sufficient foreign direct investment flows data across countries and years, as there had been for prior editions of the index. As such, in this edition, data were gathered from several sources, including the OECD, Eurostat, and national sources. This data gathering exercise also provided data on FDI stocks for a number of countries, which were used when coverage was better from national sources than from the IMF's CDIS database. The

UNCTAD FDI/TNC database was also used for historical data, although it has not been released to the public since 2014.

10 The 5-year limit on repetition was introduced in the 2016 edition of the index and is discussed further in Chapter Four of the 2016 report.

11 For telephone calls breadth, because the source dataset employed covers only a sample of partners for each reporter, we also require that data be available for at least four partner countries.

12 Note that in the Depth Dimension, the data availability rules applied here are stricter than those in the KOF Globalization Index (which focuses depth metrics in its assessment of "de facto" globalization). The 2018 edition of that index allows results to be displayed if up to 40% of the underlying variables are missing.

13 Another way to conceive of this methodological change is in terms of the assumptions implied about how a missing component would affect a country's score, if it were available. In this way of thinking, we are replacing the assumption that when a particular component score is missing, it can be estimated as a weighted average of the other component scores, with the assumption that when a particular component is missing, the growth or decline of that component can be estimated as a weighted average of the other components' growth or decline.