ECONOMIC COMPLEXITY BRIEFING

Center for International Development at Harvard University

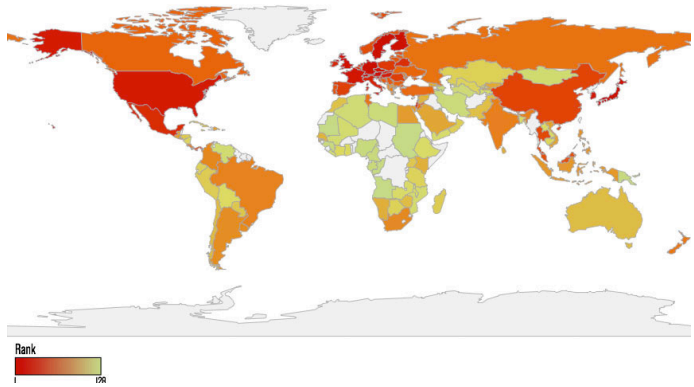
NEW APPROACH PREDICTS ECONOMIC GROWTH

|| How does an economy grow?

And why do some countries' economies grow while others lag behind? Before the industrial revolution, the difference in per capita income between rich countries and poor countries was a factor of four. Today, that factor is greater than 100. Some countries have found ways to bridge the gap, while others have failed to do so.

Traditional economics answers the question in aggregate terms: Countries are measured by their GDPs, and growth comes from increased output—the fruitful combination of labor and capital. But this approach, built on fifty years of research and experience, has shown its limitations. Countries are still poor. Policymakers still do not possess adequate methods to diagnose growth constraints or to prescribe effective development strategies. Reality, as it turns out, is far more complex—and the field of development needs a better measure of how economic growth happens and a set of tools to help countries promote it. Years of research by The Growth Lab at Harvard University's Center for International Development (CID) has resulted in the development of Economic Complexity and two new tools; *The Atlas of Economic Complexity: Mapping Paths to Prosperity* and The Atlas online. These tools help stakeholders identify a country's constraints to economic growth and utilize that country's own unique economic structure to chart its path to prosperity.

Economic Complexity is a result of multidisciplinary research at CID and an approach that is different from mainstream economics – a paradigm shift for the field of development. The Growth Lab at CID combines the tools of physics, networks and computer science together with economics and public policy to determine how countries can chart their own paths to growth. The team sees economies as intricate landscapes of products. Each country's economy is composed of millions of inputs and a multitude of industries that create products—from apples to furniture, cars to supercomputers, bridges to power plants. For a country to produce any given product, they must not only have the required machines, raw materials, and labor; they must also possess a specific set of skills, knowledge, and capabilities. Cataloguing and quantifying the vast number of products manufactured and exported by 128 individual countries across the globe generates a large data set. Analyzing this data set allows us to characterize countries and the products they make in terms of their Economic Complexity.



The map above is a visualization of the Economic Complexity of 128 countries worldwide. Darker colors indicate that a country produces more products and more complex products.

ECONOMIC COMPLEXITY

|| What exactly is Economic Complexity?

It is a measure of the amount of capabilities and know-how that goes into the production of any given product. Products are vehicles for knowledge. To make a shirt, one needs to design it, make the fabric, cut it, sew it, pack it, brand it, market it and distribute it. For a country to

produce shirts, it needs people who have expertise in each of these areas. Each of these tasks involves many more capabilities than any one person can master. Only by combining know-how from different people can any one product be made.

Key to understanding the value of Economic Complexity is that some products are more complex than others, and some countries produce more complex products that other countries cannot. Complex products—such as machinery, electronics, or chemicals—require great amounts of productive knowledge, and are mainly produced by rich countries that can weave together vast quantities of knowledge across large networks of people. Poor countries produce fewer and simpler products, requiring smaller webs of interaction and less productive knowledge—such as certain agricultural and textile products that are produced by many countries worldwide.

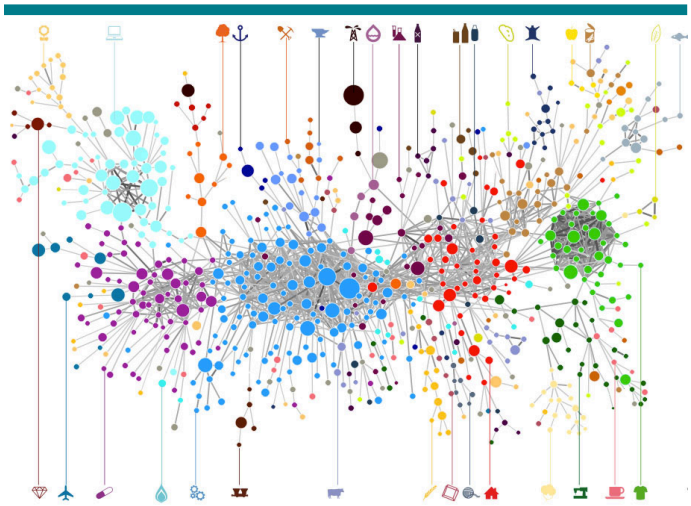
Take the game Scrabble as an analogy: If a player has more and different letters, they can make more words. Countries with more productive capabilities can make a greater diversity of products. In Scrabble, long words can only be put together by players with many letters; the most complex products can only be manufactured by countries that possess the most advanced productive capabilities.

THE PRODUCT SPACE

|| So how do we determine where countries can start to diversify their production?

Ultimately, development is the expression of the total amount of productive knowledge that is embedded in a society. Countries grow by expanding their productive knowledge and developing know-how so they can produce more and more complex products, thus increasing their level of economic complexity. Countries grow by diversifying – they do not grow by making more of the same. But how and what capabilities should countries be developing? This is crucially dependent on their initial location in the Product Space, a map that visualizes the trajectory that countries can take to diversify.

Using network science algorithms, The Product Space details nearly 800 products into 34 color-coded communities. *The Atlas of Economic Complexity: Mapping Paths to Prosperity* presents this set of maps



The Product Space

The proximity of the nodes measures the probability that two products are co-exported.

Products are depicted as nodes and are connected if they require similar capabilities. The intensity of the similarity is expressed in the shade of the links. The color of the node expresses the type of product it is (garments, machinery…) and its size expresses the size of global trade in that product.

for 128 countries illustrating where the economic opportunities for each country resides. More specifically, the Product Space is a visualization of the 'capability distance' between products. If a country makes one product, we estimate how easy it is to obtain the know-how it will need in order to make another. The resulting space is the visualization of these connections between products based on the capabilities they share. Using the Product Space, we can predict the evolution of growth.

EXPANDING CAPABILITIES

|| But how do countries develop these new sets of capabilities, and which capabilities should they focus on?

Economic growth occurs when countries develop the capabilities and productive knowledge to produce other, more complex products. But it is difficult to go from making simple products to complex ones. New capabilities are difficult to accumulate; extra Scrabble letters are difficult to obtain. The process of growth is slow. But countries are almost always more likely

Calculating Complexity

So how do we know how many capabilities are in a country? We examine two characteristics of a country's productive output to determine its Economic Complexity Index.

- Diversity of a country: Simply, how many products does a country make? Countries that make many distinct products are likely to be more complex.
- Ubiquity of a product: Simply, how many countries are able to make a product? Products that are made by very few countries are likely to be more complex.

Once we have these two measures, we can use one measure as an input to other measure. For instance, we can calculate the average ubiquity of the products that the country makes or average diversity of the countries that make a product, which will give us a better measure of complexity. We can do this iteration many times until we have a very refined measure of country and product complexity.

to develop a new product if that product is similar to products that they currently make, requiring a set of knowledge and capabilities they already possess. Essentially: it is easier to move from shirts to blouses than from shirts to engines.

By looking at the Product Space, we can visualize the economic opportunities for each country. But once we see these paths, we need to determine how a country will diversify from the products it makes to the products that are nearby or that it could be making. In other words, if we have a map that gives us a reasonable trajectory for diversification, what must countries do in order to expand upon their existing capabilities?

Trade data maps what these trajectories look like. Think again of the production of a T-shirt. A fairly ubiquitous product, T-shirts still need to be designed, the fabric procured, and then they must be cut and sewn. Next, they must be packed, branded, marketed and distributed. Transport companies are involved, as well as the infrastructure of roads, ports and planes to get the products where they need to go. In addition, facilities with power, clean water and electricity are needed to manufacture the shirts.

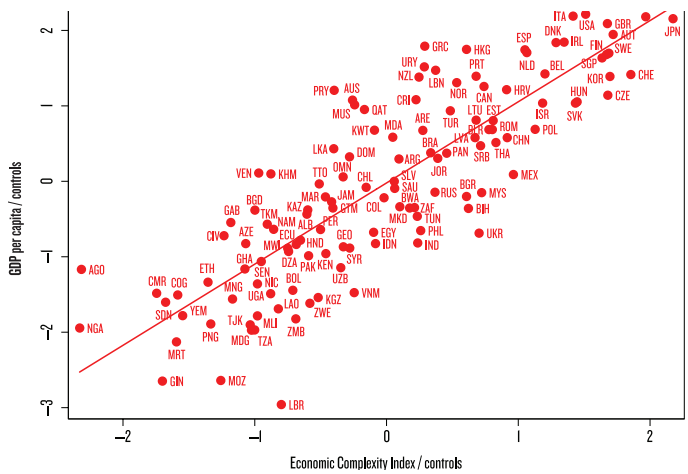
Even a simple T-shirt requires numerous capabilities, inputs of knowledge and assets to make this product possible. If a country has all of the above capabilities and infrastructure, they will likely be able to make a leap to a product that requires similar capabilities. Vietnam, for example, is very active in the garments industry. Because it has the specific capabilities mentioned, it is not a far leap for Vietnam to produce pants or blazers, in addition to t-shirts. With the possible addition of marketing know-how and additional distribution channels, Vietnam could make this strategic and near-by leap in production.

Where countries are in the Product Space and their current complexity can tell us a lot about a countries growth prospects and what each country should do to accelerate its own growth.

WHICH COUNTRIES WILL GROW THE FASTEST?

|| Where do countries fall in terms of their Economic Complexity?

The 2013 updated edition of The Atlas gives us insights on how well positioned countries are in the Product



The graph above shows the relationship between Economic Complexity and income per capita obtained after controlling for each country's natural resource exports. After including this control, economic complexity and natural resources explain 78% of the variance in per capita income across countries.

Space and thus measures their potential for growth. Specifically, we look at the current Economic Complexity Rankings of countries, as well as their Complexity Outlook Index. The Economic Complexity Index tells us how complex countries currently are. The Complexity Outlook Index captures how well positioned countries are in the Product Space by quantifying how close the products they make are to the products they do not make, weighted by how complex those products are. In simple terms, if a country is close to more complex products, they will have an easier time moving into production of those products. We also examine expected GDP growth in Per Capita GDP to 2020, as well as Expected GDP Growth to 2020.

Each of these rankings captures a different aspect of the world economy. This is well illustrated by the fact that different countries top the rankings for complexity (Japan) and potential to increase complexity and growth (India).

So what countries will be the next to grow? The countries that top our Complexity Outlook Index in 2010 are India, Turkey, Indonesia and China. In general, we see that these countries have experienced remarkable growth in production and complexity of their export basket and are well positioned to continue increasing their levels of complexity.

While Greece and Portugal also ranked high on the list, we note that both are countries whose current income was far above our expectations, given their relatively low levels of complexity. These are countries that experienced a boom in capital that followed the adoption of the Euro. This led to stronger exchange rates and less dynamic exports.

In South Asia's Complexity Outlook Index, we see India as the regional and global leader, while Bangladesh lags behind at the end of the list. In Eastern Europe, Bulgaria, Estonia and Serbia rank highly in terms of their Complexity Outlook.

In East Asia, China, Indonesia and Thailand have the most promising outlooks. South Africa has the strongest in Sub-Saharan Africa, followed by Kenya and Tanzania.

By using the measures of Economic Complexity and the Complexity Outlook, we have also created rankings of expected growth rates per capita to 2020. At the top of this list are India, China, Ukraine, Thailand and Vietnam. In the Middle East and North Africa, the expected leaders in GDP per capita growth are Egypt, Tunisia and Jordan. In Eastern Europe, Ukraine, Serbia and Bulgaria rank highly, while in Latin America, Mexico and El Salvador top the list. Finally, in Sub-Saharan Africa, the growth leaders are expected to be Liberia, Kenya, Malawi and Zimbabwe.

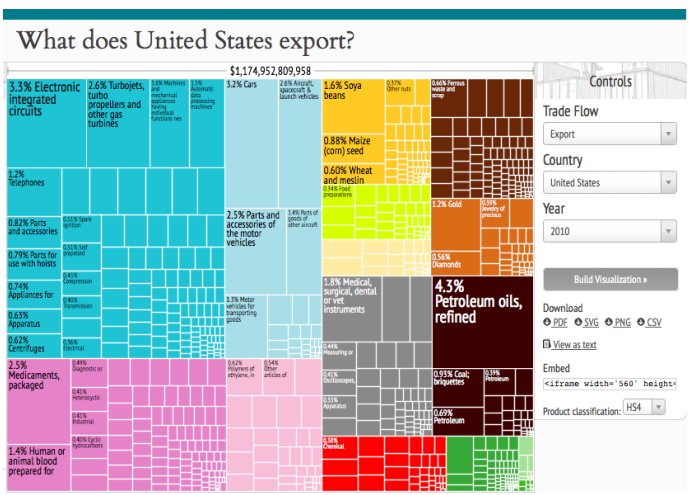
Lastly, if we look at expected GDP growth until 2020, our predictions shift further. When we add the projected rate of population growth to the expected growth in GDP per capita, India still remains on top – but the next 9 countries that round out the top 10 are all in Sub-Saharan Africa, buoyed by their high projected population growth.

HIGH BANDWIDTH DEVELOPMENT

|| So how is this research impacting the field of development?

Our research and tools allow policymakers, businesses and practitioners to orient themselves in a space that is immensely complex and determine a country's best paths to economic growth.

Members of the World Bank, the Asian Development Bank and others are embracing and applying this work to better understand the challenges that developing



The Atlas online is a tool that allows users to quickly compose a visual narrative about countries and the products they exchange.

countries face and to determine how to help their member countries. The Center for International Development has worked with the governments of Colombia, The Netherlands, Saudi Arabia, South Africa, and the Dominican Republic to help them chart paths of economic growth. By examining each countries unique situation, we have helped these governments predict the industries that are likely to disappear and appear in the next decades, evaluate the feasibility of their medium and long-term development plans, and to discuss reforms that would facilitate the structural transformation of the economy—all with the intent of increasing sustainable growth.

In addition to these specific cases, a key tool for moving forward is The Atlas online, a powerful interactive tool of *The Atlas of Economic Complexity.* This tool enables policy makers, entrepreneurs, academics, students and the general public to map the path of diversification and prosperity for 128 countries. The website can create over 20 million visualizations on demand that show the existing export dynamics amongst countries and the potential new industries available to each location using the Product Space Methodology. As of end of 2012, the site has over 125,000 unique visits from 198 countries, suggesting that CID is reaching the world's major policy and finance centers.

RESEARCH NOTES

|| No measure of a country's ability to develop economically is perfect.

There are a few inhibitors to our own measurements:

The Atlas relies on international trade data. We made this choice because it is the only dataset available that has a rich detailed cross-country information linking countries to the products that they produce using a standardized classification. It includes data on exports, but not production.

Secondly, this dataset only includes goods, and not services, because the latter do not flow through customs offices, which are the source of our statistical records.

Finally, we do not include information on non-tradable activities such as construction or restaurants. Producers and consumers meet in the same place for such activities, and while these interactions are an important part of the economic ecosystem, these factors are not actualized in current data.

Details and More Information

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