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SECTION 3

Why Is *Economic Complexity* Important?

Economic complexity reflects the amount of knowledge that is embedded in the productive structure of an economy. Seen this way, it is no coincidence that there is a strong correlation between our measures of economic complexity and the income per capita that countries are able to generate. Figure 3.1 illustrates the relationship between the Economic Complexity Index (ECI) and income per capita for the 128 countries studied in this Atlas. In this graph, we separate countries according to their intensity in natural resource exports. We color in red those countries for which natural resource exports, such as minerals, gas and oil, represent at least 10% of GDP. For the 75 countries with a limited relative presence of natural-resource exports (in blue), economic complexity accounts for 78 percent of the variance in income per capita. But as the Figure 3.1 illustrates, countries with a large presence of natural resources can be relatively rich without being complex. It is easy to see why. But if we take into account the income that is generated from extractive activities, which has more to do with geology than knowhow, economic complexity can explain about 78 percent of the variation in income across all 128 countries. Figure 3.2 shows the tight relationship between economic complexity and income per capita that emerges after we take into account a country's natural resource income. The more complex your economy, the more likely you are to have a higher level of income.

Economic complexity, therefore, is related to a country's level of prosperity. As such, it is just a correlation of things we care about. The relationship between income and complexity, however, goes deeper than this. To see this, note that this relationship is tight but not perfect. As we said before, ECI accounts for 78 percent of the variance, not 100 percent. Countries are not on the red line of Figure 3.2. Some countries are above this line and others are below. Are these gaps just a mistake of the theory or do they contain information about where countries are going? Take, for example, the case of India. Given how much it knows, we would have expected India to be richer. Well, maybe India should be richer. If so, India's recent rapid growth would be caused by the fact that the country already possesses the knowledge to be richer than it is and is, therefore, moving to "where it belongs" in the regression line. Take by contrast the case of Greece. Our approach would say that Greece is too rich for the little knowledge it has. Well, maybe Greece cannot sustain its recent level of income, which has been propped up artificially through massive borrowing that has proven unsustainable: the country is now rapidly moving to "where it belongs", but in the case of Greece it is in the opposite direction of that of India. **Countries whose economic complexity is greater than what we would expect, given their current level of income, tend to grow faster than those that are "too rich" for their current level of economic complexity.** Figure 3.3 shows the relationship between the gaps between of ECI and income in 2000 and growth in the decade 2000-2010. The relationship is strong and statistically significant: the gaps between a country's income and its complexity do tend to be closed in the future through differential growth. **In this sense, economic complexity is not just a symptom or an expression of prosperity: it is a driver.**

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FIGURE 3.1:

Shows the relationship between income per capita and the Economic Complexity Index (ECI) for countries where natural resource exports are larger than 10% of GDP (red) and for those where natural resource exports are lower than 10% of GDP (blue). For the latter group of countries, the Economic Complexity Index accounts for 78% of the variance, a variable commonly known as R^2. Countries in which the levels of natural resource exports is relatively high tend to be significantly richer than what would be expected given the complexity of their economies, yet the ECI still correlates strongly with income for that group.

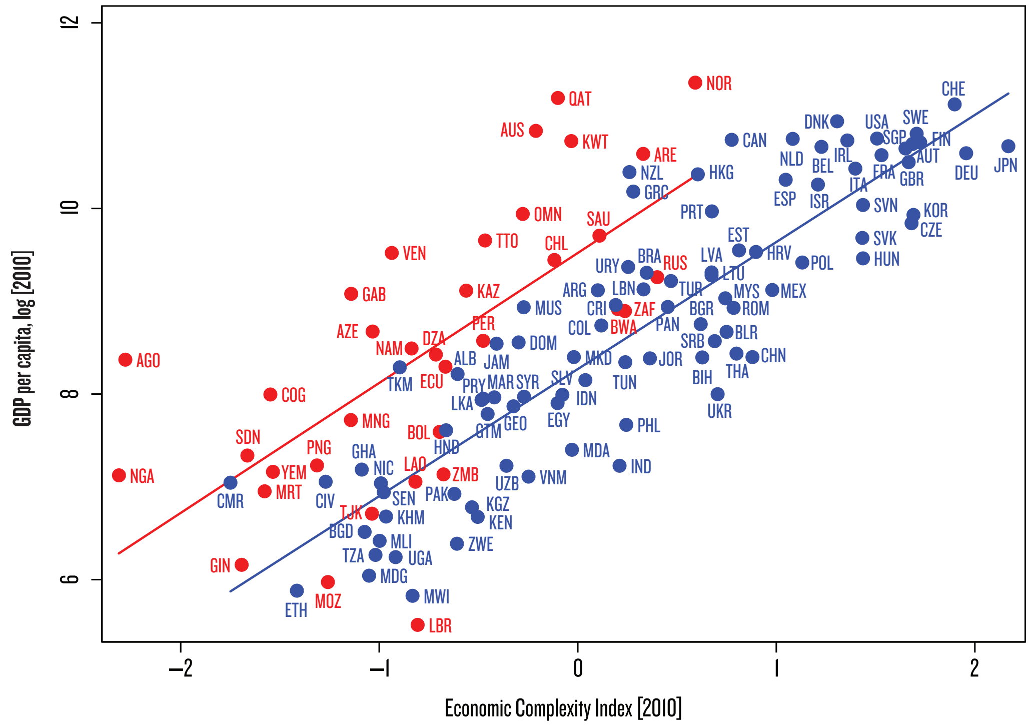

FIGURE 3.2:

Shows the relationship between economic complexity and income per capita obtained after controlling for each country's natural resource exports. After including this control, through the inclusion of the log of natural resource exports per capita, economic complexity and natural resources explain 78% of the variance in per capita income across countries.

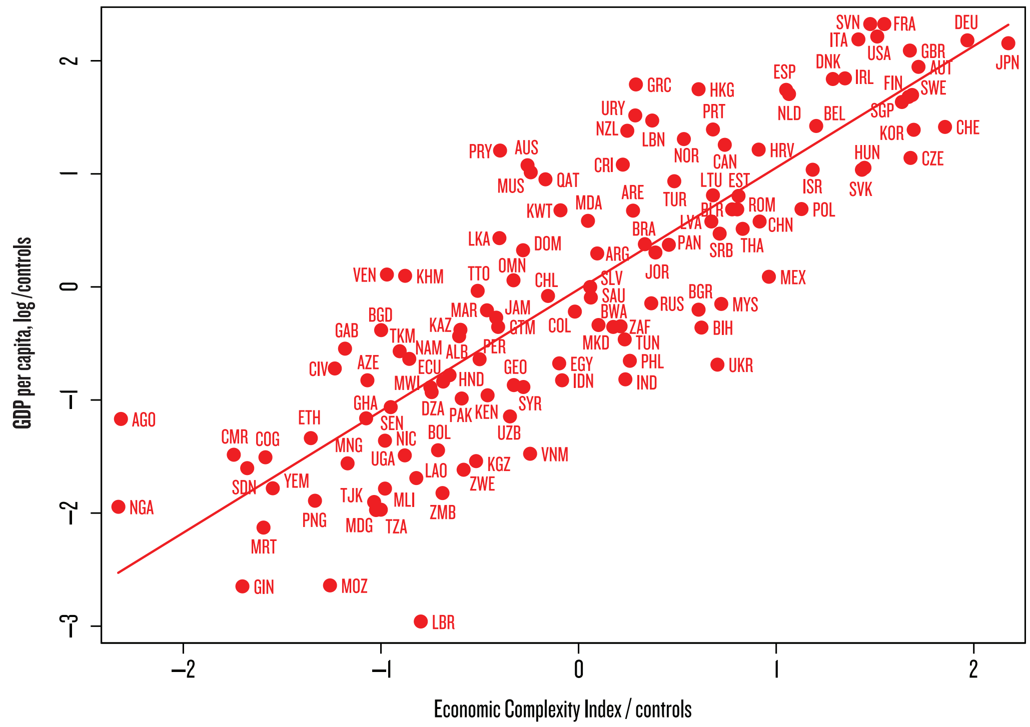

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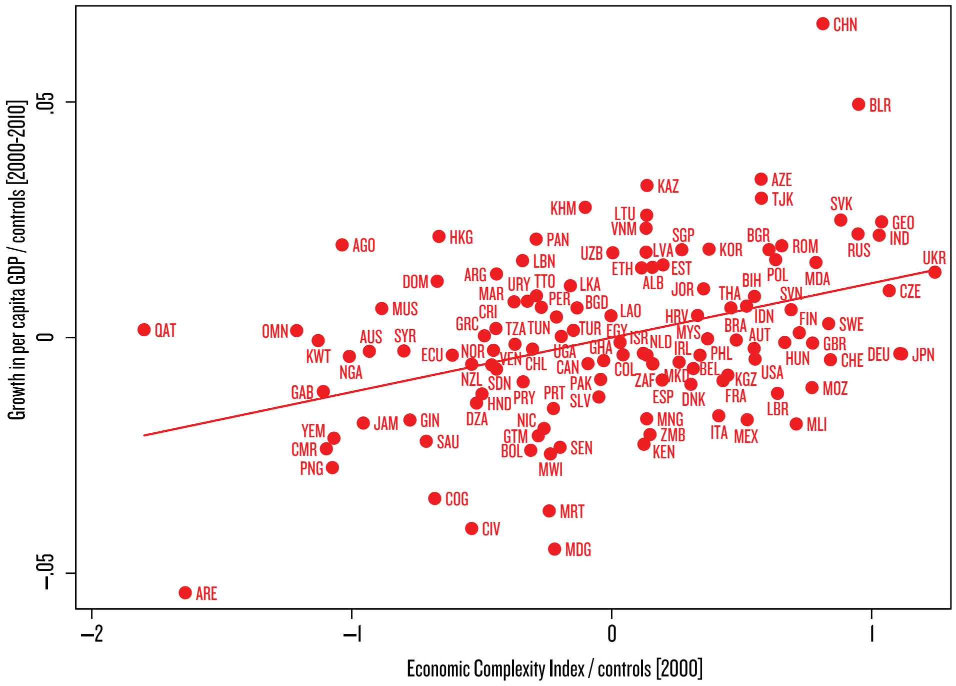
FIGURE 3.3:

Shows the relationship between the annualized GDP per capita growth for the period between 2000 and 2010 and the Economic Complexity Index for 2000, after taking into account the initial level of income and the increase in natural resource exports during that period (in constant dollars as a share of initial GDP).



Technical Box 3.1 shows the statistical evidence that supports our claim that economic complexity precedes and hence drives long run levels of income and consequently growth. The analysis uses a country's initial level of economic complexity to predict growth over the subsequent decade, after controlling for initial income and the rise in natural resource exports over the decade.

The ability of the ECI to predict future economic growth suggests that countries tend to move towards an income level that is compatible with their overall level of productive knowledge. On average, their income tends to reflect their embedded knowledge. But when it does not, as the cases of India and Greece illustrate, it gets corrected over time through accelerated or diminished growth.

Over time economic complexity evolves: countries expand their productive capabilities and begin to make more and more complex products. This process will be studied at greater length in Section 5, but for now consider that making a product that is new to a country requires the addition of all missing capabilities. Adding a product for which a country needs many new capabilities often proves difficult because it requires solving a complicated "chicken and egg" problem. An industry may not exist because the productive capabilities it requires may not be present. But there will be scant incentives to develop the productive capabilities required by industries that do not exist. Furthermore, developing those capabilities will be difficult because there is nobody in the country from which to learn the requisite know-how. Because of this problem, countries tend to preferentially develop products for which most of the requisite productive capabilities are already present, leaving fewer "chicken and egg" problems to be solved. We say that these products are "nearby" in terms of productive capabilities.

What differs between countries is the abundance of products that they do not yet make but that are near their current endowment of capabilities. Countries with an abundance of such nearby products will find it easier to deal with the chicken and egg problem of coordinating the acquisition of missing capabilities with the development of the industries that demand them. This should allow them to find an easier path towards capability acquisition, product diversification and development. Countries with few nearby products will find it hard to acquire more capabilities and hence to increase their economic complexity.

In Section 5 we will show how we measure the abundance of products that are near a country's current set of productive capabilities. We call it the **Complexity Outlook Index** (COI). This variable **is based on the distance between the products that a country is currently making and those that it is not, weighted by the complexity of the products it is not making.** Being near a complex product is worth more than being near a simple product, and being near is worth more than being far.

We show the Complexity Outlook Index plotted against the Economic Complexity Index in Figure 3.4. The graph shows an inverted U shape. Countries with low ECI (those with few capabilities) find most products very "far" and opportunities very limited. This is reflected in a low COI. Countries with a high ECI are highly diversified: they already make most of the existing products, and hence have few options to move into other existing complex products. Hence, they also exhibit a low COI. These countries can

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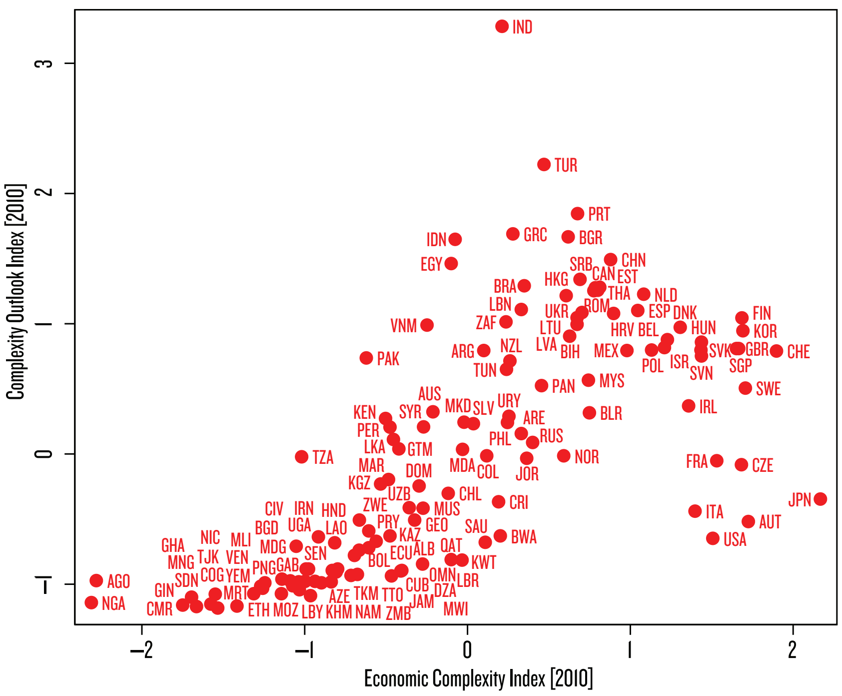
FIGURE 3.4:

Shows the relationship between the Economic Complexity Index for 2010 and the Complexity Outlook Index for 2010.



only diversify by pushing out the technological frontier, inventing products that are new to the world. Countries with intermediate ECI are in a sweet spot in which they are very near many products for which they already have many of the requisite capabilities. They face relatively smaller "chicken and egg" problems and should be able to rapidly diversify. In fact, as we show in Section 5, the Complexity Outlook Index (COI) predicts remarkably well the changes in the Economic Complexity Index, meaning that it predicts the speed at which countries acquire productive capabilities.

If the Complexity Outlook Index affects the acquisition of productive capabilities, its initial value should predict subsequent growth, even after controlling for the initial level of productive capabilities, as measured by ECI. In other words, countries not only grow based on the mismatch between their capabilities and their current income, but also according to how easy it is for them to acquire more productive capabilities as captured by the COI. As we show in Technical Box 3.1, COI is by itself a strong predictor of future growth and together with the Economic Complexity Index, initial income and the growth in natural resource exports they can explain 50 percent of the variance in 10-year growth rates for a sample of over 100 countries over three decades. As we shall see in Section 4, this is a much higher percentage than many of the variables used in the voluminous growth literature are able to achieve.

It is important to note what the Economic Complexity variables are not about: they are not about export-oriented growth, openness, export diversification or country size. They are, instead, about productive knowledge and the ease with which it can be acquired. Although we calculate the ECI and COI using export data, the channel through which they contribute to future growth is not limited to their impact on the growth of exports. Clearly, countries whose exports grow faster, all other things being equal, will necessarily experience higher GDP growth. This is simply because exports are a component of GDP. However, as Technical Box 3.2 shows, the contribution of ECI and COI to future economic growth remains strong after accounting for the growth in the *quantity* of exports.

The economic complexity of a country is also not about openness to trade: the impact of ECI and COI on growth is essentially unaffected if we account for differences in openness measured as the ratio of exports to GDP. And the ECI is not a measure of export diversification. Controlling for standard measures of export concentration, such as the Herfindahl-Hirschman Index, does not affect our results. In fact, neither openness nor export concentration are statistically significant determinants of growth after controlling for the ECI and COI (see Technical Box 3.2).

Finally, the ECI and COI are not about a country's size. The ability of the Complexity variables to predict growth is unaffected when we take into account a country's size, as measured by its population, while the population itself is not statistically significant (see Technical Box 3.2).

In short, economic complexity matters because it helps explain differences in the level of income of countries, and more importantly, because it predicts future economic growth. Economic Complexity might not be simple to accomplish, but the countries that do achieve it tend to reap important rewards. ●

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TECHNICAL BOX 3.1: THE GROWTH EQUATION

To analyze the impact of the Economic Complexity Index (ECI) and Complexity Outlook Index (COI) on future economic growth we estimate two regressions where the dependent variable is the annualized growth rate of GDP per capita for the periods 1978-1988, 1988-1998 and 1998-2008 (We excluded Liberia for our 1988 sample and Zimbabwe for 1998 sample because they were extreme outliers). In the first of these equations we do not include ECI nor COI and use only two control variables: the logarithm of the initial level of GDP per capita in each period and the increase in natural resource exports in constant dollars as a share of initial GDP. The first variable captures the idea that, other things equal, poorer countries should grow faster than rich countries and catch up. This is known in the economic literature as convergence. The second control variable captures the effect on growth caused by increases in income that come from natural resource exports, which complexity does not explain. In addition, we include a dummy variable for each decade, capturing any common factor affecting all countries during that period, such as a global boom or a widespread financial crisis. Taken together, these variables account for 29 percent of the variance in countries' growth rates. This is shown in the first column of Table 3.1.1.

In addition to initial income and the growth in natural-resource exports, the second regression includes the effect of the value of the Economic Complexity Index (ECI) at the beginning of the period. The second column of Table 3.1.1 shows that ECI is strongly associated with future economic growth. The variable is highly significant both economically and statistically. Its inclusion increases the explanatory power of the equation in column 1 by 66 percent. A 1-standard deviation increase in ECI is estimated to accelerate annual growth by 1.9 percent.

In column 3 we introduce the Complexity Outlook Index (COI) and the two control variables of column 1. It also shows that COI is highly significant, both economically and statistically, raising the explanatory power of the equation by 52 percent relative to column 1. A 1-standard deviation improvement in COI is associated with a 1.2 percent increase in growth of GDP per capita.

In column 4 we introduce both ECI and COI into our growth equation. Both variables remain highly significant and the equation as a whole explains half of the variance of 10-year growth over three decades in our sample of over 100 countries. The difference between columns 4 and 1 indicates that the ECI and COI jointly increase the regression's R^2 in 21 percentage points or 72 percent of the R^2 of equation 1.

We use the equation in column 4 of Table 3.1.1 to forecast the growth in GDP per capita and present the results in Part 2, Ranking 3. To predict average annualized growth between 2010 and 2020 we make two assumptions. First, we assume a worldwide common growth term for the decade, which we take to be the same as that observed in the 2000-2010 period. Changing this assumption would affect the growth rate of all countries by a similar amount but would not change the rankings. Second, we assume that there will be no change in the real value of natural resource exports per capita as a share of initial GDP. This implies that natural resource exports in real terms in the next decade will remain at the record-high levels achieved in 2010. This assumption may underestimate the effect on countries whose volumes of natural resource extraction will increase significantly and over-estimate the growth in countries that will see their natural-resource export volumes declines. A higher or lower constant dollar price of natural resource exports would respectively improve or reduce the projected growth performance of countries by an amount proportional to their natural resource intensity.

TABLE 3.1.1

	Annualized growth in GDP pc (by decade)			
	(1978-1988, 1988-1998, 1998-2008)			
VARIABLES	(1)	(2)	(3)	(4)
Initial Income per capita, log	-0.001	-0.011***	-0.006***	-0.011***
	(0.001)	(0.001)	(0.001)	(0.001)
Increase in net natural resource exports	0.059***	0.065***	0.065***	0.067***
- in constant dollars (as a share of initial GDP)	(0.012)	(0.009)	(0.010)	(0.009)
Initial Economic Complexity Index		0.019***		0.014***
		(0.002)		(0.002)
Initial Complexity Outlook Index			0.012***	0.007***
			(0.002)	(0.002)
Constant	0.023***	0.097***	0.058***	0.095***
	(0.007)	(0.010)	(0.009)	(0.010)
Observations	301	301	301	301
Adjusted R^2	0.291	0.472	0.436	0.498
Year FE	Yes	Yes	Yes	Yes

Standard errors clustered by country are shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1

TECHNICAL BOX 3.2: ECONOMIC COMPLEXITY IS DIFFERENT FROM COUNTRY SIZE, OPENNESS, EXPORT SUCCESS OR PRODUCT CONCENTRATION

This box explores the robustness of the impact of the complexity variables, Economic Complexity Index and Complexity Outlook Index, on growth. While the ECI and COI are constructed using export data, their relationship with future growth is not driven by the growth in the volume of exports or by their concentration. To show this, we start with our basic growth equation, which we replicate as column 1 in Table 3.2.1. Column 2 adds to this equation the increase in the real value of the exports of goods and services in the decade in question as a fraction of initial GDP. Exports are a component of GDP, and therefore, we expect them to contribute to growth. Nevertheless, after including the increase in exports, the effect of ECI and COI on growth remains strong and significant, indicating that the effect of economic complexity goes beyond its impact on export growth. Column 3 introduces exports as a share of GDP. We use this as a measure of openness. Column 4 includes the Herfindahl-Hirschman index as a measure of export concentration. Column 5 includes the log of initial population as a measure of size. This is equivalent to introducing total GDP, given that we are already controlling for GDP per capita. The contribution to growth of the variables introduced in columns 3, 4 and 5 are estimated to be very close to zero, are not statistically significant and do not affect the ability of the ECI and COI to predict future economic growth.

TABLE 3.2.1

	Annualized growth in GDP pc (by decade)				
	(1978-1988. 1988-1998. 1998-2008)				
VARIABLES	(1)	(2)	(3)	(4)	(5)
Initial income per capita. log	-0.011***	-0.010***	-0.011***	-0.010***	-0.011***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Increase in net natural resource exports	0.067***	0.025**	0.067***	0.068***	0.067***
- in constant dollars (as a share of initial GDP)	(0.009)	(0.010)	(0.010)	(0.009)	(0.009)
Initial Economic Complexity Index	0.014***	0.011***	0.014***	0.012***	0.014***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Initial Complexity Outlook Index	0.007***	0.005***	0.006***	0.006***	0.007***
	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
Increase in exports (goods and services)		0.039***			
- in constant dollars (as a share of initial GDP)		(0.006)			
Exports to GDP			0.011		
			(0.007)		
Initial Exports Concentration (Herfindahl)				-0.012	
				(0.008)	
Initial Population. log					0
					(0.001)
Constant	0.095***	0.076***	0.096***	0.094***	0.104***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.021)
Observations	301	289	300	301	301
R^2	0.5	0.65	0.5	0.5	0.5
Year FE	Yes	Yes	Yes	Yes	Yes

Standard errors clustered by country are shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1

TECHNICAL BOX 3.3: WHAT ABOUT SERVICES?

The measures, ranking and figures in this Atlas are all based on trade data, which only contains information on tradable goods. Economies, however, produce not only goods, but also services, such as tourism, finance and consulting. The lack of service data can bias our results if the complexity of a country's service structure carries different information than can be inferred from its trade in goods. Yet, we can expect service data to provide little additional information in a world where countries that have complex goods structures also have complex service structures.

Unfortunately, highly disaggregated data on services is not available, since services are not controlled at borders through customs agents in the way goods are. Hence, because of data constraints, we are limited to exploring the role of services at a more aggregate level. We used the service data from the World Bank based on IMF Balance of Payments dataset, which classifies exports of services in 12 different categories. These categories are very broad. For instance, the transportation services category encompasses all different types of transformation such as sea, rail, air and land transportation as well as bulk, containerized and refrigerated services. Business services puts together accounting, engineering, legal and management consulting in the same category. Nevertheless, this dataset is the most diverse that we have found, so we decided to use it to see whether our results are affected by the absence of this data.

Figure 3.3.1 shows the comparison of ECIs calculated using only goods to the ECI calculated with goods and services, combined. Overall, we see an almost perfect correlation, meaning that the inclusion of services does not change our basic story. Another way of calculating ECI would be to use just the services data. We checked whether all these three indices, namely ECI calculated with goods (ECIg), ECI calculated with goods and services (ECIgs) and ECI calculated only using the data from services (ECIs), are predictive of growth. Table 3.3.1 shows that ECIg and ECIgs are both good predictors of growth, whereas ECIs does not predict growth. When put together, ECIg beats ECIgs in terms of its correlation with future growth. This may be due to the fact that the services data is very coarse and does not capture well the very large differences in complexity of the different services it groups under the same heading. Hence, for now, we think that the services data is not disaggregate enough to be included in our economic complexity calculations.

FIGURE 3.3.1:

Relationship between ECI calculated with goods and ECI calculated with goods and services.

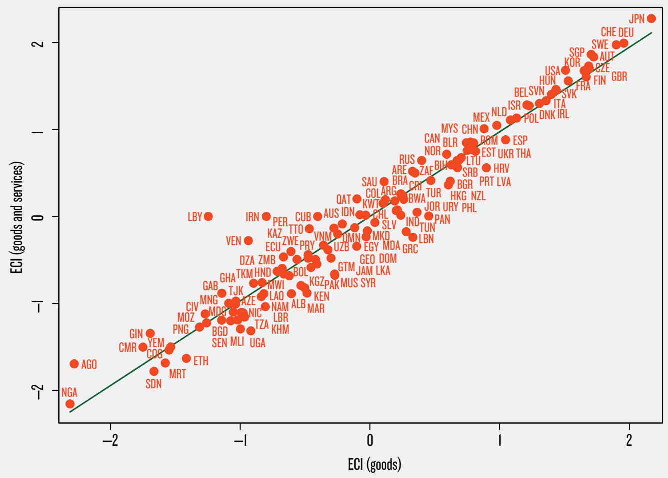

TABLE 3.3.1

	Annualized growth in GDPpc (by decade)					
	(1988-1998, 1998-2008)					
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Initial income per capita, log	-0.002***	-0.011***	-0.010***	-0.002***	-0.011***	-0.011***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Increase in natural resource exports - in constant dollars (as a share of initial GDP)	0.055***	0.062***	0.062***	0.055***	0.062***	0.062***
	(0.013)	(0.009)	(0.010)	(0.013)	(0.009)	(0.009)
Initial Economic Complexity Index (using goods)		0.016***			0.019***	0.016***
		(0.002)			(0.007)	(0.002)
Initial Economic Complexity Index (using goods and services)			0.015***		-0.003	
			(0.002)		(0.007)	
Initial Economic Complexity Index (using services)				-0.001		-0.001
				(0.001)		(0.001)
Constant	0.046***	0.110***	0.109***	0.046***	0.110***	0.111***
	(0.007)	(0.012)	(0.012)	(0.007)	(0.012)	(0.012)
Observations	218	218	218	218	218	218
Adjusted R^2	0.307	0.460	0.446	0.308	0.461	0.462
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered by country are shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1

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The Atlas of Economic Complexity

Mapping Paths to Prosperity

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THE ATLAS OF ECONOMIC COMPLEXITY

MAPPING PATHS TO PROSPERITY

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