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A COMPREHENSIVE ANALYSIS OF ARMENIA'S INNOVATION INPUT AND OUTPUT

The article explores the intricate landscape of Armenia's innovation ecosystem, thoroughly examining its strengths and weaknesses. The study using the Global Innovation Index (GII) as a benchmark reveals a complex narrative. While Armenia exhibits impressive performance in innovation output, securing the 62nd position globally in 2023, challenges prevail in innovation input, where Armenia ranks 83rd. The article emphasizes the imperative for targeted policies addressing institutional, educational, scientific, and economic dimensions. It advocates for a systematic approach, positioning the Department of Innovative, Knowledge-Based Economy of the Ministry of Economy of the RA as a crucial actor, collaborating with diverse spheres of policymakers to optimize Armenia's innovative potential. Amid global dynamics, the article delves into external and internal influences, presenting a roadmap for improvements. The article could serve as a guide for policymakers interested in leading Armenia to a more innovative route.

KEYWORDS: *innovation, output, input, knowledge, Armenia, economy, analysis*

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INTRODUCTION. In the dynamic landscape of global competitiveness, innovation serves as a pivotal driver of economic growth and sustainability. Within this context, this research undertakes a comprehensive analysis of Armenia's innovation landscape, focusing on both its input and output factors. The study navigates through the intricacies of innovation resources and their

tangible outcomes, utilizing the renowned Global Innovation Index (GII) as a robust framework.

In recent years, the significance of innovation for nations has been intensified by policymakers, businesses, and researchers recognizing its transformative potential. Armenia, nestled at the crossroads of Europe and Asia, stands at a critical juncture of harnessing innovation to propel its economic trajectory forward. Against this backdrop, the research aims to navigate the intricacies of Armenia's innovation landscape, scrutinizing both the allocation of resources (innovation input) and the tangible outcomes (innovation output).

As the global community places increasing emphasis on innovation-driven development, this study not only contributes to the empirical understanding of Armenia's innovation dynamics but also provides valuable insights for policymakers, stakeholders, and the international community at large. Through a meticulous examination of the Global Innovation Index, the research seeks to foster a nuanced understanding of Armenia's current standing and future potential.

LITERATURE REVIEW. Until the dawn of the 20th century, J. Schumpeter (2003, p. 108) defined innovation as a dynamic process in which new technologies replace old ones, leading to “creative destruction”. According to Schumpeter, development is conditioned precisely by innovation (with a new combination). In 1992, when the first set of principles for the collection of innovation statistics was published by the OECD (Organization for Economic Cooperation and Development) as comprehensive guidelines for measuring innovation and innovative activity on an international scale, it underscored the technological aspect of innovation, encompassing new products and processes, as well as organizational changes undertaken in the pursuit of economic progress and efficiency (Shavina, 2003, pp. 860-880). In 1997, when the second Oslo edition was published, the scope of innovation had already expanded to include not only industry but also construction, utilities, and other services. There, innovation was defined as innovation of technological products and technological processes, including new technological products presented on the market, as well as new technological processes used in production and their significant improvements (OECD, 1997, pp. 31-47). Therefore, it is no coincidence that innovation is frequently and persistently associated with technology, and sometimes also with information technology. Such a problem also exists in the RA, as evidenced by the 2014 UN Economic Commission's report, according to which a narrow understanding of innovation, focused on technological innovation, prevails. Such a biased comprehension is reflected both in the innovation policy complex and in the efforts aimed at the formation and implementation of the national innovation system (UN, 2014, p. 20). On a global scale, the technological aspect of innovation persisted until 2005, when the third Oslo edition was published, in which the definition of innovation was

expanded and non-technological innovation was introduced for the first time. According to the definition of the third edition of the Oslo Manual, innovation is the implementation of a new or significantly improved product (good or service) or process, a new marketing method or an organizational method (OECD, 2005, pp. 45-61). The latest edition of Oslo, October 2018, again reduced the types of innovation, distinguishing only product and process innovation, but did not narrow its boundaries, moreover, due to the general definition, it made it applicable not only to business, but also to other sectors of the economy including public administration, households, and non-profit organizations. In particular, an innovation is defined as a new or improved product or process (or a combination thereof) that is significantly different from the previous products or processes of a given entity (OECD, 2018, pp. 67-83) and which is available to its potential users (in the case of product innovation) or applied by the given entity (process innovation).

In addition to the OECD definition and proposed methodology for measuring innovation at the micro level, the Global Innovation Index (GII), published by the World Intellectual Property Organization is also widely used. The latter measures the innovation performance of countries at the macro level and allows comparisons with other countries, as well as analysis of the dynamics of individual indicators.

Empirical studies conducted at the micro level often use data derived from surveys using the methodology of the OECD Oslo manual. In the article “Core Determinants of Companies Innovation Performance: Case for Armenia”, the author used the data collected on the bases of Oslo 3rd manual to analyze arguments and counterarguments about companies’ innovative activity, size, and geographic location of the sales market (Tadevosyan, 2021).

In the empirical studies conducted at the macro level, some approximation of innovation is most often used, because even the GII, which includes 80 indicators, does not fully reflect innovation and does not fully measure it. Besides the use of any specific indicator as an approximation in the models makes the model construction easier. Frequently, the number of patent applications per million population and the R&D intensity are often used as proxies for innovation (Tadevosyan, 2023).

A study conducted according to Estonia’s example employs 25 initial indicators that characterize innovation policy, then chooses 7 robust uncorrelated indicators to analyze the role of national innovation policy on the national innovation system. The research finds that the innovation policy components have explained 44–78% of differences between countries observed, based on indicators describing the innovation-related activities in the enterprise sector. The study also concludes that indirect components of innovation policy, such as the development of an institutional environment of innovation and public support to education have the most positive influence on the enterprises’ innovation activity (Reiljan, Paltser, 2015).

Another study undertaken according to Latvia's example considers several different measures of innovation, such as the proportion of innovative enterprises, R&D intensity, etc. One of the conclusions made in the study was that Latvia needed to support innovative entrepreneurship by the strong correlation between the four sectors: entrepreneurship, R&D and education, funding and legislation (Jesiļevska, 2012).

Thus, different approaches to innovation measurement have been distinguished at different times, but regardless of the approach, for the evaluation of innovative activity, it is necessary to evaluate the resources required to create them, the input and the output obtained from their application, that is what this article is aimed at.

RESEARCH METHODOLOGY. The research methodology has employed a comprehensive set of scientific cognitive methods to rigorously investigate the subject matter. The core techniques have included statistical analysis, comparative analysis, and graphic interpretation. These methods have been selected to ensure a robust and systematic exploration of the research objectives. The statistical analysis has provided a quantitative lens for understanding patterns and relationships in the data, contributing to a nuanced exploration of innovation dynamics. The comparative analysis has facilitated systematic comparisons between entities, enhancing the identification of variations and similarities in innovation practices. The graphic interpretation method (such as charts) visually represent complex data structures, aiding in the clear communication of intricate relationships.

The deliberate choice of secondary sources, including domestic and international academic literature, reports, and statistical data from reputable organizations such as the World Intellectual Property Organization, the Organization for Economic Development and Cooperation, the World Bank, and the United Nations, have ensured a robust theoretical foundation. These sources are globally recognized for their comprehensive insights into innovation.

The official websites of these organizations have served as the primary information repositories, offering direct access to the latest and most credible data. This methodology aligns seamlessly with the research objectives, providing a multifaceted toolkit for understanding innovation dynamics. The combination of statistical, comparative, and graphic analysis methods, alongside the use of reputable secondary sources, substantiates the research findings, contributing depth and breadth to the study.

ANALYSIS. Innovation necessitates the availability of resources and conducive conditions, the utilization of which gives rise to innovative outputs. An analysis of the innovation resources and the results of different countries can be done by studying the GII published by WIPO. The GII was initially developed in 2007

and has been published annually since 2013. Over the years, it has progressively expanded its scope, encompassing a comprehensive set of 80 indicators. These indicators are categorized into two pillars: innovation input and innovation output. Together, these two reflect a country's innovation capacity and performance, and countries are ranked based on their overall score. Despite the innovation input column containing 5 sub-columns, and the innovation output having 2 sub-columns, both the innovation input and the output have equal weight in the index calculations. The 2023 report includes 132 countries representing 92.5% of the world's population and accounting for 97.6% of global GDP (WIPO, 2023, pp. 213-2017). The analysis of the reports spanning from 2013 to 2023 reveals that Armenia occupied the best position in comparison to other countries, ranking 59th, in 2013 and 2017. In the last 5 years, Armenia showed the best result in 2020, occupying the 61st position. According to the latest 2023 report, Armenia ranked 72nd, which, although 8 positions ahead of the previous position in 2022 (the worst ever occupied by the RA position - 80th), but is 11 places behind the position of 2020 (Chart 1). However, it should be noted that a change in ranking may occur not only as a result of improvement or setbacks of indicators but also as a result of the inclusion of new countries, inclusion of new sub-indicators, or non-inclusion of some previous indicators in the index. In the past, the Institutions pillar included an indicator gauging the ease of starting a business, in which Armenia excelled. However, this has been subsequently replaced by an evaluation of business policies, where Armenia does not fare as well. Such alterations in indicators can significantly influence a country's overall ranking in the GII.

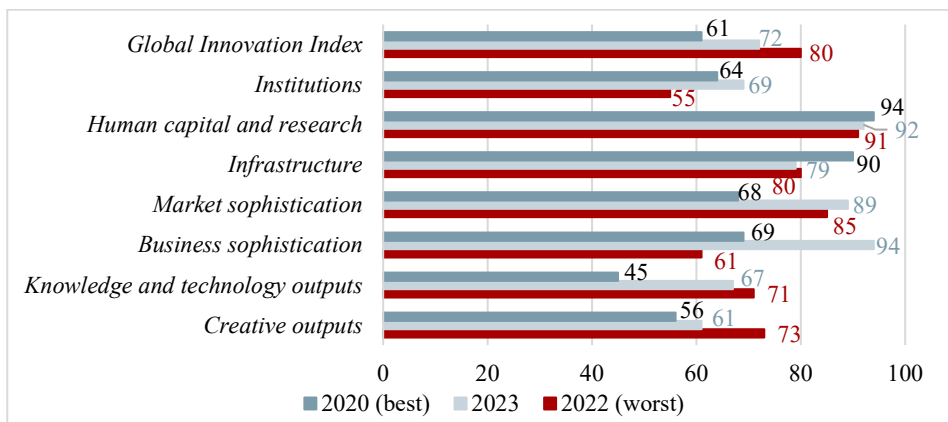


Chart 1. The best and worst positions of the pillars of the RA in the last 5 years and in 2023

As it can be seen from Chart 1, in the last 5 years, Armenia showed the best result in GII in 2020, when it ranked 61st. Then, RA's positions weakened, mainly due to the decline of the indicators of innovation output (Knowledge and

technological output and Creative output), as some of the indicators of innovation input even improved, while some experienced a slight decline.

A detailed and dynamic study of this index is of utmost importance for policymakers, as it provides a comprehensive picture of the enabling and hindering circumstances for development, taking into account more effective policies. For this purpose, a detailed examination of the individual pillars of innovation input and output and their indicators will be undertaken.

Institutes are the first pillar of innovation input. Creating attractive conditions and the right incentives for business activities through effective management is very important for fostering innovation. According to the "Government Effectiveness" indicator, Armenia is positioned in the 87th place, securing 29.9 points out of a potential 100. The "Government Effectiveness" indicator reflects perceptions concerning the quality of public services, independence of political pressures, policy formulation and implementation, and the perceived ability of the government to formulate and execute cohesive policies. In the last 5 years, the worst result of this indicator was recorded in 2023. Another indicator of the institutional environment, "Operational Stability for Business", which measures the likelihood and severity of political, legal, security risks affecting business activities, has also declined in recent years, which is logical given the high level of external security risks. Indicators characterizing the legal environment, which reflect perceptions of the state's ability to implement policies conducive to the development of the private sector, as well as indicators characterizing the enforcement of contracts, trust in the police, the courts, and norms for the protection of property rights, have also deteriorated sequentially over the past 5 years. Indicators delineating the legal environment, which encompass perceptions of the state's capability to enact policies fostering private sector development, alongside the indicators reflecting contract enforcement, trust in law enforcement, the judiciary, and norms safeguarding property rights, have exhibited a sequential deterioration over the past 5 years.

As for the other group of indicators of this pillar and the business environment, it should be noted that the latter has also worsened compared to the previous year, but we cannot compare with previous years, because the indicators have changed. Turning to the next pillar of innovation input, Human Capital and Research, it should be noted that traditionally Armenia has recorded the worst results in this pillar's indicators. In particular, according to the indicator of expenditure on education, 2.8% of GDP, Armenia ranked 111th among 132 countries. The 2021 index was included in the 2023 GNI, and in 2022 it was lower, 2.5% (UNESCO) of the GDP (graph 2): However, it should be noted that according to the RA 2014-2025 Perspective Development Strategic Plan, it was planned to increase education expenses to 3.3% of GDP in 2021, and to around 3.7% in 2025 (Plan for the perspective development of the RA for 2014-2025, the RA Government decision 2014). Meanwhile, it has been

underachieved since 2017 (by 0.4 percentage points). No such target has been defined in the programs of recent years, in particular, neither in the 2021-2026 Program of the RA Government, nor in the Transformation Strategy of Armenia in 2050, nor in the State Program for the Development of the RA Education until 2030. While the last document provides an overview of the insufficient allocation of funds to education relative to GDP, there is no provision for its increase. However, if the 2023-2025 Medium-Term Expenditure Framework (MTEF) planned to allocate only 2.3-2.5% of the GDP to education, then the 2024-2026 MTEF plans to make education allocations by the state equal to 2.8-3.1% of GDP, which in terms of drams is 293-401 billion drams (MTEF, 2024-2026). in the upper-middle income group, which includes Armenia, this indicator was 4.1% at the end of 2020, and the world average is higher -4.3%. (World Bank Indicators, 2023). Therefore, we can conclude that although Armenia is making efforts to increase public spending on education, it is still insufficient and should be continuously increased.

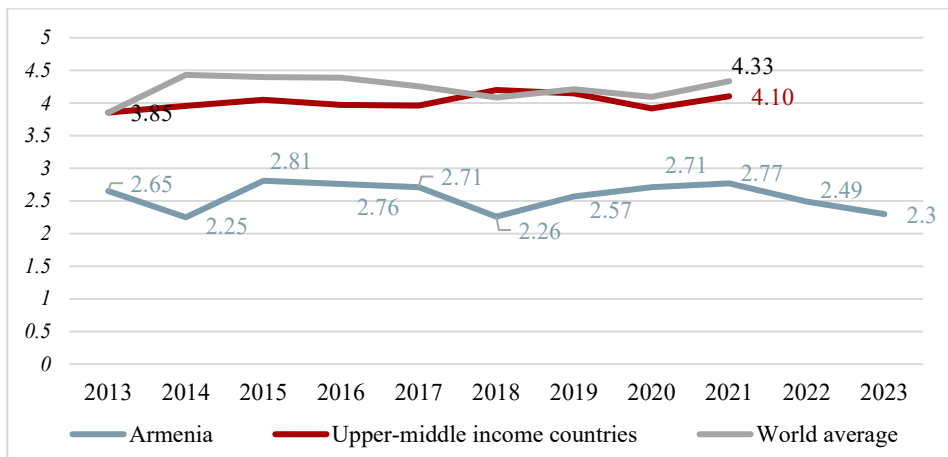


Chart 2. Public expenditure of education, % of GDP (UNESCO, UIS)

The other indicator characterizing education in GII is funding per pupil, calculated in relation to GDP per capita, in which Armenia is also in a bad position, in 2022 it ranked 81st with an indicator of 13.2%. This indicator also deteriorated compared to previous years, due to both the increase in the number of pupils in schools and the disproportionate increase in education funding along with the increase in GDP per capita.

When considering other indicators characterizing the state of education, such as School-life expectancy and the scores of the PISA international review, it should be noted that the number of the first one is increasing, which is considered positive, and the PISA scores for Armenia are missing, because Armenia has not joined PISA yet. However, since 2018, the Ministry of Education, Science, Culture and Sports has been taking steps to join the PISA international review, which will enable international comparisons of pupils' knowledge. Within the education pillar, Armenia's sole strength lies in the

pupil-teacher ratio indicator at 11.1% (the 2020 indicator was incorporated in the 2023 index), positioning Armenia 43rd globally. This indicator, which seems positive at first glance, however, does not give a complete picture, because it does not take subject, spatial and age distribution into account. Studies show that in 2021-2022 the academic year the number of teachers of many natural sciences (physics, chemistry, geography, biology), informatics and social studies was less than the number of schools both in the city of Yerevan and in the regions, that is, there are schools that do not have specialists of this or that subject. Another circumstance is the presence of unfilled teacher positions in numerous remote communities, with approximately 700 positions remaining vacant annually (the RA law on State program for the development of education of the RA until 2030, 2022). And finally, the age composition of teachers is a growing concern. Thus, the largest share of teachers, 35%, are in the age group of 50-64 years, and 12% are over 64 years old, that is, about half of teachers are over 50 years old, which indicates serious risks of generational change among teachers. Teachers in the system are aging and there are no replacements.

The aging demography of teachers, coupled with the lack of replacements, poses substantial risks to the sustainability of the educational system. Thus, even the seemingly strong side contains many problems, which will worsen in the coming years, if new policies are not developed to stop it.

The next group of indicators of the human capital and research pillar refers to tertiary education, in which the participation of the population of the appropriate age is 55.4%, according to which Armenia ranks 60th. For comparison, it's noteworthy that all EAEU countries, except for Kyrgyzstan, along with neighboring Iran and Georgia, surpass Armenia significantly in this indicator. In this group of indicators, another significant metric directly impacting innovation activity is the percentage of graduates in Science and Engineering among the total graduates, accounting for 17.7% in 2020. Armenia ranks 88th in this indicator. It is noteworthy that while the indicator has shown improvement compared to the previous years, it still remains relatively low. This underscores the importance of monitoring the effectiveness of STEM educational programs. In addition to changing the educational programs, it is crucial to incorporate incentives, particularly increasing the number of students receiving state scholarships in these specialized fields.

Research and development (R&D) are closely related to innovative activities, so several indicators characterizing them are included in the GII. Thus, the number of researchers per million inhabitants is an important indicator, which is calculated by UNESCO for several countries, but not for Armenia. The primary reason for this absence is the use of the full-time equivalence calculation, which does not align with the methodology employed by the RA. In general, we can also state that the statistics of the field of science in the RA are handled very incompletely, thus, no statistical data are published regarding the private R&D, their costs and structure, as well as the personnel

involved in specific R&D. However, using the official number of researchers and technicians and the permanent population, we have calculated the number of researchers per million inhabitants. Although not entirely comparable to the UNESCO figure due to differences in methodology, it does reveal the general trend (Chart 3).

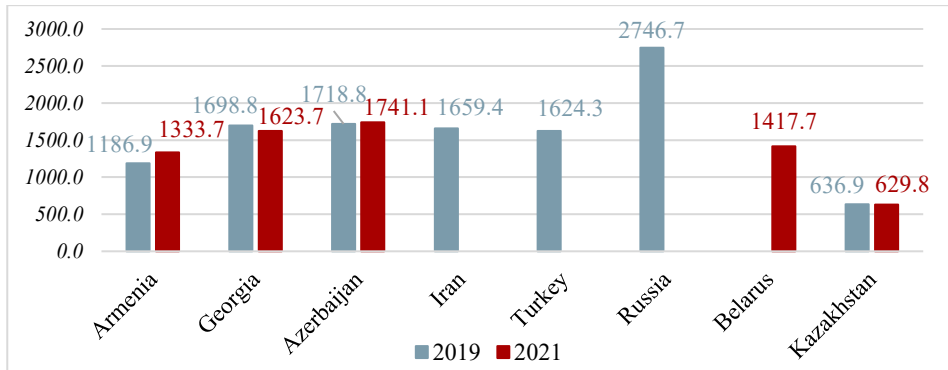


Chart 3. The number of researchers per million population, 2019 and 2021 (UNESCO, UIS, Armstat)¹*

As it can be seen from Chart 3, the leader in the number of researchers per million inhabitants is the Russian Federation, and the rear guard is Kazakhstan. While Armenia is not entirely comparable, completing the data might place its indicator close to that of Belarus. Considering the dynamics, it's worth noting that, along with increased support to the sector, Armenia's indicator is likely to rise, aligning with those of other countries in the region.

Another important factor influencing the innovation activity is the funding of science by the state, which is characterized by the percentage of gross R&D expenses in relation to GDP. Throughout the existence of independent Armenia, science funding has been very low and has fluctuated within the framework of 0.2% of GDP.

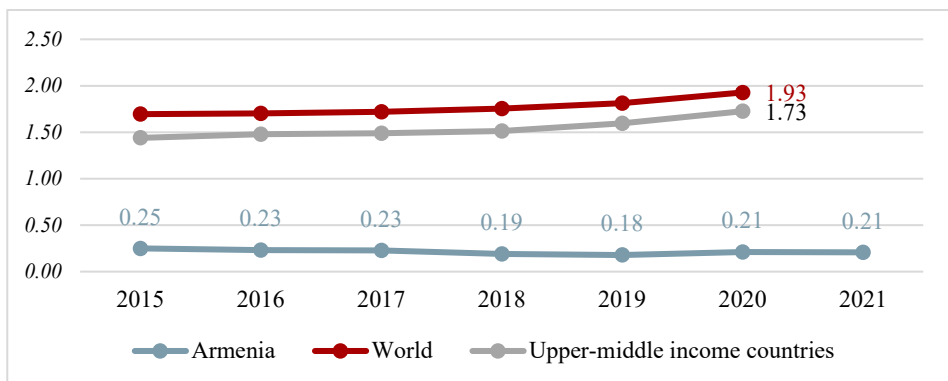


Chart 4. Gross R&D expenditure in relation to GDP, % 2015-2021 (WB Indicators)

¹ We independently computed the data for Armenia, which slightly deviates from UNESCO's methodology; hence, the results are presented with a degree of caution

As it can be seen from Chart 4, Armenia's R&D expenditure/GDP ratio is many times lower than the average of both the world and upper-middle income countries. In 2021, the Armenian budget allocated 15.1 billion AMD (MTEF application, 2023-2025) to the Scientific and Technical Research Program, followed by an increase to 22.2 billion AMD (MTEF, 2024-2026) in 2022, representing a notable increment of 7.1 billion AMD or 47% compared to the previous year. However, when considered in relation to GDP for 2022, it still remained within the 0.2% range, specifically constituting 0.26%. It should be emphasized that an increase in the absolute number of funding is also planned in the following years, which will have an impact in the future, but in order to be competitive compared to other countries, it is necessary to include the relative indicators in the targets. The last 2 indicators of the Human Capital and Research group, for which the RA score is zero, refer to the top 3 Global corporate R&D expenditures in the given country and the average score of the top 3 universities in the given country, according to the QS ranking. It should be noted that only YSU is included in the latter without unit calculation. In general, the RA universities either do not find a place in the rating scales or are in 1000+ positions, which means that our universities have a low competitiveness at the international level. QS ranks universities based on 4 main indicators: research, quality of education, internationalization and reputation among employers. Moreover, the greatest specific weight is given to research. Therefore, our universities should focus on research, create research centers, and actively get engaged in research activities to meet the accepted standards in the world.

Infrastructures are an important element of innovation input, in some of which Armenia's position is quite impressive, and in others, it is consistently bad. In particular, according to the ICT access index, which measures the share of mobile network users, mobile subscriptions per 100 inhabitants, international Internet bandwidth per Internet user (bit/s) and the percentage of households with Internet access, Armenia has a fairly high score (91.6) and is in good positions (18). Armenia also maintains above-average positions in other ICT indicators, such as the ICT usage index, the government online services index and the e-participation index, and although Armenia has slightly regressed in the last 2 indicators compared to the last year, it shows a long-term improvement trend. Unlike ICT infrastructure, Armenia ranks 114th among 132 countries in terms of general infrastructure. Specifically, in this group of indicators, the most vulnerable is the ratio of gross capital formation to GDP in Armenia, expressed as the ratio of total investment to GDP in the current local currency. This ratio has decreased in Armenia, reaching 17.1% of GDP, according to the World Bank's estimate of 19.4% in 2022. Meanwhile, new technologies are typically the subject of capital investments and are gradually incorporated into the production process through the accumulation of capital (Mnatsakanyan, 2016). Therefore, it is crucial to increase this indicator. For comparison, it's worth noting that in 2021 the average of this indicator in upper-

middle-income countries was 35% (World Bank indicators). The main problem hindering the rise of Gross Capital formation to GDP ratio is due to higher interest rates in Armenian than in any of the comparator countries, and gross capital formation appears to be responsive to changes in the real interest rate. And overall levels of investment in the economy appear to be affected by the level of the interest rate. Most recently, since 2016, as the real interest rate has declined sharply, gross capital formation in Armenia has responded positively, increasing by 13.9 percent in 2017 and 28.5 percent in 2018. This relationship is not just a recent two-year phenomenon. This recent growth in investment reversed an 8-year decline in gross capital formation, a period that began with an increase in real interest rates in 2009 (when rates jumped from 10.4 percent to 15.8 percent) and that was characterized by rates that were generally rising through much of the period. Before the abrupt increase in interest rates in 2009, Armenia's 7-year period of declining real interest rates (from 21.7 percent in 2001 to 10.4 percent in 2008) was accompanied by rapid and uninterrupted growth in gross capital formation (USAID, 2019).

Concerning the Logistics Performance Index, the next group of these indicators, Armenia's score is quite low, ranking 89th. In another indicator - the volume of electricity produced by non-traditional energy sources shows a certain decline in recent years; with this indicator, Armenia ranks 72nd.

For business promotion and innovative activities, the availability of credit, an investment-supporting environment, access to international financial markets, and a favorable competitive environment are extremely important. The market sophistication pillar sums these all up. In the context of credit opportunities, Armenia is at the 69th position for finance dedicated to startups and scaleups, and 50th concerning private sector lending as a percentage of GDP. The other group of indicators of the market development pillar refers to trade, diversification and market scale, the latter is measured by the size of GDP adjusted by purchasing power parity (PPP), by which Armenia ranks 107th among the 132 countries compared. Within this set of indicators, Armenia exhibits another vulnerability – a low degree of industrial diversification, positioning it at 93rd place. In the business sophistication pillar, Armenia has experienced a decline of 10 positions from the previous year and a notable drop of 25 positions compared to 2020. Many of Armenia's weaknesses are concentrated in this group of indicators. In particular, in the group of indicators of innovation linkages, Armenia ranks 115th, especially the indicators characterizing the state of cluster development and universities-industry R&D collaboration continue to be low. Another weakness of Armenia is the indicator of intellectual property payments included in the group of knowledge absorption sub-pillar, which is 0 percent in general trade. Nonetheless, in Armenia's context, this doesn't imply a lack of utilization of services protected by intellectual property rights; rather, they are often acquired through alternative means, predominantly without paying. In the group of these indicators, the net

FDI in Armenia continues to be modest, accounting for only 1.3% of the GDP. This places Armenia at the 95th position, indicating that 94 other countries are perceived as more attractive for investment. In the sub-pillar of business development, the only strong point of Armenia is the percentage of females employed with advanced degrees out of totally employed, standing at 16.4%, with which Armenia occupies the 44th position. And according to the knowledge-intensive employment indicator - 18.7%, Armenia ranks 77th, the latter decreased by 10 percentage points compared to 2020.

In contrast to the pillars of innovation input, the pillars of innovation output mainly registered an increase, due to which the overall innovation performance of the RA improved compared to 2022, but we are still lagging behind 2020. In the Knowledge and Technology Output pillar, Armenia has progressed by 3 positions compared to 2022, now holding the 67th position. Moreover, Armenia has achieved its best results in this and Creative Output pillars. Specifically, in the Knowledge Creation pillar, in the indicator of Utility models by origin/bn PPP GDP, Armenia ranks 16th. Meanwhile, in the last 2-3 years, according to the Patents by origin/bn PPP\$ GDP indicator, Armenia has experienced regression, dropping from the 29th position in 2020 to the 59th position in 2023. A decline in the global number of patents following the financial and economic crisis of 2009 was manifested only in 2019. Conversely, in Armenia, the number of patents increased that year, but in subsequent years, it steadily declined at a significant rate (Chart 5).

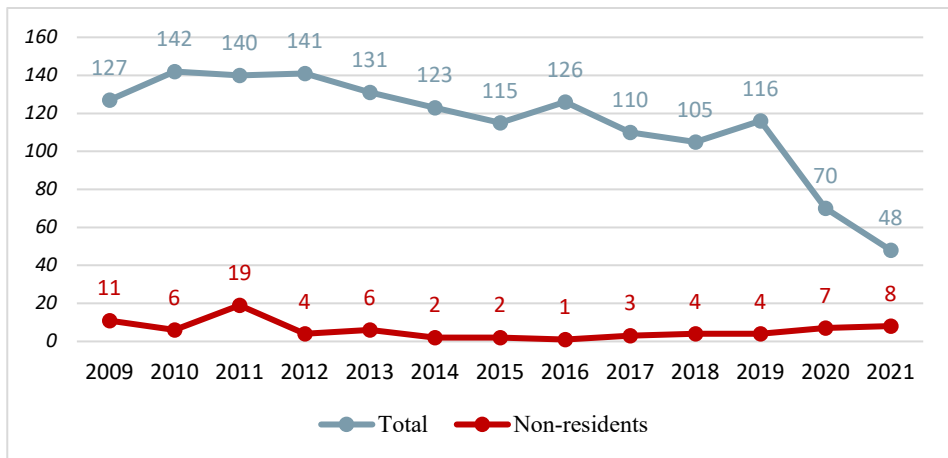


Chart 5. The number of patent applications registered in the RA, 2009-2021 (WIPO IP Statistics Datacenter)

It is crucial to emphasize that since the independence of the RA, several legislative changes have been implemented concerning patenting activities. Specifically, until 2009, the Law of the RA on Patents was in force; subsequently, the Law of the RA on Inventions, Utility Models and Industrial Designs replaced it. From 2021 onward, the Laws on Industrial Design and on

Patents of the RA have been in force. Moreover, according to the latter, there is a distinction between the invention patent (valid for 20 years) and the short-term invention patent, which is granted for a period of 10 years. However, in the statistics of the World Intellectual Property Organization (WIPO), short-term invention patents correspond to the utility model, so the total number of patents of the Intellectual Property Office of the RA Ministry of Economy does not match WIPO. Despite this discrepancy, the overall trend remains consistent: a decline since 2019. Additionally, in 2022, with the implementation of the new law in 2021, the indicator may have decreased further, considering some alterations in the process. Armenia's indicator of PCT patents applications per one billion dollars of GDP remained constant, securing the 53rd position in 2023. As reported by the Office of Intellectual Property, in 2022, the number of PCT applications amounted to 7 (Intellectual Property Office of the RA Ministry of Economy, 2022).

In the last h-index citable documents indicator of the Knowledge creation sub-pillar, Armenia secured the 76th position. In 2022, Armenia's h-index was 228, showing a 6.54% increase compared to the previous year. However, the indicators of several other countries increased at a faster rate, leading to a decline in Armenia's ranking both compared to the previous year and to the 2020 indicator.

Next, in the Knowledge Impact sub-column, the indicator of labor productivity growth is impressive: 3.4%, by which Armenia ranked 13th. The latter is calculated by the average value of GDP growth per employee over the last 5 years, so the reduction of the shadow economy also has a significant impact on this indicator. The next indicator in this sub-pillar is the value of unicorns in relation to GDP. As of April 7, 2023, the number of unicorns in the world (unicorns are those startups whose value exceeds 1 billion US dollars) is 1,207 (WIPO, 2023). And although this indicator is not calculated for Armenia, it is important to emphasize that Armenia is the only country in the South Caucasus that has a unicorn, Picsart. It is noteworthy that only a few countries with a small economy and population have startups that exceed one billion dollars. In the last indicator of this group, with the share of high and medium-high technology products in manufacturing at 5.6%, Armenia ranks 100th. It is important to emphasize that this indicator has slightly increased in recent years, by 1.2 percentage points compared to 2020. However, it is still considered one of Armenia's weak points.

Referring to the last group of the Knowledge and Technology pillar, the Knowledge diffusion sub-pillar, it should be noted that the degree of complexity of Armenia's production and export, in other words, the index of economic complexity (ECI), is problematic here. The latter is calculated based on the diversity and complexity of exported goods. Developed countries possessing great potential in knowledge, export complex products such as machinery, chemicals, vehicles, etc.

In contrary, developing countries, with limited capacity, tend to export goods with a low complexity index, such as mining and agricultural products. Over the last 20 years, Armenia has witnessed a decline in its ECI. In 2000, the index stood at 0.60, but according to the latest available data in 2022, it has regressed to -0.52. Consequently, Armenia has descended from the 35th position in 2000 to the 91st position in 2022 (The Atlas of Economic Complexity).

Another indicator reflecting knowledge diffusion is the proportion of high-tech exports in total trade. In 2020, this figure accounted for 0.7 percent of Armenia's overall trade, placing the country at the 79th position in the ranking. For comparison, it's worth noting that in GII 2020, when the 2018 indicator was applied, it was lower than the current result by 0.1 percentage points, but at that time Armenia was ranked 75th. Therefore, we can conclude that the decline in the position is not the result of the deterioration of the indicator, but simply the result of faster improvement of the indicator of other countries. Armenia's notable strength in the GII lies in the indicator of the share of ICT services export in the total trade within the Knowledge dissemination sub-pillar, standing at 7%. This achievement positions Armenia impressively at the 9th rank globally. In addition, in GII 2023 ICT 2021 indicator is used, that is, before several Russian specialists in the IT sector moved to Armenia as a result of the Russian-Ukrainian war. Therefore, we can predict that the indicators of 2022 and 2023 will be higher.

Indicators of the last pillar of the GII, Creative output, have also improved and are generally considered to be one of Armenia's strengths. Specifically, in terms of Trademarks by origin/bn PPP\$ GDP, included in the group of intangible assets, Armenia took 16th place in 2023, improving its position by one place compared to the previous year, but still falling behind by 2 places in 2020 as a result. Additionally, in the domain of Industrial designs by origin/bn PPP\$ GDP, encompassing rights that safeguard the decorative or aesthetic aspects of the applicant's product, Armenia ascended to the 45th position, signifying an advancement in comparison to the preceding year. In the group of these indicators, one of the weaknesses of Armenia is the absence of any brand among the Global Top 5000 brands. Although only 77 countries have brands in this series. In the group of creative goods and services indicators, with a 0.5% indicator of the export of cultural and creative services in general trade, Armenia took the 52nd position in 2023, declining by 0.1 percentage points compared to 2020. The indicator includes exports of advertising, marketing research, public opinion polls, cultural heritage, entertainment, and audiovisual services. In contrast to creative services, the export of creative goods (antiques, works of art, books, magazines, architectural plans and drawings, maps, films, jewelry, etc.) in the entire trade, with an indicator of 1.5%, in 2023, Armenia occupied the 35th position, improving its positions compared to both the previous year and 2020. The results recorded by Armenia in the last sub-pillar,

online creativity, are notably impressive. In terms of the indicator for general Top-level domains (gTLDs) per thousand inhabitants aged 15-69 (such as .biz, .info, .org, .net, and .com), Armenia ranks 61st. Additionally, with Country-code domains (ccTLD, such as .am, .ru, etc.), Armenia is ranked 52nd. Furthermore, there has been progress in both indicators compared to the previous year and 2020. Armenia ranks 35th in the number of commits on GitHub per million inhabitants aged 15-69. The latter is the world's largest AI code generation platform, primarily designed for developers. Finally, according to the last indicator, Mobile app creation/bn PPP\$ GDP, Armenia has improved its position compared to previous years and now occupies the 43rd position. This indicator is measured by the number of worldwide downloads of apps created in a given country.

CONCLUSIONS. In conclusion, an extensive analysis of the GII reports over the years reveals that Armenia exhibits a concentration of weaknesses in innovation input indicators while showcasing strengths in innovation output indicators. That is why, in 2023, Armenia secured the 83rd position in innovation input and the 62nd position in innovation output. This means that Armenia is effectively translating costly innovation into more and higher-quality outputs. However, this is not enough. Armenia used to perform better than it was expected to perform at its income level, while the current performance is in line with the income level, so there is a certain drop in efficiency in this respect. To unlock its full potential in innovative activities, Armenia must address its weaknesses through the formulation of a detailed strategy, incorporating specific schedules and targets for each identified area. It is important to underscore that certain weaknesses cannot be remedied in the short term, direct influence on some of them is limited and contingent upon simultaneous changes in numerous factors. Additionally, certain factors are caused by external influence and cannot be influenced only by the RA policy. However, there are factors that can be improved through the formulation of a coherent policy but these factors are not within the domain of one sector or agency. The advancement of innovative activity relies on education, science, nearly all sectors of the economy, business, and the institutional environment. Therefore, to attain substantial results, a systemic approach is imperative, but not only direct support for innovative activity at the final stage. The Department of the knowledge-based economy within the Ministry of Economy of the RA responsible for the development of innovative activities, should mainly perform the function of "project manager" to present recommendations to the officials of education, science, and other sectors of the economy in the direction of expanding innovative resources and improving the result.

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