Glossary

Distance

A measure of a location's ability to enter a specific product. A product's distance (from 0 to 1) looks to capture the extent of a location's existing capabilities to make the product as measured by how closely related a product is to its current exports. A 'nearby' product of a shorter distance requires related capabilities to those that are existing, with greater likelihood of success.

Every two products have a notion of distance between them, where products that require similar know-how and capabilities are 'closer' together (i.e. shorter distance, closer to 0), while two products that require completely different capabilities are 'farther' apart (i.e. longer distance, closer to 1). Distance can be thought of as a measure of risk of entering a product, where larger distances express little relatedness to existing know-how and the need to coordinate adding many missing capabilities and inputs in order to enter production, increasing risk. Distance reflects that not every new product has an equal likelihood of success in a location, but is dependent on its similarity to the location's existing capabilities, as reflected in the Product Space.

Technical breakout: Every two products have a globally defined *proximity* between them as measured by the probability of co-export, that if a country exports product A, what is the probability they also export product B. The product proximities are fixed globally and measured using 128 countries' export data over 50 years. The *distance* of a product is then the sum of the proximities connecting that product to all the products that the location is not currently exporting. Formally, for product p and country c, the distance d is:

$$d_{cp} = \frac{\sum_{p'} (1 - M_{cp'}) \Phi_{p,p'}}{\sum_{p'} \Phi_{p,p'}}$$

Economic Complexity

A measure of the knowledge in a society as expressed in the products it makes. The economic complexity of a country is calculated based on the **diversity** of exports a country produces and their **ubiquity**, or the number of the countries able to produce them (and those countries' complexity).

Countries that are able to sustain a diverse range of productive know-how, including sophisticated, unique know-how, are found to be able to produce a wide diversity of goods, including complex products that few other countries can make.

Economic Complexity Index (ECI)

A rank of countries based on how diversified and complex their export basket is. Countries that are home to a great diversity of productive know-how, particularly complex specialized know-how, are able to produce a great diversity of sophisticated products.

The complexity of a country's exports are found the highly predict current income levels, or where complexity exceed expectations for a country's income level, the country is predicted to experience more rapid growth in the future. ECI therefore provides a useful measure of economic development.

Technical breakout: Economic complexity is calculated from equations for diversity and ubiquity to express the recursion:

$$
\begin{aligned}
k_{c,n} &= \frac{1}{k_{c,0}} \sum_{p} M_{cp} \frac{1}{k_{p,0}} \sum_{c'} M_{c'p} k_{c',n-2} \\
&= \sum_{c'} k_{c',n-2} \sum_{p} \frac{M_{c'p} M_{cp}}{k_{c,0} k_{p,0}} \\
&= \sum_{c'} k_{c',n-2} \widetilde{M}^{C}_{c,c'}
\end{aligned}
$$

where we define

$$\widetilde{M}^{C}_{c,c'} \equiv \sum_{p} \frac{M_{cp} M_{c'p}}{k_{c,0} k_{p,0}}.$$

Hence, in a vector notation, if $\vec{\mathbf{k}}_n$ to be the vector whose cth element is $k_{c,n}$ then:

$$\vec{\mathbf{k}}_n = \widetilde{\mathbf{M}}^{C} \times \vec{\mathbf{k}}_{n-2}$$

where $\widetilde{\mathbf{M}}^{C}$ is the matrix whose (c, c')th element is $\widetilde{M}^{C}_{c,c'}$.

If we take n to infinity, this equation leads to the distribution which remains fixed up to a scalar factor:

$$\widetilde{\mathbf{M}}^{C} \times \vec{\mathbf{k}} = \lambda \vec{\mathbf{k}}$$

Therefore, $\vec{\mathbf{k}}$ is an eigenvector of $\widetilde{\mathbf{M}}^{C}$. We define Economic Complexity Index as the second largest eigenvector of the $\widetilde{\mathbf{M}}^{C}$ matrix.

Economic Complexity Growth Projection

A prediction of how much a country will grow based on its current level of Economic Complexity, its Complexity Outlook or connectedness to new complex products in the Product Space, as compared to its current income level in GDP per capita and expected natural resource exports. Economic complexity alone helps explain the lion's share of variance in current income levels. But the value of economic complexity is in its predictive power on future growth, where a simple measure of current complexity and connectedness to new complex products, in relation to current income levels and expected natural resource exports, holds greater accuracy in predicting future growth than any other single economic indicator.

To calculate Economic Complexity Growth Projections, we consider four factors as explanatory variables: the Economic Complexity Index; the Complexity Outlook Index; the current level of income; and the expected growth in the value of natural resource exports per capita. In effect, the growth projections show countries grow by expanding the know-how they have that allows them to produce more, and more complex products, depending on the connectedness of know-how and how many other products rely on similar capabilities, as well as the initial economic complexity the country held.

Economic Complexity Outlook Index (COI)

A measure of how many complex products are near a country's current set of productive capabilities. The COI captures the ease of diversification for a country, where a high COI reflects an abundance of nearby complex products that rely on similar capabilities or know-how as that present in current production. Complexity outlook captures the connectedness of an economy's existing capabilities to drive easy (or hard) diversification into related complex production, using the Product Space.

A low complexity outlook reflects that a country has few products that are a short distance away, so will find it difficult to acquire new know-how and increase their economic complexity.

Technical breakout: To calculate COI we first need to calculate **distance** of every product to existing production (from 0 to 1). We then sum the 'closeness,' i.e. 1 minus the distance to the products that the country is not currently making, weighted by the level of complexity of these products. Formally,

$$\mathrm{COI}_c = \sum_p (1 - d_{cp})(1 - M_{cp})\,\mathrm{PCI}_p$$

where PCI is the Product Complexity Index of product p. The term $1 - M_{cp}$ ensures we only count the products that a country is not currently producing.

Know-how

Know-how is the tacit ability to produce a product. Also known as productive capability, know-how refers to productive knowledge that goes into making products. Countries grow faster by diversifying the productive knowledge they have to make a wider variety of products of increasing complexity.

Know-how, as tacit knowledge that only exists in brains, stand in contrast to embedded knowledge where all knowledge is held in the technology (e.g. iPhone); and codified knowledge, where all knowledge is explained and detailed in codes or blueprints. Know-how is better conceived as the ability to walk, as tacit knowledge that cannot be fully explained using words, but the knowledge that is the slowest to transfer by requiring time-intensive processes of imitation and repetition. While embedded knowledge (e.g. iPhones) can be shipped across the world and codified knowledge (e.g. Wikipedia) can be accessed online, we believe it is the slow transfer of know-how that explains the slow, incomplete diffusion of technology and production around the world that stands at the heart of the economic growth process. Policies that aim to speed up the diffusion of or diversify the know-how of a society hold important implications on the pace of economic growth—and its inclusiveness.

Opportunity Gain

Measures how much a location could benefit in opening future diversification opportunities by developing a particular product. Opportunity gain quantifies how a new product can open up links to more, and more complex, products. Opportunity gain classifies the strategic value of a product based on the new paths to diversification in more complex sectors that it opens up.

Opportunity gain accounts for the complexity of the products not being produced in a location and the distance or how close to existing capabilities that new product is.

Technical breakout: Opportunity gain is defined as

$$\mathrm{OG}_{cp} = [\sum_{p'} \frac{\Phi_{p,p'}}{\sum_{p''} \Phi_{p'',p'}} (1 - M_{cp'})\, \mathrm{PCI}_{p'}\,]$$

$$\text{opportunity gain}_c = \sum_{p'} \frac{\phi_{pp'}}{\sum_{p''} \phi_{p''p'}} (1 - M_{cp'})\mathrm{PCI}_{p'} - (1 - d_{cp})\mathrm{PCI}_p$$

Where PCI is the Product Complexity Index of product p'. The term $1 - M_{cp'}$ counts only the products that the country is not currently producing. Higher opportunity gain implies that a product is in the vicinity of more products and/or of products that are more complex.

Product Complexity Index (PCI)

Ranks the diversity and sophistication of the productive know-how required to produce a product. PCI is calculated based on how many other countries can produce the product and the economic complexity of those countries. In effect, PCI captures the amount and sophistication of know-how required to produce a product.

The most complex products (that only a few, highly complex countries can produce) include sophisticated machinery, electronics and chemicals, as compared to the least complex products (that nearly all countries including the least complex can produce) including raw materials and simple agricultural products. Specialized machinery is said to be complex as it requires a range of know-how in manufacturing, including the coordination of a range of highly skilled individuals' know-how.

Technical breakout: PCI is determined by calculating the average diversity of countries that make a specific product, and the average ubiquity of the other products that these countries make. Formally, we can define:

$$\widetilde{M}^{P}_{p,p'} \equiv \sum_{c} \frac{M_{cp} M_{cp'}}{k_{c,0} k_{p,0}}.$$

Product Space

A visualization that depicts the connectedness between products based on the similarities of the know-how required to produce them. The product space visualizes the paths that countries can take to diversify. Products are linked by their**proximity** to each other, based on the probability of co-export of both of the two products.

The product space details the connectedness of nearly 900 products, in color-coded sectors, based on real world data on the experience of countries' diversification over the past 50 years. We are able to map a country's location in the product space from its export basket to understand what they are able to make, what products are nearby (at a short **distance**) that depend on similar know-how to that which currently exists, and to define paths to industrial diversification. By using real export data over time, the shape of the product space teaches us how diversification works in practice: countries move from things they know how to do, to things that are nearby or related, or what they call the adjacent possible. The irregularity of the space means that diversification occurs preferentially, where countries in the dense middle of the product space have many nearby opportunities for diversification, as compared to countries at the periphery. Products at the periphery require know-how that is less readily redeployed into many new industries, in cultivating coffee or extracting oil from the ground, while adding know-how to produce men's shirts may open opportunities in several other textiles (women's pants), but shows little relatedness to heavy machinery or chemical products, as fewer countries produce men's shirts and car parts. The product space allows us to predict the evolution of a country's industry, along with recommendations of those products that offer: greater economic complexity (higher wage levels), shorter distance (more existing know-how, reducing risk), and high opportunity gain (opening more adjacent products for continued diversification opportunities).

Revealed Comparative Advantage (RCA)

A measure of whether a country is an exporter of a product, based on the relative advantage or disadvantage a country has in the export of a certain good. We use Balassa's definition, which says that a country is an effective exporter of a product if it exports more than its "fair share," or a share that is at least equal to the share of total world trade that the product represents (RCA greater than 1).

One example: In 2010, soybeans represented 0.35% of world trade with exports of$42 billion. Of this total, Brazil exported nearly $11 billion of soybeans. Since Brazil's total exports for that year were $140 billion, soybeans accounted for 7.8% of Brazil's exports. By dividing 7.8% / 0.35%, we find Brazil has an RCA of 22 in soybeans, meaning Brazil exports 22 times its "fair share" of soybean exports so we can say that Brazil has a high revealed comparative advantage in soybeans.

Technical breakout: Formally, if X_{cp} represents the exports of product P by country C, we can express the RCA that country C has in product P as

$$\mathrm{RCA}_{cp} = \frac{X_{cp}/\sum_c X_{cp}}{\sum_p X_{cp}/\sum_c \sum_p X_{cp}}$$

We can use this measure to construct a matrix that connects each country to the products that it makes. Entries in the matrix are 1 if country C exports product P with RCA greater than 1, 0 otherwise. Formally, we define this as the M_{cp} matrix, where

$$M_{cp} = \{ \begin{array}{ll} 1 & \mathrm{RCA}_{cp} \geq 1 \\ 0 & \text{otherwise} \end{array}$$

M_{cp} is the matrix summarizing which country makes what, and is used to construct the product space and our measures of economic complexity for countries and products.

Diversity

A measure of how many different types of products a country is able to make. The production of a good requires a specific set of know-how; therefore, a country's total diversity is another way of expressing the amount of collective know-how held within that country.

Technical breakout: Imagine a matrix, M_{cp}, in which rows represent different countries and columns represent different products. An element of the matrix is equal to 1 if country C produces product P (with RCA greater than 1), and 0 otherwise. We can measure diversity (and ubiquity) simply by summing over the rows (or columns) of that matrix. Formally,

$$\text{Diversity} = k_{c,0} = \sum_{c} M_{cp}$$

Personbyte

Describes the amount of **know-how** held by one person. Most products today require more productive knowledge to produce than can be mastered by a single individual. To make those products, then, requires that individuals with different know-how interact with one other.

Products that require 100 personbytes cannot be made by a micro-entrepreneur working alone, nor a small village that only has a diversity of 50 personbytes. Instead, this product has to be made by an organization with at least 100 individuals (each with a different personbyte), or by a network of organizations that can aggregate these 100 personbytes of knowledge.

Proximity

Measures the probability that a country exports product A given that it exports product B, or vice versa. Given that a country makes one product, proximity captures the ease of obtaining the know-how needed to move into another product. Proximity formalizes the intuitive idea that the ability of a country to produce a product can be revealed by looking at which other products it can produce.

Technical breakout: Our measure of proximity is based on the minimum conditional probability that a country that exports product P will also export product R. Since conditional probabilities are not symmetric, we take the minimum probability of product P, given product R, and vice versa. For example, suppose that 17 countries export wine, 24 export grapes and 11 export both, all with RCA >1. Then, the proximity between the wine and the grapes is 11/24 = 0.46. Note, we use 24 instead of 17 to reduce the likelihood the relationship is false.

Ubiquity

Ubiquity measures the number of countries that are able to make a product.

Technical breakout: Considering the matrix M_{cp}—as described for **diversity** and**RCA**—in which rows represent different countries and columns represent different products, we can measure ubiquity simply by summing over the column of that matrix. Formally,

$$\text{Ubiquity} = k_{p,0} = \sum_{c} M_{cp}$$