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The effectiveness of AI-powered weapons from the standpoint of strategic decision-making (Case of Armenia)

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Abstract

The study explores the effectiveness and economic efficiency of AI-powered "smart" weapons production. It seeks to determine whether small countries facing significant security threats should allocate funds intended for arms imports toward developing an indigenous defense industry. This study employs a comprehensive analysis to evaluate key factors influencing the cost-effectiveness of AI-based weapons production. It separately examines the impact of AI-powered weapons in two scenarios: (1) importation and application and (2) domestic production. The analysis assesses their effects on national defense and security (to determine the effectiveness of defense spending) and on economic growth and development (to evaluate cost-efficiency, considering both positive and negative externalities). The analysis highlights the trade-offs between importing AI-powered weapons and investing in indigenous production. While domestic production may enhance technological independence and stimulate economic development, it also presents challenges such as high initial investment costs and technological barriers. The findings suggest that a balanced approach, considering both security needs and economic feasibility, is essential for small countries with a high probability of military conflict. The study provides policymakers with a framework for assessing the strategic and economic viability of AI-based weapons production. It offers insights into optimizing defense expenditures to enhance both national security and economic resilience.

Keywords: Artificial intelligence, Cost-effectiveness, Defense industry, Smart weapons.

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1. Introduction

The widespread use of AI in the military domain can essentially change the strategic balance in different regions and around the world. The realization of the importance of this circumstance has forced a large number of states to pay special attention to the AI development and production or acquisition of "smart" weapons. Moreover, in the context of the current world order, superpowers (in particular, the USA, China, and Russia) in their grand strategies reserve a special place for the importance of "strategic deterrence" of AI. This trend can be described as an effort to position itself as a full-fledged participant in the global race for technological superiority, attempting to compete in the realm of AI development for economic, military, and geopolitical advantages. Today, these approaches are already part of broader national identity narratives of the superpowers interwoven with more specific ideas of military "self-confidence" and pride, which serve the purpose of deterring an adversary in the long run [1].

Under such conditions, small states, as well as actors with large or small geopolitical weight in different regions, cannot remain aloof from the mentioned developments and seek to arm their military-political "arsenal" with AI-powered weapons or to accumulate the necessary potential for indigenous design and production of such weapons. In both cases, the increase in military spending is the primary factor that can contribute to the realization of such objectives. However, if in the first case we are talking about the acquisition of "smart" weapons, then in the second case, it is about the financing of military research and development. In this regard, especially in the case of small countries, a dilemma can arise in two different but related dimensions. Firstly, it is necessary to clearly assess and to record initially at the level of strategic guidelines for national security what is most important: to order and buy "smart" weapons from large private companies − mostly foreign − which, due to economies of scale, can provide relatively low prices or avoid dependence on them and direct military spending to the development of their own military applications? The stimulation of the "smart" technologies development in the civilian sector can serve as an option for a dilemma solution, given that the vector of innovative developments has shifted significantly in modern conditions, and today the effect of their distribution and further transfer to other domains begins with civilian industries. Indeed, new digital technologies are mainly developed in the civilian sector and only then they transferred to the military domain. Moreover, the financial resources allocated to scientific and technical developments in the civilian sector have come to significantly prevail over the spending allocated to research and development in the defense sector, as a result of which the defense sector becomes somewhat dependent on civilian (commercialized) developments in terms of certain technological developments [2]. However, the quandary of choosing the direction of "smart" technologies development – civilian or military – may seem simple only at first sight. It is obvious that most military applications have important features both in terms of performance and reliability requirements for the tasks performed, and the characteristics of the processed data (infrared image recognition, data from radar stations, etc.), while applications developed for the civilian sector may not meet these requirements and simply do not have the ability to adapt to the functions of military operational systems.

The main purpose of this paper is to study the issue of economic efficiency of the production of "smart" weapons based on artificial intelligence and try to answer the question: of whether it would be appropriate for a small country (such as Armenia) with a great security issue, direct funds intended for the import of weapons to the development of the indigenous defense industry? How long will it take to reach such a level of indigenous weapons production that it will be possible to ensure the country's security?

1.1. Approaches to Assessing the Effectiveness of Defense Spending

The evaluation of military spending effectiveness is one of the least scientifically studied issues. There is a much greater number of studies that assess the impact of military spending on economic indicators − mainly economic growth Das, et al. [3] and Wolde-Rufael [4] public debt Dimitraki and Kartsaklas [5] development of the non-military sector Lin, et al. [6] etc. Meanwhile, there are significant methodological differences in measuring the impact of military expenditures as an economic factor and in assessing their effectiveness as costs aimed at producing public goods. Referring to the latter, it is about methodological approaches to measuring the "volumes" of production of "defense" as a public good.

The issues associated with measurement methodology cannot be considered as resolved even if we try to distinguish between the concepts of ***cost-efficiency*** and ***effectiveness***. If in the first case, we are dealing with a simple comparison of costs and output as well as the most economical use of resources, then in the second case we are talking about the goals that must be achieved with these costs, without taking into account the price and means to achieve it. In the matter of ***effectiveness,*** the most obvious and unequivocal assessment of the production of new technology-based weapons is the degree of ensuring the country's security, which itself requires that the effectiveness of military spending must be considered from the point of view of the effectiveness of ensuring defense and state security. Meanwhile, consideration of the issue from the point of view of ***cost-efficiency*** can reveal certain contradictions, underestimation or ignoring of which can distort the true assessment of efficiency. The issue becomes quite complicated not only because it is difficult to suggest such a scale of measurement that would allow to measure the "production volumes" of defense and security, but also because the assessment of the effectiveness of military spending also implies evaluation of opportunity costs and externalities of public goods (spin-off benefits and spillover costs), since the defense is a classic example of public goods.

Hartley [7] believes that the task of determining the optimal size of "defense" should be solved based on the general principle of optimal decision-making in economics, which determines the optimal volume of output by equating the marginal costs of production with marginal revenues. However, he also notes that applying such an approach to defense will be quite difficult, since the marginal benefits of funds allocated in the country's defense are not always immediately

visible, they usually appear after a long stretch of time. On the other hand, most of these benefits – which the author divides into economic and non-economic – cannot be measured. For example, it is impossible to measure the prestige and international reputation of a country, the citizen's feelings when living in peaceful conditions, the ability of citizens to realize their talents and skills for their own well-being, etc [7]. From the standpoint of scientific task setting for the assessment of "defense output" based on the "input-output" approach, as well as for systematization and analysis of existing general approaches, the study of Hartley and Solomon [8] is also of great interest [8]. The study presents other economic models for assessing the effectiveness of defense spending – public choice model, "beneficiary-agent" model, defense production function (DPF), production function describing military R&D, which is considered as a variety of DPF, models and approaches for assessing the externalities of military R&D. Since the axis of this research is assessing the cost efficiency of different alternatives for military expenditures allocation, it makes sense to refer to the multi-objective decision-making model in the field of defense as Wall and MacKenzie [9]. The model suggests approaches to quantitatively measuring performance in the public sector, designed to address decision-making problems aimed at the realization of multiple objectives simultaneously. One of the most complex decision-making problems in public administration under conditions of "*multipurpose*" is the optimal allocation of public expenditures. According to this approach, the most important stage in making such decisions is the construction of a hierarchy of priorities (objectives), followed by an assessment of "natural", "structured" and "proxy" types of effectiveness measures, a quantitative assessment of decision-makers' preferences and marginal changes in efficiency individual indicators. Note that one of the major drawbacks of this method is that it is almost impossible to correctly assess the preferences of decision-makers. However, it provided a base for assessing the cost-effectiveness of autonomous aerial platforms and communications payloads in various military mission scenarios [10]. Although this approach is flexible enough to be adapted for assessing the cost-effectiveness of weapons relevant for different military missions, it still primarily compares the acquisition costs per unit of weapon, military equipment or military purpose other facilities, while the cost factor in determining the value of modern weapons, according to some theorists, have ceased to be important [11].

The policy paper from the US Mitchell Institute for Aerospace Studies proposes a new approach to evaluating the effectiveness of defense resources − the "cost-per-effect analysis" approach [12]. According to the authors, the new approach is a very useful analytical tool allowing us to compare the "business cases" behind different approaches and prioritize those that can simultaneously provide high mission effectiveness and fiscal efficiency. The formula for the efficiency of defense resources has a simple formulation: "Wars are not won by lowest-cost bidders". Nevertheless, even in this case no exhaustive answers are provided to the question of how, ultimately, to evaluate the "military mission performance," because the real effectiveness of all types of weapons can be assessed only after combat operations.

In the hope of providing more concrete direction to the research in the chaotic confusion of approaches to assessing defense cost-effectiveness, we will also present approaches regarding the impact of military R&D expenditures. Certainly, these approaches are also varied and often contradictory, which is likely to lead to even greater confusion in addressing the issues of allocating military spending in favour of developing local production of new AI-powered weapons.

From a methodological point of view, almost all studies compare the effectiveness of military R&D with the effectiveness of civilian R&D. Lichtenberg [13] for instance, believed that the rate of social return of government-funded R&D − mainly related to the military sector, or the impact on productivity growth in the economy, was not significantly "different from zero", in contrast to private R&D. The contrast between military (public) and civilian (private) R&D also plays a central role in the study of issues of reallocation of public expenditures from an efficiency perspective. Meanwhile, it is the opposition of these two that can lead to a senseless waste of resources when making strategic decisions on the allocation of public expenditures, since in a real economy one should serve as a support for the growth of the other, and the allocation of resources should be done according to this logic. It is especially important to develop a concept for promoting privately funded military R&D in countries facing serious security challenges. In this regard studies assessing the incentive effect of military R&D on civilian R&D and generally confirming that military R&D has a significant positive impact on private sector R&D and innovation are of great interest [14]. For example, using least squares and instrumental variables methods on a longitudinal dataset comprising data for 50 US states and the District of Columbia for the period of 1968-2017, Palante et al. showed that a 1% increase in defense R&D over 4–5 years crowds-in private R&D expenditures with an elasticity of 0.11%–0.14% [15]. According to the same study, the defense-related R&D also had a positive effect on employment in high-tech sectors, albeit with lower elasticities – 0.05-0.1%. One of the methodological features of the research is that military R&D expenditures are considered a component of the "mission-oriented" innovation policy. Such a policy implies a set of measures of the government intervention in the economy, the ultimate goal of which is not only to promote innovations, but also to provide such technological progress leading to the realization of certain social goals within a clearly defined time frame [16].

The study of the influence of artificial intelligence on innovative processes in the economy also requires special attention which will then be projected to the study of the consequences of the military AI development. The research carried out in this regard mainly proves that AI has a positive impact on the "production of ideas" and hence the rate of innovation, which ultimately leads to economic growth and to increase in productivity throughout the entire economy [17].

The authors of the study "Economic impacts of AI-augmented R&D" discovered an interesting mechanism of the impact of AI on economic growth and productivity [18]. They believe that the rate of productivity and economic growth could be increased by 2-fold if scientists can more effectively harness all the advantages that AI offers – in particular AI sub-technologies based on deep learning. The basis for this assertion is the empirical research conducted using endogenous growth models, which show that the increase in the capital intensity of R&D leads to an increase in productivity and

economic growth. At the same time, the research shows that R&D conducted with deep learning-based computer vision technology is significantly more capital-intensive than virtually any other forms of R&D in the USA. The exercise of these arguments' logic in the case of the defense domain appears that at least in terms of increasing the efficiency of military R&D, the implementation of AI can lead to cost-saving and increased productivity.

As we can see, it is difficult to find such an integrated approach to assessing the effectiveness of defense expenditures allowing to prove or disprove by reasonable calculations the cost-effectiveness of the AI-powered weapons. On the one hand, it is impossible to compare the expenditures for weapons acquisition and/or development with the results obtained, since a significant part of these results (security, peace, victory, etc.) are often not measurable. On the other hand, it is difficult to measure all "missed benefits and profits" that could have been obtained if defense expenditures had been directed to the production/acquisition of other types of weapons or to the implementation of civilian projects. Moreover, these "missed benefits" each time would have different nature, depending on the change in the set of strategic priorities of states. The possible negative and positive consequences of import substitution in case of the development of an indigenous AI-based defense industry and the assessment of the influence of time preferences rate of defense R&D remain pivotal questions, because AI as a state-of-the-art technology predetermining the future of human society lifestyle as well as the future of warfare still has great development potential, and the manufacturing the AI-powered weapons requires the implementation of large-scale R&D.

2. Research Methodology

Among the difficulties mentioned in the conclusion of the previous section, the assessment of the cost-effectiveness of AI-based weapons manufacturing is also complicated for the simple reason that there are almost no statistical data that separately present the R&D expenditures for AI application in the military domain. Therefore, in our research, we will use both quantitative and qualitative analysis methods, and in the analysis the most important factors (direct costs, opportunity costs, externalities) influencing the research object – cost-effectiveness of the AI-based weapons production – will be highlighted and then the results will be synthesized into a general conclusion. ***Direct costs*** include all expenses (raw materials, labor, R&D, etc.) that can be directly tied to the production and determine the price of weapons in the market. In our research, we emphasized the R&D expenses, because AI-powered weapons are considered as "new technological", so the R&D expenses have a large proportion of the price of such weapons. *Opportunity costs* refer to the so-called "missed opportunities" and in the context of our research relate to what the state might lose (if the state loses anything at all) in case of reallocation of resources to the production/procurement of innovative AI-powered weapons, is it possible that the resources provide greater utility (for example, a higher level of security) if they are used to acquire other types of weapons? In considering these questions, much attention has been paid to the importance of resolving the "exploration-exploitation" dilemma for small countries. At the most sample definition, *externalities* are positive or negative side effects for parties not directly involved in an economic transaction and whose gains or losses were not initially calculated as costs or benefits for either party [19].

To apply this approach, we will separately study the *impact of the application of AI-powered weapons* (in case, where they will be imported) and *the indigenous AI-powered weapons production* on defense and security issues (to reveal the effectiveness of defense spending), as well as on economic growth and development (to present the ***cost-efficiency*** of defense spending, taking into account also possible positive and negative externalities). Indeed, the separation of these dimensions will be conditional, because in the modern world they are quite intertwined, and as we have already noticed, one serves as a pillar for the other. For example, the study used the "cost-benefit" method for quantifying the effectiveness of AI weapons, by not only comparing the costs required to develop AI weapons with three different quantitative parameters of benefits (reduction in manpower due to automation, operational costs of weaponry and military equipment, and decrease in wasted ammunition due to reduced target failure) but also took into account important "benefits" that cannot be quantified (such as the ability to replace limited manpower in small countries, which has a huge positive moral and psychological impact on society as a whole). Using regression analysis, we determined some externalities for Armenia (e.g. the negative impact of military spending on public debt was studied by using Johansen [20] cointegration and Granger's causality tests Harutyunyan [21] as well as the differences in the impact of indigenous arms production and import of weapons on economic development in Armenia (using generalized method of moments [22]). However, taking into account the multidimensional nature of this research, not all the methods used have been presented in detail. We will consider all these aspects related to the research problem in the short and long-term perspectives. Based on assessments, a matrix (map) allowing to draw any definite conclusions about the various measures of the AI-based weapons effectiveness will be built.

2.1. Advantages of AI-Powered Weapons in Addressing Defense and Security Issues

There are many studies on the advantages and effectiveness of using AI systems in different domains. According to various forecasts, AI has the potential to increase labour productivity by up to 40% in 2035 [23]. However, the views of scientists on the advantages of AI-based weapons do not always coincide. The point is that unlike other areas where the application of AI can lead to increased labor productivity, output and sales volumes, reduction of rejected products, etc., the ultimate result of the AI-based weapons application is the "quintessence" of public goods − national security [24]. Albeit the economic value of national security cannot be measured as well as impossible to reveal by economic calculations all the possible losses (human, financial, material, moral, etc.) that a state could suffer in conditions of "insufficient" national security.

Moreover, the impossibility of such assessments also makes it difficult to evaluate the effectiveness of funded programs − both public and private − for the development and production of AI weapons in different states, and their comparative analysis. On the other hand, the most advanced types of such weapons were developed relatively recently, and the arguments about their real effectiveness can be "collected" only after actual combat operations. Relatively advanced AI-based weapons are also classified in almost all countries, and official information about them is scarce to be taken into account when assessing their effectiveness. Nevertheless, strong arguments can be made in favour of the effectiveness of applying AI-powered weapons.

Like any technological innovation, the R&D for the development of AI-powered weapons requires a large financial investment. Despite such high costs, various studies indicate that these weapons can provide significant economic benefits by reducing the costs of military operations in various ways [25]. For instance, the same task emerging during hostilities can be solved with fewer troops, thereby enabling the command to focus human and other resources on solving more complex combat tasks. Autonomous weapons systems based on AI technology will in all likelihood also provide an opportunity to significantly reduce military personnel costs. For example, according to David Francis, in 2013, the United States spent 850,000 USD per year to keep and equip one soldier in Afghanistan, while in the same year, the cost of one all-terrain TALON robot was only 230,000 US dollars, the South Korean SGR-A1 robot costs 200,000 US dollars, and the 710 Warrior robot costs 300 - 400 thousand US dollars [26].

For addressing defense and security issues, as already noted, the advantages that can be achieved at the operational level are the most important aspect. The functional advantages provided by AI-powered weapons are as follows: speed and accuracy, endurance, autonomy, but at the same time the possibility of coordinated work, improving the decision-making efficiency, the possibility of physical transformation. However, many researchers (see, for example, Scharre [27] and Etzioni and Etzioni [28]) believe that the greatest advantage of AI-powered weapons availability in the arsenals of various states remains the ability to save human lives. As a result of the increasing mortality rate due to the 44-day war and the pandemic in 2020, Armenia's demographic picture has sharply worsened. Population growth, which averaged about percent in the previous ten years, was 0.1 percent in 2020 and 0.8 percent in 2021. In 2022, population growth reached 3.2 percent, mainly due to the large influx of migrants as a result of the Russian-Ukrainian war, but this is temporary. In such a situation, AI-based weapons can replace manpower both directly – for example, when replacing border guards with autonomous robotic systems, and indirectly, when autonomous vehicles and equipment are used when performing operations in particularly difficult conditions (for example, when neutralizing a minefield). On the other hand, there are studies, proving that the use of AI-powered autonomous weapon systems significantly reduces the death of civilians in wartime [27]. The absence of manpower on the battlefield is one of the predicted features of future wars Allen [29] which is important to consider in strategic decision-making on AI-powered weapons production and development.

The future also belongs to "intelligentized" warfare, where the "systems confrontation" is replaced by "algorithm confrontation" [30]. In such wars, the state that will be able to acquire the utmost benefit from AI-supported decision-making and action improvement will retain the advantage. This is another incentive for those small states that are able to design technologies based on AI, to initiate the development of mechanisms enabling the seamless integration of new technologies into the military sphere. However, the issues related to the introduction of new military technologies have some important aspects that could significantly change the existing perceptions about their advantages. In particular, we are talking about the features of the *"exploration-exploitation dilemma"* when considering it from the standpoint of military innovations, since AI-powered weapons and systems, as well as structural or adaptive changes in the Armed Forces for their exploitation are, in fact, military innovations, and they will remain so for more than ten years. The core of the dilemma is that people (decision makers) have a natural − and often justifiably − tendency to "sacrifice" long-term benefits (available due to *exploration* and innovation) to short-term benefits (available through *exploitation*) [31]. If we project judgments on the issue of the efficiency of innovations in the military sphere, it becomes obvious that the choice of an "*exploitation strategy*" may imply the use of already known, time-tested weapons under conditions of minimal uncertainty or purchase such weapons, if we consider the issue in the context of an alternative "purchase or development" of new technological weapons. The "*exploration strategy*" is the search for new opportunities, for example the development of new weapons under conditions of significant uncertainty of their usefulness. The point is that in the private sector, the solutions to this dilemma are not so complicated, since financial resources are all that can be lost because of unsuccessful innovations. Meanwhile, the failure of innovations in the military sector, as well as inefficient allocations for military research and development (R&D) in the face of limited financial resources, can lead to a decrease in the combat capability of the Armed Forces of the state, deepening defense and security issues and loss of human lives [32]. Thus, small states aiming to modernize their military domain can caught in the "exploration-exploitation" trap [33].

2.2. Impact of AI-Powered Weapons Production on Economic Growth and Development

According to McKinsey Institute estimates, AI has the potential to contribute an additional 1.2% annual growth of global economic activity, increasing global economic growth by an additional US$13 trillion over the period 2018-2030 [34]. According to another research, global GDP could increase by up to 14% in 2030 compared to 2017 Studley and Kuperholz [35] and in some developed countries that together generate more than 50 percent of the world's economic output, AI has the potential to double annual economic growth rates, contributing to the annual growth rate of gross value added of 2.5-3.9% in those countries [36].

There are four main channels through which the development of AI-based arms production could have an impact on the state's overall economic development and economic growth:

- *The sense of security and peace* is an essential prerequisite for economic growth in any nation, as both human and financial capital tend to leave countries that have serious security problems. And states that manufacture high-tech weapons are naturally also the states capable of ensuring a high level of security, because they definitely have effective weapons in their arsenal.
- Artificial intelligence is transforming from a dual-use technology to a "general purpose" technology Goldfarb, et al. [37] *greatly increasing the efficiency from automation of production processes*, and the automation has been a major driver of economic progress over the past 150 years Aghion, et al. [38]. Although, as we have seen, the transfer of technologies − including AI − in the new digital era occurs according to the logic of "from civilian to military domain", however this does not exclude the reverse process, that is, the possibility of transferring technologies from the military to the civilian domain, which will create additional incentives to improve productivity in the economy. On the other hand, the production of AI-powered weapons should be preceded by R&D, which in turn will contribute to the development of fundamental studies and research infrastructure in the country, thereby promoting economic growth through another channel [39]. Moreover, Trammell and Korinek [40] show that if the automation of final good output leads to a one-time increase in economic growth, then the automation in science and research − and AI enables this automation in many ways − can provide exponential growth.
- *Positive externalities.* According to some analysts, the contribution of AI-powered weapons to economic growth through the previous two mechanisms − the increase in security and the widespread automation − can also be classified as spillover, but in our opinion, the external positive effects of the production of such weapons have completely different channels of manifestation, attributable to the system-forming significance of the defense industry in the economy and to the multiplier effect of military spending. Funding R&D for the design of such weapons through state defense orders will achieve results that are diametrically different from the impact of military expenditures spent in other areas. In particular, if the example of different states has confirmed the pattern that an increase in military spending leads to an increase in the level of the country's poverty (see, for example, Henderson [41]), then policy aimed at developing AI technologies, which can partially be implemented in the defense industry, can lead to the opposite effect, reducing poverty in the country as a positive externality (see, for example, [42, 43]). Another significant positive externality could arise for arms-importing states, which have accumulated a significant portion of their external debt as a result of continued military acquisitions [44]. The development of AI technologies will allow these countries to significantly reduce their dependence on foreign weapons supplies, reduce the deficit of the balance of payments and the state's external debt. The expectations of such a positive externality are important especially for Armenia, because, as we have already shown in our previous studies, the increase in Armenia's foreign debt in 1994-2020 was caused by the import of military products [21]. In addition, the analysis based on 15 years of data (2004-2018) of Armenia and 15 other countries (which are in the world's top 15 in terms of the share of military expenditures in public expenditures) using the GMM method showed that the countries with developed defense industry, military spending has a positive impact on GDP, and in countries that mainly import weapons, military spending has a significant negative impact on GDP [22]. The mentioned examples, as well as evidence of technological spin-offs and positive externalities of AI-powered weapons production, show that indigenous production of such weapons is preferable to importing, especially for small countries with large military budget.
- *Cost reduction.* The development of AI technologies is directly related to Denning and Lewis [45]. The latter claims that the number of transistors that can be put on integrated circuit chips has doubled every 2 years since their inception, doubling the capabilities and efficiency of computing while enabling their price reduction. In addition, according to many researchers, the application of AI-powered weapons and autonomous systems by the armed forces can reduce total military spending in the long term due to increased efficiency and reduced demand for military personnel [46]. Certainly, such a cost reduction will be some regard neutralized, since the need for widespread use of AI in the military sector will force defense agencies to attract highly skilled labor from other industries (where their salaries are quite high) by offering higher wages [47]. However, cost reduction may also be possible due to saving on capital expenditure. In particular, preventive maintenance of fixed assets − which is one of the important advantages of introducing AI in the defense industry [48] − increases the useful life of assets, thereby reducing the need for investment in the acquisition of new equipment. In general, the innovative processes associated with the introduction of AI make it possible to produce the same product at lower costs in all types of production [49].

As for the negative externalities of the production of AI-powered weapons, they can be caused mainly by the outflow of human capital working with AI technologies from other industries. The continued large financial investments in defense research and development have led to an influx of scientists and engineering personnel from other fields [50]. However, under conditions of the widespread use of AI, investments in the production of AI-based weapons can contribute not only to an increase in demand for qualified human capital and engineers, but also to an increase in supply (for example, through state military order for defense research and development to various research institutions and universities). In this case, it will be possible to achieve equilibrium in the human capital market, and this will prevent the crowding out effect [51].

2.3. Problem Solution Mapping for Armenia

In order to weigh the advantages and disadvantages of the production of AI-powered weapons for Armenia and to map possible solutions, we have separated the possible impacts of importing and producing AI-powered weapons for short-term and long-term and summarized them in Table 1. In the short term, we assessed the impact of AI-powered weapons import as ***weakly positive***, taking into account the fact that at the present stage of global geopolitical transformations, when competition between countries has stirred up, especially in the respect of possession of technological weapons, the countries producing AI-powered weapons are not yet willing to export such weapons. It is also in some extent justified by the concept of the technology life cycle, since AI and other related breakthrough technologies are still at the growth stage of the life cycle, and their export is likely to start only at the maturity stage. On the other hand, currently, Armenia does not have such a military ally or partner in the military-technical and military-economic domains ready to supply the country with AI-based weapons. Even if such weapons could somehow be imported, this would not bridge a technological gap with geopolitical adversaries that could deepen in the long term. And yet, in modern warfare, it is better to fight with advanced technological weapons than without them. As for the impact on economic development, in the short term this impact can be assessed as ***neutral***, while in the long term this impact is unambiguously ***negative***, since under conditions of a large burden of public debt servicing, any "non-productive" import will limit the possibilities for further economic growth. In the context of rapid changes in technology, this cannot be compensated even by the positive effect of adapting and imitating technology, which possibility is also quite small due to the weak interdependence between the production ecosystem of civil AI and the military domain.

For indigenous design and manufacturing of AI-powered weapons, the Armenian government must first make a choice in favor of "*exploration*" in an*"exploration-exploitation"* dilemma, leading to an "insufficient solution" of the security issues in the short term, since under budget constraints it will not be possible to simultaneously maintain a high level of current combat readiness and make large investments in research and development, the results of which will only be visible in the long term. Of course, given the speed of technological changes, the definition of time duration have also changed. Thanks to modern technologies, it is possible to modernize any nation's armed forces in a much shorter period of time (3-5 years) than at the end of the previous century or even at the beginning of the current century (15-20 years). In terms of economic development, the impact will be ***positive*** in both the short and long term, as the demand for AI technologies will increase the demand for quality labor and production volumes in related and supporting industries, dependence on weapons imports will be reduced, and new pillars will be formed for economic growth. Undoubtedly, in the modern world, ignoring the capabilities of weapons based on AI technologies and delaying the development of strategic guidelines for their design and development can have a ***strongly negative*** effect both in terms of addressing security issues and economic development for nations that have significant security problems and are forced to have large military forces and to incur large military expenses to maintain them. In the conditions of rapid changes in the nature of modern warfare under the influence of technology, technological dependence on other states and amorphous politics to overcome it is a "strategy of defeat", especially if we consider that geopolitical adversaries are implementing a much more proactive strategy in this direction.

3. Conclusion

Presented in Table 1 not large set of solutions to the problem stated at the beginning of the study (which is more appropriate − the import of weapons based on AI technologies or their indigenous production?) allows us to conclude that from the point of view of addressing both security and economic development issues, the peculiarities of the geo-economic environment of Armenia require all resources to be directed to the development of AI technologies, paying special attention to their application in the military sphere. This is the only development path that will save military expenditures, use already over-stretched budgets more efficiently, modernize the Armed Forces in the shortest possible time, bridge a technological gap with geopolitical adversaries, and in the future turn this gap in favor of Armenia. Although the achievements and potential of Armenian companies in the IT sector are often presented as justification for such a strategy, nevertheless it is necessary to change the perspective of defining strategic guidelines, and not be guided by the frame of mind that we should develop those areas where we have comparative advantages, but those areas that really need to be developed, but this requires much more effort. It turns out that the classical and neoclassical approaches to economic development (within the framework of comparative and competitive advantages, respectively) are not very good advisors when the priority is addressing security issues. The only assessment of the effectiveness of defense resources remains the victory in the war and, as we have already noted, "Wars are not won by lowest-cost bidders".

Table 1.
Problem solution mapping.

		Issues that can be solved with AI technology-based weapons			
		Security issues		**Issues of economic development**	
	Import of AI-powered weapons	**Short-term**	**Long-term**	**Short-term**	**Long-term**
		If import is possible, this can provide a solution to certain security issues *weakly positive effect*	In an environment of rapid technological change, the technology gap may widen *weakly negative effect*	None of the listed effects on economic development can actually be manifested *neutral effect*	If there is a heavy external debt burden, imports will increase the burden and further technological development will be limited *negative effect*
	Indigenous design and manufacturing of AI-powered weapons	Short-term	Long-term	Short-term	Long-term
		Limited capacities for dealing with current security issues *negative effect*	The indigenous manufacturing of AI-powered weapons will provide a significant advantage over potential adversaries *strongly positive effect*	The reduction of the import of military products will have a positive effect on the GDP; new pillars for economic growth will be formed *positive effect*	The state can develop into a technologically advanced state, since the need to make large military expenditures for security reasons will ensure the continuity of financial flows for the development of this domain *positive effect*
Alternatives to acquiring AI-powered weapons	Neglecting opportunities of IA-powered weapons	Short-term	Long-term	Short-term	Long-term
		From the standpoint of realities and trends of the AI application in modern wars, the impact is bound to be negative. *strongly negative effect*		Taking into account the facts about widespread use of AI in all branches of the economy and in all areas of society, as well as the proven positive effect on the increase in productivity of production process, the impact will be extremely negative. *strongly negative effect*	

At the same time, it is important to look for ways out of the "exploration- exploitation" trap. It is impossible to "sacrifice" indefinitely the future for the present, although, of course, the military R&D expenditures significantly discount future positive outcomes in accordance with the time preference rate (even to the point of neutralizing them), and this rate works to the detriment of R&D preferences in the extent that the country is underdeveloped. However, at some point, it is necessary to reduce the current military consumption (bringing it to the minimum necessary) and start financing innovations, in this case – to the design and production of AI-powered weapons. The challenge is in the moment, and the time is always now.

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