Supplementary material: Product space metrics

This supplementary material provides an extension to the product space description in the article, including the calculation of the product space metrics as well as additional background information.

Revealed comparative advantage (RCA)

Most work on the product space, including the seminal work by Hidalgo et al. (2007), employ the Balassa (1965) definition. In this definition, the RCA compares the value of export of a product *i* from country *c* as a portion of the total exports of that country, to the global value of export of the product *i* as a portion of total world exports. Formally, this can be stated as (Hidalgo et al., 2007):

$$RCA_{c,i} = \frac{\frac{x(c,i)}{\sum_i x(c,i)}}{\frac{\sum_c x(c,i)}{\sum_{c,i} x(c,i)}}$$

In this formulation $x(c,i)$ represents the exports of product *i* from country *c*. Using this definition of RCA, Hidalgo et al. (2007) define RCA_{x_i} (also referred to just as x_i) for a country *c*, as equal to 1 when $RCA_{c,i} > 1$ and RCA_{x_i} (or just x_i) for a country *c*, as equal to 0 when $RCA_{c,i} \leq 1$. The value of 1 is thus assigned when a country can be considered to have a revealed comparative advantage in product *i* and 0 if it cannot.

Proximity

Using the restated RCA definition, Hidalgo et al. (2007) define the concept of *proximity* as:

$$\phi_{ij} = min\left\{P\left(RCA_{x_i}|RCA_{x_j}\right), P\left(RCA_{x_j}|RCA_{x_i}\right)\right\}$$

Thus, proximity between two products (*i* and *j*) is a measure of the probability that a country will have an RCA in a product *i* if it also has an RCA in a product *j* or vice versa, whichever is the minimum. Thus, if all countries that produce the product *i* also produce the product *j*, their proximity will be equal to 1. Similarly, if no country produces both products, the proximity of the products will be 0.

Distance

Distance is a key concept that describes the position of a country in the product space relative to some product for which it does not yet have an RCA. For some product *j* for which a country *c* does not have an RCA, the distance can be calculated as follows (adapted from Hausmann et al. (2011)):

$$\Delta_j^c = \frac{\sum_i (1 - x_i)\emptyset_{ij}}{\sum_i \emptyset_{ij}} \quad (for\ all\ i \neq j)$$

Thus, if a country has a large distance to some product *j*, it could be expected that it would be more difficult to acquire an RCA for it than for some product with a smaller distance value (Hausmann et al., 2011).

Complexity

Other important metrics that have been developed in the product space literature include the *product complexity index* (PCI) and country *economic complexity index* (ECI). Hidalgo & Hausmann (2009) introduced these concepts by showing that such complexities can be calculated iteratively through the *method of reflections*.

Other competing measures for complexity have been developed by authors such as Tacchella et al. (2012) and Cristelli et al. (2013). The merits of each of these metrics have been extensively evaluated (Albeaik, Kaltenberg, Alsaleh, & Hidalgo, 2017; Mariani, Vidmer, Medo, & Zhang, 2015; Pugliese, Zaccaria, & Pietronero, 2016). Interestingly, Albeaik et al. (2017) argue that to slightly improve on the original complexity measure is

trivial, but not significant. They determine this through a more general formulation that generates 729 variations of these metrics which they test for their predictive power. For all these variations, they find that any performance gain is minimal. In this paper we thus use the original economic complexity index developed by Hidalgo & Hausmann (2009) as it is the most established metric and has been shown to be robust and near optimal. A detailed description of how the methods of reflections can be used to calculate the complexity indices is available on the OEC website: https://atlas.media.mit.edu/en/resources/methodology/.

Opportunity value/opportunity gain

Two other metrics for evaluating the strategic importance of development opportunities are the *opportunity value* and *opportunity gain*, described in Hausmann et al. (2011). These metrics, respectively, be considered to be refinements of the *open forest* and *contribution to open forest* metrics introduced in earlier works such as Hausmann & Klinger (2006, 2008). A high opportunity value implies that a country's production structure has a high proximity to a large number of products of high complexity. Specifically, the opportunity value (OV_c) for a country *c* describes the sum (for all opportunities *j*) of the product of the *density* to each opportunity[i] *j* – where *density*[ii] (ω_j^c) refers to the sum of proximities from all *existing products* to an opportunity divided by the sum of *all proximities* to the opportunity – scaled by the complexity of all these opportunities. Formally, this can be defined as:

$$OV_c = \sum_j \omega_j^c \, PCI_j \quad where \quad \omega_j^c = \frac{\sum_i x_i \emptyset_{ij}}{\sum_i \emptyset_{ij}} \quad (for\ all\ i \neq j)$$

Opportunity gain, then, provides an indication of how much the attainment of an RCA in a specific product for which a country does not yet have an RCA, will contribute towards increasing that country's opportunity value. Specifically, *opportunity gain* (OG_j^c), for a given product *j* is the change in the opportunity value for a country *c* if it would acquire an RCA for product *j* for which it does not yet have an RCA.

References not included in main text

Albeaik, S., Kaltenberg, M., Alsaleh, M., & Hidalgo, C. A. (2017). *729 new measures of economic complexity (Addendum to improving the economic complexity index)* (Arixv Working Paper No. 1708.04107). Cornell University Library.

Cristelli, M., Gabrielli, A., Tacchella, A., Caldarelli, G., & Pietronero, L. (2013). Measuring the intangibles: A metrics for the economic complexity of countries and products. *PLoS One*, *8*, e70726.

Hausmann, R., & Klinger, B. (2006). Structural transformation and patterns of comparative advantage in the product space (CID Working Paper No. 128), Harvard University.

Hausmann, R., & Klinger, B. (2008). South Africa's export predicament. Economics of Transition, 16, 609–637.

Tacchella, A., Cristelli, M., Caldarelli, G., Gabrielli, A., & Pietronero, L. (2012). A new metrics for countries' fitness and products' complexity. Scientific Reports, 2(723), 1–7.

---

i "Opportunities" refer to products for which a country does not have an RCA and "existing products" to those for which a country does.

ii Density is the complement of distance, thus for any opportunity j: $\Delta_j^c + \omega_j^c = 1$.