From FDI to economic complexity: a panel Granger causality analysis

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Abstract

In this paper, we try to assess whether attracting, and accumulating, higher amounts of FDI per capita induces a higher level of economic complexity in a country. Using a sample of 117 countries and 22 years, from 1995 to 2016, we first test for the stationarity of FDI and economic complexity, and then we use the Dumitrescu and Hurlin (2012) approach to assess their bi-directional Granger causality. We find that accumulating a higher stock of inward FDI per capita makes economic complexity increase in a country, and not viceversa. However, this causal effect holds only in countries with a sufficiently high level of development and absorptive capacity, as proxied by income, human capital and quality of institutions.

Keywords: economic complexity, foreign direct investment, panel Granger causality, unit root

JEL codes: C23, F21, F23, O19, O33

1. Introduction

The aim of this paper is to examine the effect of inward foreign direct investments on the level of economic complexity of a country. In the last two decades the concept of economic complexity has come back to the stage in the economic disciplines. A search on Scopus reveals that, between 2000 and 2018, the production of scientific documents (in economics, econometrics, finance, business, management and accounting) reporting "economic complexity" in the abstract, title or keywords has grown by a factor of 9, passing from 41 to 396.

Starting from the seminal contributions of Hidalgo et al. (2007) and Hidalgo and Hausmann (2009), the concept of economic complexity has been increasingly associated to that of economic development. In their framework, complexity arises as the outcome of two characteristics: the diversity of a country's product/export portfolio and the ubiquity of a product, which increases the lower is the number of countries producing or exporting that product. The underlying mechanism is that countries differ in their level of economic complexity, and so of economic development, because they are endowed with different sets of skills and capabilities.

Relying on this framework, in the last few years many scholars assessed the role of economic complexity in explaining aggregate economic outcomes, like the GDP per capita growth or income inequality (see, among others, Hidalgo and Hausmann (2009), Felipe et al. (2012), Ferrarini and Scaramozzino (2016), Pugliese et al. (2017), Gao and Zhou (2018) and Sbardella et al. (2017, 2018)). Recently, other studies looked at the possible role of economic complexity in affecting the capability of countries to diversify their product portfolio, or to develop new specializations in unrelated industries (Pinheiro et al. 2018).

All these papers, however, use complexity as an exogenous predictor and postulate that it is a path-dependent process where the development of new products, or industries, is the outcome of a process that recombines existing skills and capabilities (Hidalgo et al., 2007). In other words, no study clearly explains why countries differ in their degree of knowledge complexity, or why do some countries improve their level of economic complexity faster than others. To our knowledge, only two studies yet have focused on economic complexity as a dependent variable. The first is the study by Sweet and Eterovic Maggio (2015), who analyse whether a stronger IPR system triggers innovation, using the economic complexity index as a proxy for the innovative output of a sample of 94 countries across forty years, from 1965 to 2005. Their system GMM results show that more stringent IPR laws increase the capability of a country to increase the level of sophistication of its products, but this impact holds only for countries where the level of development, human capital and complexity are high. In doing so, they also include the yearly FDI inflow as a control variable, but the corresponding estimated coefficient is not statistically significant. In a study of Turkish manufacturing firms between 2006 and 2009, Javorcik et al. (2018) show that a higher capability of firms to upgrade the quality, and so the complexity, of their products depends on the amount of inward FDI in downstream sectors in the region. In this respect, multinational enterprises act as agents of structural change (Neffke et al. 2018) and innovation by improving the average level of product sophistication of firms.

The mechanisms through which multinationals can help host regions and countries to improve the complexity of their product portfolio are different. First, multinationals on average produce more innovative, technology- (or R&D-) intensive goods and services than incumbent domestic firms. For incumbent competitors these products can represent either a source of imitation or a source of innovation that should help them avoiding the increased competition generated by the arrival of these big players. Second, multinationals can make domestic firms to improve the quality, and sophistication, of their products and services through indirect knowledge spillovers or through the input-output relationships with local suppliers (Javorcik 2004; Iacovone et al., 2015). Third, multinationals can also contribute to improve the quality of the exports of a country, especially in developing regions (Harding and Javorcik, 2012). In this case, the relationship can be explained by two mechanisms: first, the use, by foreign multinationals, of developing countries as export platforms, and, second, the knowledge spillovers originating from multinationals and benefiting local exporting firms and suppliers through imitation and learning activities.

To analyse whether attracting, and cumulating, more FDI in a country is related to a higher level of economic complexity, we use panel Granger causality tests (Dumitrescu and Hurlin, 2012) and dynamic panel data techniques on a sample of 117 countries and 22 years, from 1995 to 2016. To check for the possible heterogeneity of the results, we also repeat the econometric analysis on different sub-sets of countries according to their level of income, human capital, and quality of institutions.

We find that a higher accumulation rate of inward FDI stock per capita Granger causes a faster growth of economic complexity in a country. Interestingly, we find that such a positive effect holds only in the most developed countries, with a higher absorptive capacity, while for the less developed the effect of FDI is not statistically significant.

Our results confirm and extend the evidence found by Javorcik et al. (2018) for Turkey and provide a twofold contribution to the literature. On the FDI side, we provide cross-country evidence on the

aggregate effects of FDI: as far as a higher economic complexity is correlated to a higher stage of economic development, attracting FDI and multinationals is a policy leverage to generate positive knowledge spillovers in a country. However, this is valid only in those countries with a high level of wealth, absorptive capacity and institutional quality. On the complexity side, we provide evidence that complexity is not a fully exogenous parameter, but can be affected by external elements, like foreign direct investments. We here posit that the country heterogeneity in the level of product complexity is due to the capability to attract, and cumulate, investments by foreign multinationals.
The rest of the paper is organized as follows. Section 2 presents the empirical analysis, describing the data (2.1) and the econometric strategy (2.2) adopted. Section 3 discusses the results of our estimates, while Section 4 concludes.

2. Empirical analysis

2.1. Data

Data on yearly inward FDI stocks (in Millions of US dollars) come from the UNCTAD World Investment Report Database. According to UNCTAD, these data correspond to the sum of the value of the share of capital and reserves, including retained profits, attributable to the parent company and the net indebtedness of its affiliates. Approximately, this corresponds to the accumulated value of past FDI flows. To normalize the variable across countries, we divide it by total resident population, and we obtain a measure of inward FDI stock per capita (*FDI*). We chose population, and not GDP, as the denominator to avoid potential correlation with our dependent variable, that would make the relationship between economic complexity and FDI endogenous by construction.
We merge this information with data on countries' economic complexity from the Atlas of Economic Complexity provided by Harvard University. The index is computed using trade data from UN COMTRADE and merging two elements: the number of products that a country can produce with its set of internal capabilities (*diversity*) and the number of countries that can produce a specific product (*ubiquity*). The overall economic complexity of a country increases the higher the diversity of its product basket and the lower the pervasiveness of its products. Since the index originally ranges between –2.5 and +2.8, we reparametrize it through normalization of the variable, to obtain an index that varies between 0 and 1. Finally, we transformed both variables in natural logarithm.

We also collect information on countries' income per capita and human capital using the World Bank's world development indicators, and quality of institutions using the World Governance Indicators still provided by the World Bank.

Our final sample consists of 117 countries and 22 years (1995-2016), for a total of 2,574 observations (the full list of countries is shown in Appendix, Table A1).

2.2. Econometric strategy

2.2.1. Unit root tests

Preliminary to the Granger causality analysis, we test for the stationarity of our ln*FDI* and ln*ECI* variables, using the Im-Pesaran and Shin (2003) test and the Fisher-type tests proposed by Choi (2001), based on the Phillips-Perron tests. In both tests, the null hypothesis is that all panels (i.e. all countries) in the sample contain a unit root is tested against an alternative hypothesis that there is a positive share of stationary panels (as in the Im-Pesaran-Shin test) or that at least one of the panels is stationary (as in the Fisher-type tests)[1].

Table 1 shows the results of the two tests. We find that both of them do not reject the null hypothesis of non-stationarity of ln*FDI* but they reject it with respect to ln*ECI*. With respect to this latter, while the Phillips-Perron test always rejcts H_0, the Im-Pesaran-Shin test rejects the null only when the number of lags is 1 or 2. However, we take them as a reference because, when we use the Akaike Information Criterion (AIC) to select the optimal number of lags, we find that this lies between 1 and 2 for both variables (i.e. 1.7 for ln*ECI* and 1.8 for ln*FDI*). Instead, the tests always reject the null hypothesis when the two variables are measured in first differences.

Therefore, we conclude that ln*FDI* is an I(1) process and ln*ECI* is I(0) process. The stationarity of economic complexity is not surprising. Recent studies have shown that complexity in a country, or a region, can increase or decrease over time. This is due either to product exit, when countries do not find convenient to keep the simplest products in their portfolio (van Dam and Frenken 2019), or because of the natural tendency of highly complex systems to stabilize or even decrease their level of complexity, despite their high level of entropy (Antonietti and Burlina 2019).

[1] In both tests, we include a time trend and we subtract the cross-sectional means to avoid cross-sectional dependence.

However, since the Granger causality requires variables to be stationary, we transform all our variables in equation 1 in first differences and we test whether the growth rate in the stock of inward FDI per capita (ΔlnFDI) Granger causes the growth rate of economic complexity (ΔlnECI) in a country.

Table 1 - Panel Unit Root Test

Lags	lnECI	p-value	lnFDI	p-value	ΔlnECI	p-value	ΔlnFDI	p-value
Im, Pesaran and Shin test								
1	-4.0175	0.000	0.628	0.7351	-24.89	0.000	-14.12	0.000
2	-1.6538	0.049	1.048	0.8528	-15.88	0.000	-6.430	0.000
3	1.0991	0.864	0.336	0.6316	-8.163	0.000	-4.963	0.000
Fisher-type test (based on Philipps-Perron tests)								
Lags	lnECI	p-value	lnFDI	p-value	ΔlnECI	p-value	ΔlnFDI	p-value
1	-15.16	0.000	4.505	1.000	-52.12	0.000	-26.80	0.000
2	-15.15	0.000	4.035	1.000	-55.21	0.000	-27.20	0.000
3	-14.95	0.000	3.894	1.000	-58. 46	0.000	-27.74	0.000

Notes: In all tests we included a time trend and subtract cross-sectional means. In the Fisher-type test we only report the p-value of the inverse-Normal statistics. The p-values of all the other three statistics (inverse Chi-squared, modified inverse Chi-squared and inverse Logit) are in line with those of the inverse-Normal.

2.2.2. The panel Granger causality test

The starting empirical model used to analyse the causal relationship between inward FDI and economic complexity is the following:

(1) $\Delta lnECI_{it} = \alpha + \sum_{k=1}^{K} \beta_k \, \Delta lnECI_{it-k} + \sum_{k=1}^{K} \gamma_k \, \Delta lnFDI_{it-k} + \epsilon_{it}$

where *i*=1, …, *N* refers to the country, *t*=1,…,*T* to the year, and ϵ is the stochastic error term. To apply the Granger causality tests, both ln*ECI* and ln*FDI* must be stationary. In this case, Δln*FDI* Granger causes Δln*ECI* if the past values of Δln*FDI* can predict the current values of Δln*ECI*, even once the past values of Δln*ECI* have been included in the model. This happens when the coefficients γ_k are jointly statistically different from zero. By exchanging the two variables, one can test for causality in the opposite direction. In the Dumitrescu-Hurlin (2012) version of the Granger causality test, all the coefficients can vary across countries, but are invariant over time. The null hypothesis becomes:

(2) $H_0: \gamma_{i1} = \gamma_{i2} = \cdots = \gamma_{iK} = 0 \qquad \forall\, i = 1, \dots, N$

which corresponds to the absence of causality for all the countries in the dataset. The alternative hypothesis, instead, is that there can be causality between Δln*FDI* and Δln*ECI* for some countries, but not necessarily for all of them. The test works as follows. After running the *N* individual regressions in (1), we perform the F-test of the *K* linear hypotheses in (2) and generate the individual Wald statistics W_i. Then we compute the average Wald statistic[2].

With large *N* and large *T*, Dumitrescu and Hurlin (2012) show that the standardized statistics $\bar{Z}$ follows a standard normal distribution. However, for panels with large *N* and small *T* (with $T > 5+3K$), as in our case, the test uses an approximated standardized statistic $\tilde{Z}$, which is still normally distributed.

We choose the optimal lag order *K* using the whole sample of countries and the Akaike information criterion. In addition, to avoid the cross-sectional dependence across countries, we use the bootstrap procedure suggested by Dumitrescu and Hurlin (2012) with 1,000 replications.

At the same time, we also test for the opposite direction of causality, i.e. from Δln*ECI* to Δln*FDI*. If the test rejects the null hypothesis, we conclude that FDI and economic complexity do mutually influence each other. On the contrary, if the test does not reject H_0, it means that causality runs from FDI to economic complexity.

To check for the general validity of our results, we also perform the Granger causality tests on specific subsets of countries, identified on the base of aggregate indicators of economic development like income per capita, education and quality of institutions. With respect to income, we split the sample in two groups, high-income and low-income countries, where he former includes those countries with a level of income per capita above the median, according to the World Bank classification. With respect to human capital, we distinguish countries with a share of tertiary educated resident population above the median from countries with a tertiary educated population below the median. Finally, with respect to institutional quality, we make use of the World Governance Indicators provided by the World Bank, which identifies six items measuring the quality of governance in a country: voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law and control of corruption. For each of them, we select countries with an individual score in 1995 above the median.

[2] We use the user-written package *xtgcause* provided by Lopez and Weber (2017) for Stata 15.

3. Results

Table 2 shows the results of the Granger causality test on the full sample. We test both directions of causality, first from Δln*FDI* to Δln*ECI* and then viceversa. We find that the p-value of the $\widetilde{Z}$ statistic is significant always statistically at 5%, allowing us to conclude that a causality relationship can be found from increasing inward FDI and the growth in economic complexity. Instead, the statistic is never statistically significant when testing for the opposite direction of causality: this means that, on average, the accumulation of inward FDI is not driven by increasing economic complexity.

Table 2. Granger causality test: full sample

FDI --> ECI		
$\bar{W}$	10.932	
$\bar{Z}$	20.2904**	p-value = 0.0250
$\tilde{Z}$	1.8856**	p-value = 0.0290
ECI --> FDI		
$\bar{W}$	8.4151	
$\bar{Z}$	11.6815	p-value = 0.1850
$\tilde{Z}$	0.0594	p-value = 0.9600

In the following, we provide the results of the Granger causality test when we split the sample of countries according to the level of income per capita (Table 3), tertiary education (Table 4) and institutional quality (Tables 5).

With respect income, we group countries according to the ex-ante classification released by the World Bank. Countries are divided in four classes ranging from low income to high income. We pool together medium-high and high-income countries on the one hand, and medium-low and low-income countries on the other. As shown in Table 3, the direction of causality run from FDI to ECI only when considering high-income countries, whereas we do not find any statistically significant Granger causality for low-income countries. Interestingly, when we further split the sub-sample of high-income countries into high-income and medium-high income economies, we find that the previous result holds only for the former group ($\tilde{Z}$ =1.881, p-value 0.040).

As in Table 2, we never find any significant evidence of a Granger causality from Δln*FDI* to Δln*ECI*.

Tab. 3 Granger causality test, by income class

FDI --> ECI	*Medium high + High income*	*Medium-low + Low income*
$\tilde{Z}$	1.869**	0.676
(p-value)	(0.020)	(0.390)
ECI --> FDI		
$\tilde{Z}$	-1.445	0.960
(p-value)	(0.160)	(0.230)

Table 4 shows the results when countries are clustered according to their median level of human capital, given by the share of resident population enrolled in tertiary education programmes. Specifically, we consider as *High education* a country where the median share of tertiary educated residents across the years is higher than the corresponding median share of all countries. In line with the previous results, we find that higher rates of FDI accumulation Granger cause higher increases in economic complexity only where the level of education is high enough. Again, we do not find significant evidence in favour of the opposite direction of causality.

Tab. 4 Granger causality test, by level of education

FDI --> ECI	*High education*	*Low education*
$\tilde{Z}$	1.717**	0.946
(p-value)	(0.032)	(0.230)
ECI --> FDI		
$\tilde{Z}$	-0.253	1.045
(p-value)	(0.797)	(0.322)

We then show the results of the Granger causality test when countries are grouped according to their quality of institutions, as captured by the set of World Governance indicators (WGI). Specifically, the quality of a specific type of institution is considered as high if the country's median score across the 22 years is higher than the corresponding median value for all countries. We consider here four out of six indicators of institutional quality, which capture the ease of doing business and the quality of the regulatory framework of a country: control of corruption, Government effectiveness, regulatory quality and rule of law.

The first index captures the extent to which public power is exercised for private gain, including both petty and grand forms of corruption. The second measures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. The third, instead, captures the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development, while the fourth indicator approximates the quality of contract enforcement, property rights, courts and police system, as well as the likelihood of crime and violence.

Table 5 summarizes the results for the four institutional variables.

Table 5. Granger causality test, by level of institutional quality

FDI --> ECI	*High control of corruption*	*Low control of corruption*
$\tilde{Z}$	2.470***	0.226
(p-value)	(0.008)	(0.804)
ECI --> FDI		
$\tilde{Z}$	-0.377	0.451
(p-value)	(0.659)	(0.617)
FDI --> ECI	*High Government effectiveness*	*Low Government effectiveness*
$\tilde{Z}$	0.684	1.937**
(p-value)	(0.439)	(0.021)
ECI --> FDI		
$\tilde{Z}$	-0.894	0.545
(p-value)	(0.377)	(0.557)
FDI --> ECI	*High regulatory quality*	*Low regulatory quality*
$\tilde{Z}$	2.125**	0.552
(p-value)	(0.014)	(0.518)
ECI --> FDI		
$\tilde{Z}$	0.169	0.827
(p-value)	(0.828)	(0.454)
FDI --> ECI	*High rule of law*	*Low rule of law*
$\tilde{Z}$	2.078***	0.582
(p-value)	(0.000)	(0.480)
ECI --> FDI		
$\tilde{Z}$	-0.336	0.423
(p-value)	(0.700)	(0.620)

We find that a higher rate of accumulation of FDI stock in a country Granger causes economic complexity growth only when the level of institutional quality is sufficiently high, that is when the control of corruption, the quality of regulation and of the rule of law are higher than the median. Interestingly, this does not happen for Government effectiveness, where we find evidence of Granger causality for lower levels of its quality. This can make sense as the index captures different aspects of Government action, including the quality of public services. Instead, we also find that the strongest Granger causality (i.e. the lowest p-value) between $\Delta \ln FDI$ and $\Delta \ln ECI$ occurs when the quality of the rule of law is the highest: this seems in line with Sweet and Eterovic Maggio (2015), who find that a strong, and reliable, IPR system is generally required to stimulate innovation and product sophistication.

4. Conclusions

In this paper, we use a wide panel of countries and years to assess the causal relationship between inward FDI stock per capita and economic complexity. We use a set of unit root tests and the panel Granger causality approach proposed by Dumitrescu and Hurlin (2012) to assess, respectively, the order of integration of the processes underlying the two variables and their direction of causality. We also repeat the Granger causality tests on sub-samples of countries, identified according to their median level of income per-capita, education and institutional quality.

We find that attracting, and accumulating, more FDI helps countries improve their average level of knowledge complexity, and not viceversa. However, this holds only in those countries with a high level of income per capita, education and institutional quality, i.e. control of corruption, regulatory quality and rule of law.

In line with the literature on the aggregate effects of FDI, we posit that the positive effect of FDI on innovation and complexity is not for all but requires a minimum threshold of development and absorptive capacity. Therefore, our results confirm and extend the evidence found by Javorcik et al. (2018) for Turkey and provide a twofold contribution to the literature. On the FDI side, we provide cross-country evidence on the role that FDI can have in promoting growth and development: as far as a higher economic complexity is correlated to a higher stage of economic development, attracting FDI and multinationals is a policy leverage to generate positive knowledge spillovers in a country. On the complexity side, we provide evidence that complexity is not a fully exogenous parameter, but can be affected by external elements, like foreign direct investments.

References

Aitken, B., and A. Harrison. 1999. “Do Domestic Firms Benefit from Direct Foreign Investment? Evidence from Venezuela.” *American Economic Review* 89(3): 605-618.

Antonietti, Roberto, Raffaello Bronzini, and Giulio Cainelli. 2015. “Inward Greenfield FDI and Innovation.” *Journal of Industrial and Business Economics* 42(1): 93-116.

Antonietti, Roberto, and Chiara Burlina. 2019. “From Entropy to Economic Complexity: Evidence from Italian Regions. “ Paper presented at the II Rethinking Clusters International Workshop, Padua, 15-17 May, 2019.

Choi, In. 2001. “Unit Root Tests for Panel Data.” *Journal of International Money and Finance* 20(2):249–72.

Dumitrescu, E.I., Hurlin, C. 2012. “Testing for Gramger non-causality in heterogeneous panels.” *Economic Modelling* 29(4): 1450-1460.

Felipe, Jesus, Utsav Kumar, Arnelyn Abdon, and Marife Bacate. 2012. “Product Complexity and Economic Development.” *Structural Change and Economic Dynamics* 23(1):36–68.

Ferrarini, Benno and Pasquale Scaramozzino. 2016. “Production Complexity, Adaptability and Economic Growth.” *Structural Change and Economic Dynamics* 37:52–61.

Gao, Jian and Tao Zhou. 2018. “Quantifying China’s Regional Economic Complexity.” *Physica A: Statistical Mechanics and Its Applications* 492:1591–1603.

Greenstone M., Hornbeck R., Moretti E..2010. Identifying agglomeration spillovers: Evidence from winners and losers from large plants openings, *Journal of Political Economy,* 118(3), p. 536-598.

Harding, T. and Javorcik, B.S. 2012. “Foreign direct investment and export upgrading”. *Review of Economics and Statistics*, 94(4): 964-980.

Hidalgo, C. A., B. Klinger, A. L. Barabási, and R. Hausmann. 2007. “The Product Space Conditions the Development of Nations.” *Science* 317(5837): 482 LP-487.

Hidalgo, César A. and Ricardo Hausmann. 2009. “The Building Blocks of Economic Complexity.” *Proceedings of the National Academy of Sciences of the United States of America* 106(26):10570–75.

Iacovone, L.eonardo, Beata S. Javorcik, Wolfgang Keller, and James Tybout. 2015. “Suppliers Responses to Walmart’s Invasion in Mexico.” *Journal of International Economics* 95: 1-15.

Im, Kyung So, M. Hashe. Pesaran, and Yongcheol Shin. 2003. “Testing for Unit Roots in Heterogeneous Panels.” *Journal of Econometrics* 115(1):53–74.

Javorcik, Beata S. 2004. “The Composition of Foreign Direct Investment and Protection of Intellectual Property Rights: Evidence from Transition Economies.” *European Economic Review* 48(1): 39-62.

Javorcik, Beata S., Alessia Lo Turco, and Daniela Maggioni. 2018. “New and Improved: Does FDI Boost Production Complexity in Host Countries?” *The Economic Journal* 128(614):2507–37.

Lopez, Luciano, and Sylvain Weber. 2017. “Testing for Granger Causality in Panel Data.”. IRENE Working Paper n. 17-03, University of Neuchatel.

Neffke, Frank, Matté Hartog, Ron Boschma, and Martin Henning. 2018. “Agents of Structural Change: The Role of Firms and Entrepreneurs in Regional Diversification.” *Economic Geography* 94(1):23–48.

Peri Giovanni, D. Urban. 2006. “Catching-Up to foreign technology? Evidence on the Veblen-Gerschenkron effect of foreign investment.” *Regional Science and Urban Economics* 36: 72-98.

Pesaran, M. Hashem 2006. “Estimation and inference in large heterogeneous panels with a multifactor error structure”. *Econometrica*, 74(4): pp.967-1012.

Pesaran, M. Hashem and Ron P. Smith (1995). “Estimating long-run relationships from dynamic heterogeneous panels” *Journal of Econometrics*, Vol. 68(1): pp.79-113.

Pinheiro, Flávio L., Aamena Alshamsi, Dominik Hartmann, Ron Boschma, and César A. Hidalgo. 2018. *Shooting High or Low: Do Countries Benefit from Entering Unrelated Activities?* Utrecht.

Pugliese, Emanuele, Guido L. Chiarotti, Andrea Zaccaria, and Luciano Pietronero. 2017. “Complex Economies Have a Lateral Escape from the Poverty Trap” edited by W.-X. Zhou. *PLOS ONE* 12(1):e0168540.

Reynolds, Christian et al. 2018. “A Sub-National Economic Complexity Analysis of Australia’s States and Territories.” *Regional Studies* 52(5):715–26.

Sbardella, Angelica et al. 2018. “The Role of Complex Analysis in Modelling Economic Growth.” *Entropy* 20(11): 883.

Sbardella, Angelica, Emanuele Pugliese, and Luciano Pietronero. 2017. “Economic Development and Wage Inequality: A Complex System Analysis” edited by T. Preis. *PLOS ONE* 12(9):e0182774.

Westerlund, J. 2005. “New simple tests for panel cointegration”, *Econometric Reviews*, 24: 297-316.

Sweet, Cassandra Mehlog, and Eterovic Maggio Dalibor Sacha. 2015. “Do Stronger Property Rights Increase Innovation.” *World Development* 66: 665-677.

Van Dam, Alje, and Koen Frenken. 2019. “Variety, Complexity and Economic Development.” Papers in Evolutionary Economic Geography n. 19.12, Utrecht University.

APPENDIX

Tab. A1 - List of countries

Albania	Estonia	Kyrgyz Republic	Papua New Guinea	Turkmenistan
Algeria	Ethiopia	Lao PDR	Paraguay	Uganda
Argentina	Finland	Latvia	Peru	Ukraine
Australia	France	Lebanon	Philippines	United Arab Emirates
Austria	Georgia	Liberia	Poland	United Kingdom
Azerbaijan	Germany	Libya	Portugal	United States
Bangladesh	Ghana	Lithuania	Qatar	Uruguay
Belarus	Greece	Madagascar	Romania	Uzbekistan
Bolivia	Guatemala	Malawi	Russian Federation	Venezuela, RB
Brazil	Guinea	Malaysia	Saudi Arabia	Vietnam
Bulgaria	Honduras	Mali	Senegal	Yemen, Rep.
Cambodia	Hong Kong SAR, China	Mauritania	Singapore	Zambia
Cameroon	Hungary	Mauritius	Slovak Republic	Zimbabwe
Canada	India	Mexico	Slovenia	
Chile	Indonesia	Moldova	South Africa	
China	Iran, Islamic Rep.	Mongolia	Spain	
Colombia	Ireland	Morocco	Sri Lanka	
Congo, Rep.	Israel	Mozambique	Sudan	
Costa Rica	Italy	Netherlands	Sweden	
Croatia	Jamaica	New Zealand	Switzerland	
Czech Republic	Japan	Nicaragua	Tajikistan	
Cote d'Ivoire	Jordan	Nigeria	Tanzania	
Denmark	Kazakhstan	Norway	Thailand	
Ecuador	Kenya	Oman	Trinidad and Tobago	
Egypt, Arab Rep.	Korea, Rep.	Pakistan	Tunisia	
El Salvador	Kuwait	Panama	Turkey	