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Integrating Services in the Economic Fitness Approach

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Abstract

Economic Complexity is a set of network-based and algorithmic methods for the study of economic development and competitiveness. In this framework, Economic Fitness is an innovative approach that improves the mathematical and conceptual scheme. For convenience, these methods were originally conceived on trade in goods. This paper extends the Economic Fitness methodology to include a trade in services element to yield a *universal* matrix of world trade and thus provide a more complete picture of a country's development and global competitiveness. The paper applies two algorithms to the universal trade in goods and services matrix to contrast country competitiveness and change in complexity and diversification when services are added to the traditional goods-only matrix. The results show that (i) the competitiveness of many countries was previously over- or underestimated, that is, many countries gain or lose positions in the ranking of economic fitness when services trade is considered alongside goods; and (ii) complex services tend to cluster with complex manufacturing, suggesting a common capabilities structure. These findings show how developing complex services aids diversification strategies for developing countries.

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Integrating Services in the Economic Fitness Approach

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1. Introduction

Economic Complexity is a new field of research that provides a framework to investigate macroeconomic competitiveness and economic development. This approach is data-driven and interdisciplinary, borrowing from diverse fields such as dynamical systems, complex networks, and machine learning. In general, we are interested to optimize both large data analysis and algorithms to enhance our capability to extract information and maximize, in a broad sense, the signal-to-noise ratio.

The first attempt applying this framework to macroeconomics was proposed in a series of papers that used a network of products to investigate the development of countries, the Product Space [Hidalgo et al. 2007] and an index for countries' competitiveness, called the Economic Complexity Index (ECI) [Hidalgo et al. 2009]. These papers laid the foundations for the field that is now known as Economic Complexity. Pietronero et al., proposed a new set of tools with the aim to solve some mathematical and conceptual issues which were present in the previous approach of ECI and Product Space. For instance, the ECI algorithm is linear and based on an averaging procedure, which was inconsistent with the nested structure of the input data [Pietronero et al. 2017] and with the capabilities hypothesis [Cristelli et al. 2013]; and the Product Space does not take into account the time evolution of countries' export baskets and does not compare its results with any statistical null model (for a systematic comparison of the two methodologies, that goes beyond the aims of the present work, the reader is referred to [Cristelli et al. 2013; Pietronero et al., 2017]). The Fitness and Complexity algorithm [Tacchella et al. 2012] and the Taxonomy or Product Progression Network [Zaccaria et al. 2014; Pugliese et al. 2017b] were proposed as the state of the art methods to improve the mathematical and conceptual framework.

In order to discern the research field (Economic Complexity) from the single set of methodologies, we will adopt the terminology "Economic Fitness" to indicate the broader approach introduced by the group of Pietronero [Tacchella et al. 2012; Zaccaria et al. 2014, Pugliese et al. 2017b].

This set of tools is typically applied to the export database of trade flows of physical products between countries [Gaulier et al. 2010]. They are able to give different insights and they have been used to analyze single countries [Zaccaria et al. 2016] or regions [Cristelli et al. 2014], or to tackle specific problems such as the escape from the poverty trap [Pugliese et al. 2017A] and wage inequality [Sbardella et al. 2017]. Moreover, this approach can be also used to forecast economic growth [Cristelli et al. 2015, Liao and Vidmer 2018], and its application leads to a prediction power comparable with industry standard (IMF) GDP growth forecasts [Cristelli et al. 2017].

In this paper we apply the Economic Fitness approach to a novel dataset that extends the goods-only database, i.e. the UN-COMTRADE data traditionally considered in the Economic Complexity field [Gaulier and Zignago 2010]. Our dataset harmonizes goods data with services data that are sourced from the IMF Balance of Payments (BPM6) database [IMF 2016a; Loungani et al. 2017]. This novel dataset, which we call *Universal*, aims to consider all exportable human activities, harmonizing physically tangible goods with the less-tangible services to provide an unprecedented, comprehensive view of the productive structure of countries.

In a recent paper, [Stojkoski et al. 2016] proposed a first attempt to integrate services and goods data in one comprehensive database. In the present work we consider a more recent and complete database for services and we consider a larger number of sectors (105, out of which 22 are services, while they consider 22 sectors, out of which 12 are services). The sectors' numerosity is crucial to obtain a reliable application of the Economic Fitness algorithms, for which diversification is a key element. In the Annex we discuss in detail this and other differences between the present work and the approach adopted by [Stojkoski et al. 2016].

In general, the Economic Fitness approach relies on the analysis of carefully selected data, usually the export of physical products. This choice is at odds with many common approaches which are present in the economic literature and in a number of practical applications [IMF 2016b; ASD 2011]. For instance, the GDP forecast made by the International Monetary Fund and the production of the World Economic Outlook report are based on the assessment of hundreds of variables, literally "Big Data". Some scholars and reporters, commenting on the parallel increase of data availability and the improvement of data mining techniques, even claimed that these could cause the "End of Theory" [Anderson 2008]. However, we believe that in general parsimonious models, in agreement with the general rule known as Occam's razor [Blumer et al. 1987], could provide a better understanding of the cause-effect relationships and give the required flexibility to investigate specific issues. Moreover, it is a well-known problem that in a number of situations "Big Data" may lead to "Big Noise", in the sense that adding more variables to a given model does not always bring better understanding or better predictions, because usually how to combine such variables is far from trivial, leaves room for arbitrary assumptions, and can increase the complexity of the problem one wants to solve in an exponential way. Some scholars have investigated this issue in a rigorous way, and we refer to them for a detailed discussion [Hosni and Vulpiani 2017; Cecconi et al. 2012]. As a consequence, the choice to use a single database aims at avoiding the "Big Noise" situation depicted above and, in this sense, at optimizing the signal-to-noise ratio.

In this context, one may wonder if the inclusion of the services dataset may be in contrast with this approach. This is not the case, for two reasons. First of all, the services data are structurally very similar to the goods-only data that are already used: they are export data, expressed in units of dollars, and recorded by independent and international institutions. So we are simply considering exports, as before, but regarding different sectors and collated by other parties than COMTRADE. Secondly, the concept of capabilities – the set of tangible or intangible endowments a country needs to export a product – is perfectly applicable also to traded services. The capabilities approach, at the basis of the Economic Complexity field [Hidalgo and Hausmann 2009; Cristelli et al. 2013; Zaccaria et al. 2014], assumes that the combination of such endowments in a country is key to export a product and to increase the competitiveness of such country. These endowments can be seen as the slowly-varying, hidden building blocks of products. This approach does not change if the exported product is physical (like in the case of manufacturing, agriculture, and commodities) or not (as in the services case); what is important is the ability of the country to be competitive in that activity.

Therefore, we can conclude that the integration of the physical goods with the services data is completely *natural*, in the sense that it represents an obvious addition to the standard database. As a consequence, one should not expect to fall in the above-mentioned signal-to-noise issue; on the contrary, the comparison of the results coming from the application of the same algorithms to the two databases (with and without services) will lead to novel insights and a global improvement of our conclusions.

Structural transformation refers to the transition of an economy from low productivity and labor intensive *traditional* economic activities to higher productivity and skill intensive *modern* activities. Traditionally, structural transformation has been viewed as the movement from agriculture to industry, where manufacturing was viewed as the primary driver of economic growth [Rodrik 2015; Rodrik 2017; McKinsey 2012; UNCTAD 2016]. However, recent technological innovations are disrupting this view of structural transformation, as the drivers of growth are shifting from manufacturing to services or a combination, especially in developing countries. Results have shown that the growing sophistication in exporting services provides an additional channel for sustained high growth in developing countries [Mishra et al. 2011].

Technological changes are providing a wide array of services to be traded without the need for buyers and sellers to be face-to-face. Such services can be traded globally across and within borders almost instantly through global digital connectivity. The internet and other systems of technologies like mobile phones, big data, and artificial intelligence are providing technical changes to production techniques and business processes [Lougani et al. 2017], where software has become the main component of all hardware systems [Loungani and Mishra 2015]. Unlike physical goods, services can be produced, stored and transported virtually [Loungani et al. 2017, Mishra et al. 2009, Anand et al. 2012]. Companies are shifting from "selling products to selling an integrated combination of products and services that deliver value," a development that the academic literature refers to as the "servitization of manufacturing" [Baines, Lightfoot, and Smart 2011]. Services export plays a central role in globally interconnected production networks and value chains [OECD 2015]. Moreover, the growth in big cities naturally reduces the demand for physical goods and increases the demand for services [Jun 2017; Ghani et al. 2015].

These changes have led services to become the dominant component of the world economy and a fast growing share of world trade. Services now contribute over 70 percent of global value added in GDP and over half of global formal employment (World Development Indicators, 2018). Services export in world GDP has also increased from 1 percent in 1970 to over 6 percent in 2014, and the share of services export in total goods and services export has doubled from around 9 percent in 1970 to over 20 percent by 2014. In particular, the share of developing countries in the world services export market has increased from below 1 percent in 1970 to over 20 percent in 2015. Given the growing importance of services in the world economy, it would be a mistake to ignore its role in assessing the competitiveness of nations.

This paper is organized as follows. First, we provide a short description of the two datasets and illustrate the merging procedure to obtain the universal database. Second, we introduce two algorithms: The Fitness and Complexity algorithm, and an algorithmic technique to infer time-delayed correlations among sectors to build a Progression Network. Third, we describe our results and compare them with the traditional analysis based only on physical products. We conclude the main text with possible future developments. In the annex we discuss our data sanitation procedure and compare results with the study by [Stojkovski et al. 2016] who made an attempt to merge physical goods and the services export data from another source.

2. Data

The universal matrix of world trade is a combination of product export data from COMTRADE, with services exports data from the IMF BPM6. The two sources are combined to obtain a consistent annual panel time-series between 2005-2015.

2.1. Goods data

For products data, we used the BACI database processed by CEPII [Gaulier and Zignago 2010]. It is trade data with unit values, that are more reliable than the raw data from COMTRADE. The BACI data are the result of an original procedure to reconcile flows reported by exporters and importers. In general, import values are reported CIF (cost, insurance and freight) and exports are reported FOB (free on board). To allow the comparison between mirror data, CIF rates have to be estimated and removed from imports values using a gravity-type equation [Gaulier and Zignago 2010].

It is important to note that the BACI data incorporates FOB-FOB mirror numbers, where the reliability of each country's data is reported by "computing an indicator of the reporting distance among partners (the absolute value of the natural log of the ratio of mirror flows) and decompose it using a (weighted) variance analysis" [Gaulier and Zignago 2010]. The relative reliability of country reporting is then cleaned from the effects of its geographical and sectoral specialization, providing more reliable data than the raw data that includes the reconciliation of mirror figures to correct discrepancies.

The goal of BACI is to provide highly dis-aggregated data as a tool to track medium-term changes in the international division of labor i.e. variety of exported products, vertical differentiation, technological content, and stage of production [Gaulier and Zignago 2010]. For example, re-exports for Hong Kong SAR, China, and the United States are dropped since there is no way to know the final destination of the flow. The reader can refer to the BACI database and associated technical documentation for more details [Gaulier and Zignago 2010].

The most exhaustive version of BACI provides values and quantities at the 6-digit level (with more than 5,000 products), geographical coverage (more than 200 countries) of the first HS classification, launched in 1988. With the objective of integrating the products and services in a meaningful manner, we used the 2002 (HS2) i.e. level 2 also called chapters data identified by 2-digit numerical codes. We used a total of 82 goods sectors as “products”, a number that has the same order of magnitude as the number of sectors in the services data. The sectors are listed in the Annex.

2.2. Services data

For the services trade statistics we used the IMF BPM6 data. The BPM6 data are the current standard for collection of trade in services data i.e. credit and debit accounts from the BOPS. The BPM6 framework combines all the prior BPMs from 1-5 to provide harmonized historic and latest statistics incorporating trade in services. The advantage of using BPM6 is three-fold, (a) it provides the maximum number of countries for a comprehensive global sample, (b) it provides reliable time-series estimations starting from 2005, and (c) it provides detailed statistics for one-, two-, and three-digit services export categories. Using an older classification such as EBOPS2010 or EBOPS2002 would not provide comparable data for recent time-periods and would yield data that would be outdated for future analysis.

The IMF Statistics Department (STA) started publishing balance of payments (BOP) and International Investment Position (IIP) data on a BPM6 presentational basis with the August 2012 edition of the IMF's International Financial Statistics (IFS) and the online Balance of Payments Statistics (BOPS) database. BPM6 introduces new measurement updates compared to previous BPM5: (i) financial intermediation services indirectly measured (FISIM); (ii) methodological changes in insurance transactions; (iii) treatment of intellectual property; and (iv) addition of manufacturing services and maintenance services [BPM6, 2016]. The BOPS is the only source of harmonized world data on services trade that includes developing countries. To improve the data quality and maximize available information to combine the different degrees of services export categories, we used the following modifications to the raw data: (i) Dropping any negative values of the export data because negative export values imply those observations are actually imports. (ii) Dropping 7,457 observations at the one-digit level with values equal to 0 which imply the export sectors do not exist, (iii) Generating the total sum of exports by summing up the export values at the one-digit level and compare the sum with the reported total exports value [Loungani et al. 2017]. Based on the cross-validation of different aggregation options, we chose the final services database without double-counting and maximizing reliable country reporting as a combination of 1 and 2 digit levels. This is a trade-off between maximizing countries and sectors coverage. Table 1 presents the final services sectors highlighted in blue. The data coverage is about 160 countries (eg, in 2012 – 56 advanced economies and 111 developing) for 1995-2015 in 24 categories[1].

The World Trade Organization (WTO) classifies services in four modes of supply. Mode 1 is the cross-border supply services that cross the border, for example through telecommunications (telephone, fax, television, Internet, etc.), or the sending of documents, disks, tapes, etc.; Mode 2 is consumption abroad, which occurs when consumers consume services while outside their country, for example expenditures of tourism related services; Mode 3 is the commercial presence in a foreign country, for example subsidiary R&D

1 This data is publicly available at the IMF BOP website (http://www.imf.org/external/datamapper/datasets/BOP) and the IMF Trade in Services Toolkit (https://data.imf.org/ITS).

departments of a conglomeration. Mode 4 is the presence of natural persons, for example service providers in construction, or insurance that travel abroad. However, the BOP does not allow a separation between modes. Furthermore, the intangible nature of many Mode 1 services (that can be considered *modern services)* is difficult to capture based on current measurement science and macroeconomic accounting. Albeit, the current account statistics based on the BPM6 offers a proxy to capture this phenomenon of the global of the services sector. Readers should refer to the IMF BPM6 manual [IMF 2015] for more specific details on the treatment of services statistics.

Table 1. Service Exports Sectors, Balance of Payments 6 Categories.

BPM6 Code	Sector	Description
BXSOOBPM_BP6	Business	Professional and management consulting services
BXSOOBRD_BP6	Business	Research and development services
BXSOOBTT_BP6	Business	Technical, trade-related, and other business services
BXSOTCMC_BP6	Computer and Information	Computer services
BXSOTCMM_BP6	Computer and Information	Information services
BXSOTCMT_BP6	Computer and Information	Telecommunications services
BXSOFIEX_BP6	Finance	Explicitly charged and other financial services
BXSOFIFISM_BP6	Finance	Financial intermediation services indirectly measured (FISIM)
BXSOGGS_BP6	Government	Government goods and services n.i.e.
BXSOIN_BP6	Insurance and pension	Insurance and pension services
BXSORL_BP6	Intellectual Property	Charges for the use of intellectual property n.i.e.
BXSR_BP6	Maintenance and repair	Maintenance and repair services n.i.e.
BXSM_BP6	Manufacturing	Manufacturing services on physical inputs owned by others
BXSOPCRAU_BP6	Personal, Cultural	Audiovisual and related services
BXSOPCRO_BP6	Personal, Cultural	Other personal, cultural, and recreational services
BXSTRA_BP6	Transport	Transport, Air Transport
BXSTROT_BP6	Transport	Transport, Other mode of Transport
BXSTRPC_BP6	Transport	Transport, Postal and courier services
BXSTRS_BP6	Transport	Transport, Sea Transport
BXSTVB_BP6	Travel	Travel, Business
BXSTVP_BP6	Travel	Travel, Personal

2.3. The Universal matrix

The input of the Economic Fitness algorithms is a series of matrices $\boldsymbol{M}$ (one for each year) whose elements M_{cs} take the value 1 if the country c competitively exports in sector s and 0 otherwise. Our proposed universal matrix is hence constructed by combining the BACI data on goods exports and services exports from the IMF BPM6. The argument for the universal matrix is that the large weight of services in GDP may lead to omissions in using the Economic Fitness algorithms when only manufacturing capabilities are considered. Services can be as complex (relatively unique and produced by countries with advanced capabilities) as many advanced manufacturing components in the world trade network. In order to increase the accuracy of measuring the competitiveness of countries, we constructed the universal matrix. First of all, services statistics are available only at a very high level of aggregation: as a consequence, we cannot use 6 digits physical goods data, because the signal coming from the services sectors would be crowded out. Hence, the final pragmatic aggregation choice is to use HS 2 digits + BPM6 services to construct the universal matrix. This choice is coherent with the relative weight of goods and services in global trade: in this way we have about 20 categories of services, representing 20 percent of global trade, and about 80 industrial sectors representing the remaining 80 percent. In practice, we first build a universal export matrix, whose elements represent the export volumes of a given country in a given product or service sector, and then we compute Balassa's Revealed Comparative Advantage [Balassa 1965]. We then apply a threshold equal to 1 to assess if that country is competitive in that sector, obtaining a binary matrix ***M***. Note that another reasonable choice would be to compute the Balassa index separately for products and services, and to aggregate the two matrices as a second step. As shown by [Stojkoski et al. 2016], and confirmed by our calculations, one obtains roughly similar results.

3. Methods

In this section we present the two methodologies. First, we present the algorithm to assess country fitness and complexity of activities (products and services). Second, we present the Progression Network algorithm - which computes the conditional probability that, given the fact that a country is competitive in a specific sector, it will become competitive in a different sector after a given number of years.

3.1. The Fitness and Complexity algorithm

The input to the Fitness and Complexity algorithm is the export matrix ***M*** and the output is the quantitative assessment of both country competitiveness (the Fitness) and sector sophistication (the Complexity) [Tacchella et al. 2012].

The idea is the following. Each country has some capabilities, which represent its social, cultural, and technological structure [Dosi et al. 2000]. These capabilities are expressed in what a country produces and exports, so sectors (physical goods and services) and their complexities are linked to the fitness of each country; in particular, the complexity of a sector increases with the number and the quality of the capabilities needed in order to be competitive in it, and the fitness is a measure of the complexity and the number of the competitively exported sectors. In order to make this line of reasoning more quantitative, we start by considering the global structure of the matrix ***M*** whose elements M_{cs} take the value 1 if the country *c* competitively exports the sector *s* and 0 otherwise. In order to assign these binary values to the matrix elements we considered the Revealed Comparative Advantage [Balassa 1965], a simple function of the export volumes widely used in the economic literature, which has the advantage to remove any trivial correlation with economic size. Once countries and products are suitably arranged, the matrix ***M*** is triangular, showing that developed countries have diversified exports, while poor or less developed countries export fewer, lower complexity products, and these products are actually the ones exported by all countries. But how to extract the information about countries' competitiveness and sectors' complexity from the matrix ***M***? We propose the following set of nonlinear, coupled equations [Tacchella et al. 2012]:

$$\tilde{F}_c^{(n)} = \sum_p M_{cs} Q_s^{(n-1)} \quad (1)$$

$$\tilde{Q}_s^{(n)} = \frac{1}{\sum_c M_{cs} \frac{1}{F_c^{(n-1)}}} \quad (2)$$

$$F_c^{(n)} = \frac{\tilde{F}_c^{(n)}}{< \tilde{F}_c^{(n)} >_c} \quad (3)$$

$$Q_s^{(n)} = \frac{\tilde{Q}_s^{(n)}}{< \tilde{Q}_s^{(n)} >_s} \quad (4)$$

where F_c is the Fitness of country c, Q_s is the complexity of the industrial sector *s*, and the normalization of the intermediate "tilded" variables (Equations (3) and (4)) is made as a second step and *n* is the iteration index.

Let us justify this algorithm starting from Equation (1). Simple diversification, given by $d_c=\sum_s M_{cs}$, may lead to an immediate proxy for countries' fitness as the number of products they export, yet to obtain a more complete information about the export basket of a country we can consider also the complexity of products as weights in this sum, obtaining Equation (1). The evaluation of sectors' complexity, on the other hand, is subtler. Indeed, if a country like the United States exports a product, say metal nails, this fact does not carry a lot of information, because the United States exports a lot of diverse products. On the contrary, if a less-developed country exports metal nails this will be highly informative, since this is a hint that a modest endowment of capabilities is required to be competitive in that specific market. This means that one must assign a low complexity score to those products which are exported competitively by even only one low-fitness country. As a consequence, a linear approach cannot be appropriate: instead, low fitness values should play a major role in decreasing the complexity of products, and this leads to Equation (2).

At this point we have defined the fitness of countries as a function of the complexity of products, and vice versa. So we need to choose some initial conditions $F^{(0)}$ and $Q^{(0)}$ and to iterate the algorithm up to convergence. The fixed point of these maps has been studied with extensive numerical simulations and was found to be stable and not depending on initial conditions [Pugliese et al., 2016].

Similar in spirit to the Google PageRank approach, this algorithm ranks countries based on their implied productive capabilities and produces the information on inter and intra-sectoral dynamics in a transparent manner for international policy and economic policy and investment decision-making. The approach provides novel insights with respect to standard economic analyses. For instance, it is able to spot that for countries like China and India the observed GDP growth is driven by genuine development of capabilities and a real increase in competitiveness, while for other countries, like Brazil or the Russian Federation, the GDP growth appears to be boosted by the price bubble of raw materials [Tacchella, et al., 2012]. In conclusion, the algorithm provides a reliable way to rank the competitiveness of countries based on the complexity of their export baskets.

3.2. The Progression Network algorithm

The algorithm presented above considers a quantitative assessment of the competitiveness of countries, the Fitness, which summarizes in a single measure the economic complexity of its export basket. This approach, not taking explicitly into account the information about the time evolution of such export baskets, cannot immediately be used to make dynamical analyses or recommendations about specific sectors. Hence, in this section we introduce a methodology - the Progression Network - that tackles this issue by computing the conditional probability that, given the fact that a country is competitive in a specific sector, it will become competitive in a different sector after a given number of years. This technique has been introduced in this form in [Pugliese et al. 2017b] and is inspired by the Taxonomy Network and the Assist Matrix discussed in [Zaccaria et al. 2014]. Let us consider the schematic representation of Figure 1. Each arrow represents a nonzero element of the same export matrix ***M(t)*** discussed previously: for instance, the yellow arrows represent the United States having a Revealed Comparative Advantage higher than one in the export of wheels at time t and in the export of cars at time t plus a given time interval, thus introducing a delay (in the following we will take this time delay equal to 3 years). If this situation - when a country at time t exports wheels, after three years it will export cars - is systematically present in many countries, then there is a connection, a directed link going from wheels to cars which implies a time-delayed correlation between these two industrial sectors. The network whose nodes are those sectors, and whose links are put following this idea is the *Progression Network* (PN). Let us now try to express this line of reasoning using a mathematical formulation. Let us first define the number of co-occurrence

$$N_{s,s'}(t,t+\Delta t) = \sum_c M_{c,s'}(t+\Delta t) M_{c,s}(t) \tag{5}$$

this is an SxS matrix whose element $N_{s,s'}(t, t+\Delta t)$ counts how many countries exported s at time t and s' at time $t+\Delta t$. Obviously, the higher the co-occurrences the stronger the signal that s is followed by s' in the PN. However, one should also take into account the fact that if a country is very diversified, like the United States, the information coming from this country is less, and the same is valid for products. For this reason, the co-occurrences should be normalized with respect to the ubiquity of sectors

$$u_s(t) = \sum_c M_{c,s}(t) \tag{6}$$

and the diversification of countries

$$d_c(t) = \sum_s M_{c,s}(t) \tag{7}$$

obtaining the final formula

$$B_{s,s'}(t, t+\Delta t) = \frac{1}{u_s(t)} \sum_c \frac{M_{c,s'}(t+\Delta t) M_{c,s}(t)}{d_c(t+\Delta t)} \tag{8}$$

that can be also seen as the conditional probability of being competitive in sector s' given the competitiveness in sector s' Δt years before.

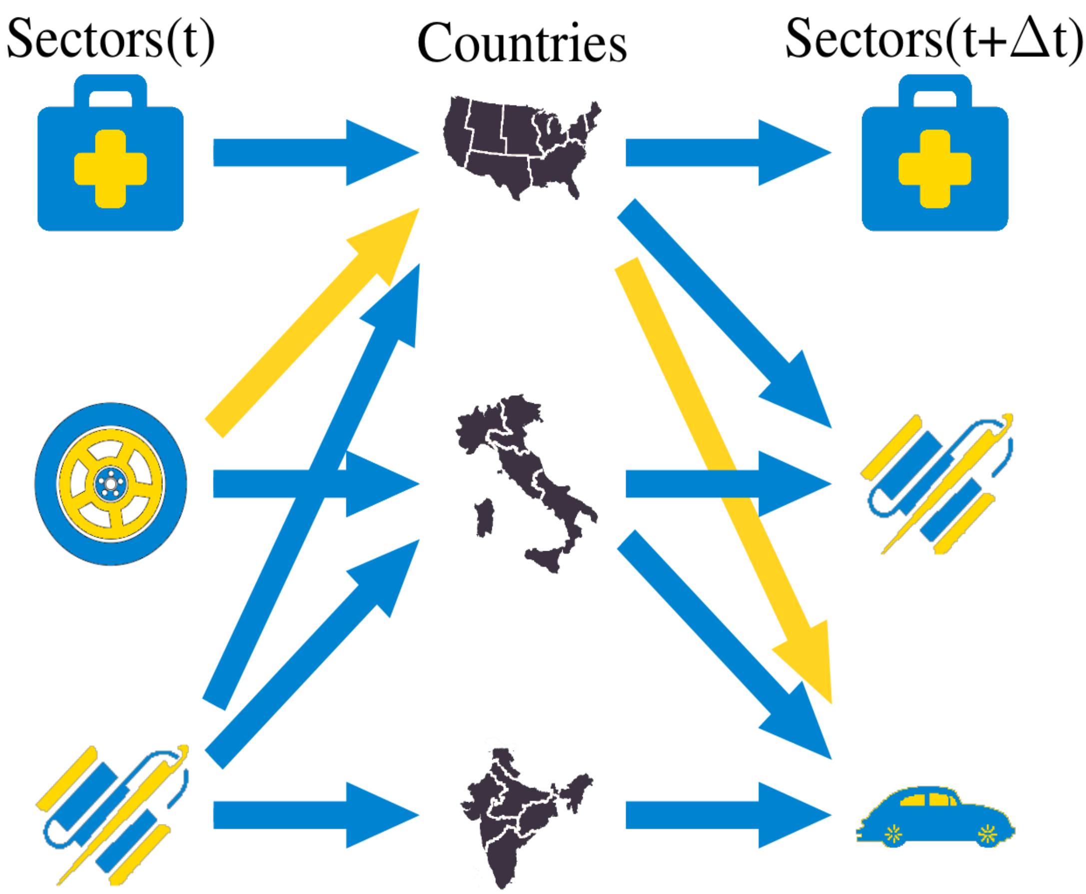

Figure 1: A schematic representation of the connections among sectors via the respective exporting countries. This idea is at the basis of the algorithm to build the progression network, as explained in the main text.

One then can repeat the procedure for all the years in the database and consider the resulting average, that now will be time independent. The matrix B can be seen as a network, that is a collection of nodes (the sectors) and directed links (in other words, arrows) among them. This network is almost full, in the sense that most of the links are present. However, we need to discriminate the real inter-dependencies from the random co-occurrences coming simply from the fact that a product is very common or a country exports a lot. This filtering can be performed by comparing each element of the full matrix B with a set of realizations of the same link coming from a random null model, in which diversification and ubiquity are kept constant on average [Saracco et al. 2015], [Saracco et al. 2017].

There are two important differences with respect to the other methodologies that are commonly used to build a network of products, such as [Hidalgo et al. 2007]:
(i) the PN takes explicitly into account the time evolution of the export baskets, computing a time-delayed projection of two and not one bipartite networks, and
(ii) the filtering procedure is made by selecting the statistically significant links with respect to a null model.

The details of this procedure go beyond the scope of the present paper, and the interested reader is referred to [Pugliese et al. 2017b]. The application of this approach is to uncover strategic opportunities for countries and companies to discover pathways for diversification. Previously, this algorithm has only been applied to assess progression of physical goods (manufacturing, agriculture, and commodities); here we studied the marginal impact of adding services to the world network of products. In particular, the PN algorithm can help us answer important economic development questions, for example whether services exports are central to global production networks; or, whether specialization in sophisticated services components can aid developing countries to gain a host of other specializations, whether it be in other services or high-technology manufacturing components.

4. Results

In this section we first discuss the results of the application of the Fitness and Complexity algorithm to Universal Matrices. In particular, we analyze the fitness ranking for a specific year (2015) and the time evolution of the complexity rankings. The second sub-section presents the results of the Universal Progression Network incorporating services to reassess the strategic diversification opportunities in developing countries.

4.1. The Fitness of Countries

As discussed in the Introduction, the inclusion of services in the Economic Complexity approach is *natural*, in the sense that it represents a reasonable addition to a goods-only database, at least for two reasons: first of all, our BOP database is based on credits from a country to another country, and so represents the obvious counterpart of physical products passing through customs; secondly, the capabilities approach, which is at the base of the Economic Complexity methodology, can be directly applied also to services. As a consequence of this consistency, we expect many of the results of the Economic Fitness approach to be reproduced also when the Universal database is considered; the deviations from a goods-only analysis will be instead the fingerprints of the value added by including services in our analysis.In order to show the consistency between the Universal and the goods-only databases we plot in Figure 2 the fitness rankings obtained with products-only and with the universal. In particular, we uniformly distribute the countries in the 0-1 interval, in such a way that the one with the lowest fitness (Iraq in both cases) takes a value equal to zero. It emerges that when one computes the fitness with or without services highly correlated rankings are obtained. This means that, at least from a statistical point of view, the general results of the Economic Fitness methodology are preserved.

However, some deviations are present and these represent the net effect of adding services to the database. In Figure 3 we consider the increments or the decrements of these fitness values and we represent them as horizontal bars, one for each country. We then order all countries vertically according to the corresponding fitness variation. Among the countries that gain positions, we find Ireland (IRL), Switzerland (CHE), Singapore (SGP) and, just a little below, Canada (CAN). The economic complexity of these countries was underestimated by a goods-only approach. Notice that low fitness countries like Burkina Faso (BFA) can experience high fluctuations because of their very low goods-only fitness, that in turn is due to their low number of exported physical products. Among countries that lose rank when services are also taken into account are Cyprus (CYP), Greece (GRC), Albania (ALB), and Uganda (UGA). These reductions in rank show that other countries took in a better way the opportunity represented by services and this resulted in a change in the relative global competitiveness. In the annex we present the detailed list of the countries, divided on the basis of their over- or under-estimation with respect to the standard, goods-only based evaluation.

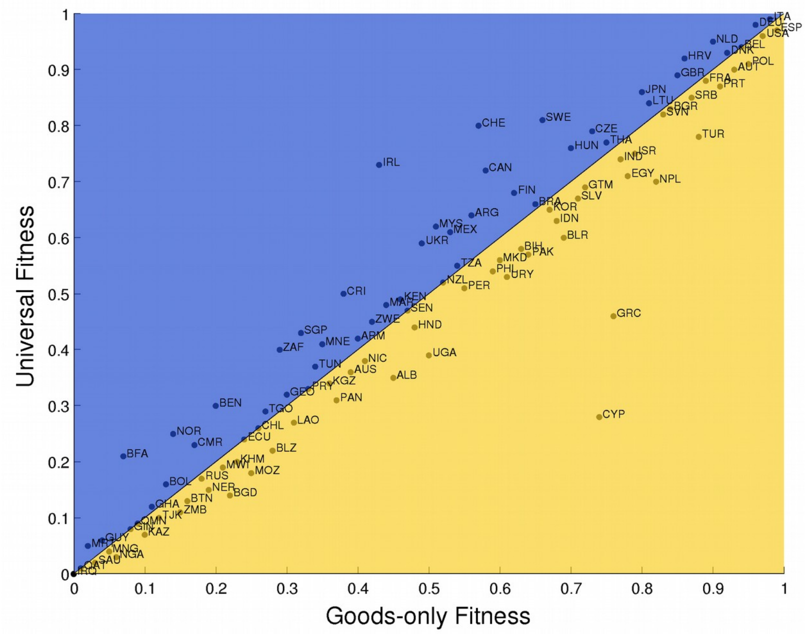

Figure 2: The Universal and the Goods-only Fitness are highly correlated. This is a signal that adding services to the Economic Fitness approach does not change the main conclusions in an arbitrary way.

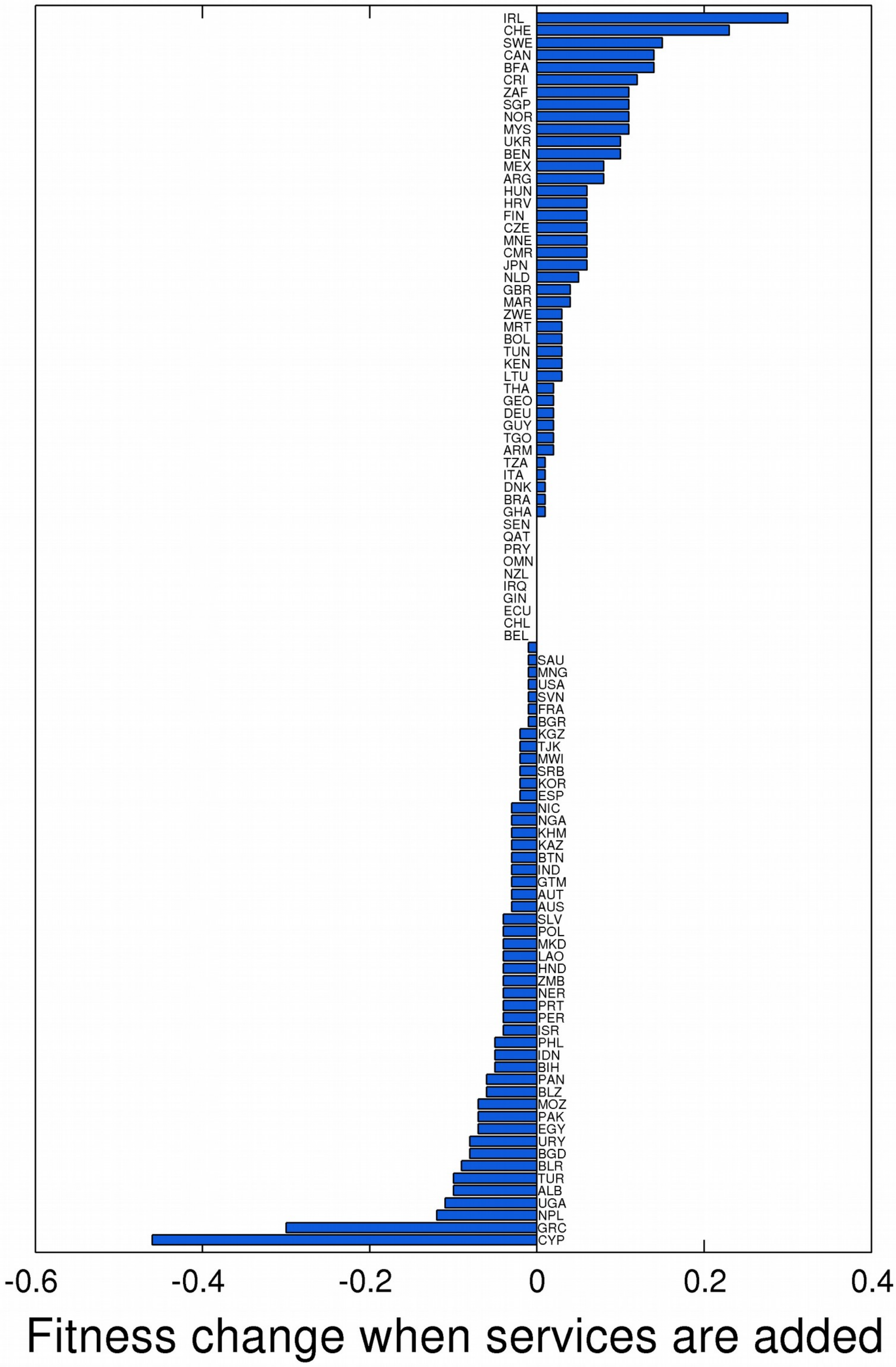

Figure 3: Since trade in service is a natural extension of goods-only, adding new data provides new information. In particular, countries such as Ireland, Switzerland, and Singapore gain positions in the fitness rankings with respect to an assessment based only on physical goods.

4.2 The Complexities of Sectors

Now we consider the time evolution of the sector complexities. We would expect the evolution of sector complexity to show a systematic change in rank, i.e., the complexity rank of services should not be volatile (switching radically every year), and it should also be coherent with the complexity rank of the firmly-established goods-only sectors.

We report our results in Figure 4. On the right we show the relative ranking in the latest year. The sectors with a very high complexity, such as "Aircrafts and Spacecrafts", "Intellectual property", and "Research and Development" are a trait of high fitness countries. As expected, raw materials such as "Mineral fuels" and "Earths and stones" share a low value of complexity, coherently both with common sense and previous applications of the algorithm to the goods-only database.

In this figure we consider a time span of 11 years. The complexity value of each year is connected with the following one with a smooth line of the same color. The colors are based on the rankings of the last year in our database (2015) and can be followed backwards in time to check the stability of such ranking. This stability reflects the goodness of our theoretical assumption, the idea of capabilities as the hidden and slowly-varying ingredients of products. Indeed, while some fluctuations are certainly natural, a complete overturning of the rankings would have meant that the capabilities needed to be competitive in a specific sector varied on a yearly basis - something at odds with our general idea of capabilities.

The chart shows that many services components are equally complex as high technology manufacturing. Recent policy literature shows that some countries are investing for the onset of the services-led Fourth Industrial Revolution in ways whose quantitative assessment is still an open issue [WEF 2016]. The ranking of complexity based on services and goods provides a reliable approach to monitor and track the complexity of sectors in a more comprehensive way. Especially in a globalized world, in which what goes on in factories fails to reflect the true flows of value-creating activity [McKinsey 1992], a universal complexity offers a way to put the growing tradability, productivity, and value-creation of services at the forefront of policy and investment planning. The chart also shows that many other services such as travel and transport are extremely ubiquitous, i.e. many more countries are specialized in such services components than in traditional goods. For developing countries, the growing complexity of services offers specialization opportunities to help the countries become more “fit” and competitive.

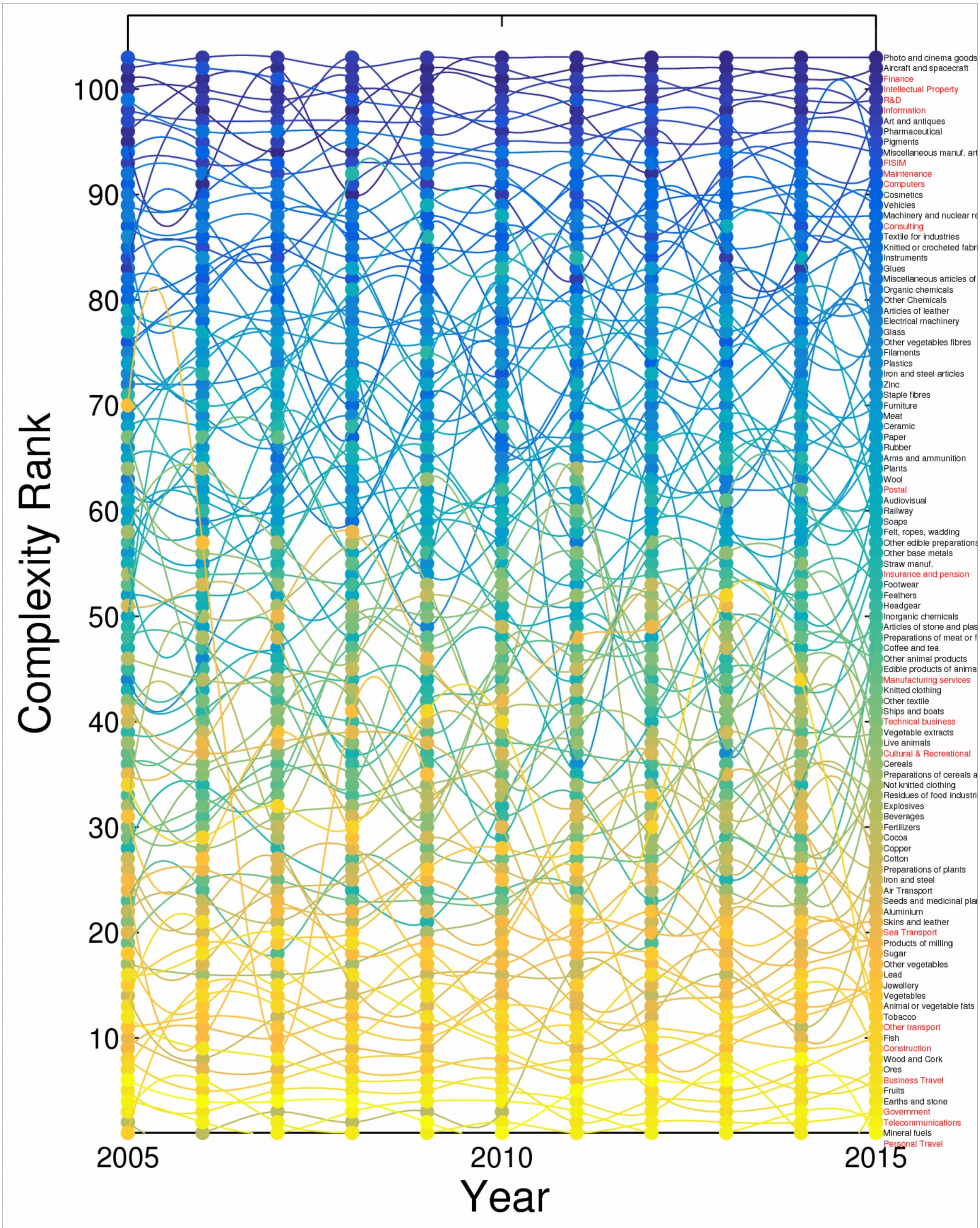

Figure 4: Time evolution of sector complexities. Goods (black) and services (red) are not segregated. The rankings are relatively stable in time, a necessary condition for our capabilities approach to be correct.

4.3. Progression in the Universal (Goods and Services) Network

Knowledge spillover is an exchange of ideas among individuals [Carlino 2001], where exports are a key transmission mechanism for knowledge spillovers between countries. For example, knowledge produced through R&D activities in developed countries can spill over through trade to other countries, and such knowledge is embodied in the services (and products) that countries export. Specialization in certain activities can create pathways to other activities, for example building a mother-board for a computer CPU can help gain specialization to assemble various other components of the CPU, and the whole computer eventually. In this section, we present the results based on the progression network algorithm applied to the universal matrix of world trade, and we study the importance of services to determine implied production progression patterns. As discussed in the Methods section, the network is built by linking those sectors whose time-delayed presence in the same country is highly correlated: in other words, we put a link from sector A to sector B if we have observed that a statistically significant number of countries show a comparative advantage in A and, after 3 years, in B.

In figure 5 we show the progression network for the universal matrix, keeping those links that are statistically significant at the p=0.0001 level. Blue nodes are goods-only sectors, while yellow nodes represent services. The network is spatially organized using a standard layout to make possible clusters visible. At a glance, one notices that services are not segregated, in the sense that they do not constitute a cluster on their own: on the contrary, they are fully integrated with the industrial sectors, indicating that they share a high number of capabilities. This is true, in particular, for the high complexity services such as Research and Development and Intellectual Property, that are highly connected with sophisticated industrial sectors, such as Aircraft and Spacecraft and Pharmaceutical. We point out that, in these cases, there is no net flux of information going from a sector to the other: instead, all these sectors benefit from the presence of the other sectors in the same country at the same time. On the left a textile sector is present, containing Leather, Footwear, and Knitted Clothing, while in the lower corner one can find raw materials and basic agriculture. In table 2 we report, as an example, the connections between two sectors (Research & Development and Electric Machinery) and the other sectors. We will discuss further details of this Progression Network, as well as some possible applications, in a following paper.

The centrality of complex services such as finance, research and development, business consulting, and intellectual property provides new insights with respect to the goods-only approach. These complex services can help countries gain competitiveness in (a) other services such as air-transport, sea-transport, and business services, and (b) advanced manufacturing components in the world trade network, such as pharmaceuticals, photographic, cinematic goods, and electrical machinery. The centrality of complex services reinforces the idea that ignoring services specialization will misinform about production structure and potential opportunities for countries.

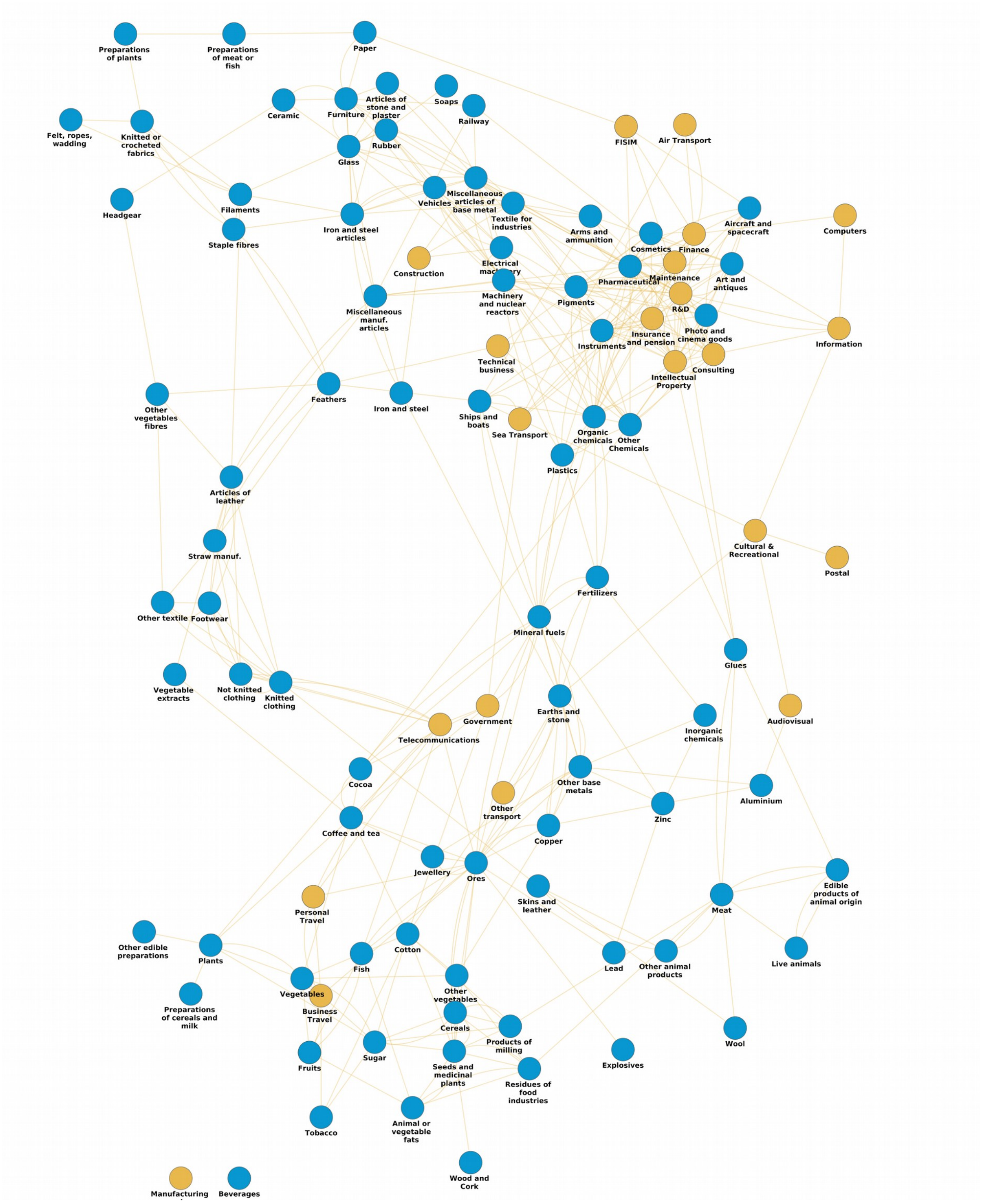

Figure 5: The Universal Progression Network. Each node represents a sector (goods in blue, services in yellow), while the links represent a statistically significant correlation with a time delay of 3 years.

a) Research and Development	b) Electric Machinery
Maintenance	*Construction*
Intellectual Property	Miscellaneous articles of base metal
Information	Instruments
FISIM	Vehicles
Consulting	Machinery and nuclear reactors
Miscellaneous articles of base metal	Rubber
Art and antiques	Other Chemicals
Arms and ammunition	
Instruments	
Aircraft and spacecraft	
Machinery and nuclear reactors	
Textile for industries	
Photo and cinema goods	
Glues	
Pigments	
Pharmaceutical	

Table 2: The sectors connected to R&D and Electric Machinery in the Universal Progression Network. Countries competitive in one of these sectors usually are competitive in the other sectors in 3 years.

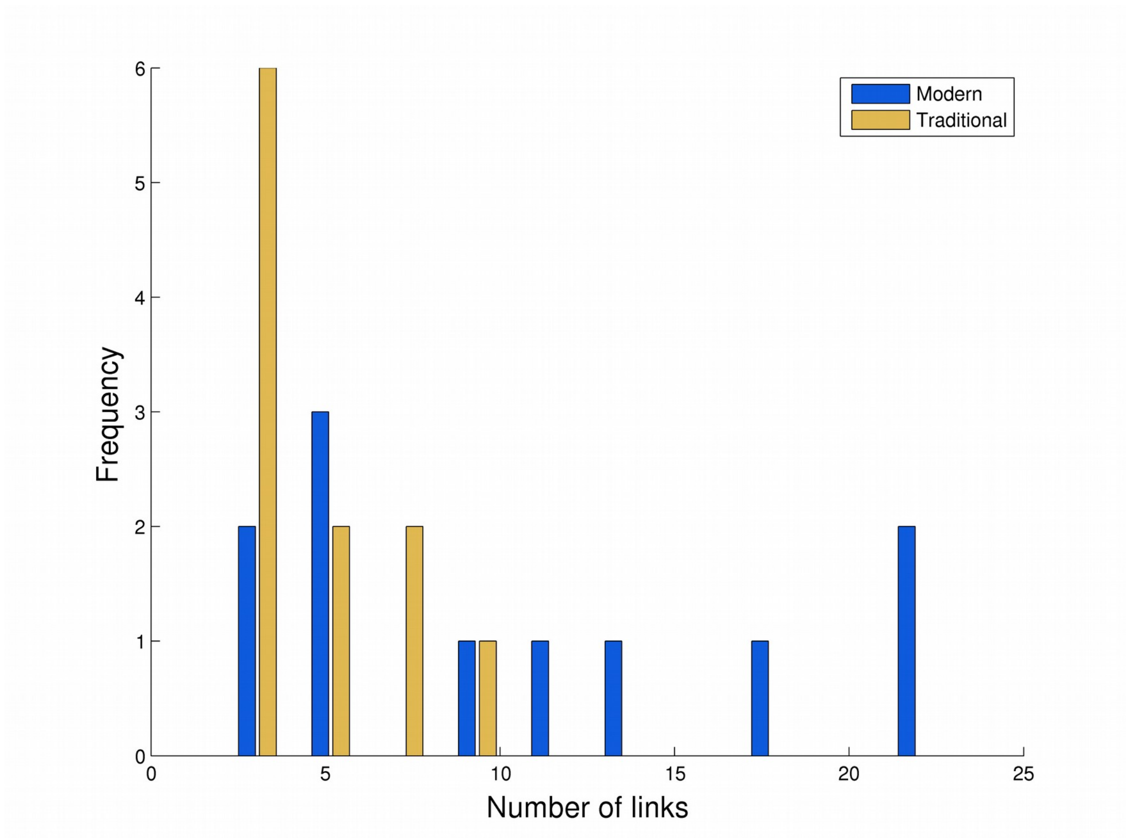

Figure 6: On average, modern services have a higher number of connections than the traditional ones, representing a better gateway towards other sectors.

Finally, we investigate the connectivity of services in the Universal Progression Network by dividing them into *traditional* and *modern.* The criterion of this segmentation is typically based on the proximity of buyer and supplier [Loungani et al. 2017]. In Figure 6 we show that, on average, modern services have a higher number of links with respect to the traditional ones. This means that being a competitive exporter of modern services increases the probability to be competitive in a larger number of sectors in the next years. The relationship of this dynamics with the complexity of sectors will be investigated in a future work.

5. Conclusions

This paper incorporated services trade statistics to enhance the previously goods-only approach presented in the Economic Complexity literature. Acknowledging the limitations of measurement and data for services, this work showed a reliable way of integrating trade in goods and services to construct a *universal* matrix of world trade and assess the competitiveness of countries through what we termed *universal* fitness. We have shown that the economic complexity of countries such as Canada, Switzerland, and Singapore, is underestimated if one does not consider services. On the contrary, countries such as Cyprus and Greece are overestimated in rank if only goods are considered.

In addition to updating the conventional view of country competitiveness and sector complexity, we have also shown the importance of services in the progression of countries from one industrial sector to the other. Services can be not only complex but offer opportunities for broader diversification. Competitiveness in complex services can spill over in many other services and high technology manufacturing sectors.

These new data, methodologies, and applications open new areas of research that have important implications for policy and investment strategies. For example, policy makers are interested in better informing country-specific diversification strategies and how the inclusion of services updates their long-run growth plans. Similarly, investors are increasingly interested in high-return services components in addition or as compared to investments in traditional manufacturing industries. The explosion in big data, artificial intelligence, and fin-tech is disrupting the pattern of growth and development. The prioritization of resource allocation to services will likely lead to increased production in complex manufacturing, and the continued growth in complex new services components.

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Business and Industrial Statistics (ISBIS), and September 2017 International Finance Corporation Economic Fitness Workshop. We thank our reviewers from the World Bank Group, IMF, and OECD. We especially thank Ali Alsamawi and Marcos Vaena.

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ANNEX

Comparison with the work of Stojkoski et al. 2016

To the best of our knowledge, the first attempt to reconcile physical goods and services data in the context of Economic Complexity is due to [Stojkoski et al. 2016], who applied a slightly modified version of the Fitness and Complexity algorithm to their universal database. In this section we compare our data, approach, and results with theirs.

Database

Regarding the goods data, Stojkoski et al. use two datasets, the one from the Center for International Data [Feenstra et al., 2000] for the period 1988-2000 and the one from UN-COMTRADE to cover also the years up to 2010 [Gaulier et al., 2000]. They consider the Standard International Trade Classification (SITC) rev.2 and aggregate the export data up to the 1 digit level considering, therefore, 10 sectors of goods.

For the services data, they consider the World Bank Trade in Services Database [Francois et al., 2013] based on the Extended Balance of Payments Classification. This database contains 12 different types of services, and is based on the Extended Balance of Payments Classification. The creators of this dataset consolidate multiple sources of bilateral trade data in services and calculate the export trade flows of a reporter by using information on imports of the partner country. While this database identifies and corrects some of the inconsistencies present in the raw sources for services trade data (EBOPS), the nature of the trade in services makes it difficult to collect services data as accurately as goods data. The main deficiency with the choice of this database is that it provides an obsolete view of services statistics. The database is based on an older classification of BPM5 services statistics and the data stop in 2011. Furthermore, extracting bi-directional flow from the raw data source of services export values may generate greater uncertainty of the estimates. The BPM6 data, which are used in the present work, consolidates the older BPM versions in a consistent time-series with some new sector features and updating historic values. For more details on the BPM6 data, readers can refer to the data chapter in the main text of this paper.

Stojkoski et al. consider a total of 22 sectors and 130 countries, while we have 105 sectors and 101 countries. We believe that our situation has a number of advantages. First of all, as country diversification is a key element of the Fitness and Complexity algorithm [Pietronero et al., 2017], an appropriate number of sectors is essential to discern the economic complexity of a country with enough precision. Second, our export matrix $\boldsymbol{M}$ is practically a square matrix. Since, roughly speaking, when we use the Economic Fitness algorithms we are measuring a property of countries using the products and vice versa, a square matrix is the ideal situation to balance the two assessments. Finally, having 105 instead of 22 sectors enriches the structure of the Universal Progression Network, making economical clusters naturally emerge.

Table A1. Service Exports Sectors, Balance of Payments 6 Categories. The blue rows indicate the final categories of services used in the universal matrix of world trade.

BPM6 Code	Sector	Description	Level
BXGS_BP6	Total Goods and Service Exports	Goods and Services	0
BXG_BP6	Total Goods Exports	Goods	0
BXS_BP6	Total Service Exports	Services	0
BXSOOB_BP6	Business	Other Business Services	1
BXSOOBPM_BP6	**Business**	**Professional and management consulting services**	**2**
BXSOOBRD_BP6	**Business**	**Research and development services**	**2**
BXSOOBTT_BP6	**Business**	**Technical, trade-related, and other business services**	**2**
BXSOTCM_BP6	Computer and Information	Computer and Information	1
BXSOTCMC_BP6	**Computer and Information**	**Computer services**	**2**
BXSOTCMM_BP6	**Computer and Information**	**Information services**	**2**
BXSOTCMT_BP6	**Computer and Information**	**Telecommunications services**	**2**
BXSOCN_BP6	Construction	Construction	1
BXSOCNA_BP6	Construction	Construction abroad	2
BXSOCNAR_BP6	Construction	Construction in reporting economy	2
BXSOFI_BP6	Finance	Financial services	1
BXSOFIEX_BP6	**Finance**	**Explicitly charged and other financial services**	**2**
BXSOFIFISM_BP6	**Finance**	**Financial intermediation services indirectly measured (FISIM)**	**2**
BXSOGGS_BP6	**Government**	**Government goods and services n.i.e.**	**1**
BXSOIN_BP6	**Insurance and pension**	**Insurance and pension services**	**1**
BXSOINAI_BP6	Insurance and pension	Auxiliary insurance services	2
BXSOIND_BP6	Insurance and pension	Direct insurance	2
BXSOINPG_BP6	Insurance and pension	Pension and standardized guaranteed services	2
BXSOINRI_BP6	Insurance and pension	Reinsurance	2
BXSORL_BP6	**Intellectual Property**	**Charges for the use of intellectual property n.i.e.**	**1**
BXSR_BP6	**Maintenance and repair**	**Maintenance and repair services n.i.e.**	**1**
BXSM_BP6	**Manufacturing**	**Manufacturing services on physical inputs owned by others**	**1**
BXSMA_BP6	Manufacturing	Manufacturing services on physical inputs owned by others, Goods for processing abroad	2
BXSMR_BP6	Manufacturing	Manufacturing services on physical inputs owned by others, Goods for processing in reporting economy	2
BXSOPCR_BP6	Personal, Cultural	Personal, cultural, and recreational services	1
BXSOPCRAU_BP6	**Personal, Cultural**	**Audiovisual and related services**	**2**
BXSOPCRO_BP6	**Personal, Cultural**	**Other personal, cultural, and recreational services**	**2**
BXSTR_BP6	Transport	Transport	1
BXSTRA_BP6	**Transport**	**Transport, Air Transport**	**2**
BXSTRAFR_BP6	Transport	Transport, Air Transport, Freight	3
BXSTRAO_BP6	Transport	Transport, Air Transport, Other	3
BXSTRAPA_BP6	Transport	Transport, Air Transport, Passenger	3
BXSTRAPAS_BP6	Transport	Transport, Air Transport, Passenger, Of which: payable by border, Airsonal, and other S-T workers	4
BXSTRFR_BP6	Transport	Transport, Freight	2
BXSTRO_BP6	Transport	Transport, Other	2
BXSTROT_BP6	**Transport**	**Transport, Other mode of Transport**	**2**
BXSTROTFR_BP6	Transport	Transport, Other mode of Transport, Freight	3
BXSTROTO_BP6	Transport	Transport, Other mode of Transport, Other	3
BXSTROTPA_BP6	Transport	Transport, Other mode of Transport, Passenger	3
BXSTROTPAS_BP6	Transport	Transport, Other mode of Transport, Passenger, Of which: payable by border, Other mode ofsonal, and ot	4
BXSTRPA_BP6	Transport	Transport, Passenger	2
BMSTRPAS_BP6	Transport	Transport, Passenger, Of which: payable by border, seasonal, and other S-T workers	4
BXSTRPC_BP6	**Transport**	**Transport, Postal and courier services**	**2**
BXSTRS_BP6	**Transport**	**Transport, Sea Transport**	**2**
BXSTRSFR_BP6	Transport	Transport, Sea Transport, Freight	3
BXSTRSO_BP6	Transport	Transport, Sea Transport, Other	3
BXSTRSPA_BP6	Transport	Transport, Sea Transport, Passenger	3
BXSTRSPAS_BP6	Transport	Transport, Sea Transport, Passenger, Of which: payable by border, seasonal, and other S-T workers	4
BXSTV_BP6	Travel	Travel	1
BXSTVB_BP6	**Travel**	**Travel, Business**	**2**
BXSTVP_BP6	**Travel**	**Travel, Personal**	**2**

Algorithm

Stojkoski et al. have implemented the Fitness and Complexity algorithm as discussed in the first paper by [Tacchella et al. 2012]. However, they experienced the same convergence issues described in [Pugliese et al., 2016]: some countries and sectors converge to zero values. As pointed out by [Pugliese et al., 2016], this situation is a consequence of both the sparsity and the structure of the matrix and can be tackled by considering the rankings instead of the values, after implementing a suitable convergence criterion. Stojkoski et al. bypass this problem modifying the original algorithm putting a constant term in the formula for products' complexity (Equation (2) of the main text). Our Universal matrix does not suffer from this problem since practically all the values of both fitness and complexity remains finite, and so there is no need to modify the algorithm; in any case, we adopt the convergence criterion described by [Pugliese et al., 2016] and we consider the rankings in our discussions.

Results

With both the dataset and the algorithms different, it is not straightforward to compare the outputs of the two approaches. Moreover, Stojkovski et al. did not publish the complete rankings, which one can only in part reconstruct from their analysis of PIIGS countries and the highlighted countries of Fig.4 of their paper.

Data sanitation

The main source of service statistics is the International Monetary Fund's Balance of Payments Manual 6, herein referred to as the BPM6. There are few other sources of services such as the World Bank Trade in Services Database or the OECD Trade in Value Added (TiVA) data, but they both use the Balance of Payments statistics as the original sources. One deficiency with the alternative sources is they use an older classification i.e., the BPM5 which is obsolete now. The BPM6 provides the best picture possible with currently available data. While these data have its deficiencies, such as not capturing services in the WTO modes of supply, they are the most reliable data on world trade in services to help build a more complete picture of world trade networks accommodating both goods and services [Loungani et al, 2017, BPM6].

The raw data we obtained shows a number of anomalies. The most important one is the presence of wild fluctuations in the data, leading to countries acquiring and/or losing a large market share from one year to another. Even if from the raw volumes one computes the RCA and binarizes – a procedure that usually improves the signal to noise ratio – in our case we are left with situations like the one illustrated in Figure 6. We plot the number of service sectors in which the Netherlands and Iceland are competitive (in the RCA sense) as a function of time. While the former shows a smooth and reasonable time evolution, the behavior of the latter is more likely due to a misreporting in the original data than to a real, abrupt economic transition. Indeed, one should keep in mind that these sectors are highly aggregated and, as a consequence, it is completely unreasonable to have such a sudden and strong transition from a low to a high competitiveness in all these sectors. In these situations, we adopted a conservative strategy, disregarding the whole country from further analyses. While this choice obviously can lead to a loss of information, in our opinion it increases the signal-to-noise ratio of the remaining data and leads to a better input for the algorithms, yielding more trustworthy and robust results.

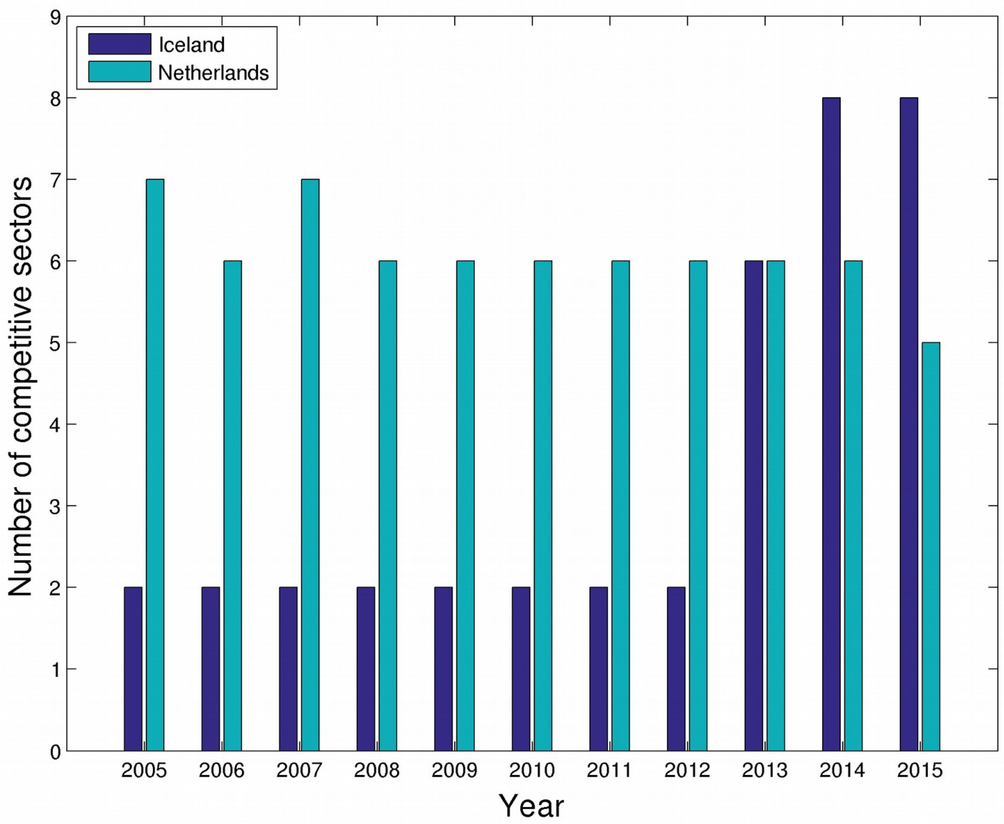

Figure A1: Number of competitive services sectors as a function of time for two sample countries. While the Netherlands show a smooth evolution in time, Iceland has a sudden increase in 2013.

Detailed comparison with goods-only fitness

In the following table we report all the countries we analyzed dividing them in three sets according to the difference between their fitnesses, computed with or without services. In particular, in the "Understatement" column we report those countries whose fitness was underestimated by an evaluation made only on the basis of the goods data. The ordering is based on the difference between universal and goods-only fitness: higher ranking means that differences are larger. In this respect, countries such as Ireland and Switzerland increase their fitness ranking. The second column refers to those countries whose fitness is practically unaffected by the inclusion of services data. Finally, the countries in the third column lose positions in the fitness ranking when services are included, meaning that the goods-only approach was overestimating their economic complexity. Also in this case the ranking is based on the difference between the two complexities, meaning that Greece and Cyprus are the countries that lose more positions in the ranking once services are included.

Understatement (Rank increase)	No effects	Overstatement (Rank decrease)
Ireland	Senegal	Cyprus
Switzerland	Qatar	Greece
Sweden	Paraguay	Nepal
Canada	Oman	Uganda
Burkina Faso	New Zealand	Albania
Costa Rica	Iraq	Turkey
South Africa	Guinea	Belarus
Singapore	Ecuador	Bangladesh
Norway	Chile	Uruguay
Malaysia	Belgium	Egypt, Arab Rep.
Ukraine	Russian Federation	Pakistan
Benin		Mozambique
Mexico		Belize
Argentina		Panama
Hungary		Bosnia and Herzegovina
Croatia		Indonesia
Finland		Philippines
Czech Republic		Israel
Montenegro		Peru
Cameroon		Portugal
Japan		Niger
Netherlands		Zambia
United Kingdom		Honduras
Morocco		Lao PDR
Zimbabwe		Macedonia, FYR
Mauritania		Poland
Bolivia		El Salvador
Tunisia		Australia
Kenya		Austria
Lithuania		Guatemala
Thailand		India
Georgia		Bhutan
Germany		Kazakhstan
Guyana		Cambodia
Togo		Nigeria
Armenia		Nicaragua
Tanzania		Spain
Italy		Korea, Rep.
Denmark		Serbia
Brazil		Malawi
Ghana		Tajikistan
		Kyrgyz Republic
		Bulgaria
		France
		Slovenia
		United States
		Mongolia
		Saudi Arabia

Extensive fitness

The Fitness and Complexity algorithm can be applied also to an *extensive* version of the **M** matrix. We use the term extensive, in analogy with physical systems, for a quantity that is correlated with size: while for instance the volume of a gas is extensive, its temperature is *intensive,* because it is not dependent on how much gas I am considering, while the opposite is true for volume. In [Tacchella et al. 2012] both an intensive and an extensive version of the Fitness have been proposed. While in the main text we only study the intensive fitness, here for completeness we report the country ranking for the extensive fitness. We divide countries in high, medium, and low fitness only for readability. Countries on top have higher extensive fitness. While its intensive counterpart should be compared with GDP per capita, as it is usually done [Cristelli et al. 2015], the extensive fitness is correlated with GDP. As a consequence, it can be used when size should be taken into account, for instance in gravity models.

High fitness	Medium fitness	Low fitness
United States	Argentina	Cyprus
Germany	Philippines	Tanzania
United Kingdom	Israel	Paraguay
France	South Africa	Ghana
Japan	New Zealand	Zambia
Italy	Saudi Arabia	Bosnia and Herzegovina
The Netherlands	Bangladesh	Nigeria
Korea, Rep.	Ukraine	Macedonia
Belgium	Pakistan	Nicaragua
Canada	Chile	Bolivia
India	Greece	Mozambique
Switzerland	Bulgaria	Iraq
Mexico	Egypt, Arab Rep.	Uganda
Ireland	Peru	Nepal
Poland	Morocco	Cameroon
Thailand	Slovenia	Georgia
Brazil	Belarus	Togo
Turkey	Latvia	Albania
Singapore	Kazakhstan	Mongolia
Austria	Ecuador	Lao PDR
Russian Federation	Costa Rica	Armenia
Indonesia	Croatia	Kyrgyzstan
Australia	Guatemala	Malawi
Czech Republic	Tunisia	Guyana
Malaysia	Panama	Niger
Sweden	Uruguay	Benin
Hungary	Oman	Guinea
Portugal	Honduras	Tajikistan
Norway	El Salvador	Belize

Codes and description of industrial sectors

Table A2. Goods Exports Sectors, classified according to the Harmonized System 2 digits. Some sectors have been aggregated during the data sanitation procedure.

Sector Code	Description
01	Live animals
02	Meat
03	Fish
04	Edible products of animal origin
05	Other animal products
06	Plants
07	Vegetables
08	Fruits
09	Coffee and tea
10	Cereals
11	Products of milling
12	Seeds and medicinal plants
13	Vegetable extracts
14	Other vegetables
15	Animal or vegetable fats
16	Preparations of meat or fish
17	Sugar
18	Cocoa
19	Preparations of cereals and milk
20	Preparations of plants
21	Other edible preparations
22	Beverages
23	Residues of food industries
24	Tobacco
25	Earths and stone
26	Ores
27	Mineral fuels
28	Inorganic chemicals
29	Organic chemicals
30	Pharmaceutical
31	Fertilizers
32	Pigments
33	Cosmetics
34	Soaps
35	Glues
36	Explosives
37	Photo and cinema goods
38	Other Chemicals
39	Plastics
40	Rubber
41	Skins and leather
42	Articles of leather
43	Furskins
44	Wood and Cork
46	Straw manufacturing
47	Paper
50	Silk
51	Wool
52	Cotton
53	Other vegetables fibres
54	Filaments
55	Staple fibres
56	Felt, ropes, wadding
57	Carpets and tapestries
59	Textile for industries
60	Knitted or crocheted fabrics
61	Knitted clothing
62	Not knitted clothing
63	Other textile
64	Footwear
65	Headgear
67	Feathers
68	Articles of stone and plaster
69	Ceramic
70	Glass
71	Jewellery
72	Iron and steel
73	Iron and steel articles
74	Copper
76	Aluminium
78	Lead
79	Zinc
81	Other base metals
83	Miscellaneous articles of base metal
84	Machinery and nuclear reactors
85	Electrical machinery
86	Railway
87	Vehicles
88	Aircraft and spacecraft
89	Ships and boats
90	Instruments
93	Arms and ammunition
94	Furniture
96	Miscellaneous manuf. articles
97	Art and antiques