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Using Input-output Links to Measure the Potential for ServiceLed Development in Formerly Transition Economies and Central-West Asia

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Abstract

Many Central-west Asian countries have not diversified their economies according to traditional indicators, leading policy analysts to suggest that the objective should be to increase the share of manufacturing employment in the economy to levels similar to East Asian countries. This paper uses input-output analysis to develop a better measure of diversification that accounts for global production links and suggests that the key to development for these primary product exporting economies is business and professional services, even if they are not directly exported. The paper also looks at measures of comparative advantage and diversification and explains why worries of premature deindustrialization are unwarranted if value-added contribution is properly measured.

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1. Introduction

The countries of the Former Soviet Union (FSU) have had a unique development path since the time of the breakup. Following the independence of republics since 1990, carefully crafted production and distribution links were severed, factory towns specializing in one aspect of production were shut down, trade came to a halt within republics and commonwealth countries, and in some cases the desire for sovereignty of newly-independent republics and inward-looking policies may have eroded networks and trade links. At least a decade of growth was lost. Since then, most countries have recovered and transitioned for the most part to be grouped with the so-called 'emerging market economies'. Yet their development path has been quite different following the steep output drop, and certainly started this century with a higher average level of education and scientific knowledge than other countries at similar income range.

These long-term developments contrast with the conventional path of structural change typically studied in the literature. The more 'conventional' path has seen countries move from being largely agriculture-based, to manufacturing, to services in tandem with development from middle-income to high-income status towards the end of the 20th century. In studying the features of countries that have moved to high-income status, two pre-requisites are often stressed in the literature. First, the need for economic diversification, which for manufacturing is achieved through diversification of the export product space (Hausmann and Hidalgo, 2011). Second, the importance of developing a strong manufacturing base, as measured by the share of employment in manufacturing to total employment. Two recent phenomena have occurred which have some development practitioners 'worried' that current middle-income and transition economies may not quickly join the club of developed countries: (i) so-called 'premature deindustrialization' in which the manufacturing employment share is peaking earlier for their level of development and at much lower shares (for example, Rodrick, 2016); and (ii) the development of mostly domestic-origin (but possibly foreign-financed) high-tech enclave service-sector economies which 'skip' the stage of greater diversification of the manufacturing export base.

This paper seeks to explain to what extent these 'worries' are based on misconceptions about the importance of manufacturing and industry. The development of capabilities as many economies of the Organisation of Economic Cooperation and Development (OECD) grew to become high-income happened simultaneously during the heyday of manufacturing and industry, leading many to attribute a lot of the acquisition of capabilities to the process of manufacturing per se. Since then, production processes have changed drastically and there are serious mismeasurements of services productivity and the contribution of non-tradable services to manufacturing. The paper dispels the myth that there is something 'special' about diversification of the manufacturing processes that needs to be replicated for an economy to increase its wealth. New studies using firm-level data for mostly European countries (Crozet and Milet, 2015; Bernard et.al, 2017) and for developing Asia (Ablaza and Mercer-Blackman, 2018), OECD (Miroudot and Cadestin, 2017) and United States (US) (Berlingieri 2014) have found that when the value-added contribution of non-tradable services to the production and exports of goods is properly accounted for, services become critical for a knowledge-based economy, in particular business and professional services.

Using the ADB's Multi-Regional Input-Output Tables (MRIOT), the paper extends concepts developed in earlier work on the measurement of economic diversification and trade in value added. Mercer-Blackman, Foronda and Mariasingham (2017) construct an 'agglomeration index' of economic diversification which considers input-output linkages across more detailed sectors, both domestic and foreign. It finds that a country with a very diversified economic structure is able to develop other sectors domestically which may be different to the area where it has an international comparative advantage. While most countries may have only a few sectors which are export-intensive and tend to grow very quickly, only those economies that are able to use that advantage to forge links with other domestic, mostly service-based sectors can acquire the capabilities necessary for sustainable development. The inter-sectorial linkages of the input-output structure highlighted in the paper--mostly ignored in the traditional structural transformation literature—sheds light on the key role of the business and professional services sector in advanced economies.

The paper disputes the notion that some of the larger and more developed FSU countries for which we have data are economically undiversified. We find that our measure of economic diversification (a high value of the agglomeration index) paints a different picture compared to some conventional indicators precisely because services are being accounted for. Therefore, there is nothing precluding them from reaching higher stages of development by 'skipping' manufacturing and moving directly to high-tech services. Our diversification indicator is able to capture the contribution of services and shows that they are crucial in the quest for development. Kazakhstan, perhaps the best example, has a fairly well-developed oil and gas services sector and the potential to further develop transport and logistics sectors and agricultural research and development, yet traditional indicators that do not account for the role of hi-tech services sectors and consider them 'unproductive' (as measured by their value added to employment) will not capture this potential (see Appendix 2).

The paper is divided as follows. The next section explains how this paper fits into the economic literature. Section 3 discusses the traditional indicators used to measure development and structural change and how they characterize FSU countries. Section 4 defines and analyzes the results of the agglomeration index (which helps measure economic diversity), how it relates to measures of trade in value added comparative advantage and discusses the role of business services in the economic transformation of countries. Section 5 discusses policy implications and concludes.

2. Literature Review

Three strands from the literature are related to our analysis: papers that discuss structural transformation, papers on economic diversification and deindustrialization, and more recent papers looking at cross-country linkages and the effects of services on value added.

The reallocation of economic activity from agriculture to manufacturing has played a key role in economic development over the recent decades. Following studies by Garbiel and Ribeiro (2019), Marconi et al (2016) on structural transformation, the manufacturing sector is traditionally believed to exhibit special properties that make it instrumental in the processes of catching up and economic development. This 'special characteristic' of the manufacturing sector engenders imitation, adaptation and technical knowhow and thus leads to increased

sophistication and growth. The evidence points to how in the 1950s manufacturing propelled the growth of now-advanced economies, as well as the export-led manufacturing growth in Asia.

The patterns of structural change have invariably led to a higher share of services, and this is considered problematic. The course of development in now-advanced economies over the last century show that the expansion of GDP per capita has been accompanied by a decline in the share of agriculture in employment and nominal value added. By contrast, the share of services has risen. Industry, which is largely influenced by manufacturing, has moved on quite a different trajectory as its share follows a 'hump shape' (Figure 1). Services comprise more than half of GDP, and this share continues to rise. Some developing economies including East Asian countries and Mauritius seem to follow a development path that looks similar to the one carved out by the currently rich countries. In contrast, other developing countries in both Latin America and Africa seem to have run out of industrialization opportunities through 'premature deindustrialization'. Szirmai (2012, p. 417) represents the view that "neither tourism nor primary exports nor services have played a similar role [in development], with the possible exception of software services in India since 2000".

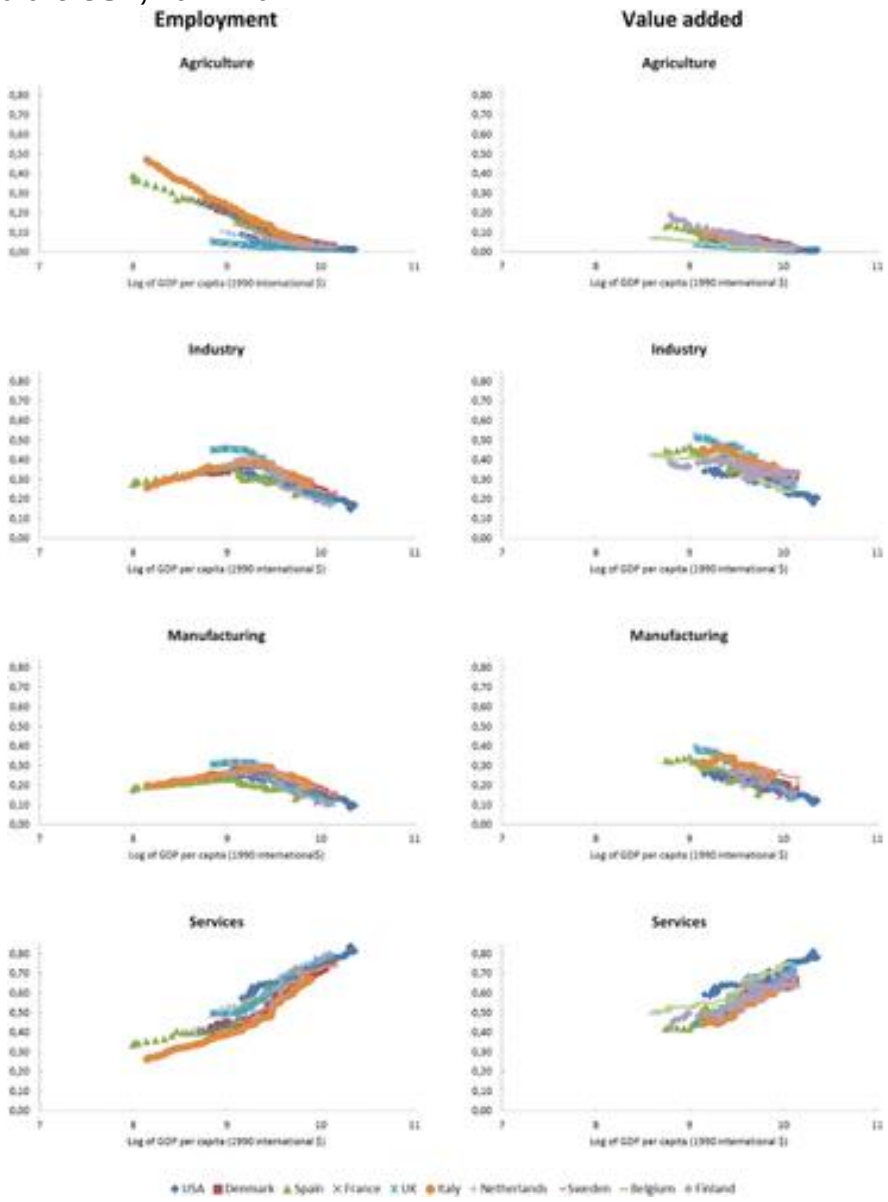
Some studies also posit that the manufacturing sector has lost steam over the last two or three decades. This has resulted in the so-called 'premature deindustrialization' or non-industrialization of developing economies (Haraguchi et al, 2017; Szirmai and Verspagen, 2015). These studies find that manufacturing continues to have positive, moderate impact on growth but that it has become a more difficult route to growth than the pre-1990 era when most industrialized countries grew.

However, there are other recent routes to development. Abu Dhabi, Panama, and Hong Kong, China, which have insignificant sizes of manufacturing but very advanced services sectors are moved ahead in their development path by all practical standards. Other small relatively well-off islands in the Caribbean have also moved from agriculture directly to services. Therefore, it appears that this premise does not always hold. Moreover, the countries of the Former Soviet Union do not fit the standard pattern as many were highly industrialized before 1990, have had a different structural trajectory in tandem with sharply falling output due to broken links as they became independent countries.

The role of outsourcing and globalization through input-output links has been largely overlooked in the literature on structural change until recently. But the heterogeneity of services – documented by recent studies (e.g. Jorgenson and Timmer, 2011; Duarte and Restuccia, 2017) –has largely been ignored so far in discussions of structural transformation. Miller and Blair (1985) was an early paper that provided a mechanism for identifying interconnections of sectors and identifying those sectors that are most connected are the 'key' sectors. In this perspective, the availability of increasingly disaggregated data on economic activity at the sector level has helped to reassess the existing results. Mercer-Blackman, Mariasingham and Foronda (2017) use this methodology but only look at a few countries. Feenstra, Inklaar, and Timmer (2015) develop total factor productivity measures by sector for more than 100 countries and relate it to trade flows and economic growth in the new Penn World Tables. Fadinger, Ghiglino, and Teteryatnikova (2015) develop a dot-plot matrix visualization—similar to this paper--to look at how differences in input–output structure and sectoral productivity translate into income differences. They find that the sparse input–output structure of low-income countries helps to mitigate impact of very low productivity levels on some sectors (similar to our methodology except we differentiate the effects of manufacturing and services sectors). Bartelme

and Gorodnichenko (2015) construct input-output tables going far back and document a strong and robust relationship between the strength of industry linkages and aggregate productivity. They find that distortions—which act as taxes on revenue or intermediate input usage—reduce the multiplier effect of the input–output linkages. In other words, government intervention can affect the pull or push effect of intermediate demand. This makes statistics based on the input–output entries potentially powerful indicators of the presence of distortions in the economy. We also find that publicly-provided activities are poorly linked to the rest of the economy in many countries.

Figure 1: Sectoral Shares of Employment and Nominal Value Added – Selected European Countries and the USA, 1947–2011.



Source: Van Neuss (2018) using GGDC 10-Sector Database (see wileyonlinelibrary.com)

The findings of this study complement those of other literature on the rising role of services. Zhao and Tang, 2018 show that while the development path of other economies was more concentrated in manufacturing, economic acceleration can also be achieved through the services sector. Doytch and Uctum (2011) finds that a shift from manufacturing to financial service FDI enhances growth in service-based economies by stimulating activity in both manufacturing and service sectors. A large set of papers also resort to input–output statistics to assess the extent of outsourcing from manufacturing to services (e.g. Petit, 1986; Russo and Schettkat, 1999, 2001; Greenhalgh and Gregory, 2001; Peneder, 2002; Gregory and Russo, 2006; OECD, 2017). The growth of global value chains and offshoring observed in advanced countries over recent decades has been accompanied by the parallel growth of services – particularly Professional and Business Services. Although many empirical studies evidence the key role of changes in sectoral linkages in contributing to the expansion of services over recent decades, the multisector growth literature has largely overlooked this mechanism of structural change. Perhaps one exception is Berlingieri (2014). Using a calibrated model with intermediate inputs and full sectoral linkages, the paper predicts the trajectory of the employment shares of manufacturing and services in the USA between 1948 and 2002, and finds that the evolution of the input–output structure, mostly due to professional and business services outsourcing, can account for around 36% of the growth in services employment and 25% of the decline in manufacturing. In turn, Lind (2014) evidences that the real explosion of GVCs has been associated with a reduced average manufacturing backward linkage towards the aggregate economy in advanced countries, as well as a reduced degree of vertical linkages within the broad domestic manufacturing sector.

More recent papers look at the so-called 'servicification' of manufacturing (Crozent and Millet (2015), Miroudot and Cadestin (2017), Mercer-Blackman and Ablaza (2018)) suggest that with outsourcing—both domestic and foreign; the splintering of production processes and the digitization of many services, create a major problem with the way value added in manufacturing is measured, and even its attribution. Other recent studies looking at the contribution of manufacturing (for example IMF 2018), using more granular data, suggest that some services are equally, if not more productive than manufacturing. Firm-level studies in Europe also confirm the special role of services. For example, in looking at the reasons for firms switching activities from manufacturing to services in Denmark, Bernard, Smeets, and Warzynski (2017) find that those that splinter into services and specialize tend to become much more productive than those that do not, suggesting that the results are different at the firm level.

The classification into manufacturing or services in the modern era has become very difficult amid splintering and outsourcing of production, but input-output approaches do not rely on this distinction. The traditional structural transformation models define three distinct sectors: agriculture, industry (manufacturing) and services, without delving into the differences within the sectors, nor understanding the links across the sectors (see excellent survey by Van Neuss (2018). If the model talks about the 'relative price' or 'substitution effect' of one sector versus the other, one is unable to conceptualize the complexity of the production of goods and services in the 21st century, let along the digital economy. To give an example, Algeria and Oman have the highest manufacturing to GDP shares, in part because refining and petrochemical production is such an important part of their economies. But they are not brought in as examples of development through industrialization. Moreover, there is a range of sophistication within manufacturing. Comparing the production of sophisticated semiconductors in Republic of Korea to the processing of fish into fishmeal in an island economy—both manufacturing processes—means that the definitions themselves can bias the conclusions about the role of manufacturing.

In this analysis, we are not able to directly explain why some linkages are stronger than others and even less whether they are due to policy distortions. Within an economy, the linkages are determined by the most cost-efficient production technology specific to an industry and product. In practice, the response of a country to structural transformation depends on several factors and conditions. These include workers' or firms' abilities to absorb new technology and to adapt to changes in the availability of natural resources (ESCAP, 2019). Therefore, if the policies are effective and some of the basic elements of an "economic ecosystem" are in place, innovative sectors should be able to develop and eventually penetrate export markets. Moreover, we do not study economic growth per-se, but to the sectorial pattern of the development. In other words, some countries that have grown faster than others could have quite similar sectorial patterns, and that explanation is beyond the scope of this paper.

Finally, pronouncements by economists about a country's competitiveness and long-term growth prospects through the acquisition of capabilities relies on trade data, not domestic production data. Insufficient data give us a limited view of what is happening within the domestic economy. The internal linkages reflect increasing spillovers across different sectors, which is what can lead to a stronger development. From there, certain sectors may develop a comparative advantage in something specific and push export-led growth, although such a development does not have to come hand in hand with economic diversification.

The next section discusses the data and how it has traditionally been analyzed.

3. What's going on with the country structures and how different to OECD comparators?

FSU countries had to 'start from scratch' in terms of economic linkages after the breakup, and this has also partly impacted the lack of economic diversification. We do not have the data before 1990 when the Soviet Union was an economic unit with the possibility to plan all stages of production: there was specialization across region/countries but the production and distribution links were very strong, even in fairly remote areas such as Siberia and Kazakhstan. These were not natural linkages but deliberately created by the planners. With the collapse of the Soviet Union that system of linkages imploded.

Some FSU countries suffered more than others. Russia, the largest economy of the FSU, was the economic epicenter so was able to maintain many of the internal production and distribution links created during the central planning time. But others had to essentially start again from low levels. Smaller countries such as Armenia, Tajikistan, Uzbekistan and Kyrgyz Republic continue to be dependent on the Russian as a large share of their income comprises worker remittances from Russia; while Azerbaijan, Kazakhstan, and Turkmenistan have been able to bounce back—at different paces of transition—mostly through strong commodity export growth. Estonia, Latvia and Lithuania have joined the EU and their economic structures now resemble those of their west European neighbors.

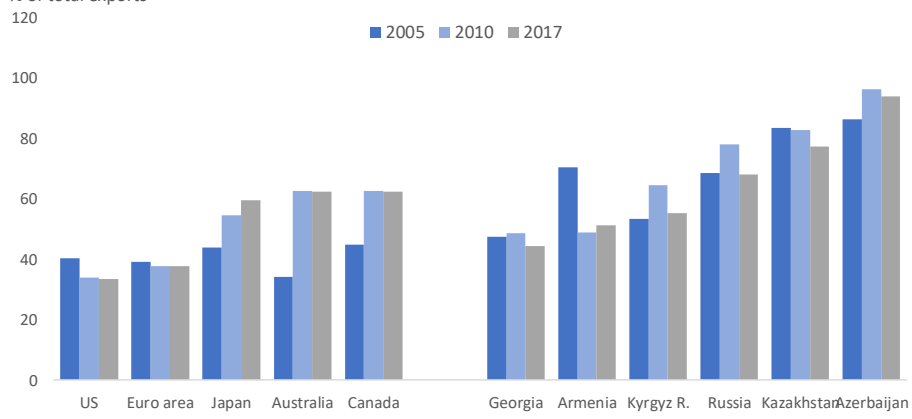
Indicators of diversification

Almost 30 years after, economists now revert to conventional comparisons of income given that these economies essentially function like any other market economy. However, the harsh deindustrialization but also opening to world markets, combined with a fairly high level of education and skills compared to other countries at their level of income suggests that some of the underlying assumptions about development do not fit well for FSU countries.

Emphasis in economic literature on the virtues of exporting comes from evidence suggesting that higher exports are a manifestation of production sophistication and competitiveness. First, export diversification is considered the culmination of a number of factors (Hausmann and Hidalgo 2011). One can equate observed sophistication of exports across product space as a sign of innovation and complexity. Felipe and Kumar (2012) equate the diversity and sophistication of products manufactured by a specific country with its per capita GDP, with the implication that the greater the variety of products exported and the closer they are to the structure of a rich country's product space, the more it signals that a country's development is going in the right direction. Three traditional indicators could be considered when looking at diversification.

The ***export concentration ratio*** (defined here as the share of the value of the largest three products over total exports) should be high for undiversified countries. According to this simple indicator, Russia, Kazakhstan and Azerbaijan are the least diversified, even compared to other large advanced commodity exporters such as Canada and Australia (Figure 2). Using this indicator, Georgia, Armenia and Kyzgyz Republic look much more 'diversified'.

Figure 2. Export Concentration Ratio: Share at HS2 level of goods disaggregation, Top 3 Exports, as % of Total

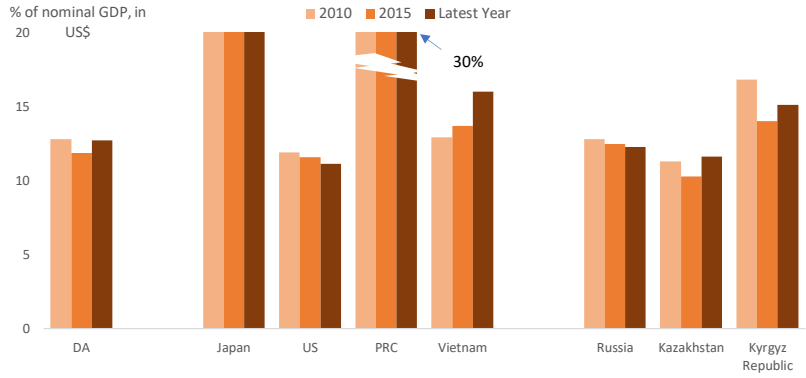


Source: Calculated using data from Word Development Indicators in Haver Analytics (accessed 23 August 2019).
Note: HS - harmonized system of classification

Another indicator that is also used to capture the importance of passing through the stage of industrialization in the process of economic development is the ***share of manufacturing value added in total GDP***. In this regard, since 1990 we observe the 'hump' discussed earlier, whereby most countries have experienced some amount of deindustrialization, including highly industrialized countries in developing Asia as a whole. Still, not surprisingly the largest ratios are

seen in Asia and a few small middle-income countries. Using this indicator, Russia, Kazakhstan and Kyrgyz Republic are not too industrialized, as the share of manufacturing to GDP in 2017 reached 12.3%, 11.6% and 15.2% (Figure 3). However, they are very much at par with Canada (10.3%), Australia (5.8%), and even so-called advanced economies such as the US (11.2%). Canada and Australia are good comparators because they are countries with similar natural endowments: vast stretches of land, rich in minerals mostly bordering isolated parts of the planet. Therefore, we find that this indicator is again not allowing us to paint a clear picture of the structural change occurring in FSU countries in comparison to advanced economies.

Figure 3. Manufacturing value added (share of GDP)



Note: Latest data: US = 2017, Japan = 2017, MENA = 2017.
Source: Calculated using data from Word Development Indicators in Haver Analytics (accessed 23 August 2019).

A more updated indicator is the ***Economic Complexity Index (ECI)***, which measures the relative knowledge intensity of an economy by aggregating the knowledge intensity of the products it exports.[1] Using this measure, the ubiquity of the products FSU countries export has in general improved. Countries that are now part of EU or are in ascension have been able to catch up faster, but Russia and Kazakhstan have also shown important improvements. In terms of the ECI, Russia has improved by 22 points since 1995 when most countries appeared in the index, and most of that improvement happened in the first 10 years. In contrast, Turkmenistan, Georgia and Armenia (the former already having low complexity) have actually lowered their ranking relative to other countries (table 1). Compared to commodity exporting advanced economies with similar endowments, Russia ranks about the same as Canada, while Kazakhstan and Kyrgyz Republic rank about the same as Australia. While the ECI performs well in terms of capturing capabilities embodied in exports of goods, it does not include services. None of these consider remittances, tourism, or exports of other professional services

Table 1. Economic Complexity Index Rankings, Selected Economies

Country	Rank 2017, out of 125	Rank improvement, 1995-2017
Armenia	85	-26
Azerbaijan	84	1
Georgia	63	-4
Kazakhstan	58	15
Kyrgyzstan	68	NA
Tajikistan	109	
Turkmenistan	112	-11
Uzbekistan	96	8
Russia	27	22
Latvia	35	19
Lithuania	34	16
Estonia	26	12
Belarus	30	13
Ukraine	39	22
United States	7	1
Canada	24	-3
Australia	59	-18
China	33	-8
Vietnam	83	-15

Source: The Observatory of Economic Complexity, https://oec.world/en/rankings/country/eci/ (accessed 22 August 2019)

[1] Note that this only refers to goods exported, not services. For a more detailed definition of the index see https://oec.world/en/rankings/country/eci/

related to research partnerships. These have grown quickly in some FSU countries such as Georgia, Armenia, Kyrgyz Republic and Uzbekistan.

More importantly, export diversification is not always related to economic diversification. The tendency in the literature to discuss exports also has to do with the relatively good availability of export and import data, which contrasts with data on firms or production of sectors. Trade data, rather than domestic production structures, are oftentimes used to make inferences about a country's domestic productivity, sophistication, and even structural transformation. This also stems from the difficulty of gathering evidence on the role of domestic production structures, which overwhelmingly are services and frequently procured under informal arrangements. Moreover, if exporting is the culmination of a firm or sector's increasing competitiveness in the domestic economy, policy makers ideally need to discover the features and characteristics of the production and employment structure before that country can begin to ramp up exports successfully.

The somewhat mixed and partial evidence about whether the countries in question are diversified, and if so, whether manufacturing plays a prominent role in their development needs to be better understood. In the next section we describe the methodology and results and some possible correlates.

4. Findings

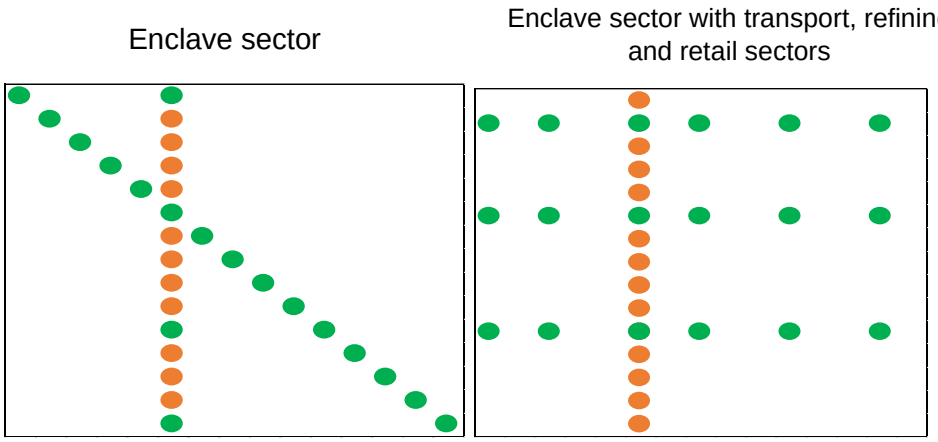
4a. Approach and Methodology

For this exercise, the economy is divided into the 35 production sectors from ADB's Multi-Regional Input–Output Table or database (MRIOT). The table includes 62 countries and 'rest of the world', which are stacked together through input-output linkages. This means we have captured all 63×35 country-sector production activities. In turn, we classify all sectors into production groups of economic blocks, depending on the nature of the production (See ADB, 2018). Sectors are ordered according to how "tradable" they are: agriculture and natural resources are listed first, then manufacturing, comprising 18 sectors, in turn divided into two types: med- to hi-tech sectors and low-tech sectors. The services are divided into supporting infrastructure such as transport and telecommunications, and private sector services which include business and professional services, the finance sector, real estate, wholesale and retail trade, rental and leasing of machinery and equipment, and other business activities. Finally, government and community services, including education, are listed at the end given that these tend to be publicly provided (although not necessarily). The sectors and blocks are listed in Appendix 2.

The hypothesis to test is as follows. Consider a unit-value change in the demand for the products of each sector (demand shock). So as to respond to that shock, the output of the sector being considered as well as that of other sectors supplying it will change: either it only demands intermediate inputs from itself, or it demands from every single sector of the economy an amount that is more than just negligible. The extent of inter-industry demand, of course, does not necessarily have any discernible direct relationship to the growth of the value added or export potential of the sector. However, if one sector depends on some other sectors for supplies, and these sectors in turn increase their demand for other sectors' products, domestic output will increase. Such supply-and-use or input–output links could set the stage for a faster and dynamic structural transformation in the local economy in the long term and could perhaps lead to greater diversification.

Conversely, a hypothetical “enclave” sector that only demands inputs from itself, is vertically integrated, and is responsible for the bulk of exports (an extreme case of non-diversification) would be the only sector to create domestic demand for inputs, as represented in the dot-plot matrix where each dot represents a significant technical coefficient (Figure 4).

Figure 4: Illustrative Representation of an Enclave Sector in the Dot-Plot Matrix Space



Source: Authors.

How does the structural transformation evolve in input–output tables for standard countries that advance to higher income? Initially a nascent sector like agriculture is likely to have only basic linkages to a few other manufacturing sectors (its suppliers), as well as transport and trade services. However, with new investments and without policy or institutional distortions, other related sectors will begin to develop to take advantage of the ecosystem and the business opportunities it presents. Further, as the economy develops, it is possible for the economy to mature into increasingly, many sophisticated services which cater to high-end manufacturing. Moreover, the country could establish new services to support exports directly and indirectly; and develop a revealed comparative advantage in certain portions of a global value chain but without directly exporting a product (as discussed further below).

4b. Results of Dot-plot Matrix Observations

We examine the dot-plot matrix representation of an input output matrix characterizing the technical coefficient, assuming that if the value is less than 0.02 it denotes low participation and is thus insignificant[2]. Appendix 1 shows the results for advanced economies (taking OECD economies as a block), United States, the FSU Central Asian countries with available data in the MRIOT (Kazakhstan and Kyrgyz Republic), Russia; as well as comparator countries: People’s Republic of China, Australia and Canada. Each country has the dot-plot matrix representation for four years (2000, 2007, 2011 and 2017).[3] Table 2 shows the legend and sector definitions.

[2] The threshold level of when the coefficient is sufficiently large to denote significant participation is to some extent arbitrary. We experimented with different leves and did not see significant changes beyond 0.02. Calculations were made using other threshold levels for robustness.
[3] All countries and years are available upon request from authors.

Table 2. Sector and Economic Block descriptions and color legend for dot-plot matrix.

Economic block	Color code in dot-plot matrix
Primary	
Low-technology manufacturing	
Medium- to high-technology manufacturing	
Infrastructure services	
Business services	
Personal and public services	

Code	Sector	Economic Block
1	Agriculture, Hunting, Forestry and Fishing	Primary
2	Mining and Quarrying	Primary
3	Food, Beverages and Tobacco	Low-technology manufacturing
4	Textiles and Textile Products	Low-technology manufacturing
5	Leather, Leather and Footwear	Low-technology manufacturing
6	Wood and Products of Wood and Cork	Low-technology manufacturing
7	Pulp, Paper, Paper, Printing and Publishing	Low-technology manufacturing
8	Coke, Refined Petroleum and Nuclear Fuel	Medium- to high-technology manufacturing
9	Chemicals and Chemical Products	Medium- to high-technology manufacturing
10	Rubber and Plastics	Low-technology manufacturing
11	Other Non-Metallic Mineral	Medium- to high-technology manufacturing
12	Basic Metals and Fabricated Metal	Medium- to high-technology manufacturing
13	Machinery, Nec	Medium- to high-technology manufacturing
14	Electrical and Optical Equipment	Medium- to high-technology manufacturing
15	Transport Equipment	Medium- to high-technology manufacturing
16	Manufacturing, Nec; Recycling	Low-technology manufacturing
17	Electricity, Gas and Water Supply	Infrastructure services
18	Construction	Infrastructure services
19	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	Business services
20	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	Business services
21	Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods	Business services
22	Hotels and Restaurants	Business services
23	Inland Transport	Infrastructure services
24	Water Transport	Infrastructure services
25	Air Transport	Infrastructure services
26	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	Business services
27	Post and Telecommunications	Infrastructure services
28	Financial Intermediation	Business services
29	Real Estate Activities	Business services
30	Renting of M&Eq and Other Business Activities	Business services

31	Public Admin and Defence; Compulsory Social Security	Personal and public services
32	Education	Personal and public services
33	Health and Social Work	Personal and public services
34	Other Community, Social and Personal Services	Personal and public services
35	Private Households with Employed Persons	Personal and public services

Note: The figures plot input-output direct requirements matrix defined as the amount of economy output used per dollar of output of industry i (column i). We only plot linkages with at least \$0.02 per dollar of output. See a more formal derivation of the direct requirements matrix A in Asian Development Bank. 2015. *Key Indicators for Asia and the Pacific 2015: Part IV Global Value Chains: Indicators for International Production Sharing*. Manila. (Appendix technical note, p. 374).
Source: ADB calculations based on the ADB Multi-Regional Input-Output Table

Put simply, the more populated the dot-plot matrix, and the more they spread over time toward more sophisticated manufacturing or services, the more economic diversification is occurring in the process of structural transformation. The larger the circle the higher the technical coefficient for a given level of participation, implying a larger multiplier effect (which explains why many country-sectors have large 'circles (or multipliers) on the diagonal. The seven economic activity blocks are illustrated by different colors in the matrix representations in the legend (top of table 2). The first three blocks produce primary and manufacturing goods, and the others generally produce, though not necessarily, non-tradable services or supporting activities. Of course, the aggregation of the economic activity blocks is the input–output technical coefficients matrix of the economy as a whole.

The interpretation of the dot-plot matrix is as follows. higher the clustering or agglomeration of dots (for any specific economic block comprising a set of sectors with similar production characteristics), the more integrated and linked sectors are, and the higher the number of sectors that "take part" in those linkages. For true agglomeration, we value the spillover and multiplier of a sector 'and' its ability to reach out and form linkages with other firms/sectors/countries that can enhance its production capabilities. This can be examined visually in a dot-plot matrix, where the size of the circle provides a measure of the size of the technical coefficient. Read vertically, if there is a \$1 increase in sector i's demand, this will incite a direct requirement (demand) for sector j by the amount. If the value is 0.3, it would be 30 cents. Moreover, the matrix dots are color-coded to describe the type of sector or economic block. In terms of the forward linkages, read horizontally, it denotes the supply of a sector to each of the other sectors, including itself. Note that the services sectors and the refining sector tend to have strong forward linkages whereas the primary sectors and manufacturing sectors tend to have strong backward linkages and be more concentrated along the diagonal more likely to supply to themselves or similar sectors.

This leads to three main takeaways.

- **First, what separates advanced economies from emerging markets is invariably the strong 'forward links' of sector 30, which is entitled "rental of machinery and equipment and other business and professional services"** (denoted as a horizonal dot plot for the US and the prototypical OECD economy). This is showing an economy where professional services –accountants, engineers, lawyers—drive the value added of almost all sectors. Moreover, there is a 'clustering' of many of the advanced non-infrastructure services, which means that they provide value to each other through spillovers.

- **Second, the pattern of a dot-plot matrix for a specific country generally changes little over time for high-income economies**. The dot-plot matrix also shows that China still depends primarily on manufacturing: although some economies are very diversified domestically, the bulk of the action occurs in the manufacturing sectors. Economies that have grown very quickly and have diversified seem to show the greatest pattern changes. Note that 2007 was a somewhat sparser year for all linkages in part due to high commodity prices (given that the MRIOT are expressed in current dollars).
- **A final aspect that stands out in some of the dot-plot matrices is the size of the diagonal.** A relatively large technical coefficient and a relatively large total requirements (Leontief) coefficient in the diagonal indicate that the production processes of the country-sector in consideration is relatively less reliant on other sectors, located in the same country or abroad. Especially in a non-competitive input-output tables, high ratios in the diagonal signify high domestic same sector reliance and low backward GVC participation[4]. The level of forward participation of a country-sector in GVCs can be discerned through the off-diagonal elements across the row attributed to the country-sector in the technical and total requirement matrices derived from the MRIOT. It is certainly possible to have high coefficients in the diagonal and a high forward GVC participation.

Russia, Kazakhstan and Kyrgyz Republic still have a strong concentration in the primary sector, according to the dot-plot matrix, although some development in the services sector (certainly more than what would have been expected). The former two economies show particularly strong forward linkages in the manufacturing of basic metals (sector 12). Russia also shows lots of activity in the hi-tech manufacturing sectors. Latvia Estonia and Lithuania increasingly begin to resemble in structure a typical OECD economy.

[4] Global value chain (GVC) participation here uses the definition from Wang, Wei, Yu, and Zhu (2017). That paper proposed an alternative decomposition of final production at the country-industry level in value-added terms from two perspectives: forward and backward linkage. On the one hand, value-added generated by one economy-sector can contribute to its own or another economy-sector's final production. Tracing where a focal economy-sector's value-added 'goes to' corresponds to the forward linkage perspective. On the other hand, an economy-sector's final production can be decomposed into value-added contributions made by economy-sectors worldwide. Tracing the origin of value-added given a fixed focal destination country-industry corresponds to the backward linkage perspective.
When tracing the origin or destination of value-added in the context of global value chains, it is not only the perspective that matters. Some kind of geographical characterization is important in quantifying the amount of value-added that is GVC-related. WWYZ (2017) characterizes value-added into three major categories: (a) value-added that is domestically produced and consumed, (b) value-added that is embedded in final product exports or imports and (c) value-added that is embodied in intermediate exports or imports of goods and services. Only value-added associated with trade in intermediate goods (item c) is considered GVC-related. The fraction of value added associated with trade in intermediate goods from the forward linkage perspective is known as forward GVC participation. It is operationally defined, for each economy-sector, as the domestic value added generated through GVC-related activities as a share of total value added. Similarly, backward GVC participation refers to the fraction of value added associated with trade in intermediate goods from the backward linkage perspective. It measures the percentage of an economy-sector's total production of final goods and services that represent value added involved in GVC activities.

4c. The Agglomeration Index

The dot-plot matrix only provides a clear visual representation of these changes, therefore, a numerical value which represents the degree of economic diversification is developed to capture what the dot-plot matrix shows. We construct summary indicators of the degree and strength of related linkages, defined as the "agglomeration" index for each economic activity block and for the whole economy. The index numerically summarizes the degree of clustering as a whole and for each economic activity block. It is the formulaic interpretation of the dot-plot matrixes of Appendix 1 (differentiated by the color of the dots in the country technical coefficients matrix).

More formally, we define the agglomeration index of an economic activity "block" $k \in \{1,2,\dots,7\}$ of country $c \in \{1,2,\dots,5\}$ as AGG_c^k. There are two components of agglomeration: the first is that formed by "backward" linkages (the number of "dots" along the sector "column" and intensity of a given sector as illustrated in the dot-plot matrixes). We will define this term as,

$$AGG(b)_c^k = \ln\left[\sum_{i=1}^{l} m(b)_i * \frac{\sum_{i=1}^{l}\sum_{g=1}^{n} p_{g,i}}{l*n}\right] \qquad (1)$$

Where $m(b)_i$ is the backward total requirements multiplier of sector i, defined as the additional output, in value terms, that must be produced by all the sectors in an economy if sector i is to produce one more unit value of output for final consumption including exports. $m(b)_i$ is also the vertical sum of each element in the Leontief inverse matrix for the column corresponding to sector i. l is the number of sectors in an economic activity block k, whereas n is the total number of sectors in the economy. $p_{g,i}$ is the indicator of participation, defined as a "significantly important" contributor from the technical coefficient matrix. This particular variable is defined as the metric that indicates whether sector i contributes to the production process of any given sector of the economy, including itself. To denote its significance, $p_{g,i}$ is a binary variable that takes the value of 1 if the direct requirements coefficient is greater than 0.02 and zero otherwise.[5] A well-diversified economy has a high $p_{g,i}$.

Essentially, $AGG(b)_j^k$ describes the degree of agglomeration or clustering of economic activity in a particular economic block (or a particular economy) created by backward (demand) linkages. It provides an indicator, not only of the strength of the linkages among sectors (given by the sum of multipliers, $m(b)_i$), but also the degree of participation of other sectors in the production of that sector. Hence, in some ways, the product provides a "booster" to the multiplier term if many sectors are involved in production. The extreme counter example is an enclave, which has a high multiplier but only demands from itself. The indicator is expressed in logs to create a more manageable range.

Similarly, we define the term $AGG(f)_c^k$ as the agglomeration was formed through forward linkages. The agglomeration indicator for the k^{th} economic block of country c is

[5] The direct requirement or technical coefficients matrix generally has a value for each entry, but some are insignificantly small, which for all practical purposes indicates a very weak link to the respective intermediate sector. Therefore, we assume this is statistically not different from zero. We test this for sensitivity and get a slightly different value of the indicator, but qualitatively the same results.

$$AGG(f)_c^k = \ln\left[\sum_{j=1}^{l} m(f)_j * \frac{\sum_{j=1}^{l}\sum_{h=1}^{n} p_{j,h}}{l*n}\right] \qquad (2)$$

where $m(f)_i$ is the "forward" total requirements of a sector i, defined as the additional supply. In value terms, that sector i provides to all the sectors in an economy in response to a unit value increase in the final demand for the products of each of the sectors, including itself. $m(f)_i$ is also the horizontal sum of each element in the Leontief inverse matrix for the row corresponding to sector i. The indicator $p_{j,h}$ has the same interpretation, except that it boosts the forward multiplier if sector i contributes to the production of many goods or services of the economy (as opposed to just a few). $m(f)_i$ is large when sector i provides a large share of the value added consumed or exported. A sector will have a high value of $AGG(f)_c^k$ if $m(f)_i$ is large and it provides intermediate inputs to the production of many goods and services. We expect that in a vibrant economy, transport, telecommunications, and some business services would have a high value of $AGG(f)_c^k$, although $AGG(f)_c^k$ and $AGG(b)_c^k$ have different interpretations, for the economy as a whole (aggregating all 35 sectors), $AGG(f)_c^k = AGG(b)_c^k$. For the backward indicator we would be adding along the columns for all 35 demanding sectors i (and for the latter across the rows for all 35 producing sectors j).[6] However, we are also interested in the economic blocks, so we compute both $AGG(f)_c^k$ and $AGG(b)_c^k$ separately, as well as taking the average of the two.

Define $$AGG_c^k = \frac{AGG(b)_c^k + AGG(f)_c^k}{2} \qquad (3)$$

Since the hypothesis to be tested is that export sectors that grow quickly will demand from many sectors of the economy, and that services essentially have a supportive function, one would expect the "economic blocks" of agriculture, natural resources, and manufacturing to have high backward linkages for sectors that export, and the services blocks to have high forward linkages. Ideally, productive sectors will have both high forward and high backward linkages of all types.

Table 3 shows the results of the comparator countries. As expected, the primary sectors seem to show low or negative backward agglomeration in most countries—including commodity producers. Even more negative values are observed for the 'personal and public services' economic block, signifying their low participation in production. Countries with strong interventionist governments such as Kazakhstan get a very low number. By far the higher agglomeration levels are seen in the business services block, particularly for more advanced economies. Agglomeration index scores on low-tech manufacturing are the second-highest, especially in advanced economies.

[6] In notation, *L=n=k*=35: the number of sectors in the economic block when the economic block is the full economy is equal to the total economy. We are adding up all the elements in the two components of the product in equations (1) and (2) but in different order. The elements of the Leontief inverse matrix that compose $m(b)_i$ are also in $m(f)_j$.

Table 3. The Agglomeration Index Results for FSU Countries and Comparators

	Agglomeration index - backward			Agglomeration index - forward		
	Primary	Low-technology manufacturing	Medium- to high-technology manufacturing	Infrastructure services	Business services	Personal and public services
Kazakhstan						
2000	-0.66	0.64	0.41	0.31	0.54	-0.16
2007	-0.91	0.01	0.16	-0.08	0.39	-0.18
2011	-1.52	0.30	0.27	0.33	0.47	-0.38
2017	-0.92	0.20	0.24	0.55	0.13	-0.16
Kyrgyz Republic						
2000	-0.78	0.72	0.78	0.91	0.28	0.00
2007	-1.95	-0.08	-1.17	-0.39	0.26	0.00
2011	-1.62	0.46	-0.09	0.46	0.93	-3.49
2017	-0.88	0.49	0.25	0.25	1.27	-2.37
Russia						
2000	-0.64	0.63	0.76	0.50	1.37	-1.58
2007	-0.87	0.91	1.03	0.79	1.36	-1.54
2011	-0.84	0.83	1.08	0.70	1.40	-1.55
2017	-0.61	0.79	1.04	1.16	1.53	-0.90
United States						
2000	-0.36	1.00	0.79	0.18	1.85	-1.18
2007	-0.82	0.94	0.74	-0.34	1.83	-1.33
2011	-0.99	0.85	0.66	-0.50	1.76	-1.49
2017	-0.75	0.88	0.62	-0.37	1.85	-1.19
OECD countries						
2000	-0.57	1.09	0.93	0.34	1.96	-1.48
2007	-0.80	1.16	0.89	0.08	1.96	-1.33
2011	-0.80	1.08	0.91	0.03	1.91	-1.48
2017	-0.68	1.06	0.98	0.21	1.96	-1.66
Australia						
2000	-0.48	0.83	0.79	0.43	1.93	-1.32
2007	-0.50	0.97	0.68	0.60	1.98	-1.50
2011	-0.49	0.76	0.56	0.71	1.91	-1.51
2017	-0.70	0.71	0.73	0.78	1.89	-1.70
Canada						
2000	-0.51	0.84	0.54	0.43	1.99	-1.21
2007	-0.43	0.96	0.60	0.41	2.02	-1.20
2011	-0.55	0.96	0.64	0.33	1.95	-1.39
2017	-0.43	1.04	0.84	0.48	2.04	-1.10

Source: Asian Development Bank's calculations based on the ADB Multi-Regional Input-Output Table

In contrast to the export concentration index, the central Asian countries all seem to be very diversified domestically, particularly Russia. Russia comes out as the fourth most diversified economy out of the 63 analyzed in the MRIOT according to the total agglomeration index, as the networks across manufacturing and services show (see table 4). Still, Kazakhstan is ranked 35 just above Vietnam, which is always considered a very diversifies economy. Kyrgyz Republic, in contrast, ranks 49th, so not very diversified. One interpretation for the high value for Russia compared to the other FSU countries is that Russia was the economic epicenter during the Soviet Union times, so by severing the links that held all FSU republics together this part of the impact was significantly more intense for other countries. Whereas Russia was large enough that it was able to make up for most of the industries and reestablish links across sectors. Related to this, unlike other developing countries where there have been significant improvements in the agglomeration index, Russia's index has not changed much since 2000 (the first available year in the data).

Table 4: Country Rankings Based on Total Agglomeration Index

Rank	Country	Total agglomeration index
1	**People's Republic of China**	**2.67**
2	Thailand	2.37
3	Republic of Korea	2.33
4	**Russia**	**2.32**
5	Malaysia	2.27
9	**Australia**	**2.25**
11	**Canada**	**2.24**
14	**United States**	**2.18**
	OECD average	1.92
35	**Kazakhstan**	**1.86**
38	Viet Nam	1.83
49	**Kyrgyz Republic**	**1.68**

Source: Asian Development Bank's calculations based on the ADB Multi-Regional Input-Output Table

Overall the patterns of the agglomeration index show that economic diversification is mostly specific to the stage of development and country-specific effects. Other aspects of the total agglomeration index that we looked at are less informative. We regressed the total agglomeration index against standard indicators but found few distinct relationships. We do not find the relationship with how developed the country is (per-capita income, institutional quality) and its agglomeration index, even after controlling for country and time fixed effects and experimenting with lags. For example, Ireland, Luxembourg and Hong Kong with high income show relatively low values of the agglomeration index. There seems to be some loose positive association between the size of the economy and its economic diversification, but driven mostly by People's Republic of China and to a lesser extent Brazil and US. In contrast, Thailand and Malaysia score in the top 10 on the index. In general country idiosyncratic fixed effects dominate—although poorer countries tend to have improved scores over time.

Economic diversification across business services may be positively or negatively related to income, thus also presenting a mixed picture. Taking agglomeration of non-public non-infrastructure services as a whole (including retail trade) showed no clear association with

development (economic or institutional). This may have to do with the heterogeneity of services in terms of importance for productivity. For example, most countries have strong forward links of retail trade or inland transport, regardless of how developed. But this service is very different in its contribution to growth and export value added compared to, say, business and professional services (see below). Likewise, some manufacturing sectors such as metal processing or refining have high forward agglomeration because steel production and fuel is required for so many economic activities.

4d. Results of the juxtaposition with trade in value added indicators

What is the relationship with export growth? The dot-plot matrices show that sectors in which the country has a comparative advantage in trade in value-added terms does not always have a clear relationship with the sectors where there seems to be more agglomeration. And this is not necessarily expected: as explained earlier, the model of an 'enclave' sector that takes from many sectors but has no spillover effects is perfectly consistent with high export and high GDP growth. However, it is worthwhile to see what are the characteristics of countries that start with a high revealed comparative advantage in a country-sector and the agglomeration index, particularly in key sectors such as high-tech manufacturing and services.

We use an alternative to the traditional comparative advantage indicator. To succeed in the export market, a sector has to undergo a series of stages of growth and nourishment. Generally, indicators of revealed comparative advantage are used to measure success of that country's production activity (see appendix 2 for a formal definition of the indicator). We compute the indicator developed by Wang, Wei, and Zhu (2014) and ADB (2015) to measure the comparative advantage of various country-sectors. A sector *i's* relative comparative advantage can be measured using a traditional method (by looking at how an exported product compares with other products), or by computing the value of the product created by a country and embodied in an export, regardless of whether the final export originated in the country in question (see New Revealed Comparative advantage, of $NRCA_{i.}$.[7]

Unlike the agglomeration index, this indicator is strongly associated with the value-added growth of the sector. This after controlling for country/sector fixed effects as well as time effects. To test this, we postulate the following model of the indicator of trade-in-value added comparative advantage of a sector. The New Revealed Comparative Advantage (NRCA) in year 2017 depends on :

$$NRCA_{i,s} = \beta_0 + \beta_1 \Delta lnGVA_{i,t-2000,s} + \gamma_1 CE + \gamma_2 SE + u_i \qquad (4)$$

[7] A simple example is iPhones: the PRC produces the glass screen and assembles the final product ready for export, but behind the production of an iPhone there is much know-how, mainly produced in the United States. In the TRCA formula, we measure the comparative advantage in exports of the full iPhone, whereas in the NRCA only the value of the glass screen and assembly services of the product in the PRC is attributed to the PRC and compared with other countries that also produce glass screens and assemble iPhones. Hypothetically, the PRC may not have a comparative advantage in the export of smartphones, but it may have a comparative advantage in glass screen production and assembly. In the latter case, the revealed comparative advantage indicator is correctly attributing the productivity of the country to that good or service

where:

$\boldsymbol{NRCA_{i,s}}$= is the new revealed comparative advantage (NRCA) index of each country i (i = 1 to 62) for each sector s (s =1 to 35, corresponding to each sector of the ADB Multi-Regional Input Output Table).
$\Delta\boldsymbol{lnGVA_{i,t-2000,s}}$= represents the cumulative compound annual growth rate of each country's Gross Value Added for each sector s since 2000.

We estimate a panel OLS regression which include
$\boldsymbol{CE}$ = country effects, and $\boldsymbol{SE}$ = sectoral effects., $\boldsymbol{t}$ = refers to time t (t = 2017) and $\boldsymbol{u_i}$= is the error term. The estimation results are shown in table 5. This shows the high significance of this for the growth of the sector, as well as the economy because we have controlled for country/sector fixed effects. It is also worth noting that sectors that have high forward GVC participation globally (machinery and transport equipment, electrical and electronic equipment, retail trade, business and professional services) have even higher NCRA, beyond what is explained by the sector's overall value-added growth. In terms of country effects, a few small tourist-intensive islands show strong effects.

Table 5. Panel Regression Results

Dependent variable:	**NCRA in 2017**		
	(1)	(2)	(3)
VARIABLES	nrca	nrca	nrca
lngva_cagr	0.0656***	0.0416***	0.0912***
	(0.013)	(0.009)	(0.014)
Greece	1.060**		1.270***
	(0.472)		(0.469)
Maldives	1.798***		1.635***
	(0.482)		(0.478)
Textiles and Textile Products		0.966***	1.115***
		(0.370)	(0.370)
Machinery, Nec		-0.686**	-0.806**
		(0.335)	(0.336)
Electrical and Optical Equipment		-0.749**	-0.736**
		(0.347)	(0.346)
Transport Equipment		-0.782**	-0.916***
		(0.337)	(0.338)
Wholesale Trade and Commission		-0.509	-0.651**
		(0.330)	(0.330)
Financial Intermediation		-0.570*	-0.782**
		(0.329)	(0.331)
Renting of M&Eq and Other Busine		-0.634*	-0.898***
		(0.332)	(0.336)
Constant	1.030***	1.481***	1.400***
	(0.306)	(0.234)	(0.382)
Observations	1,939	1,939	1,939
R-squared	0.043	0.043	0.082

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results on the comparative advantage indicator are in line with new research on GVC participation. With high and growing GVC participation, a country that develops a comparative advantage in a specific process to insert into a particular global value chain can take advantage of the expanded demand. This would be indeed a requirement for a country to develop, if it does not have a natural domestic endowment. And to sustain that development, the benefits from the growth in this sector would have to spread across other sectors.

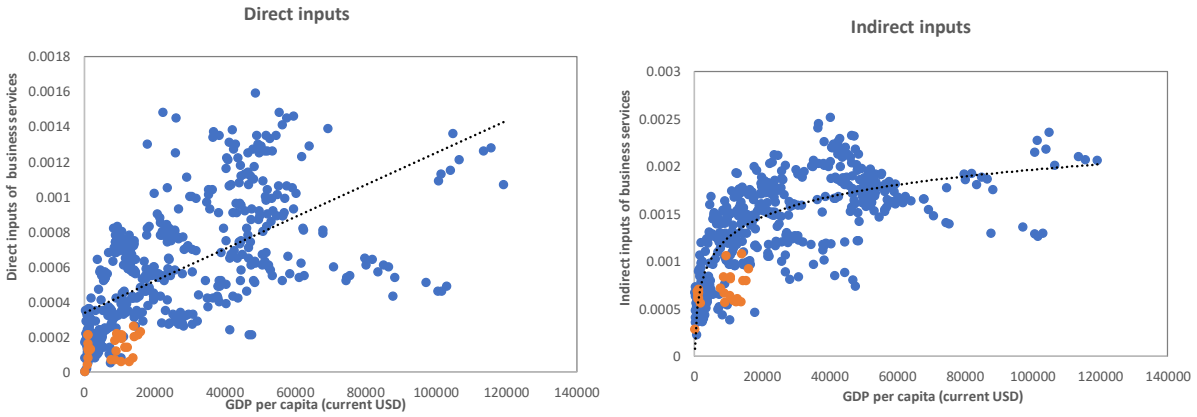
4e. The special role of business and professional services

There is one particular sector that tends to have strong and significant forward agglomeration for high-income economies, as illustrated in the dot-plot matrix, and at the same time has high trade in value added revealed comparative advantage for the country: sector 30 in the MRIOT: "leasing of machinery and professional and business services". In other words, countries that have high agglomeration of services in general and have managed to grow in the past to high stages of

development have this found that this sector contributes directly and indirectly to economic activity. Mercer-Blackman and Ablaza (2019) also find that with globalized production, many of the processes formerly accounted for as part of the manufacturing sector and traditionally taking place there have now splintered and have been outsourced—domestically and internationally—to the services sector. Putting it plainly, the research and development, engineering and design, development of robotics, marketing, logistics and accounting that is required to build a machine or a manufacturing good—the bulk of the value creation—is not happening at the factory floor, but in many cases very far away geographically. National accounts will attribute the massive increase in productivity from automated manufacturing to what happens in the factory floor and not to the sectors where there was the greatest amount of value creation.

Using the MRIOT, the authors develop an indicator of the 'servitization' of manufacturing which shows the direct and indirect production contributed by sector 30: 'business and professional services' in a particular country' for every $1 increase in the demand for a manufacturing product anywhere around the world[8]. Figure x shows the results. Business services tend to be a key player in development for high-income economies, despite being barely traded internationally. Since the majority of services are not directly exported, but only contribute to the value of other exported goods, it is easy to undervalue their importance in the growth of manufacturing and an export-led development strategy. When high-tech manufacturing products are exported, this tends to stimulate business services, including legal and professional services. Indeed, the greater the direct and indirect linkages (servicification) of business services in manufacturing value added, the more developed the economy is (Figure 5).

Figure 5. Inputs of own country/year professional and business services into manufacturing value added and GDP per capita, 2000 and 2010-2017:



Source: Mercer-Blackman and Ablaza (2019). Note: Russia, Kazakhstan and Kyrgyz Republic shaded in orange.

[8] Using the technical coefficient matrix, the authors quantify the number of services used directly as inputs in manufacturing sectors for arm's-length transactions. The Leontief coefficients give us the total number of services used in manufacturing, that is, they represent the sum of what we denote as direct and indirect components. To illustrate these concepts, consider the case of an automobile manufacturer that uses equipment leased by another company to produce one vehicle. The rent paid for the equipment is an example of a direct service used as an input by the automobile manufacturer; however, this does not account for all of the equipment rentals that are paid for in the process of producing one vehicle. For instance, the automobile manufacturer may require basic metals as part of its raw materials. Assuming these metals are also produced using leased equipment, then the rent serves as an indirect input to the manufacture of a vehicle.

To examine whether this strong relationship holds after controlling for time and country fixed effects, we regress both the direct and indirect coefficients of servitization against indicators of development such as GDP per capita and institutional quality. The specification is as follows:

$$BSMFG_{i,t,c} = \beta_0 + \overbrace{\beta_1 lnGDPpc_{i,t-n} + \beta_2 BSMFG_{i,t-n,c}}^{X_{i,t,c}} + \gamma T + u_{i,t,c} \quad (5)$$

$\boldsymbol{BSMFG_{i,t,c}}$= is the contribution of business servitization of manufacturing, grouped into either direct, indirect, and/or total, for each country or entity i.
$\boldsymbol{X_{i,t,c}}$ = represents the independent variables, where $lnGDPpc_{i,t}$ = ln per capita GDP in nominal US$ and $BS\_MFG_{i,t-1,c}$ is the 1-period lag of BS_MFG.
$\boldsymbol{T}$= refers to the time dummy.
$\boldsymbol{t}$ = refers to time t = 2010 to 2017, and n = lag from time 0 to 2.
$\boldsymbol{u_{i,t,c}}$= is the error term.

Table 6 shows the results.

Table 6. Panel Regression Results on Business and Services Servitization of Manufacturing

Dependent variable: **Business servitization of Manufacturing Sector**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Indirect impact sector 30				Indirect impact sector 30			
ln(GDPperK)	0.401*	0.247*	0.213**	0.327***	0.0529*	0.0475*	0.0513**	0.0678**
	(0.204)	(0.128)	(0.0953)	(0.0968)	(0.0283)	(0.0282)	(0.0194)	(0.0271)
2011.year	-0.0566**				-0.0142**			
	(0.0244)				(0.00650)			
2012.year	-0.0513**		0.00976	0.0277	-0.00567		0.0172***	
	(0.0203)		(0.0108)	(0.0178)	(0.00765)		(0.00589)	
2013.year	-0.0393	-0.00572	0.0292**	0.0407**	0.00268	0.00100	0.0203***	-0.00798
	(0.0283)	(0.0343)	(0.0144)	(0.0168)	(0.00987)	(0.00733)	(0.00710)	(0.00609)
2014.year	-0.0248	0.0132	0.0290*	0.0436**	0.00403	0.00449	0.0165***	-0.00924*
	(0.0303)	(0.0258)	(0.0157)	(0.0204)	(0.00991)	(0.00639)	(0.00535)	(0.00496)
2015.year	0.0646*	0.0792**	0.0860***	0.114***	0.0268**	0.0250**	0.0383***	0.0117*
	(0.0351)	(0.0303)	(0.0252)	(0.0286)	(0.0102)	(0.00948)	(0.00827)	(0.00671)
2016.year	0.0433	0.0580	0.0325	0.0455*	0.0300**	0.0240*	0.0274***	-0.00579
	(0.0351)	(0.0466)	(0.0250)	(0.0233)	(0.0117)	(0.0126)	(0.00757)	(0.00821)
2017.year	-0.0229	0.0220	-0.00916	-0.00253	0.0167	0.0172	0.0122	-0.0138
	(0.0442)	(0.0444)	(0.0298)	(0.0324)	(0.0137)	(0.0135)	(0.0100)	(0.0108)
ln(GDPperK--lag 1)		0.0311		-0.142		-0.0312	-0.0317	-0.0809**
		(0.239)		(0.0878)		(0.0352)	(0.0258)	(0.0371)
ln(GDPperK--lag2)		0.211				0.0621		0.0846**
		(0.257)				(0.0419)		(0.0353)
Lag sector 30 dependent var			0.655***	0.666***			0.622***	0.631***
			(0.130)	(0.135)			(0.0945)	(0.0877)
Constant	-2.697	-3.568	-1.671*	-1.434	-0.0394	-0.282	-0.0244	-0.498**
	(1.945)	(2.243)	(0.874)	(0.897)	(0.267)	(0.368)	(0.199)	(0.239)
Observations	480	360	420	420	480	360	420	360
R-squared	0.114	0.117	0.423	0.425	0.123	0.118	0.421	0.397
Number of ctrycode	60	60	60	60	60	60	60	60

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

They show a strong positive association between country's development and the contribution of business and professional services to manufacturing—particularly the indirect contribution which is less likely to be captured in national accounts. The Wald test suggests that time effects are important, particularly 2015 during which the large fall in the price of manufacturing goods

producer price index may lead to an overestimation of the real contribution on productivity. It is also worth noting that there is dynamic persistence, as the inclusion of the lagged dependent variable as a regressor significantly improves the fit. In other words, the higher the contribution of business and professional services in previous years, the stronger the links between business and professional services the current year.

Taken together with the earlier evidence of the strong forward agglomeration of this sector in advanced economies, the data seem to suggest that what is being couched as "premature deindustrialization" may not be happening in terms of value creation9. Contrary to interpretations by Rodrik (2016), this implies that the barometer for the speed of economic development may no longer be to increase the share of employment in manufacturing, but instead the degree of links (servicification) between business and professional services and manufacturing value added. It is also consistent with recent work by Ferrantino and Koten, (2019) highlighting the size of business-to-business linkages also supporting their important role of sophistication of services in development.

4e. Data issues

While the patterns that we try to infer from the data are long-term trends, the data do not go back far enough to make trend comparisons of processes that can take a long time to develop. Since the breakup of the Soviet Union the former republics have all takes very different courses, with some showing still strong economic ties with Russia and others more isolated or developing ties with Europe in the quest for ascension.

As data improves some of these development patterns will be easier to verify. For the remaining central Asian countries, the Asian Development Bank is currently working with Armenia, Azerbaijan, Tajikistan, and Uzbekistan, among other regional member countries, to produce more current supply-use tables (SUTs) and Input-Output tables (IOTs) as per international standards conforming to the System of National Accounts (SNA) 2008 recommendations. By December 2020 the project participant countries would have constructed the current and constant price SUTs and IOTs for reference years 2016, 2017 and 2018. The tables thus produced will also be integrated into ADB's multi-regional input-output table database to produce statistics to better analyze the state and evolution of any given country-sector's participation on GVCs. The fundamental challenges in constructing the tables for the FSU countries as per SNA2008 recommendations and current international standards are that the data collection vehicles (surveys and administrative data) are not adequately designed to gather information required for a modern and effective statistical system. The collection vehicles and processes need to be revamped to serve the information needs of fast-evolving societies. Further, even the data collected have various gaps, including incomplete, incorrect and incoherent information, requiring significant adjustments, imputations and corrections during the data development process to produce official key economic indicators, which themselves are at times not coherent with relevant

[9] "Servicification" is the process in which economies are shedding manufacturing jobs and gaining service jobs, may also just reflect internal value chains where specialization with economies of scope is the most efficient process (eg: machinery leasing, distribution, etc).

indicators compiled by international organizations, academic institutions and think tanks (see table 7).

Table 7. Availability of IOTs for former republics of the Soviet Union*.

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	Armenia																			
2	Azerbaijan												96 x 96							
3	Belarus																			
4	Estonia 1/ 2/	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35
5	Georgia 3/							67 x 45	67 x 45	67 x 45	67 x 45	67 x 45	67 x 45	67 x 45	67 x 45	67 x 45	67 x 45	67 x 45	67 x 45	
6	Kazakhstan 1/	35 x 35							35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35
7	Kyrgyz Republic	35 x 35							35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35
8	Latvia 1/ 2/	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35
9	Lithuania 1/ 2/	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35
10	Moldova																			
11	Russia 1/ 2/	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35	35 x 35
12	Tajikistan												96 x 96							
13	Turkmenistan																			
14	Ukraine													42 x 42	42 x 42	42 x 42	42 x 42	42 x 42		
15	Uzbekistan															(unofficial tables)				

* Cell denotes number of demand sectors x number of supply sectors available from statistical authorities.
1/ Included in World Input-Output Tables (WIOD); 2/ Included in ADB's Multi-Regional Input-Output tables (MRIOT); 3/ Only supply-use tables available

5. Conclusions and Policy Implications

The nature of global production processes is changing very quickly and most manufacturing production can be described as a value chain with many country/sectors contributing tradables and non-tradables to the final value added of goods for export or domestic consumption. As a result, structural transformation cannot be explained in term of three well-delineated and highly distinct sectors, as has been the paradigm explaining the path of now advanced economies. Specifically, advising countries to diversify into manufacturing when many have neither the endowment nor the capabilities could create more problems than solutions. Kazakhstan is a case in point: given its high export concentration—mainly oil and gas—analysts and external policy-makers have advised them to develop their industry further (see for example Alexander and Tanigushi (2018) and Gill et. al. (2014). But much of the industry is managed by formerly state-owned enterprises that thrived under a very different era and a very different system which no longer exists. Instead. Kazakhstan has developed a thriving oil an gas sector with significant local content that employs high-skilled labor. FSU has slight advantage of being rich in natural resources but also in relative terms having an educated population that can develop the services sector and R&D. But they need to pen up because they do not participate in GVCs.

Policy-makers also still assume that there will be more employment if manufacturing is supported without understanding that employment and value added can be created indirectly from related sectors. Most production processes have value added from both manufacturing, services and in some cases even natural resources. Take the oil and gas sector, which is one of the most sophisticated endeavors, from exploration, to research, to distribution. Moreover, it has the highest 'GVC participation index' from any other sector. Traditionally it is considered a 'primary sector' and thus countries engaged in these by definition will have a Dutch Disease and never develop. a situation often labelled the 'resource curse'. In McMillan et al.'s (2014) terms, the 'resource curse' hypothesis lies on the low capacity of the mining and quarrying sector to create a lot of jobs and absorb the excess of workforce engaged in agriculture and low-productivity services. This has been indeed the advice given to Russia and Kazakhstan for many years: that

they should develop manufacturing sectors. Yet Russia has a sophisticated IT and software sector, and Kazakhstan an impressive oilfield services sector: Atakhanova (2018) suggests that Kazakhstan it is much more diversified if the contribution of intermediate sectors such as oilfield services are properly accounted for (See appendix 3).

This paper has shown that in terms of domestic economic diversification—as measured by the agglomeration index, the FSU countries for which we have data have good ratios or certainly above average for their level of development. However, their business services sectors still display somewhat weak linkages with the rest of the economy compared to OECD countries suggesting some potential for development. Therefore, the strategy of developing business and professional services seems best since they have mostly 'missed the boat' when it comes to manufacturing sector development for export. The results show that countries with the strongest forward linkages in business and professional services have the ability to develop faster in this day and age.

While still at small scale, the examples of wealthy economies such as Hong Kong, China and Abu Dhabi, UAE 'skipping' the manufacturing stage of development present some interesting alternatives.

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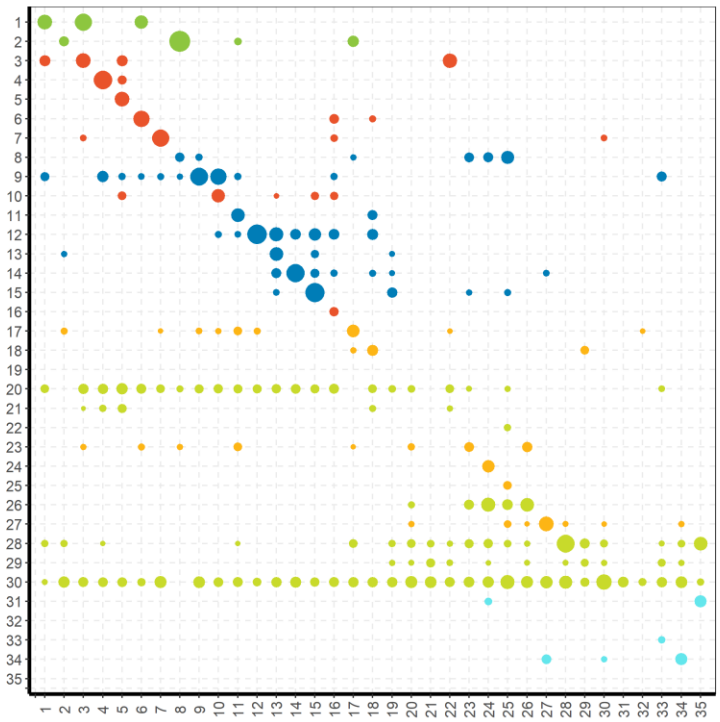
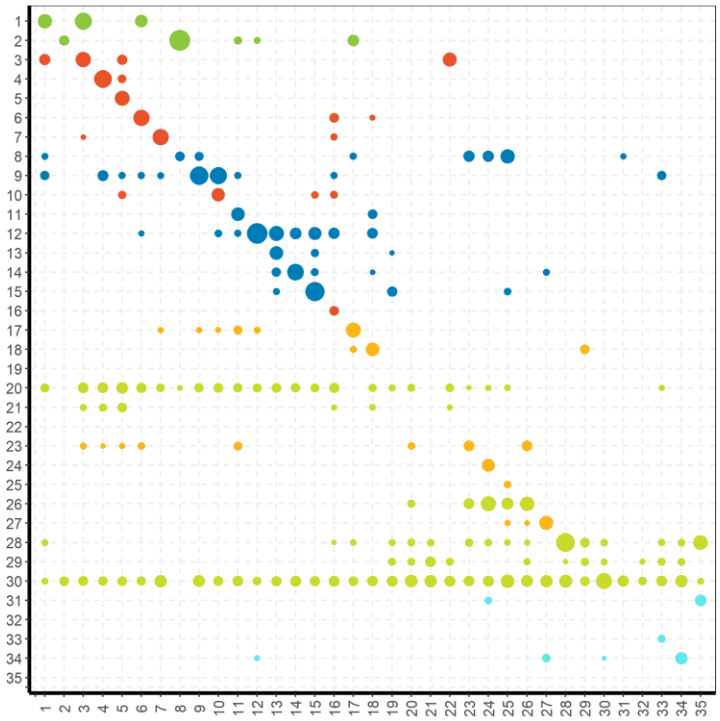
Appendix 1. Agglomeration of Economic Sector-Specific Productive Activities Using the Dot-Plot Matrix Representation (see legend for sector description)

OECD countries, 2000



OECD countries, 2007



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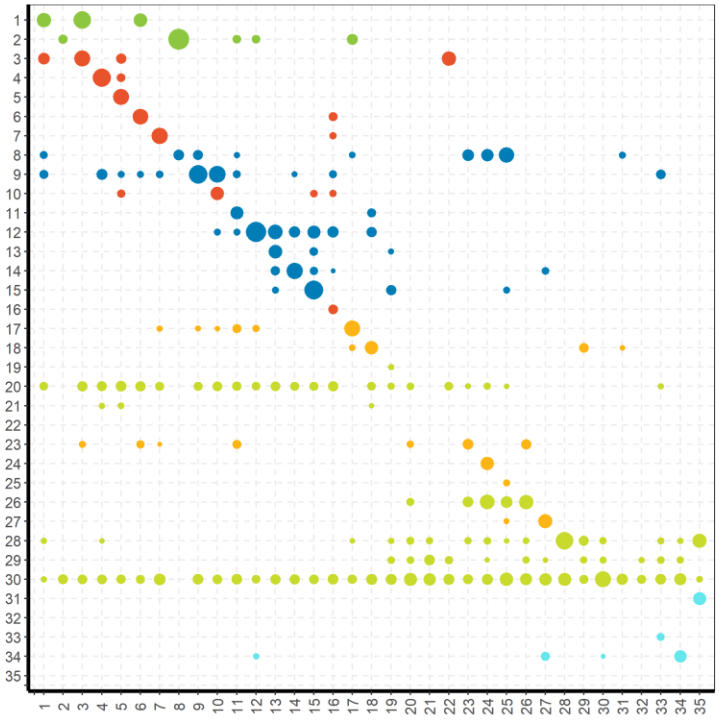

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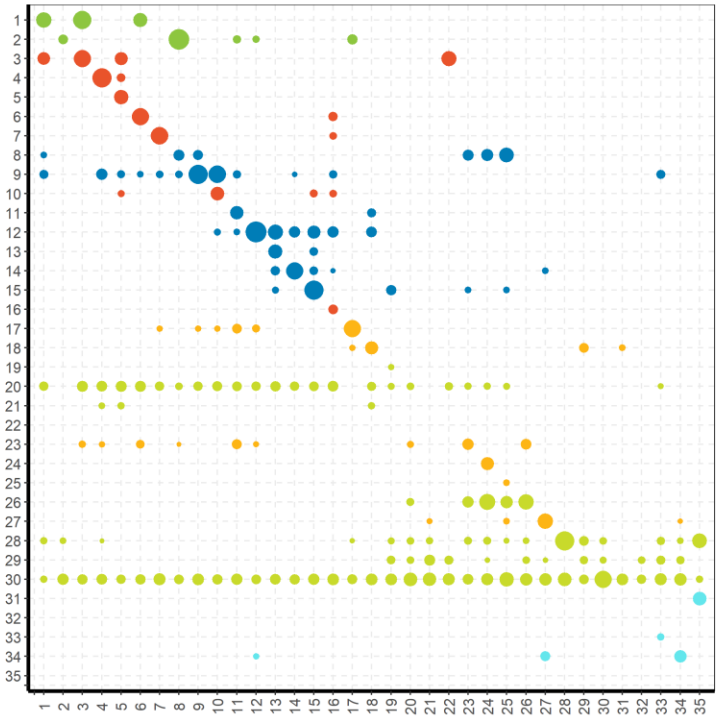
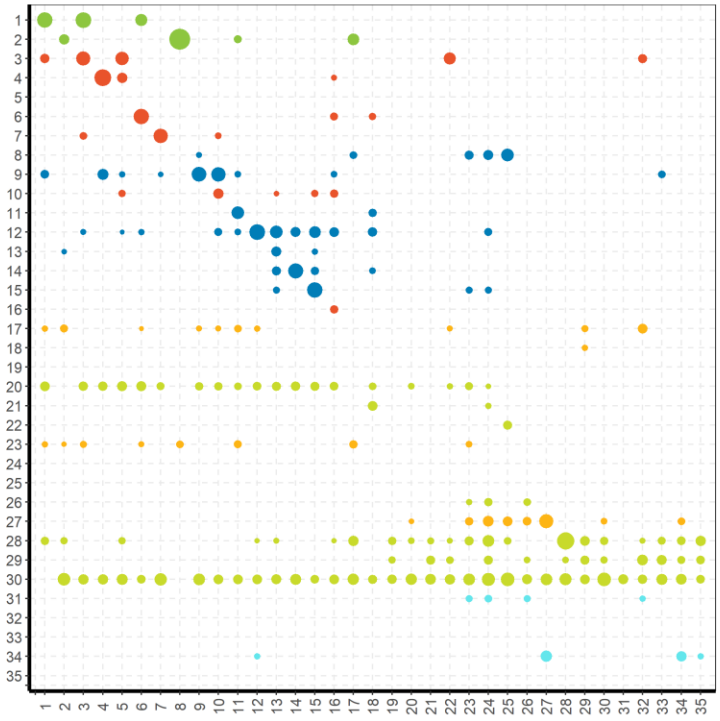


United States, 2000



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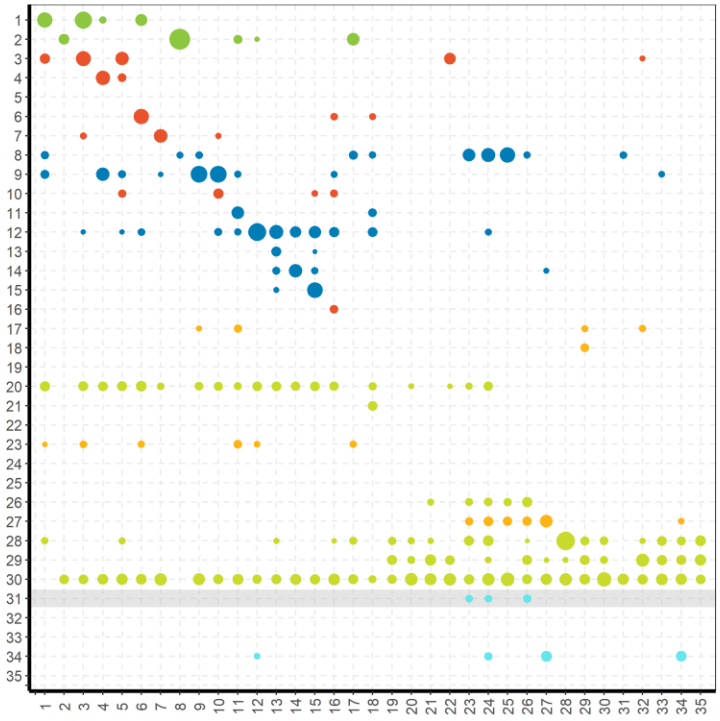

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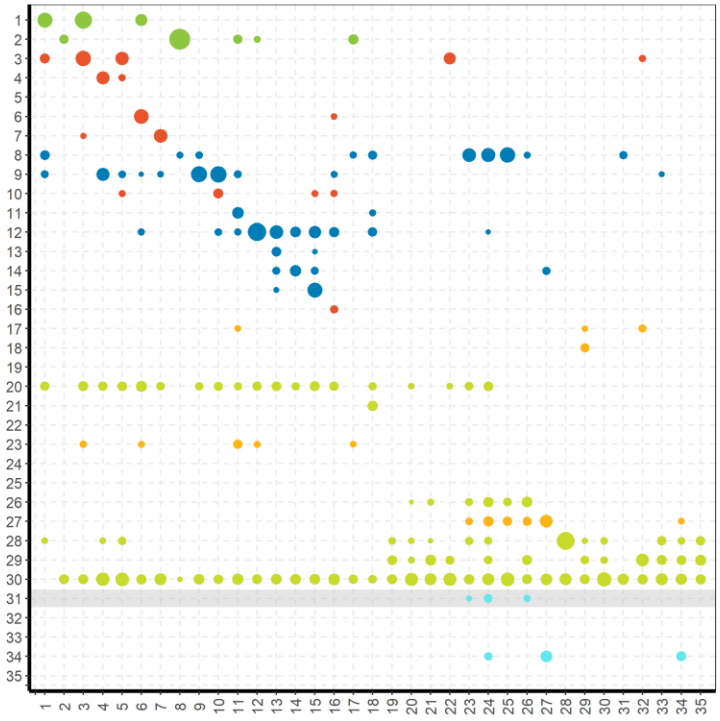
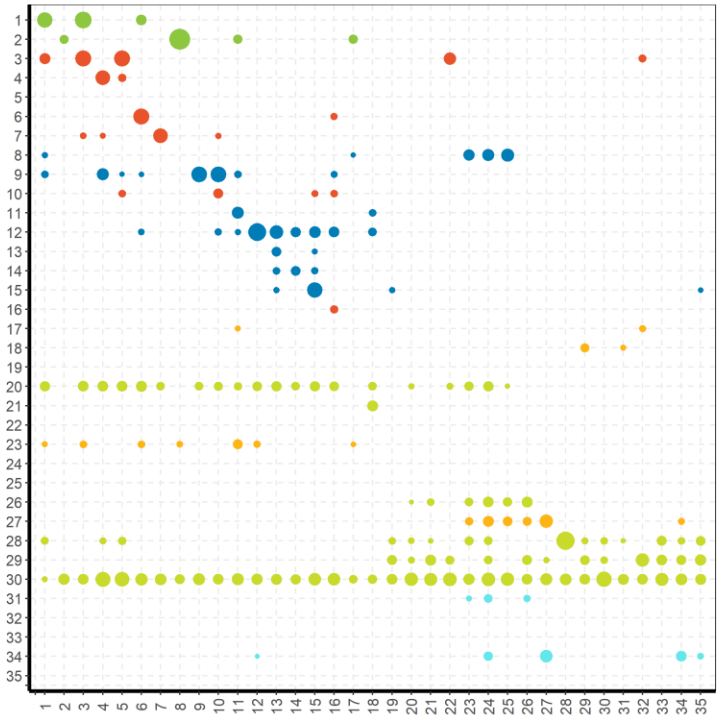
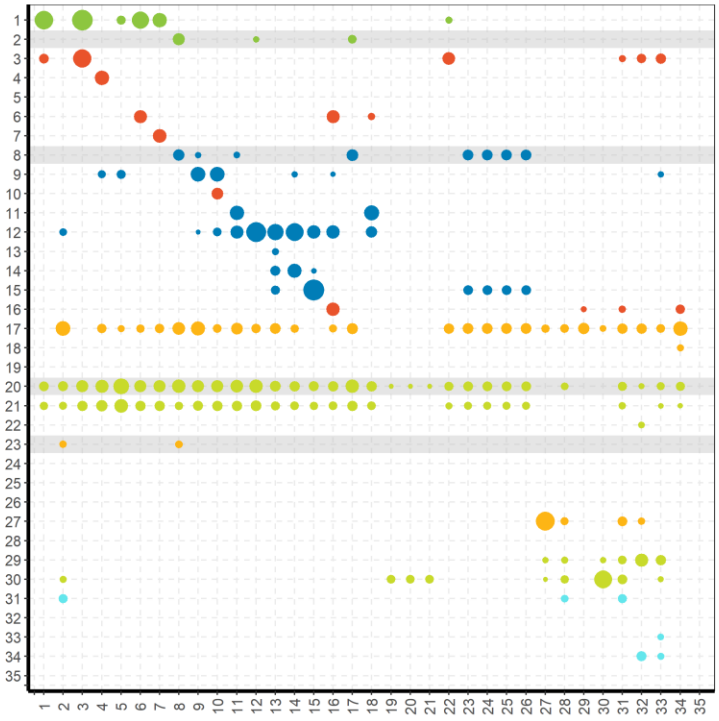


United States, 2017



Russia, 2000



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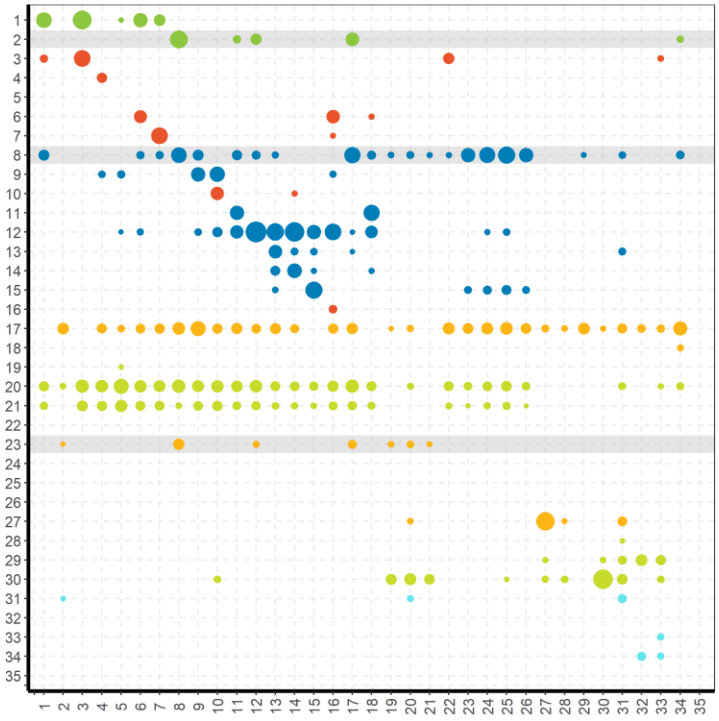

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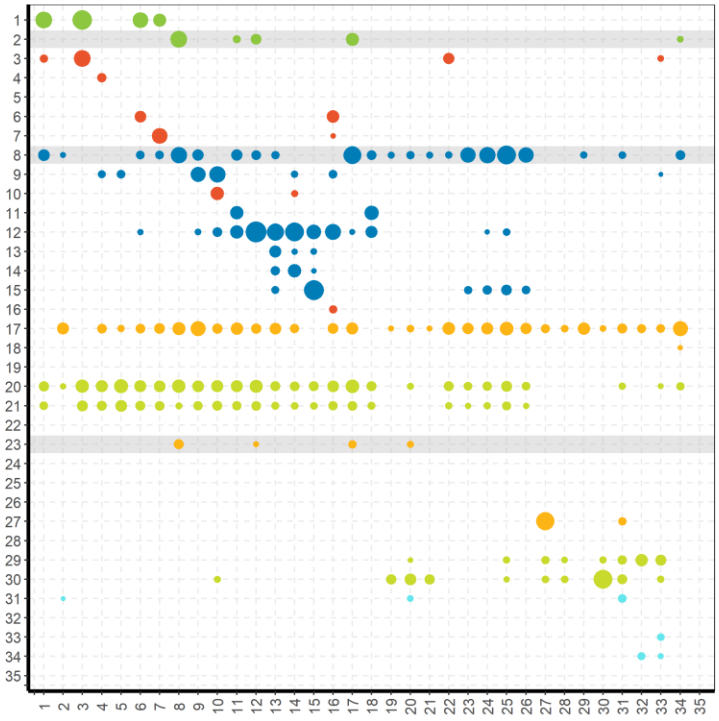

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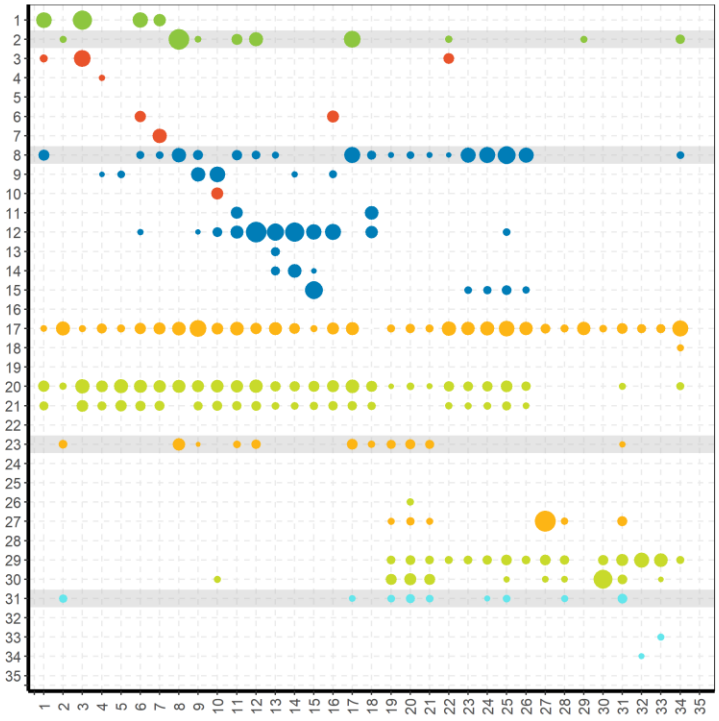
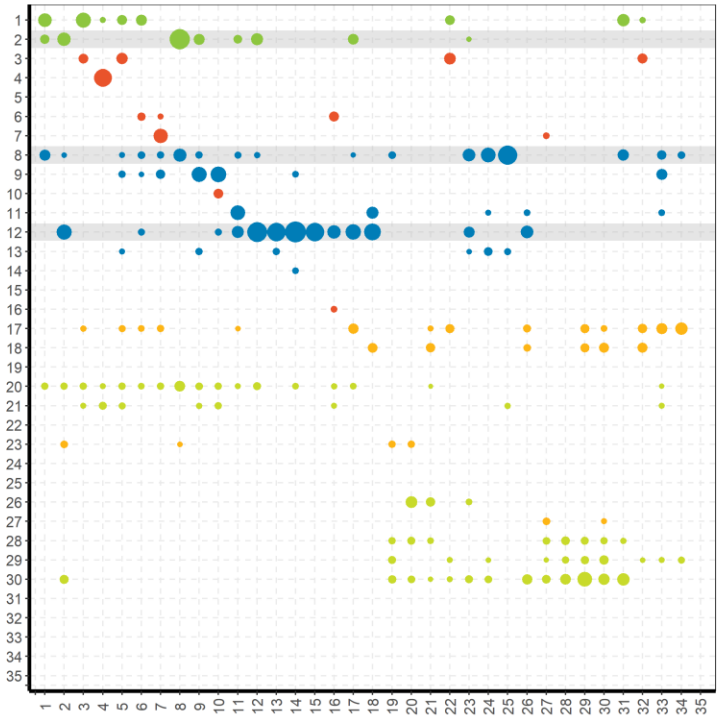


Kazakhstan, 2000



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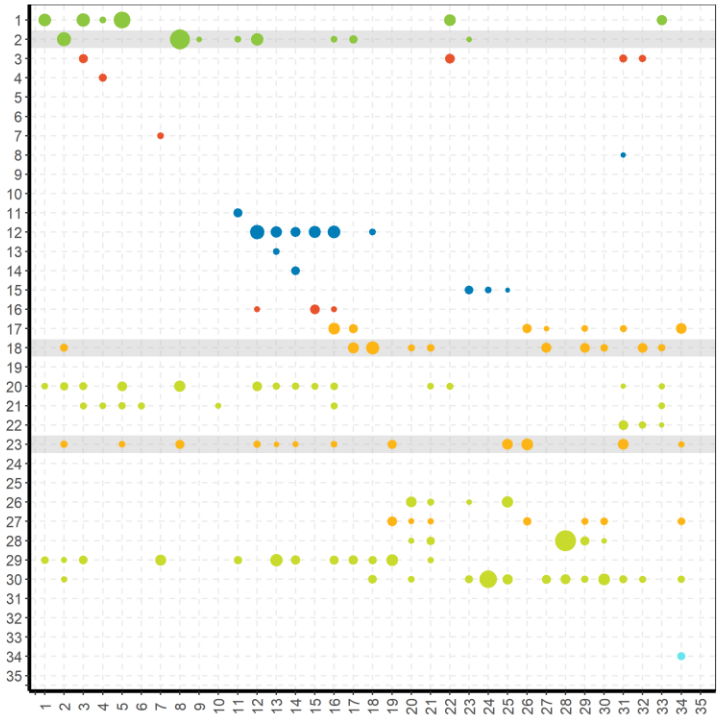

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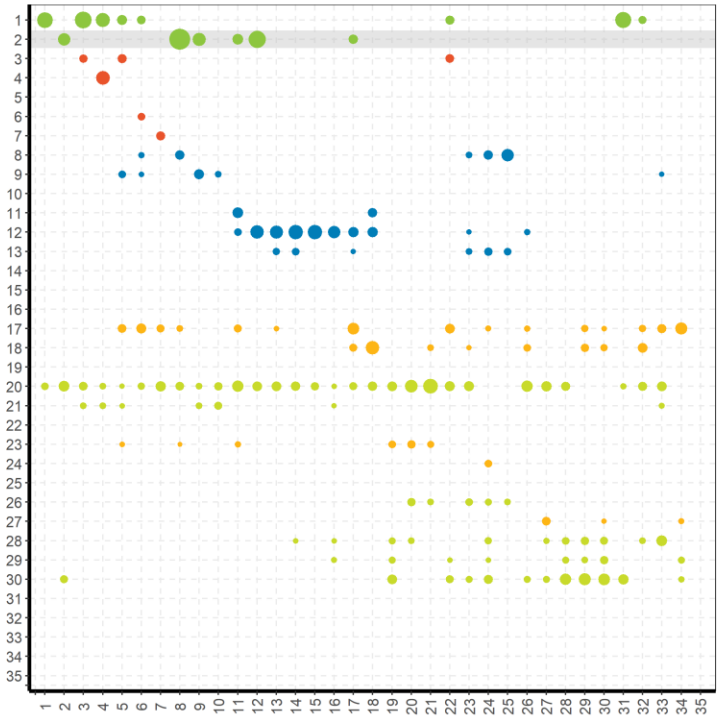
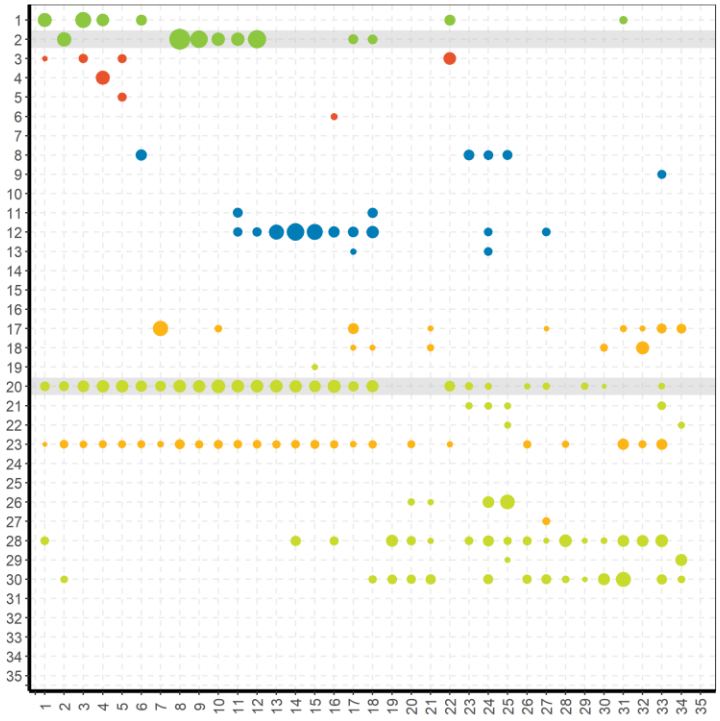
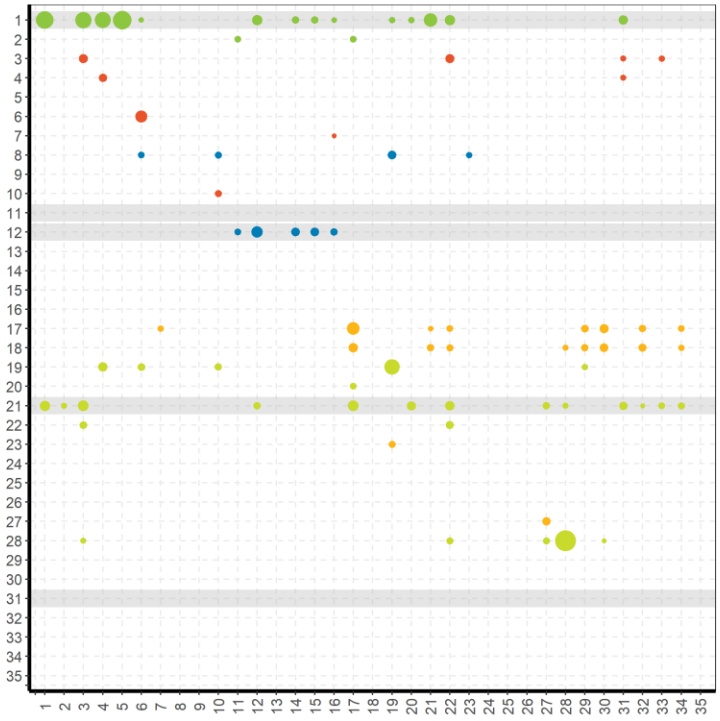


Kazakhstan, 2017

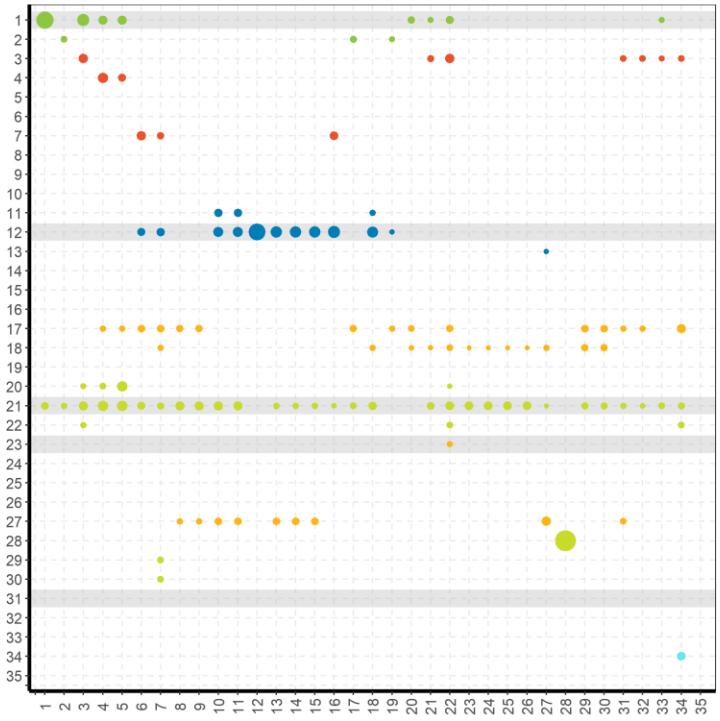


Kyrgyz Republic, 2000

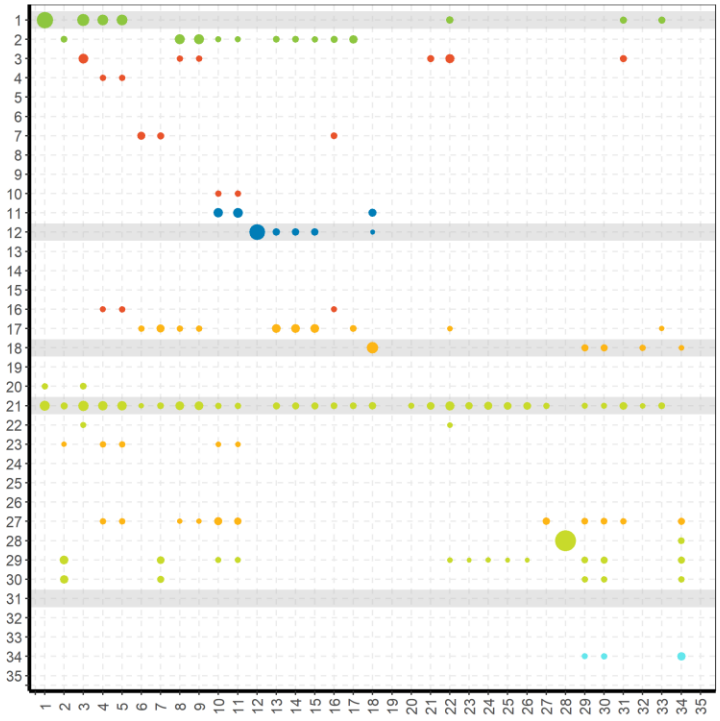
Kyrgyz Republic, 2007



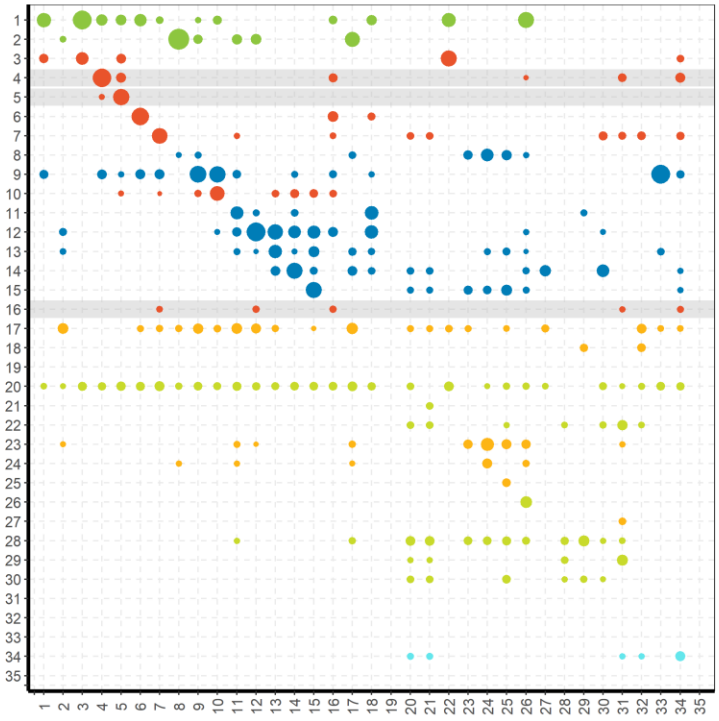
Kyrgyz Republic, 2011



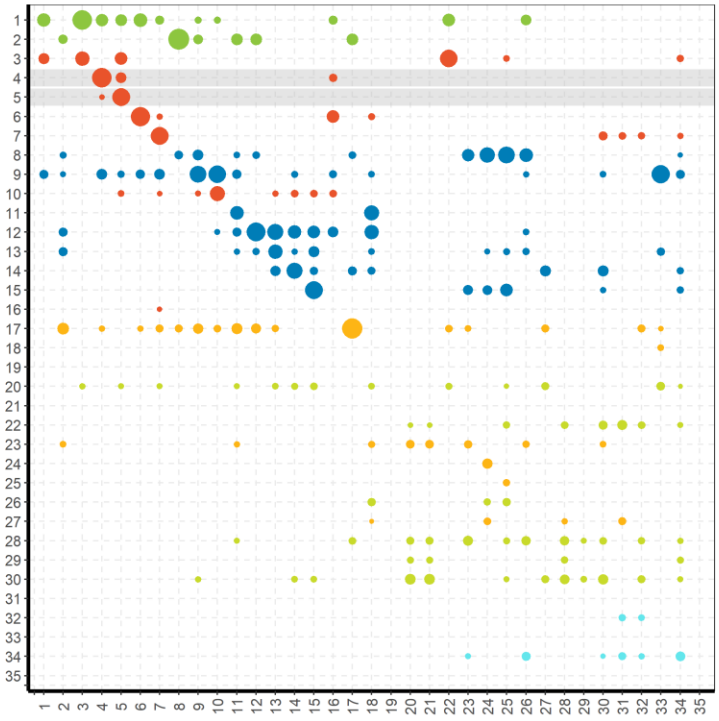
Kyrgyz Republic, 2017



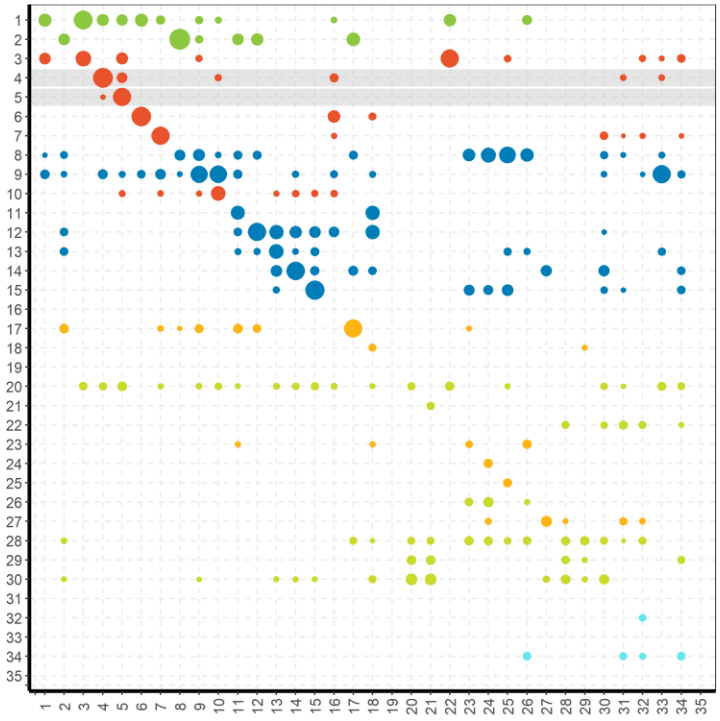
People's Republic of China, 2000



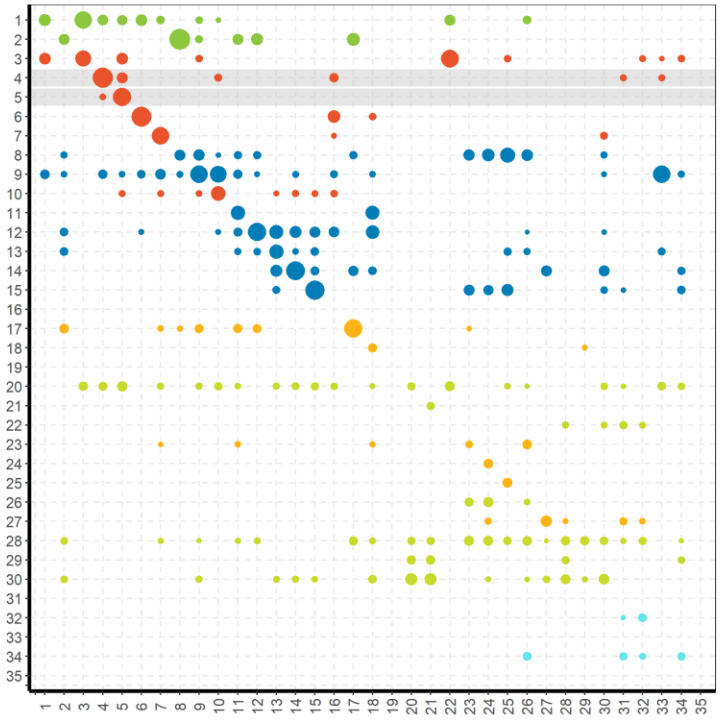
People's Republic of China, 2007



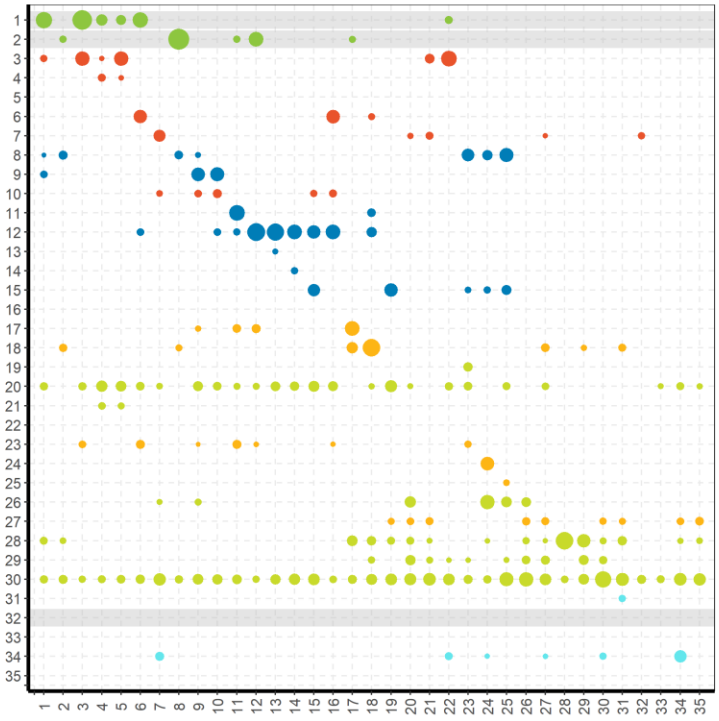
People's Republic of China, 2011



People's Republic of China, 2017



Australia, 2000



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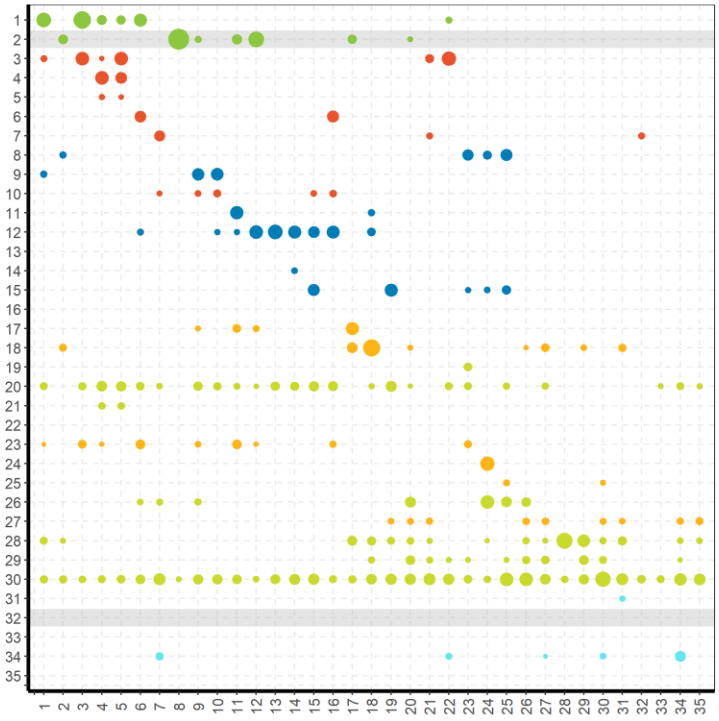

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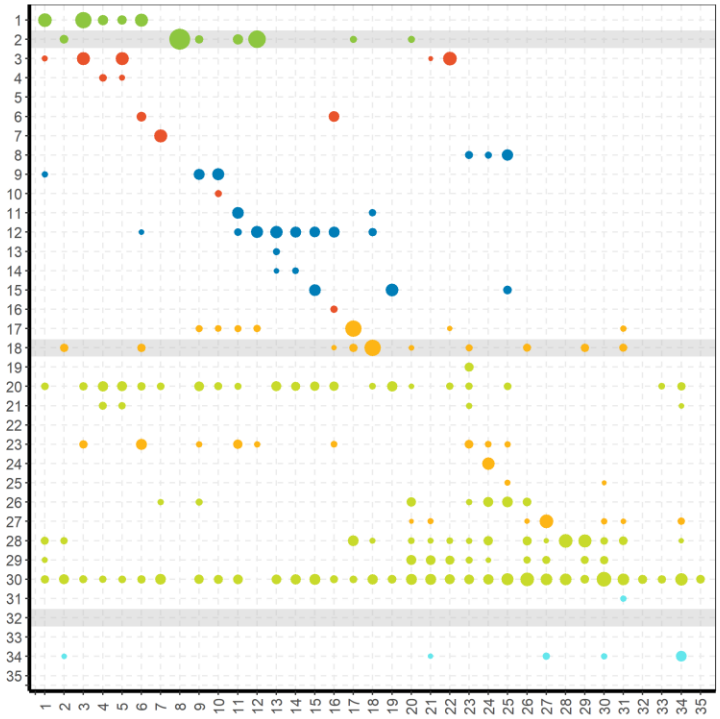

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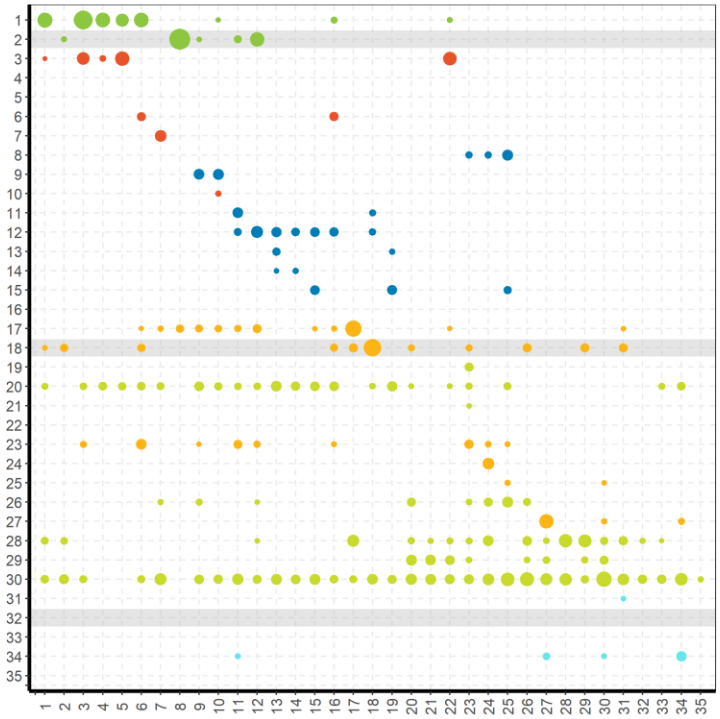

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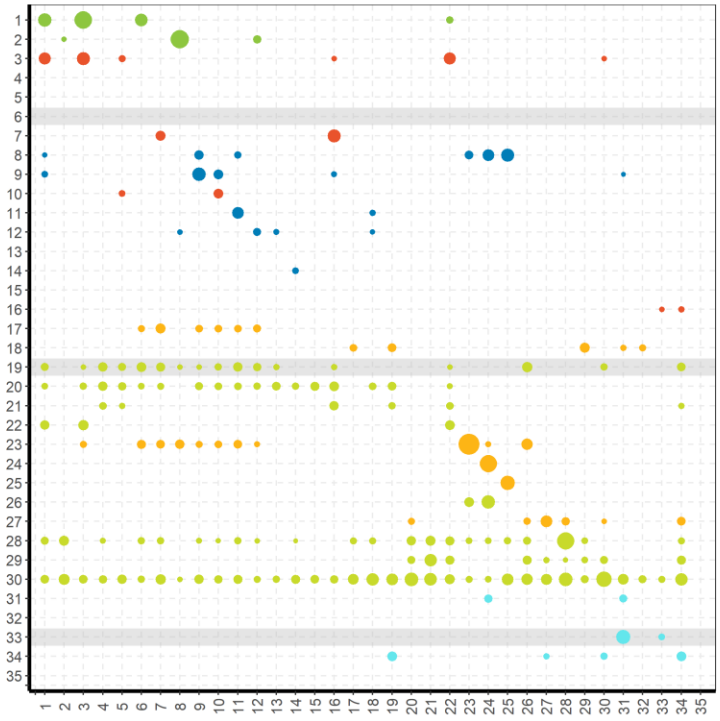
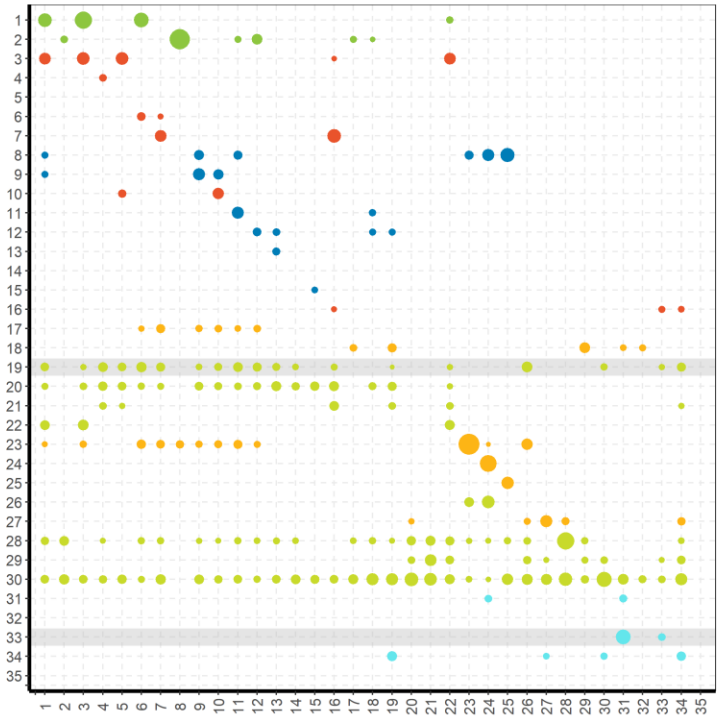
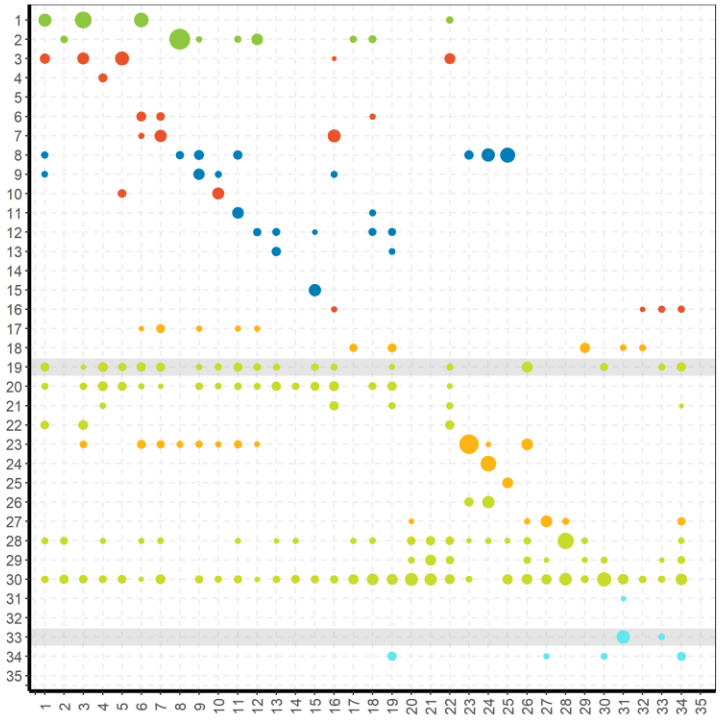


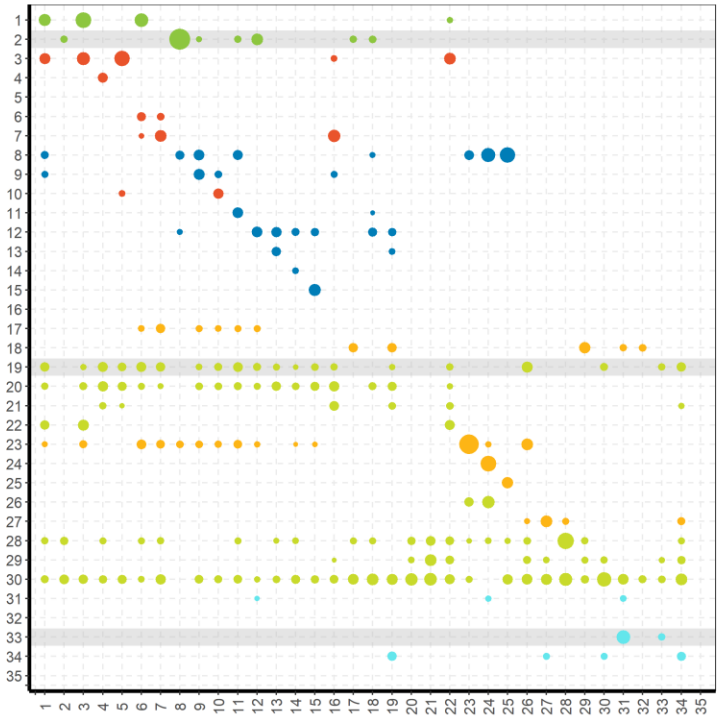
Canada, 2007



Canada, 2011



Canada, 2017



Appendix 2: Revealed Comparative Advantage

Revealed comparative advantage (RCA) measures the intensity of trade specialization of a country or an economy-sector in the world. RCA of a particular sector can be measured in a more traditional way by looking at how an exported product compares with other products using gross terms. It can also be measured by the actual value added created by a country and embodied in an export.

Traditional measures of revealed comparative advantage (TRCA) utilize gross exports data. In particular, a country is said to have a comparative advantage in a certain sector if the share of that sector to total country exports exceeds the its share to total world exports **(Balassa 1965).** Otherwise, it is said to have a comparative disadvantage in that sector. Policymakers use TRCA in identifying key sectors in the economy; in fact, it is taken to be a measure of export competitiveness (**Serin and Civan 2008**)

In view of recent empirical advances in global value chain analysis, the concept of 'revealed comparative advantage' can be revised to incorporate information on exports of domestic value added. **Wang, Wei and Zhu (2013)** proposed a new measure of revealed comparative advantage based on forward-linkage based domestic value added exports. This measure, called new revealed comparative advantage (NRCA), is analogous to Balassa's measure except that it is based on domestic value added. Extracting value added from gross exports and disaggregating these value added items can be used to measure an economy's RCA at the sector level based on value added terms that takes into account foreign outsourcing and domestic production sharing. Wang, Wei, and Zhu (2013) proposes a new measure of revealed comparative advantage (NRCA) that (i) excludes foreign value added and pure double counted terms in gross exports but (ii) includes indirect exports of an economy-sector's value added through other sectors of the exporting country. WWZ (2013) defines NRCA as the share of an economy-sector's forward linkage-based measure of domestic value added embedded in exports, *dvix_f*, in country's total domestic value added in exports relative to that sector's total forward linkage based domestic value added in exports from all countries as a share of global value added in exports. The NRCA is defined as:

$$NRCA_i^r = \frac{\frac{dvix\_f_i^{r*}}{\sum_{i=1}^{n} dvix\_f_i^{r*}}}{\frac{\sum_t^G dvix\_f_i^{t*}}{\sum_i^n \sum_t^G dvix\_f_i^{t*}}}$$

$$NRCA_i^r = \frac{\frac{vax\_f_i^r + rdv\_f_i^r}{\sum_{i=1}^{n}(vax_{f_i}^{\ r} + rdv_{f_i}^{\ r})}}{\frac{\sum_t^G(vax_{f_i}^{\ r} + rdv_{f_i}^{\ r})}{\sum_i^n \sum_t^G(vax\_f_i^r + rdv\_f_i^r)}}$$

The first term refers to the domestic value-added and indirect exports of the economy-sector over the total value-added and indirect exports of the country, thereby estimating the share of that economy-sector with respect to total domestic value-added in exports. The second term uses the

total domestic value-added and indirect exports of all countries in that sector over the global value-added exports.

Appendix 3. Servitization in Oil and Gas Services in Kazakhstan[10]

The oil and gas services sector provides a pointed example of the servitization of production of nonrenewable resources. Oil production and exploration are performed by multinational companies organized around joint ventures that contract the services of all sorts of experts, such as geologists and geophysicists, lessors of oil rigs, drilling services, welders, lawyers, pipeline companies, shippers, and distributors. These services are tightly linked to production and extraction but are typically provided at arm's length by oil field and exploration services companies (OFS).

Oil field services (OFS) companies have driven innovation in oil and gas, increasing in scale and scope and enabling extraction from fields at levels impossible to conceive before 2000. By 2011, the global revenue of OFS was estimated at $750 billion (The Economist 2012). In mid-2018, the market capitalization of the largest supplier, Schlumberger, stood at $95 billion and exceeded that of major international oil companies, such as ENI and Statoil. It carries out most of the tasks involved in finding and extracting oil. Most recent innovations in oil and gas production and distribution are the result of OFS work, and the rate of innovations in the sector is astounding. The 2006 oil price increases unleashed innovation, and horizontal drilling and shale oil and gas (three-dimensional seismology and directional drilling), as well as enhanced oil recovery techniques, flourished. This allowed accessible oil and gas reserves to flow much more easily, and also gave producers the ability to draw on capacity in shorter periods of time. More importantly, it gave the sector the ability to splinter the production process even further and refine the value chains. Another discovery has been the ability to transport natural gas more economically in liquefaction boats, such as small liquefied natural gas carriers and bunker vessels.

One way Kazakhstan has been able to increase capabilities in this sector is through a concerted effort to establish local-content regulations, providing a chance for local engineers and oil services firms to get involved. On average, between 1994 and 2014 oil and gas production accounted for only 0.5% of total employment in Kazakhstan. However, the indirect impact on total employment through forward linkages was considerable, as the spending of oil rents supported the growth of labor-intensive services. The share of service jobs in total employment grew from 38% in 2001 to 48% in 2014 The direct and indirect inputs by services in Kazakhstan suggest considerable servicification.

Between 2005 and 2015, the oil and gas sector purchased over 50% of all its intermediate inputs from the services sector, growing from 55% in 2005 to 74% in 2015 (Table 2). This likely underestimates the importance of know-how and skills that went with it: R&D services were crucial in developing the Kashagan field in the northern Caspian Sea, one of the largest in the world with an estimated 13 billion recoverable barrels of oil. It was discovered in 2000, but the geological and technological challenges led to $50 billion being spent on R&D over 17 years; of this amount. almost one-quarter went to local service firms, as joint ventures and consortiums between local and foreign OFS companies were promoted as vehicles for transferring technologies and skills.

[10] This box is based on a larger discussion in Mercer-Blackman and Ablaza (2019).

Despite the huge inputs of services, the national accounts show large increases in oil and gas production, but only slight services output increases by domestic services firms.

Table A3: Share of Services in Intermediate Inputs Purchased by the Oil and Gas Sector

Service	2005	2010	2015
Repairs	1.08	0.48	3.28
Auxiliary mining services	17.17	13.99	20.67
Construction	1.61	0.48	1.68
Professional services	7.8	3.5	11.16
Oil field services	27.7	18.5	36.8
Total services (%)	**55.36**	**36.95**	**73.59**

Source: Atakhanova (2018) using the Kazakhstan National Committee on Statistics.