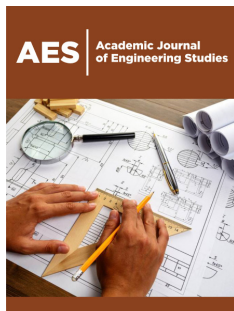


# Can Creativity Explain Economic Complexity?

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## Abstract

As the economy has advanced, production has become more complex and economics has reckoned the importance of economic complexity on the growth and economic development. Economic complexity depends on the knowledge basis of each country, but few more is known on the reasons of the difference of those differences. In this paper we propose that the literature on creativity can help to understand this issue, since we test that creativity and economic complexity are positively associated with data of the indexes of Economic Complexity and Creativity developed.

**Keywords:** Economic complexity; Creativity

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## Introduction

As economic development advances, the productive system becomes more complex and sophisticated. This sophistication is due to the fact that products require a larger amount of knowledge embedded. While, let's say, one century ago one product included a certain amount of knowledge to suit consumers' preferences, nowadays that same product requires a larger amount of knowledge to do it, due to the larger importance of design, technological changes in the production process, quality controls, more sophisticated intermediate inputs, marketing procedures, etc. That amount of knowledge can hardly be provided by the same number of individuals than in the past. It is well stated in Economics, since Adam Smith, that specialization and trade allow to enhance productivity increasing the total production and, then, welfare. This specialization will not happen only among individuals, but also organizations (i.e. firms) and countries.

As well as different stages of the production process were allocated in different countries in accordance with their comparative advantages to produce, the incorporation of knowledge will also be spread across countries to be incorporated into each final product. This specialization has been fostered by the globalization wave of the late 20<sup>th</sup> century when offshoring and international trade of goods and more recently services increased and spread worldwide. Consequently, each country shows a different degree of sophistication in its production according how much knowledge each one was able to embed in its output. Those countries that exploit better the possibilities of incorporating knowledge and expertise from different locations will be able to achieve a better situation, while those ones that are limited to incorporate only the knowledge located in their country will face higher constraints to increase their production. Economists have found in the increase of stock of knowledge a source (if not the source) for economic growth once the possibilities that further increases in the stock of capital or labour seem exhausted. Robert Solow, nobel laureate in Economics in 1987, concluded that economic growth is explained by technological progress that allows to increase the production with the

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same amount of labour and capital. This point redirected the focus of economics towards the reasons of technological progress and how to promote it. The first factor which economists looked at was R&D expenditures (amount, effectiveness, etc) as well as the development of institutions that allowed that new ideas were applied to economic production.

However, fewer research has been done in the field of economics on the reasons that foster individuals to generate such ideas. In this paper we propose that the existing literature on creativity can be helpful to fill this gap in the economic literature on the birth and development of new ideas. To do so, we will show how creativity is related to the sophistication of the economic production across a large set of countries. In the next section we present the economic complexity is measured and that this index is related to most of the economic achievements that are related to wellbeing of their populations. Section three presents the creativity index that will be used in the empirical analysis of section four where throughout different econometric models the relationship between economic complexity and the creativity level will be stated. The final section presents the conclusions as well as the future research lines that these results suggest.

### **Economic complexity**

In economics, complexity makes reference to a combination of production diversity (the number of different goods and services that it is able to produce) and non-replicability (how difficult is that others mirror the production process). Both elements reflect the variety of capabilities that the population of one country has. The larger the variety, the larger the set of goods and services that can be produced, since it is the capabilities that knowledge provide the basis to produce different items even with the same material inputs. The non-replicability element makes reference to a exclusivity endowment of some of the capabilities that makes that no other can replicate their productions. With this ideas in mind, Hausmann et al. [1] in the Center of International Development at Harvard University (<http://atlas.cid.harvard.edu/>) designed and computed the Economic Complexity Index, where they combined the number of products each country produced and the number of countries each of those products were also made.

So, the idea is to capture in an index the number of products (the larger the more complex their productive system will be) but also taking into account in which countries were also those products were produced (between two countries with the same number of products, the one whose products are only made in countries with a simplistic production process will be consider as less complex that one whose products are made only in complex products). Skipping hear the technical details on the design of the index [1], we can refer that the Economic Complexity Index is calculated on the basis of 4-digit product classification for close to 130 countries along the last years. In the top positions (2015 data) we find Japan, Swit-

zerland, Germany that produce a large array of goods and services that are only also produced in highly complex countries; meanwhile the bottom positions are occupied by Bangladesh, Niger and Sudan whose set of products is smaller and it is also replicated in a large set of countries. In any case, it must be noted that other authors, developed different indexes using alternative technical procedures [2], but getting quite similar conclusions concerning the levels of complexity of each country. Using the ideas of specialization of the production (that can be traced back to Adam Smith) that reveals that specialization and trade will increase the consumption possibilities and classic market functioning that states that in a differentiated product it will be possible to charge prices higher than costs, will in non-differentiated products with multiple agents and free entry, prices will converge to marginal costs, economics has found a rationale for linking economic complexity and higher levels of GDP.

The proper research team of the Atlas of economic complexity shows that Economic complexity is positively linked to the level of income of the countries and more importantly to its growth in the future (taking into account other variables that economic models have stated as explanatory as natural resources, human capital, institutional characteristics, etc). Other authors have shown that economic complexity is negatively linked to economic inequality [3], positively to human development [3,4], export competitiveness [5], etc. Although economic literature has stated that economic complexity is well related to many of the indicators of economic growth and development, there is a gap to fill on why some countries have a more varied knowledge base to generate such economic complexity. Prospective analysis show that economic complexity is higher in countries with more years of schooling or some of the results of the PISA analysis. However, those indicators are clearly insufficient to capture the knowledge basis that sustains the economic complexity.

A larger and more varied set of products requires some creative ideas on its workforce, not only to generate new products, but to see the possibilities that the existing production process (techniques, resources, infrastructure) has to allow that new products can succeed in the market. It must be noted that the complexity of one country will increase more when the new product is not in the production set of the countries that share the rest of the production set. Again, that requires the capability to develop and carry on ideas "out-of-the-box" that is not something that can be captured by the years of formal schooling that the population (or just the working population) may have. Actually, some research has shown a relationship between creativity in territories and patents [6]. Consequently, we think that the literature on creativity could provide a basis to explain this element of economics.

### **Creativity**

Although with some discussions on how to best define and conceptualize it, creativity can be considered a human quality that implies the capability of developing new ideas, concepts or

linkages among them able to provide new solutions to problems. It is basically an individual's characteristic although clearly the environment can foster it. There is a vast literature that has tried to analyze in what ways creativity can be stimulated in children or youngsters [7,8] since it is the basis for a better personal development with clear advantages for the whole society. However, many of those measures of creativity are personal indicators, and in many cases for specific actions [9] for scientific issues, Dumas et al. [10] for engineering design, Haavold [11], for mathematics, etc) and not for general aspects on the society. However, given the relevance for international analysis, some approaches have been done to establish a measure of each country creativity that goes beyond specific analysis of pairs of countries for very specific questions. The Martin Prosperity Institute, housed at University of Toronto (<http://martinprosperity.org/>), elaborates and publishes a Creativity Index for 139 countries based on three dimensions (the 3Ts): Technology used, size of the creative class & global Talent and Tolerance [12].

The Global Creativity Index 2015 ranks Australia, US and New Zealand at the top and Madagascar, Ghana and Iraq at the bottom. It must be noted that, although income per capita may foster some of the elements that determine the Creativity index (i.e. a higher income per capita may make a country more appealing for creative workers that can be more moveable, or that certain technologies

require a minimum income to can be deployed) countries like Qatar (with a very high income per capita) ranks 109th below Sri Lanka and close to Pakistan or Indonesia (with a medium development of technologies) that stands below Cambodia; meanwhile Uruguay ranks over Israel due to higher tolerance levels even this last one has a higher income per capita and innovative class.

### Creativity and complexity

In order to know the relationship between the creativity level of each country and its economic complexity, we estimate an econometric model where the economic complexity will be explained in terms of the creativity index for 2015. The reason to take this year is that, although the Complexity Index is calculated for more years, the Creativity Index is only available for that year. As it is known, ordinary least squares establish a relationship only in terms of the averages of the distributions, however the relationship between the variables can be also analyzed in other points of the distribution. Even more, extreme values can bias the values of the averages, and other positions (such as the median) can avoid that effect; equally, asymmetries can affect the properties of the OLS-estimators. To avoid all those effects, results of Table 1 present, not only the ordinary least squares estimation but also the median and the first and third quartiles.

**Table 1:** Results of the econometric regressions.

Table 1: Results of the Econometric Regressions				
	OLS	Q25 regression	Median	Q75 regression
Constant	-1.376** (12.170)	-1.385** (8.870)	-1.499** (8.440)	-1.007** (5.330)
Creativity Index	3.142** (13.490)	3.222** (8.210)	3.490** (10.350)	3.216** (8.970)
# obs	112	112	112	112
R <sup>2</sup>	0.592			
Pseudo R <sup>2</sup>		0.322	0.394	0.432
F-test	181.9			

Notes: t-ratios in parenthesis, \*\*Indicate significance at 5%.

As we can see in the models of the econometric regressions, there is a positive and significant relationship between the value of the Creativity index that each country and its value in the Economic Complexity Index. This relation holds both if the analysis is based on OLS estimation as if it is based in any of the three quartiles of the statistical distribution, so we can exclude any bias due to atypical/extreme values. The positive (and statistically significant) estimated coefficient confirms that countries that achieve higher levels of creativity exhibit higher levels of economic complexity. More specifically, the obtained estimation of 3.142 indicates that for a country like Chile (whose creativity index is 0.611 over the average of the sample 0.468) an increase of 0.12 in its creativity (half the standard deviation of the 112 countries like the one that separates Argentina from Ecuador or Viet Nam from Sri Lanka) will increase its economic complexity from its current value of 0.03168

to a situation similar close to Hong-Kong increasing 18 positions in the ranking surpassing countries like Costa Rica or Portugal, for instance or for a country like Thailand surpass in economic complexity to countries like Spain, China or Brazil.

### Conclusion and Discussion

As the production processes have become more sophisticated, both for the used technology as its spread across different locations in the world, the concept of economic complexity has been coined to make reference to the diversity and specificity of the required knowledge to carry on the production that each country is doing. Economic research has stated that economic complexity is related to some of the relevant indicators of wellbeing of the population as well as economic growth. This complexity relies of the specific knowledge that each country hosts and that is applied to produc-

tion supposing an new and differentiated set of items delivered to markets. Although this element becomes a key element in the new conceptualization of the modern economies, there is a gap in the literature on the reasons that make that one country can host the specific knowledge that will foster such creativity.

In this paper we have proposed that the literature on creativity can help to fill such void, since creativity (whatever is proxied or measured) will be the actual basis to generate the needed ideas to make a economic system more sophisticated and differentiated from other countries. We have tested the relationship between the Creativity Index elaborated by Florida et al. [12] and the Complexity Index of Hausmann et al. [1]. They are not the only indexes, and as any other they have their shortcomings but they provide a complete reference for a set of over one hundred countries to do the econometric analysis. The results confirm a positive, and statistically significant, relationship, concluding that as one country becomes more creative, the complexity of its economic system increases [13].

This result suggests interesting future research lines. On the one hand, it seems necessary to analyze more deeply which kind of creativity is the most relevant to promote a complex and sophisticated productive system. For sure, the effect will not be the same if such creativity is focused to artistic activities that if it is to solve problems or to focus scientific or engineering problems. On the other hand, research on the reasons that limit the effectiveness of a creative basis to foster complexity (whether they are in the institutions, in the financial-economic system, etc) deserve further research too.

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