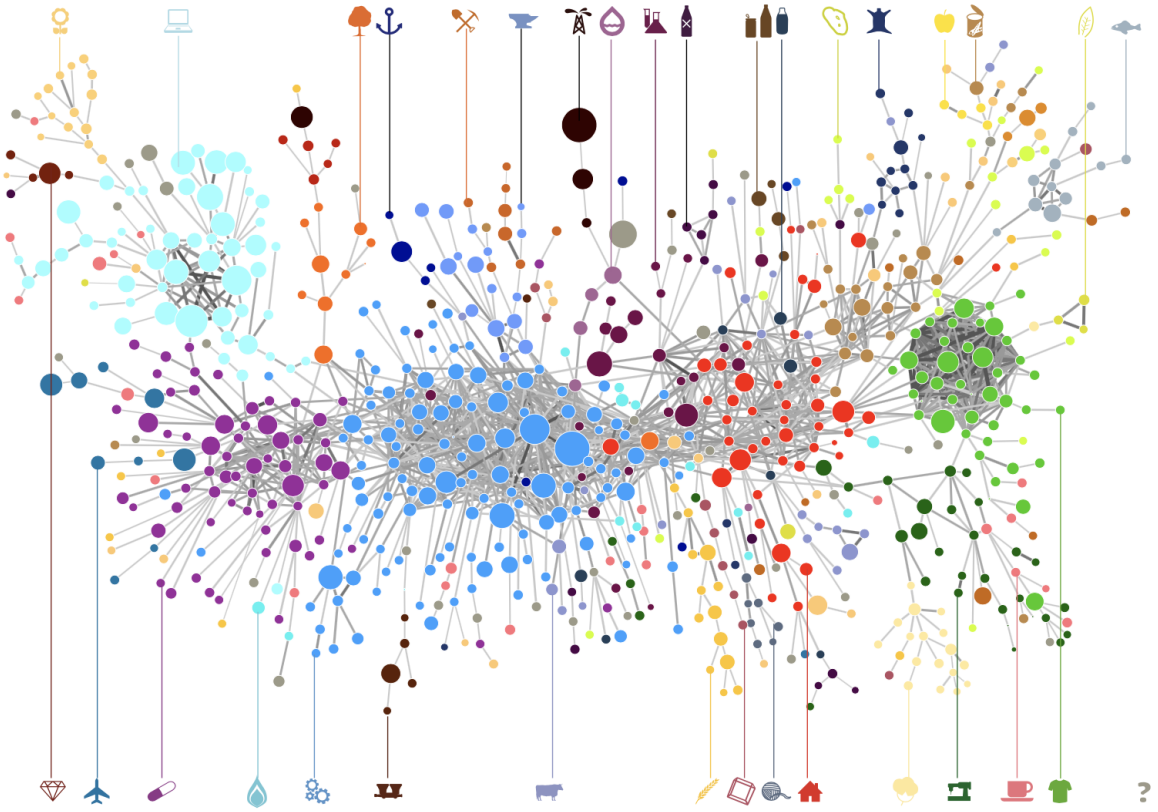

https://atlas.cid.harvard.edu/

Optimal Industry Development Strategy Using Economic and Product Complexity

Russia

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The Economic Complexity Lab - Columbia University

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Optimal Industry Development Strategy for Russia

0. Executive Summary

In this report, we aim to uncover the economic path Russia went through during the period from 2013 to 2021. Specifically, we dive into the topic through a macroeconomic overview of Russia from the perspective of Gross Domestic Product (GDP) and Economic Complexity Index (ECI), which reflect countries' production capability and production structure, respectively. We find that during the period of our interest, Russia demonstrated a low level of economic growth with an average annual GDP growth rate of 1.31% between 2013 and 2018 and 2.41% between 2019 and 2021, with a similar or increased economic complexity compared to other major developed economies.

The mixed progress during the period, we believe, can be partially explained through the analysis of the economic and product complexity structure of Russia on the industry group level, as well as the improved macro and microeconomic strategies. The product classification system we adopt allows us to measure the realized industry development for various industry groups and to observe that Russia regressed in developing most of its industries during the period while its developed counterparts and emerging economies around the globe also adopted complex and progressive paths with variable degrees of success.

Based on our analysis of the opportunity gain and sensitivity analysis of major industry groups, Russia could further its gains by prioritizing Raw Manufacturing, Weapons, and Chemical Manufacturing in 2018. Three years later, its focus should shift to the Energy Drilling and Precious Stones industries, which are also one of the more developed industries at the time. We further note that Russia has a heavily mismatched development strategy that indicates a low level (compared to other developed countries) of structural optimality on the complexity level, having an adjusted R-square of around -0.37 in 2018 and a much higher score of 0.21 in 2021, demonstrating shift and improvement in development. Since a significant positive correlation exists between five-year GDP growth between 2013 and 2018 and the structural optimality index of an economy as we define and calculate, Russia indeed has a suboptimal growth experience as compared with fast-growing economies both on a regional scale and on a global scale and has the potential to further its economic gains through industrial structure optimization as suggested in the paper.

The three years following showed a significant improvement in Russia's economic growth, boosting its position on the global scale. Its GDP recovered to above the pre-pandemic levels, and it saw a significant boost in the ECI, particularly compared to its peer countries. Its current strategy still has the viable potential upside to increase its performance and optimize its structure further.

1. Report Overview

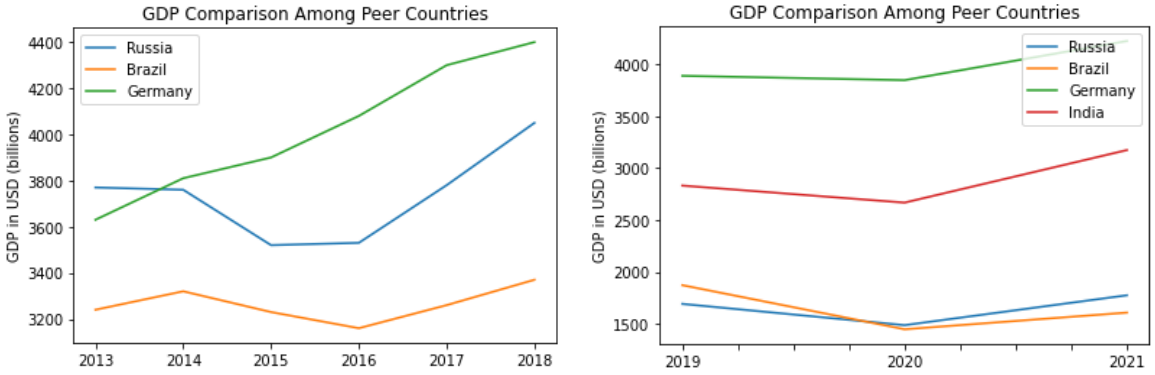
In this report, we aim to uncover the economic path Russia went through during the period from 2019 to 2021, before and after the COVID pandemic, compared to its performance from 2013 to 2018, before and after the annexation of Crimea. Specifically, we dive into the topic through a macroeconomic overview of Russia from the perspective of Gross Domestic Product (GDP) and Economic Complexity Index (ECI), which reflect countries' production capability and production structure, respectively. We then analyze the industrial framework and changes of Russia during the period based on quantitative measures such as the Product Complexity Index (PCI) and Product Family Complexity Index (PfCI), followed by a detailed analysis of how such changes have matched with development strategies as quantitatively measured by opportunity gains on an industry-level. We conclude our report with macro-level results and predictions of Russia, as deduced from regression models we have established on a global scale, which take into account countries' stances in their product space.

2. Macroeconomic Results

2.1 GDP Ranking and Changes

Figure 1a illustrates the time-series GDP results for Russia and two of its peer countries (Brazil and Germany) from 2013 to 2018. Similar to the other countries, Russia displayed an eventual upward trend over the period; however, its growth was less consistent than both Russia's and Germany's growth. Russia's average annual GDP growth rate (1.31%) is in the middle of the pack, as it is greater than Brazil's rate (0.69%) but less than Germany's rate (3.28%).

Figure 1b shows the GDP levels for Russia and its peer countries (Brazil, Germany, and India from 2019 to 2021. Similar to the other countries, Russia displayed a drop in GDP from 2019 to 2020 because of the pandemic, with all GDPs rebounding in 2021. Over these three years, Russia's average annual GDP growth rate (2.41%) is in the middle of the pack, as it is greater than Brazil's rate (-3.87%) but less than Germany's (2.91%) and India's rates (4.39%). It is notable that the GDP levels in Russia and Brazil almost evened out after 2018.



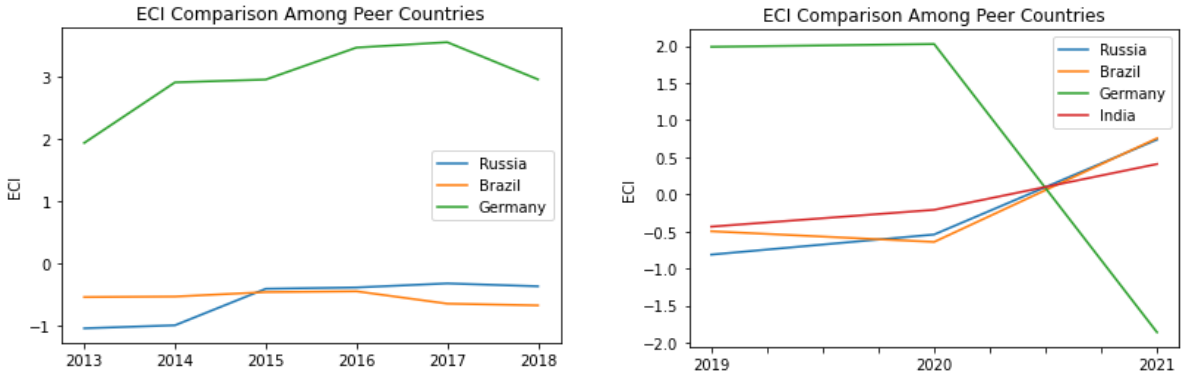
Figures 1a and 1b. GDP Comparison Among Peer Countries (left: 2013-2018; right: 2019-2021)

2.2 ECI Ranking and Changes

The Economic Complexity Index (ECI), as defined by Ricardo Hausmann and Cesar Hidalgo in 2009 to explain the knowledge accumulated in a country's population, is illustrated in Figures 2a and 2b.

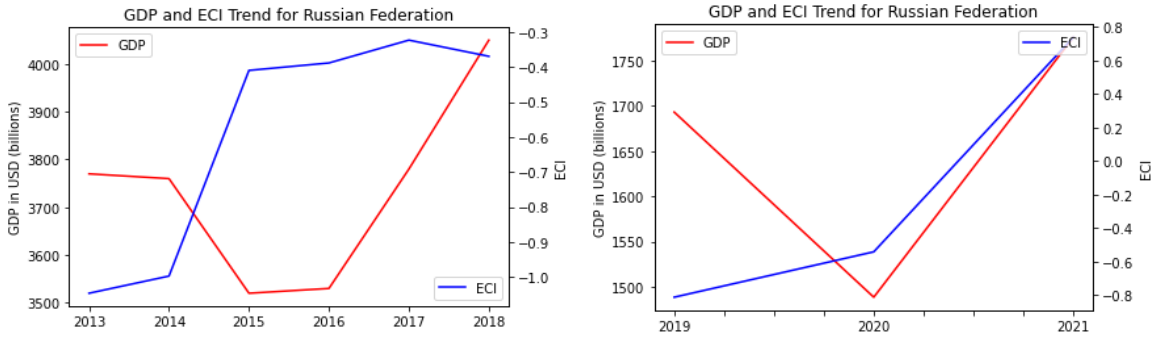
As shown, Russia exhibits a small increase in production capability from 2013 to 2018. Russia is in a strong position in ECI terms, as its ECI change of 64.66% is greater than both Brazil (-24.62%) and Germany (52.80%).

The comparable countries maintain a small change in ECI level between 2019 and 2020, with a sharp change between 2020 and 2021. Russia exhibits a large increase in production capability in 2021 to levels not seen prior, with extensive microeconomic stimulus packages being one of the reasons. Russia has seen a 191% increase in its ECI, which is greater than Brazil's (252%), India's (193%), and Germany's (-194%).



Figures 2a and 2b. ECI Comparison Among Peer Countries (left: 2013-2018; right: 2019-2021)

Figures 3a and 3b offer a further comparison of GDP Growth and ECI over the time span from 2013 to 2021 for Russia. Similar to the GDP drop and further increase from 2013 to 2018, the GDP growth during the period from 2019 to 2021 is accompanied by a similarly volatile increase in ECI. The results show that the economic growth experienced by Russia during the period from 2013 to 2018 is only partially consistent with the predictions by ECI and that Russia made strong progress towards effectively developing a competitive product space that helps to accumulate complicated knowledge and technology. For the period 2019 to 2021, the ECI followed GDP trends, which can be interpreted as advancements in production. In order to provide a more concrete answer to why this has happened, we will dive into an analysis of Russia's production structure and its product space designs in the next few sections.



Figures 3a and 3b. GDP Growth and ECI for Russia (left: 2013-2018; right: 2019-2021)

3. Production Analysis

3.1 Product Categorization

Our main data source in this research is the UN Comtrade Website (https://comtrade.un.org), which provides us with valuable information on countries' export values on an annual basis, including highly specific export data for more than 5000 categories of products. In order to have a holistic vision of the product space of a country, however, a level of categorization is required. Products in our data source are labeled from 010000-999999, with the first two digits representing a general category to which the product belongs. Based on the 99 categories extracted from the label, we further group the products into the 18 most widely-accepted industries, as summarized in Table 1.

Note that the High-complexity Products industry group is not a distinct industry but rather an aggregated industry that encompasses the most complicated products from the most technologically-advanced industries (as measured by PCI). This industry serves as an indicator for us to quantitatively evaluate how well a country has performed in developing cutting-edge technologies and closing its technological gap with advanced economies, which has become a topic of wide concern today. Indeed, when we rank the 18 categories based on PfCI (an equivalent concept of PCI as calculated based on the 18 categorized product groups), the High-complexity Products industry has the highest PfCI among all industry groups.

Category	Description
Animals and By-products	All kinds of meat, livestock and related by-products
Vegetables, Fruits and Plants	All kinds of plants, edible vegetables and fruits
Food and Preparations	Edible preparations, raw cooking materials and appliances
Clothing and Accessories	All kinds of fabrics, filament, clothing and accessories
Textiles	All kinds of textile articles and related products
Wood Products	Book, paper and other elementary products related to wood
Metals	Mining of all sorts of raw Metals
Refined and Processed Stones	Refined or processed stone products such as pearl and ceramics
Energy Drilling and Mining	Mining industry for energy, minerals, stone materials, etc.
Daily Instruments	Basic daily instruments such as sport requisites, timing and measuring tools
Raw Manufacturing	Basic products made from plastic, rubber, leather, etc.
Chemical Manufacturing	Advanced chemical products and pharmaceutical products
Chemicals	Raw chemical materials and by-products
Machinery and Construction	Machinery and mechanical appliances, including electrical equipment
Transportation	Vehicles and locomotives including aircraft, ship, railway, etc.
Weapons	Explosives, arms and ammunition
Services and Utilities	Financial, business, legal, communication, travel Services and Utilities, etc.
High-complexity Products	Agglomeration of advanced products with highest PCIs

Table 1. Categorization of Products

We further observe a positive correlation between the GDP and the export of High-complexity Products. A higher adjusted R-square exists between GDP and High-complexity Products exports, indicating that more successful economics, as measured by GDP, tend to be those that are capable of producing and exporting High-complexity Products as we define them. Tables 2a and 2b show the OLS results in a universe of 107 and 21 typical countries respectively.

	High-complexity Products	Food and Preparations	Animals and By-products
Adj. R-squared	0.075	0.006	0.002
F-statistic	9.556	1.638	1.175
No. Observations	107	107	107

Table 2a. OLS Regression Results of GDP against Percentage Volume of Exports

	High-complexity Products	Food and Preparations	Animals and By-products
Adj. R-squared	0.149	0.003	-0.012
F-statistic	4.510	1.059	0.7542
No. Observations	21	21	21

Table 2b. OLS Regression Results of GDP against Volume of Percentage Exports

3.2 Realized Industry Development

Based on the aforementioned product categorization, we aim to capture Russia's realized industry production strategy between 2013 and 2021 on a complexity level. In Hausmann and Hidalgo (2009), distance is defined to be a measure of how far a country is from a certain product, not in its product space. We extend this concept to all product groups and quantify how technically equipped a country is to develop the corresponding product groups. In other words, the shorter the distance between a country and a product group, the more capable a country is of developing products within that group. Defining this net distance change as the Realized Industry Development (RID), our export data allow us to calculate and compare the RID of Russia and the 18 product groups in 2021 and 2018 through the difference, where a positive RID indicates a shortening of the distance (i.e., advancement of the industry), and a negative RID indicates the reverse. It is notable that the number of industries with positive RID has increased from 0 to 5 from 2018 to 2021.

Category	RID (2021)	RID (2018)
Daily Instruments	-0.0676	-0.1450
Chemicals	-0.0619	-0.1473
Weapons	-0.0342	-0.1401
Wood Products	-0.0330	-0.1487
Transportation	-0.0313	-0.0780
Machinery and Construction	-0.0291	-0.1615
Metals	-0.0289	-0.1563
Raw Manufacturing	-0.0257	-0.1652
Services and Utilities	-0.0238	-0.1356
Clothing and Accessories	-0.0211	-0.1684
Chemical Manufacturing	-0.0201	-0.1757
Food and Preparations	-0.0133	-0.0297
Textile	-0.0103	-0.1364
High-complexity Products	0.0002	-0.0974
Vegetables, Fruits and Plants	0.0026	-0.1972
Animals and By-products	0.0040	-0.1819
Energy Drilling and Mining	0.0098	-0.1609
Precious Stones	0.0307	-0.1979

Table 3. Realized Industry Development (RID) of Russia

3.3 Regional and Global Comparison

Tables 4a-4b below summarize how the production strategy adopted by Russia compares with selected leading economies in the world across different years, as measured in RID. Leading economies such as France, the United States and Germany gave a considerable level of attention to more advanced product groups such as Weapons and High-Complexity Products in 2018 and Services and Utiliteis, Precious Stones, and High-Complexity Products in 2021.

Ranking	France	the UK	Germany
1	High-complexity Products	Services and Utilities	High-complexity Products
2	Chemical Manufacturing	Weapons	Transportation
3	Daily Instruments	Raw Manufacturing	Wood Products
4	Animals and By-products	Precious Stones	Metals
5	Food and Preparations	Animals and By-products	Food and Preparations

Table 4a. RID Comparison across Leading Economies (2018)

Ranking	France	the UK	Germany
1	Services and Utilities	Precious Stones	Daily Instruments
2	Precious Stones	High-complexity Products	Transportation
3	High-complexity Products	Services and Utilities	Chemicals
4	Energy Drilling and Mining	Energy Drilling and Mining	Chemical Manufacturing
5	Machinery and Construction	Wood Products	Clothing and Accessories

Table 4b. RID Comparison across Leading Economies (2021)

Tables 4c-4d further examine Russia's development strategy against those of emerging economies on a global scale. Reasonably, emerging economies such as China, South Korea, and Singapore, have devoted the majority of their efforts to intermediate industry groups, showing drastic shifts in strategies over the course of three years.

Ranking	China	South Korea	Singapore
1	High-complexity Products	Transportation	Transportation
2	Transportation	Textile	High-complexity Products
3	Machinery and Construction	High-complexity Products	Precious Stones
4	Energy Drilling and Mining	Chemical Manufacturing	Daily Instruments
5	Daily Instruments	Machinery and Construction	Services and Utilities

Table 4c. RID Comparison across Emerging Economies (2018)

Ranking	China	South Korea	Singapore
1	Chemicals	Chemicals	Weapons
2	Daily Instruments	Daily Instruments	Energy Drilling and Mining
3	Transportation	Transportation	Transportation
4	Raw Manufacturing	Textile	Machinery and Construction
5	Weapons	Raw Manufacturing	High-complexity Products

Table 4d. RID Comparison across Emerging Economies (2021)

4. Product Space Design

4.1 Suggested Development Vector

As outlined above, distance gives us an idea of how far each new product is from a country's current mix of exports. As defined in Hausmann and Hidalgo (2009), distance is "the weighted proportion of products connected to goods p that country c is not exporting, i.e., MCP=0." Based on this definition, the distance between a country and any product that the country is currently exporting (i.e., the country is a significant exporter of the product as compared to the global average) is zero. Similarly, opportunity gain quantifies the contribution of a new product in terms of opening up the doors to more and more complex products. Intuitively, a product that a country is currently exporting (i.e., MCP=1) has an opportunity gain of zero. An unreasonable investment in a certain product p would lead to a relative decrement in the export of more profitable products and therefore lead to a negative opportunity gain of product p. The opportunity gain is not the only estimator of a country's level of economic development. However, among countries with comparable economic strength, those having higher ECI, or in other words, more reasonable economic structures are often in better shape.

Ranking	Russia	India	Greece
1	High-complexity Products	Weapons	Precious Stones
2	Machinery and Construction	Raw Manufacturing	Weapons
3	Transportation	Machinery and Construction	Clothing and Accessories
4	Services and Utilities	Services and Utilities	Machinery and Construction
5	Daily Instruments	Daily Instruments	Services and Utilities
6	Chemicals	High-complexity Products	High-complexity Products
7	Chemical Manufacturing	Transportation	Daily Instruments
8	Weapons	Animals and By-products	Transportation
9	Textile	Vegetables, Fruits and Plants	Chemicals
10	Raw Manufacturing	Food and Preparations	Animals and By-products
11	Energy Drilling and Mining	Energy Drilling and Mining	Vegetables, Fruits and Plants
12	Metals	Chemicals	Food and Preparations
13	Wood Products	Chemical Manufacturing	Energy Drilling and Mining
14	Animals and By-products	Wood Products	Chemical Manufacturing
15	Clothing and Accessories	Clothing and Accessories	Raw Manufacturing
16	Food and Preparations	Textile	Wood Products
17	Precious Stones	Metals	Textile
18	Vegetables, Fruits and Plants	Precious Stones	Metals
ECI	-1.046296933	-0.358933609	-0.232930358

Table 5a. Opportunity Gain Ranking on a Comparable Scale (2013)

Ranking	Russia	India	Greece
1	High-complexity Products	Weapons	Precious Stones
2	Transportation	Raw Manufacturing	Clothing and Accessories
3	Machinery and Construction	High-complexity Products	High-complexity Products
4	Daily Instruments	Transportation	Transportation
5	Weapons	Machinery and Construction	Machinery and Construction
6	Chemicals	Services and Utilities	Weapons
7	Chemical Manufacturing	Daily Instruments	Chemicals
8	Textile	Animals and By-products	Services and Utilities
9	Raw Manufacturing	Vegetables, Fruits and Plants	Daily Instruments
10	Animals and By-products	Food and Preparations	Animals and By-products
11	Precious Stones	Energy Drilling and Mining	Vegetables, Fruits and Plants
12	Food and Preparations	Chemicals	Food and Preparations
13	Energy Drilling and Mining	Chemical Manufacturing	Energy Drilling and Mining
14	Metals	Wood Products	Chemical Manufacturing
15	Services and Utilities	Clothing and Accessories	Raw Manufacturing
16	Clothing and Accessories	Textile	Wood Products
17	Vegetables, Fruits and Plants	Metals	Textile
18	Wood Products	Precious Stones	Metals
ECI	-0.369731143	-0.503771207	-0.425579783

Table 5b. Opportunity Gain Ranking on a Comparable Scale (2018)

Rank	Russia	India	Greece
1	Precious Stones	Energy Drilling and Mining	Wood Products
2	Energy Drilling and Mining	Services and Utilities	Energy Drilling and Mining
3	Animals and By-products	Wood Products	Clothing and Accessories
4	Vegetables, Fruits and Plants	Metals	Services and Utilities
5	High-complexity Products	Daily Instruments	High-complexity Products
6	Textile	Precious Stones	Vegetables, Fruits and Plants
7	Food and Preparations	High-complexity Products	Food and Preparations
8	Chemical Manufacturing	Raw Manufacturing	Textile
9	Clothing and Accessories	Vegetables, Fruits and Plants	Precious Stones
10	Services and Utilities	Textile	Weapons
11	Raw Manufacturing	Animals and By-products	Animals and By-products
12	Metals	Food and Preparations	Metals
13	Machinery and Construction	Clothing and Accessories	Raw Manufacturing
14	Transportation	Machinery and Construction	Chemicals
15	Wood Products	Transportation	Machinery and Construction
16	Weapons	Chemical Manufacturing	Daily Instruments
17	Chemicals	Chemicals	Transportation
18	Daily Instruments	Weapons	Chemical Manufacturing
ECI	**0.7368**	**0.4076**	**0.2304**

Table 5c. Opportunity Gain Ranking on a Comparable Scale (2021)

We define the ranking of opportunity gain for a country *c*, as the Suggested Development Vector (SDV) of *c*. Tables 5a-5c summarize how the SDV of Russia compares with a selected group of comparable and leading economies in the world, with the industry groups ranked in decreasing order of significance. We focus on SDV results for 2018 because they give the most accurate snapshot of complexity for global comparison in the absence of the irregular effects of the COVID-19 pandemic observed in 2021.

Dark blue indicates positive opportunity gains, light blue indicates zero opportunity gains, and white indicates negative opportunity gains. The result shows that leading countries barely have any industries with positive opportunity gain. In other words, those countries are already in the most stable and efficient economic structure. Without the necessity of economic transition, those countries merely need to maintain a steady and balanced economic development. In contrast, developing countries have nearly half of industries with positive opportunity gain and share common interests in industrial manufacturing and High-complexity Products industries. It can be concluded that Russia shares the characteristics of developing countries, with a balanced economic structure that leans towards intermediate-level industries.

Ranking	Thailand	Italy	Spain	United Arab Emirates
1	Animals and By-products	Energy Drilling and Mining	Energy Drilling and Mining	High-complexity Products
2	Food and Preparations	Precious Stones	Precious Stones	Transportation
3	Chemicals	Vegetables, Fruits and Plants	Weapons	Machinery and Construction
4	Raw Manufacturing	Animals and By-products	Textile	Daily Instruments
5	Textile	Food and Preparations	Chemicals	Chemicals
6	Machinery and Construction	Chemical Manufacturing	Daily Instruments	Weapons
7	Transportation	Raw Manufacturing	Animals and By-products	Textile
8	High-complexity Products	Wood Products	Vegetables, Fruits and Plants	Chemical Manufacturing
9	Energy Drilling and Mining	Clothing and Accessories	Food and Preparations	Raw Manufacturing
10	Vegetables, Fruits and Plants	Textile	Chemical Manufacturing	Energy Drilling and Mining
11	Precious Stones	Metals	Raw Manufacturing	Precious Stones
12	Weapons	Machinery and Construction	Wood Products	Services and Utilities
13	Clothing and Accessories	Daily Instruments	Clothing and Accessories	Metals
14	Services and Utilities	High-complexity Products	Metals	Clothing and Accessories
15	Wood Products	Weapons	Transportation	Wood Products
16	Metals	Chemicals	Services and Utilities	Animals and By-products
17	Chemical Manufacturing	Services and Utilities	Machinery and Construction	Vegetables, Fruits and Plants
18	Daily Instruments	Transportation	High-complexity Products	Food and Preparations
ECI	1.68914409	1.179705915	0.45830144	-0.734459148

Table 6. SDV of Other Sample Countries (2019)

4.2 Budgeted Industry Development Strategy and Interpretation

The optimal budgeted industry development strategy aims to solve the most efficient allocations under the budgeted constraint of different situations of heuristic total export growth. In order to obtain such an allocation portfolio, we formulate an optimization problem as the following:

$$\max_{x \in \mathbf{R}^{|P|}} \quad \left(\frac{k(x) - < k(x) >}{stdev(k(x))}\right)_C$$

Subject to

$$\sum_{p \in P} x_p \leq B$$

$$x \succcurlyeq 0$$

where k(x) is the second largest eigenvector of $M_{CC'}$ after adding x to the original export vector, C is the country that we are interested in, P is the product space, B is the heuristic budget.

If we can solve this problem, then we can know what the largest ECI to which a country can improve. Accordingly, the optimal solution x * that we obtain here is exactly our optimal

allocation. However, the biggest problem is that the objective function is not convex. Therefore, we cannot apply the classical tools for convex optimization to this problem. In order to solve this problem, our idea is to use a greedy algorithm. The way that we apply the greedy algorithm is that firstly we separate the total budget into k equal parts, and then for the first equal part we try to search for the product that can optimize our objective function by iterating through each $p \in P$. After we find the optimal product p for this equal part, we add the amount back to the export value of this product p and update the ECI for this country. If we observe that ECI does not change after iterating all the products, then we can add up one more equal part to invest. Until we find there is an ECI increment, we add the amount now to that product. The equal rest parts can be done in the same way.

By definition, a greedy algorithm is a kind of local search algorithm that is possible to run into a local minimum. Therefore, for local search algorithms, one typical way to keep it away from the local minimum is to enhance the vision of the algorithm by looking more steps forward. In our setting, whenever we obtain an increment of ECI, we mark down the required amount of export growth. Simultaneously, we continue searching for the next ECI increment point, compare the ratios of these two possibilities and pick the largest one. The ratio is defined as the following:

$$Ratio(p) = \frac{ECI_p - ECI_0}{||x_p - x_0||_1}$$

where ECI_p is just the ECI of the country after adding some amount of export increment to product p, which is exactly the amount that is able to make ECI change. Also, we can express it in the way of $||x_p - x_0||_1$.

In this way, we can obtain a further sighted greedy algorithm. Also, the number of parts that we would like to separate the budget into also matters. In order to solve this problem, we added a stabilizer on top of the enhanced greedy algorithm by running the algorithm for different numbers of parts and selecting the portfolio with the largest ECI increment and most complex economic structure.

Besides, it is quite common that there is a surplus in the budget. To deal with the surplus, we just add it to the product which needs the least amount of dollars to make $M_{cp} = 1$ (i.e., the smallest amount of required export increase).

Economic Panel:

As stated above, the enhanced greedy algorithm is developed mainly for solving the optimal allocation strategy. In order to visualize this allocation, an economic panel is created, consisting of a pie chart, a line chart and a table. First, a pie chart is used to show the percentage of each product in the optimal portfolio. The number located in the center of the circle denotes the heuristic growth of total export, which is also our budget. Each category in the chart has a determined percentage of the allocated budget. The lines below the pie charts show how the ECI changes during the searching process of the greedy algorithm. Even though sometimes an increase of the export by 15% or 20% does not seem reasonable to

developed countries, yet it can also give a sense of how a country should develop in the long term. Eventually, the graph in the end is just for numerical explanation for the pie charts.

Interpretation:

For the purpose of a clear explanation of the line charts, we label all the products in Table 7. Please refer to this table when trying to understand the investment trajectories in the line charts.

Label	Product Names
1	Animal and By-products
2	Vegetables, Fruits and Plants
3	Food and Preparations
4	Energy Drilling and Mining
5	Chemicals
6	Chemical Manufacturing
7	Raw Manufacturing
8	Wood Products
9	Clothing and Accessories
10	Textile
11	Metals
12	Machinery and Construction
13	Transportation
14	Weapons
15	Daily Instruments
16	Precious Stones
17	High-complexity Products
18	Services and Utilities

Table 7. Products Labeling

Figures 4a-4c show an economic panel for Russia in 2013, 2018, and 2021. We can see that for different percentages of heuristic total export growth, the ECIs of Russia actually have different increments. Overall, 5 percent export growth results in an ECI improvement pattern starting from around -1.05 and ending at around 0.28. As the budget is increased to 10 percent export growth, the ECI of Russia can achieve a slightly higher level, which is around 0.84. With a much more growth budget, including 15 and 20 percent growth, Russia is able to achieve an even much higher stage, which is around 0.85.

For 2013, in the case of 5 percent export growth, raw manufacturing is one of the main components. With a budget of 10 percent export growth, machinery and construction account for most of the portfolio. As the budgets are increased to 15 and 20 percent export growth, not only do they follow similar ECI improvement trajectories but also they share a pretty close investment portfolio, which is mainly made up of Machinery and Construction, Chemical Manufacturing, Chemicals, etc. In these four ECI improvement trajectories, we also notice that the largest improvement comes from Services and Utilities, suggesting that with a low economic improvement anticipation, Russia should focus more on developing the industry of Services and Utilities. A more detailed numerical representation of the portfolio is shown in Table 8a.

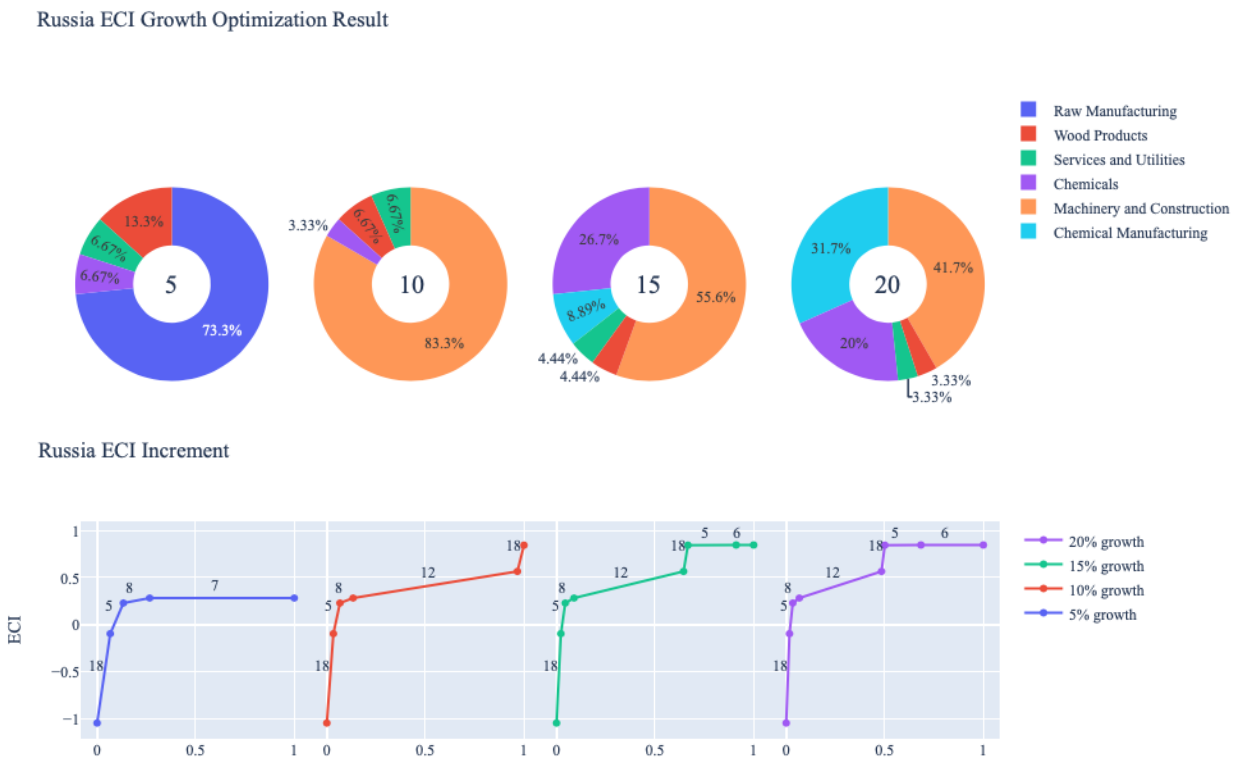


Figure 4a. Greedy-Based ECI Improvement Results of Russia with Different Budgets (2013)

Russia (2013)				
Original ECI			**-1.05**	
Heuristic Export Growth	**5%**	**10%**	**15%**	**20%**
Chemicals	1.87E+09	1.93E+09	2.24E+10	2.24E+10
Chemical Manufacturing	0.00E+00	0.00E+00	7.46E+09	3.54E+10
Raw Manufacturing	2.05E+10	0.00E+00	0.00E+00	0.00E+00
Wood Products	3.73E+09	3.85E+09	3.73E+09	3.73E+09
Machinery and Construction	0.00E+00	4.82E+10	4.66E+10	4.66E+10
Services and Utilities	1.87E+09	3.85E+09	3.73E+09	3.73E+09
Increased ECI	**0.28**	**0.84**	**0.85**	**0.85**

Table 8a. Portfolio of Russia (2013)

For further suggestions on Russia's development in the future, we also offer the optimization result based on its export data in 2018. Below is the economic panel for Russia in 2018. We can see that there are two patterns for the ECI improvement trajectories in four cases: the improvements in 5 and 10 percent export growth share one pattern, and the improvements in 15 and 20 share another one. For 5 and 10 percent growth, even though the ECI improvement trajectories are not so different, the main components in the portfolio are quite distinguishable. In detail, for 5 percent export growth, chemical manufacturing, textile, and raw manufacturing are the main components, while for 10 percent, daily instruments, chemical manufacturing, and raw manufacturing are the main ones. For the cases of 15 and 20 percent growth, not only do they follow similar ECI improvement trajectories but also they share a pretty close investment portfolio, which is mainly made up of Transportation, High-complexity Products, Chemical Manufacturing, etc. A more detailed numerical representation of the portfolio is shown in Table 8b.

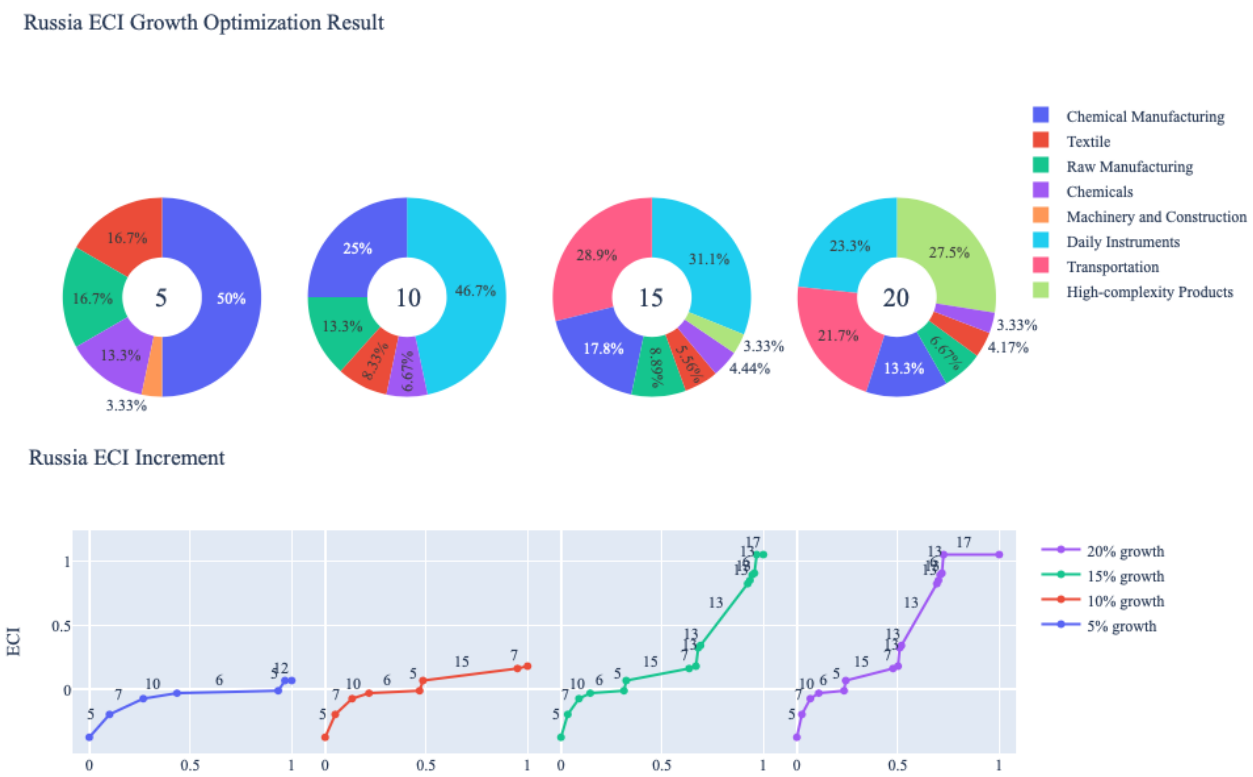


Figure 4b. Greedy-Based ECI Improvement Results of Russia with Different Budgets (2018)

Russia (2018)				
Original ECI			**-0.37**	
Heuristic Export Growth	**5%**	**10%**	**15%**	**20%**
Chemicals	3.43E+09	3.64E+09	1.65E+10	1.24E+10
Chemical Manufacturing	1.28E+10	1.37E+10	6.60E+10	4.95E+10
Raw Manufacturing	4.28E+09	7.28E+09	3.30E+10	2.47E+10
Textile	4.28E+09	4.55E+09	2.06E+10	1.55E+10
Machinery and Construction	8.57E+08	0.00E+00	0.00E+00	0.00E+00
Transportation	0.00E+00	0.00E+00	1.07E+11	8.04E+10
Daily Instruments	0.00E+00	2.55E+10	1.15E+11	8.66E+10
High-complexity Products	0.00E+00	0.00E+00	1.24E+10	1.02E+11
Increased ECI	**0.07**	**0.18**	**1.05**	**1.05**

Table 8b. Portfolio of Russia (2018)

To compare with the performance in 2013 and 2018, we also re-examine suggested strategies for 2021. For 2021, a 5 percent increase in export would emphasize Energy Drilling and Mining, followed by Animals and By-products, Vegetables, Fruits, and Plants, and Energy Drilling in Mining again for 10, 15, and 20 percent export growth respectively. These strategies go in line with the suggested trajectories based on ECI. A very slight boost in ECI comes from the export growths at different levels, which differs significantly from the portfolios in 2013 and 2018 with industries such as Animals and By-products, Vegetables, Fruits and Plants, and Food and Preparations. A more detailed numerical representation of the portfolio for Russia is shown in Table 8c.

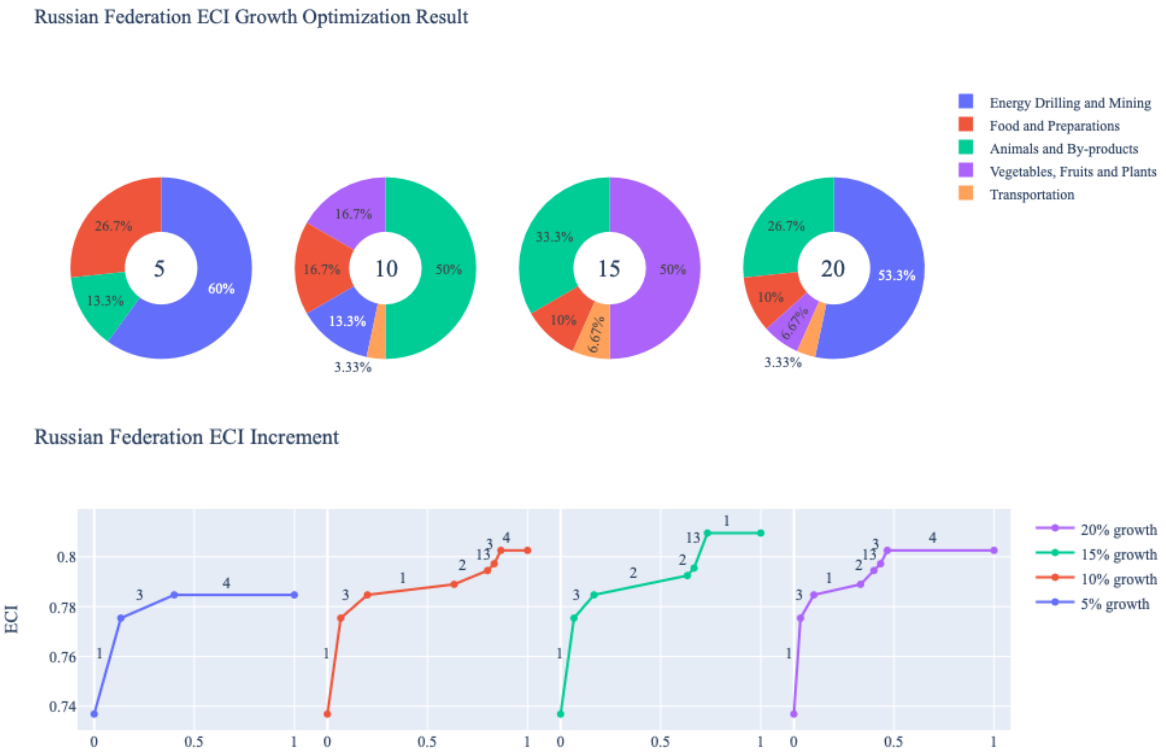


Figure 4c. Greedy-Based ECI Improvement Results of Russia with Different Budgets (2021)

Russia (2021)				
Original ECI		**0.74**		
Heuristic Export Growth	**5%**	**10%**	**15%**	**20%**
Animals and By-products	3.87E+09	3.10E+10	3.77E+10	3.10E+10
Vegetables, Fruits and Plants	0.00E+00	1.03E+10	5.66E+10	7.74E+09
Food and Preparations	7.74E+09	1.03E+10	1.13E+10	1.16E+10
Energy Drilling and Mining	1.74E+10	8.25E+09	0.00E+00	6.19E+10
Transportation	0.00E+00	2.06E+09	7.55E+09	3.87E+09
Increased ECI	**0.78**	**0.80**	**0.81**	**0.80**

Table 8c. Portfolio of Russia (2021)

4.3 Sensitivity Analysis and Contingency Strategy

In the following section our broad aim is to understand how sensitive Russia is to changes in export in various industries. While the Economic Complexity Index has been shown to contain valuable information about the economic strength/capacity of a country, little has been said as to the stability of the measure itself. We seek to uncover the main drivers of stability under a country's ECI score and better understand longer-term projections for ECI growth. Additionally, gaining an intuition on the industries that are bolstering an economy and the industries that offer the greatest return per unit of investment is best done through visualization of industry-specific sensitivity. To this end, we have developed two categories of sensitivity analysis.

ECI Sensitivity Graph

First, in order to assess the effect particular industries have on each respective country, we developed ECI Sensitivity graphs (Figure 5). We use the shocking methodology to increment or decrement an industry's export level by a certain percentage and recalculate the ECI all else being equal. While freezing the export dynamics of the rest of the world and enacting an instantaneous shock in export for a particular industry and country may not reflect real-life dynamics, what it does offer us is an understanding of a country's level of dependency on an industry in the context of ECI. The shocking is done in small percentage increments in order to smooth out the resulting curve. Additionally, a recurring theme one will see is that for most industries, a breaking point occurs where the ECI either jumps upwards or downwards, creating a hockey stick shape rather than a linear trend. While the inflection point may not be accurate in the context of real life, comparing the various inflection points across industries can give us valuable insight.

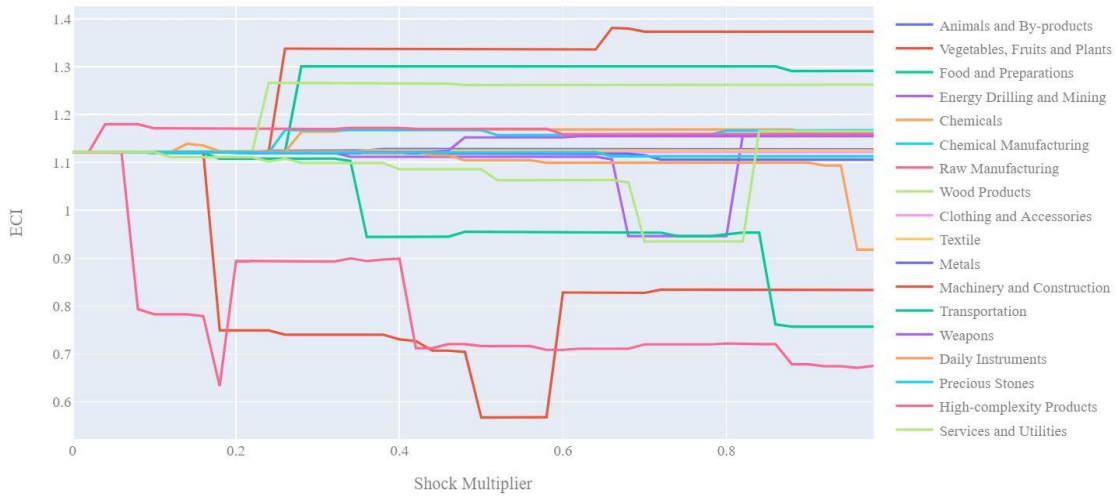


Figure 5. Sample ECI Sensitivity Graph (2018)

The graphs are formulated as follows. There are six ECI Sensitivity graphs, two for each of the following years: 2021, 2018, and 2013. The first chart, Incremental ECI Sensitivity, shows positive shocking in which export numbers are shocked upwards per industry. The X-axis is in terms of percentage shock per current dollar value of export. The Y-axis is the recalculated ECI level post-shocking. The second chart, Decremental ECI Sensitivity, follows the same format except the X-axis represents negative shock. In other words, exports for each industry are decremented, and the ECI is accordingly recomputed.

SDV sensitivity

Secondly, we analyze the sensitivity of the SDV to changes in export levels. The goal is to understand how export level changes for a particular industry can affect the marginal opportunity gain for other industries. We will be using specifically High Complexity Products

and Food and Preparations as our base industries. We will be increasing or decreasing the absolute export level in both of these industries and observing the effects on the SDV.

When the opportunity gain of an industry is negative, the SDV sensitivity approximates how an over-development of the industry jeopardizes the economic structure of a country. When the opportunity gain of the industry is zero, the SDV sensitivity determines whether the further development of the industry shapes the country with a better economic structure and predicts how the SDV would change accordingly. Specifically, as we reduce the export of such an industry to 25%-50% of its original value, a few other industries originally with negative opportunity gain could likely become profitable.

Similar to the ECI sensitivity graphs above, we will be shocking the export of High Complexity Products and Food and Preparations in small percentage increments. A new SDV, represented by a new column in the charts, is recorded only when a certain level of shock changes the structure of the SDV. In effect, we are incrementing or decrementing export levels of two industries until the marginal opportunity gain of any industry changes in category (positive, negative, or neutral). Below is an example of an SDV Sensitivity chart with Positive Shocking. Industries with positive marginal opportunity gain are colored blue, neutral is colored white, and negative is colored red.

	0.0%	10.0%	30.0%	50.0%	80.0%	100.0%	120.0%
0	Vegetables, Fruits and Plants	Vegetables, Fruits and Plants	Vegetables, Fruits and Plants	Chemicals	Chemicals	Chemicals	Machinery and Construction
1	Daily Instruments	Daily Instruments	Daily Instruments	Services and Utilities	Services and Utilities	Daily Instruments	Chemicals
2	Weapons	Weapons	Weapons	Textile	Textile	Textile	Daily Instruments
3	Transportation	Transportation	Transportation	Weapons	Daily Instruments	Services and Utilities	Services and Utilities
4	Machinery and Construction	Machinery and Construction	Machinery and Construction	Transportation	High-complexity Products	Transportation	Transportation
5	Metals	Metals	High-complexity Products	Machinery and Construction	Transportation	Chemical Manufacturing	Textile
6	High-complexity Products	High-complexity Products	Chemicals	High-complexity Products	Machinery and Construction	Weapons	Chemical Manufacturing
7	Chemicals	Services and Utilities	Services and Utilities	Daily Instruments	Chemical Manufacturing	High-complexity Products	Weapons
8	Services and Utilities	Chemicals	Textile	Chemical Manufacturing	Weapons	Machinery and Construction	High-complexity Products
9	Textile	Textile	Chemical Manufacturing	Precious Stones	Clothing and Accessories	Clothing and Accessories	Clothing and Accessories
10	Chemical Manufacturing	Chemical Manufacturing	Precious Stones	Clothing and Accessories	Precious Stones	Precious Stones	Raw Manufacturing
11	Precious Stones	Precious Stones	Clothing and Accessories	Vegetables, Fruits and Plants	Raw Manufacturing	Raw Manufacturing	Precious Stones
12	Clothing and Accessories	Clothing and Accessories	Raw Manufacturing	Raw Manufacturing	Wood Products	Metals	Wood Products
13	Raw Manufacturing	Raw Manufacturing	Metals	Metals	Metals	Wood Products	Metals
14	Energy Drilling and Mining	Energy Drilling and Mining	Energy Drilling and Mining	Wood Products	Energy Drilling and Mining	Energy Drilling and Mining	Energy Drilling and Mining
15	Wood Products	Wood Products	Wood Products	Energy Drilling and Mining	Animals and By-products	Animals and By-products	Animals and By-products
16	Animals and By-products	Animals and By-products	Animals and By-products	Animals and By-products	Vegetables, Fruits and Plants	Food and Preparations	Food and Preparations
17	Food and Preparations	Food and Preparations	Food and Preparations	Food and Preparations	Food and Preparations	Vegetables, Fruits and Plants	Vegetables, Fruits and Plants
ECI	2.261503667	2.520234671	3.08896214	3.452901685	4.299466299	4.439916975	5.069638102

Table 9. Sample Incremental SDV Sensitivity for High-Complexity Products (2018)

Contingency Plan

The Contingency Plan aims to present a set of solutions with respect to upheavals in different industries. Instead of compensating for the declining production directly, the best strategy is to develop those incipiently profitable industries. In this manner, we can derive a contingency strategy for countries to deal with possible abrupt declines of crucial industries. In some cases, the SDV remains unchanged even when a zero-opportunity-gain industry declines to 20% in terms of export. We can then conclude the industry is not indispensable to the country. As a clarification, the three consecutive N/As mean that the country doesn't even need to respond to a collapse in the industry. Countries tend to have distinct solutions to the ups and downs of the same industry. To create the contingency strategy table, we decrease

the export level for each industry in the country's current production space by 60% respectively. The three highest-ranking industries in the new SDV are then returned.

Product Names	0	1	2
Animal and By-products	Services and Utilities	Daily Instruments	Weapons
Vegetables, Fruits and Plants	Services and Utilities	Daily Instruments	Weapons
Food and Preparations	Services and Utilities	Daily Instruments	Weapons
Energy Drilling and Mining	Services and Utilities	Daily Instruments	Weapons
Chemicals	Services and Utilities	Daily Instruments	Weapons
Chemical Manufacturing	Services and Utilities	Daily Instruments	Weapons
Raw Manufacturing	Services and Utilities	Daily Instruments	Weapons
Wood Products	Services and Utilities	Daily Instruments	Weapons
Clothing and Accessories	Services and Utilities	Daily Instruments	Weapons
Textile	Services and Utilities	Daily Instruments	Weapons
Metals	Services and Utilities	Daily Instruments	Weapons
Machinery and Constructions	Services and Utilities	Daily Instruments	Weapons
Transportation	Services and Utilities	Raw Manufacturing	Daily Instruments
Weapons	Services and Utilities	Daily Instruments	Transportation
Daily Instruments	Services and Utilities	Weapons	Transportation
Precious Stones	Services and Utilities	Daily Instruments	Weapons
Daily Instruments	Services and Utilities	Daily Instruments	Weapons
Services and Utilities	Daily Instruments	Weapons	Transportation

Table 10. Sample Contingency Strategy (2019)

4.3 Sensitivity Analysis Results and Interpretation

We examine Russia's ECI Decremental and Incremental Sensitivity Charts for 2021. An increase in High-Complexity Products will lead to the highest change in ECI, followed by Chemical Manufacturing and Chemicals. The strong sensitivity effect of manipulating the Chemical Manufacturing category remains consistent across these three years. For the negative shock cases, Vegetables and Fruits become most impactful, a new trend across the data from the three years. The rest of the industries do not appear to have the same level of sensitivity.

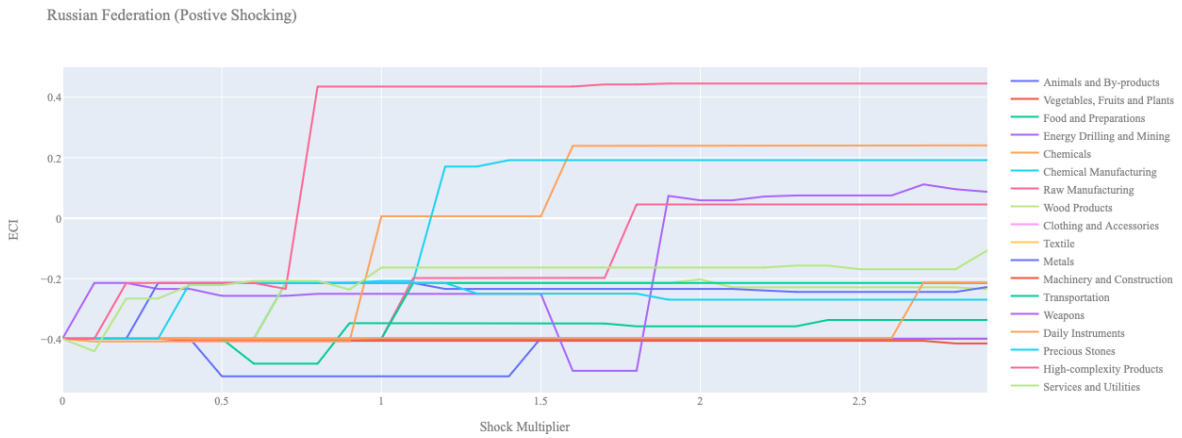


Figure 6a. Incremental ECI Sensitivity for Russia (2021)

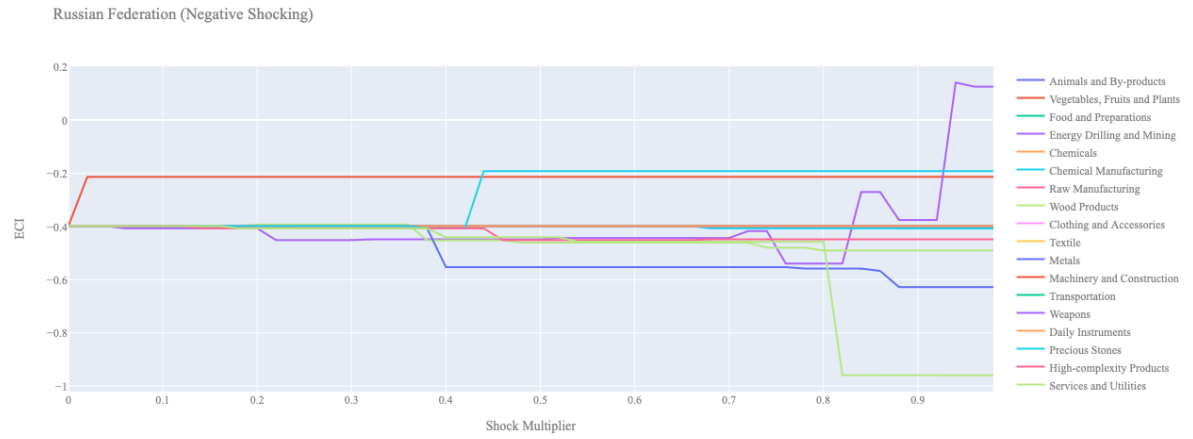


Figure 6b. Decremental ECI Sensitivity for Russia (2021)

Below is Russia's 2018 ECI Sensitivity Charts. First, in the positive chart, we notice immediately that increases in Raw Manufacturing, Weapons, and Chemical Manufacturing lead to an uptrend of ECI. Raw Manufacturing and Chemical Manufacturing seem to give the most immediate increase in ECI for only a 20-30% increase in export magnitude.

Next, we consider Russia's 2018 Negative Shock chart. We see that Russia is sensitive to changes in export levels in Energy, Drilling, and Mining as well as Services and Utilities. Interestingly, Russia is highly insensitive to changes in most other industries suggesting that Russia has a good blend of industries that complement each other and are able to compensate for reductions in other industries.

Figure 7a. Incremental ECI Sensitivity for Russia (2018)

Figure 7b. Decremental ECI Sensitivity for Russia (2018)

Next, we consider the 2013 ECI Sensitivity graphs (Figures 8a and 8b). We see that in the positive shocking case, the landscape of ECI sensitivity has not altered significantly over the three-year period. Raw Manufacturing, Weapons, Chemical Manufacturing, and Services and Utilities lead to an uptrend in ECI. However, we see that in 2018 Russia seems to be highly sensitive to increases in Energy Drilling and Mining.

In the 2013 negative shocking case, we see that again Russia is very sensitive to drawbacks in Energy. Again we see that Russia is highly insensitive to drawdowns in the majority of its industries. However, unlike the 2018 case, we see quite a bit of sensitivity to Metals.

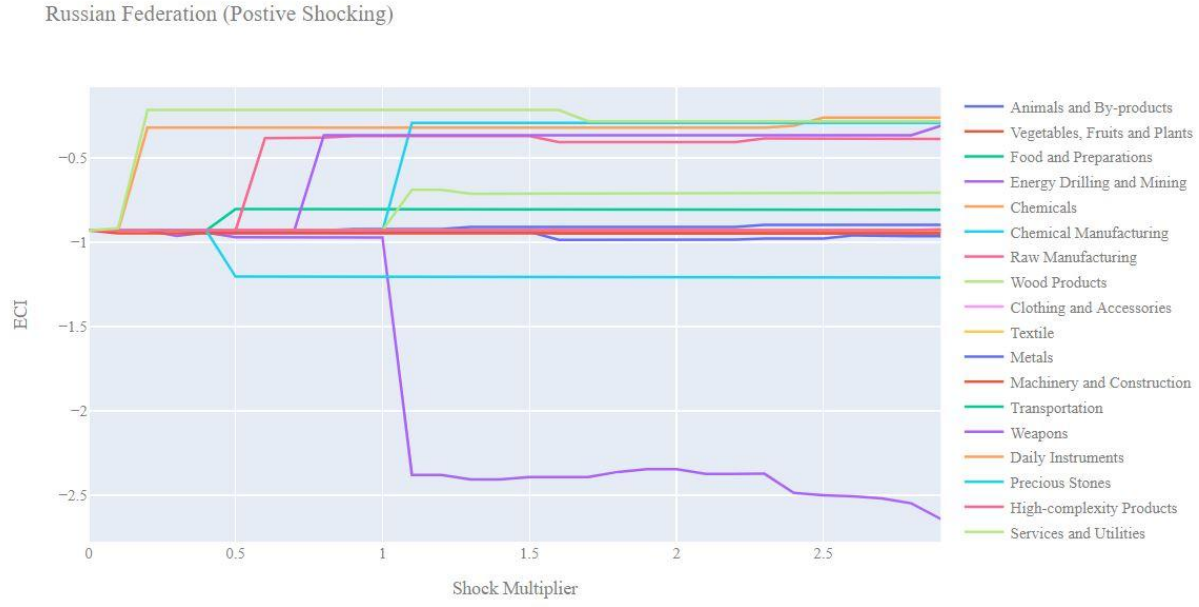


Figure 8a. Incremental ECI Sensitivity for Russia (2013)

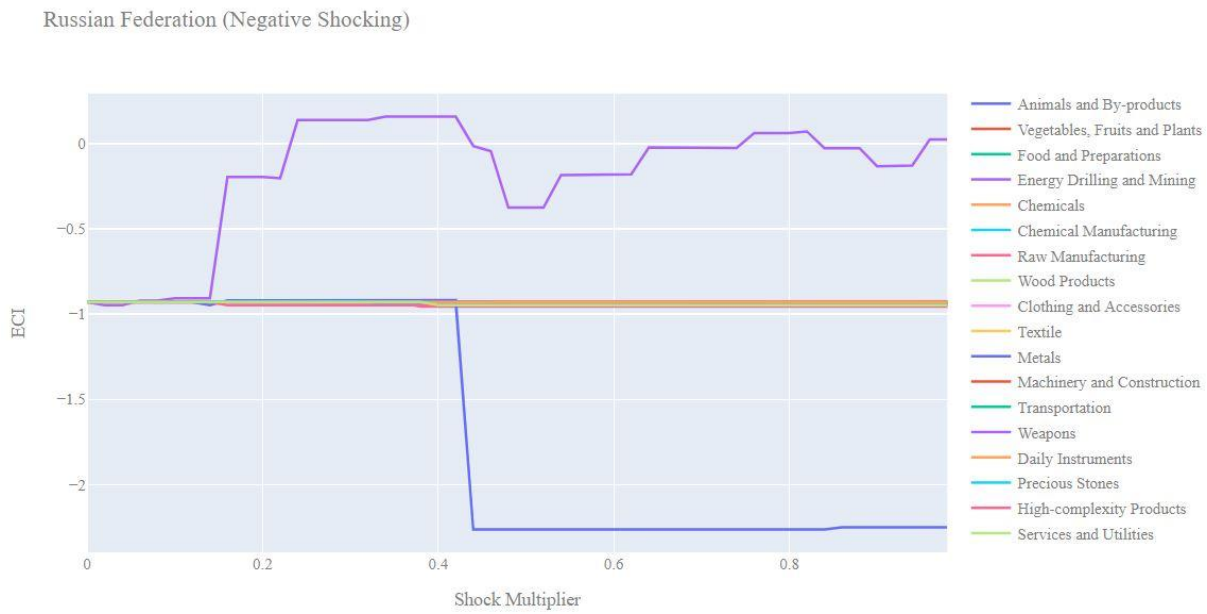


Figure 8b. Decremental ECI Sensitivity for Russia (2013)

Below we see the SDV sensitivity charts for High Complexity Products (Tables 11 and 12). Russia's SDV is quite insensitive to changes in High Complexity Products since this does not seem to be a key industry for the Russian economy. In both the positive and negative SDV sensitivity chart we see that the SDV does not change for any level of shock to the export level of High Complexity Products.

Considering the Food and Preparations SDV sensitivity charts, we see that Russia again is fairly insensitive to this industry. We see a slight change in the SDV from a decrease of 26% in Food and Preparations, but in general, the industries that have positive opportunity gain and negative opportunity gain for Russia are unchanged by shocks to the Food and Preparations industry.

Rank	Incremental	Decremental
1	Vegetables, Fruits and Plants	Vegetables, Fruits and Plants
2	High-Complexity Products	High-Complexity Products
3	Machinery and Construction	Machinery and Construction
4	Transportation	Transportation
5	Daily Instruments	Daily Instruments
6	Chemicals	Chemicals
7	Textile	Textile
8	Services and Utilities	Services and Utilities
9	Metals	Metals
10	Food and Preparations	Food and Preparations
11	Energy Drilling and Mining	Energy Drilling and Mining
12	Weapons	Weapons
13	Chemical Manufacturing	Chemical Manufacturing
14	Clothing and Accessories	Clothing and Accessories
15	Raw Manufacturing	Raw Manufacturing
16	Precious Stones	Precious Stones

17	Wood Products	Wood Products
18	Animals and By-products	Animals and By-products
ECI	**-0.6537**	**-0.6537**

Table 11. Russia's SDV Sensitivities for High-Complexity Products (2018)

Rank	Incremental	Decremental
1	Vegetables, Fruits and Plants	Vegetables, Fruits and Plants
2	High-Complexity Products	High-complexity Products
3	Machinery and Construction	Machinery and Construction
4	Transportation	Transportation
5	Daily Instruments	Daily Instruments
6	Chemicals	Chemicals
7	Textile	Textile
8	Services and Utilities	Weapons
9	Metals	Services and Utilities
10	Food and Preparations	Metals
11	Energy Drilling and Mining	Energy Drilling and Mining
12	Weapons	Chemical Manufacturing
13	Chemical Manufacturing	Clothing and Accessories
14	Clothing and Accessories	Raw Manufacturing
15	Raw Manufacturing	Precious Stones
16	Precious Stones	Wood Products
17	Wood Products	Animals and By-products
18	Animals and By-products	Food and Preparations
ECI	**-0.65368**	**-0.653866**

Table 12. Russia's SDV Sensitivities for Food and Preparations (2018)

4.4 Contingency Strategy

Decreasing export of each industry in Russia's current production space by 60% respectively, we derive the contingency strategy shown below.

Product Names	0	1	2
Animal and By-products	Vegetables, Fruits and Plants	High-complexity Products	Machinery and Construction
Vegetables, Fruits and Plants	Vegetables, Fruits and Plants	High-complexity Products	Machinery and Construction
Food and Preparations	Vegetables, Fruits and Plants	High-complexity Products	Machinery and Construction
Energy Drilling and Mining	Vegetables, Fruits and Plants	High-complexity Products	Transportation
Chemicals	Vegetables, Fruits and Plants	High-complexity Products	Machinery and Construction
Chemical Manufacturing	Vegetables, Fruits and Plants	High-complexity Products	Machinery and Construction
Raw Manufacturing	Vegetables, Fruits and Plants	High-complexity Products	Machinery and Construction
Wood Products	Vegetables, Fruits and Plants	High-complexity Products	Machinery and Construction
Clothing and Accessories	Vegetables, Fruits and Plants	High-complexity Products	Machinery and Construction
Textile	Vegetables, Fruits and Plants	High-complexity Products	Machinery and Construction
Metals	Vegetables, Fruits and Plants	High-complexity Products	Machinery and Construction
Machinery and Construction	Vegetables, Fruits and Plants	High-complexity Products	Machinery and Construction
Transportation	Vegetables, Fruits and Plants	High-complexity Products	Machinery and Construction

Weapons	Vegetables, Fruits and Plants	High-complexity Products	Machinery and Construction
Daily Instruments	Vegetables, Fruits and Plants	High-complexity Products	Machinery and Construction
Precious Stones	Vegetables, Fruits and Plants	High-complexity Products	Machinery and Construction
High-complexity Products	Vegetables, Fruits and Plants	High-complexity Products	Machinery and Construction
Services and Utilities	Vegetables, Fruits and Plants	High-complexity Products	Machinery and Construction

Table 13. Russia's Contingency Strategy (2018)

5. Macro-level Predictions

5.1 Structural Optimality Index

Indeed, such choice of prioritization has proven to be a significant factor in deciding the economic outcomes of countries. In order to quantitatively evaluate how effective our development strategies are and how deviations from the suggested developmental path will lead to suboptimal growth results, we define the measure – Structural Optimality Index (SOI) – on a country level as the Adjusted R-Square obtained from regressing the country's realized industry development over the suggested development strategy. Both strategies are quantified in nature, with the realized development represented by increasing export in every major industry group and the suggested development strategy represented by the opportunity gains of developing the corresponding industry groups as calculated in previous sections. The adjusted R-square from the regression thus provides us with a quantified measure of how the development path adopted by the country has fitted with/differed from calculations on a complexity level.

After obtaining this measure for all countries in our database, we further regress countries' five-year economic growth, which is defined as the percent increase in GDP (USD), over their SOI. Figure 9 illustrates the regression output, which shows a strong positive correlation between countries' SOI and their five-year GDP growth, significant at the 1% level and achieving an adjusted R^2 of 4.5%. In other words, the more a country develops as suggested by calculations on a complexity level, the better economic outcomes it achieves.

Table 14: OLS Regression Results	
Dep. Variable: GDP	**F-Statistic:** 5.963
R^2: 0.054	**Prob (F-Stat):** 0.0163
Adj R^2: 0.045	**No. Observations:** 106

Figure 9. Regression of Five-Year GDP Growth over SOI (2013-2018)

5.2 SOI of Russia and Its Implications

Russia, for instance, has a low level of structural optimality as compared with its developed peers. As the regression in Figure 10a suggests (the red curve represents export increase and the blue curve stands for opportunity gain of the corresponding industry), Russia demonstrates a low level of correlation with the suggested developmental path, having an adjusted R-square of around -0.37. Russia ranks in the third quartile among all countries in terms of SOI and has made a slow rate of economic progress among its emerging peers from 2013 to 2018 with a 5-year GDP growth rate of 7.42%, which is consistent with the regression result in Figure 4b. This is in direct contrast to emerging economies such as Turkey, where there is a high SOI of around 21.8% and corresponding GDP growth of 36.7% from 2013 to 2018, making it one of the fastest developing economies during the period. In sum, Russia's slow economic progress from 2013 to 2018 can be at least partially explained by a development strategy that demonstrates a considerable but not perfect level of matches with our suggested developmental path. In specific, Russia invested heavily in the Food and Preparations industry, while it should have focused more on industry groups such as Raw Manufacturing.

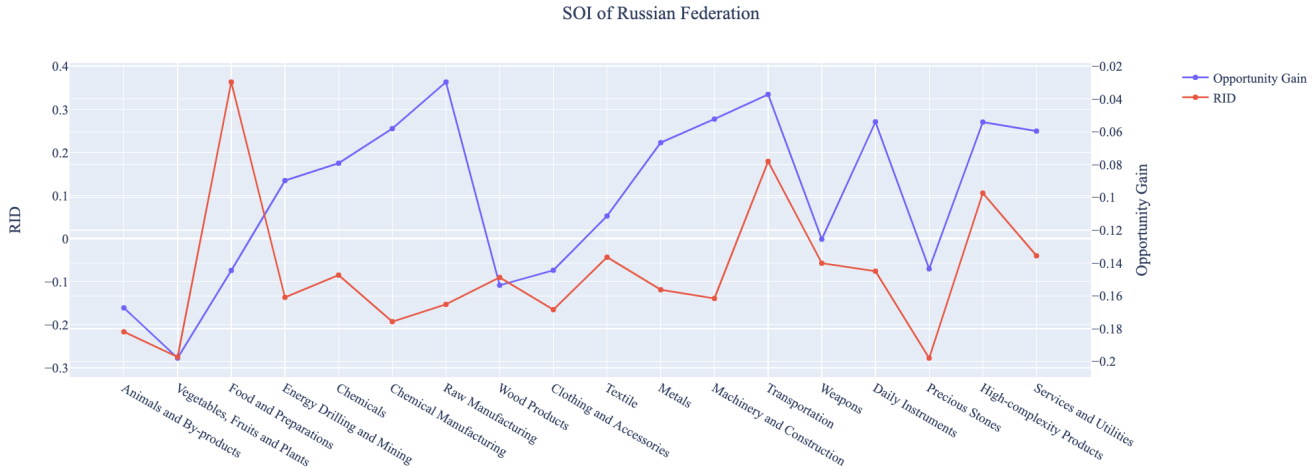


Figure 10a. SOI of Russia (2013-2018)

For the 2019-2021 years, Russia has a strong presence in the Energy Drilling and Precious Stones industries, which both present a good opportunity for further investment. It also could consider Metals, Machinery and Construction, and Weapons to improve its growth. Russia has seen an growth in GDP over those three years of 4.88%, with an average growth of 2.41%, compared to 1.31% for the average yearly growth for the five years prior. Russia also ranked in the first quartile among all countries in terms of SOI.

Higher than before, its adjusted R-squared value of 0.21 still indicates a low correlation between the GDP growth and the implemented development path. Progress is slow on a global scale during this period, but Russia demonstrates a greater ability to adjust to negative economic shocks by improving SOI and increasing GDP growth than it did between 2013 and 2018.

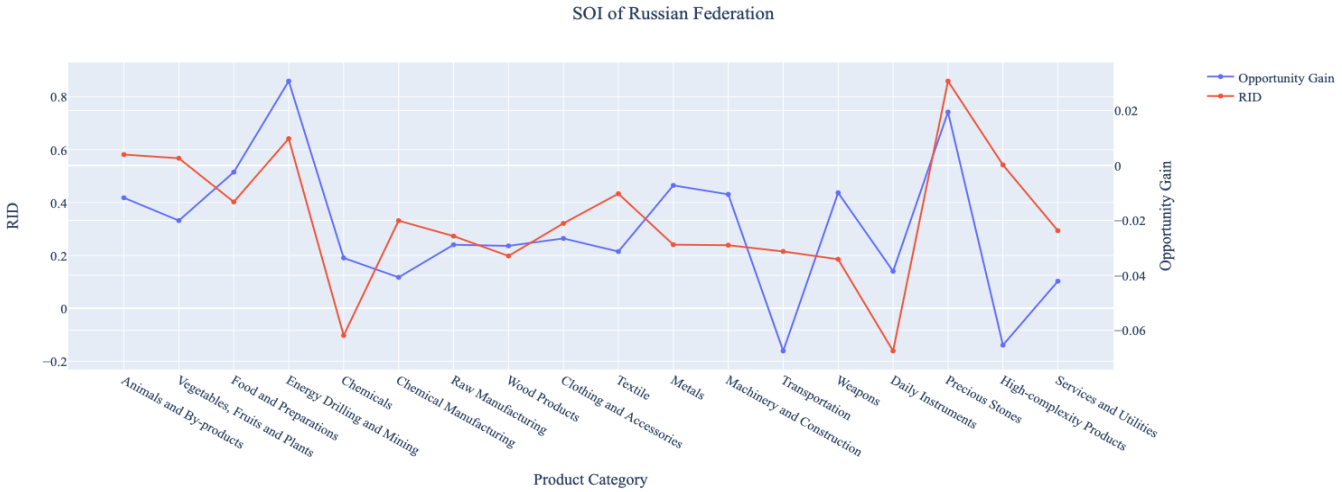


Figure 10b. SOI of Russia (2019-2021)

6. Concluding Remarks

In conclusion, Russia has demonstrated a low level of economic growth in terms of annual GDP increase during the period from 2013 to 2018, concurrent with an increase in economic complexity as compared with other major developed economies. For 2019-2021, the growth in GDP has increased alongside a large boost in ECI, in line with its comparable countries and higher than some of the leading economies in the world.

The mixed progress during the first period, we believe, can be partially explained through the analysis of the economic and product complexity structure of Russia on the industry group level. The product classification system we adopt allows us to measure the realized industry development for various industry groups and to observe that Russia regressed in developing most of its industries during the period, while its developed counterparts and emerging economies around the globe adopted much more complex and progressive paths.

Based on our analysis of the opportunity gain and sensitivity analysis of major industry groups for 2013-2018, Russia can further its gains by prioritizing Raw Manufacturing, Weapons, and Chemical Manufacturing. We further note that Russia has a heavily mismatched development strategy that indicates a low level (compared to other developed countries) of structural optimality on the complexity level, having an adjusted R-square of around -0.37%. Since a significant positive correlation exists between five-year GDP growth and the structural optimality index of an economy as we define and calculate, Russia indeed has a suboptimal growth experience as compared with fast-growing economies both on a regional scale and on a global scale and has the potential to further its economic gains through industrial structure optimization as suggested in the paper.

During the second examined period from 2019 to 2021, Russia performed much stronger than before and compared to other countries, particularly Germany. We also note that Russia has increased its investment in the sectors identified earlier, leading to a strong boost from Energy Drilling and Precious Stones industries, leaving some room for strategic improvement. It did invest in the industries which contributed the most to its advancements, such as Energy Drilling and Precious Stones industries. The ECI suggests that greater growth could have been achieved through High-Complexity Products, followed by Chemical Manufacturing and Chemicals. The surprising growth also increased the adjusted R-squared value to 0.21 in 2021 from -0.37 in 2018, demonstrating the pursued strategies contributed to the GDP. With the revised focus, Russia has further potential to advance its economic growth to maintain its position among other countries to continue its post-pandemic recovery.

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