ISSN: 3106-0641
e-ISSN: 3104-4727

JOURNAL OF
Economics

JOURNAL OF ECONOMICS

Volume: 3 Issue: 3

2026

International Indexing

economics@aem.a
info@aem.az
https://aem.az/en

Journal of ECONOMICS
August 2026, Volume: 3, Issue: 3, pp. 5−16
DOI: https://doi.org/10.36719/3104-4727/8/5-16

Lionel Robbins on the Definition and Subject-Matter of Economics: Some Critical Observations

Khandakar Elahi

Abstract. *In "An Essay on the Nature and Significance of Economic Science," Robbins challenged the classical conception of economics, which he called "materialist." He replaced this classical idea with the "scarcity" concept: "*Economics is the science which studies human behaviour as a relationship between ends and scarce means which have alternative uses." The definitions of economics we find in modern textbooks are variants of Robbins' statement, and the catchphrase that has finally emerged from this controversially acclaimed definition is: "Economics is a science of choice." This paper represents a *critique that systematically examines Robbins' century-old adage to argue that Robbins' thesis is logically indefensible for many reasons, including the fact that the definition of science cannot be derived from its subject-matter, which expands as time passes; the subject matter of a science is supposed to be implied by the definition. However, the most damaging influence of Robbins' conception on modern economics is his submission that the discipline is free from all moral obligations because it is a science. Following this submission, some prominent economists have devoted their personal and private time and society's resources to research that serves little social welfare. Some of it indeed contradicts society's legal and judicial system.*

Keywords: *microeconomics, homo economicus, macroeconomics, health economics, health policy, medical care industry*

Introduction

One of the longest-lasting controversies in economics concerns its definition and subject-matter. In his controversial classic, *An Essay on the Nature and Significance of Economic Science*, Robbins (1932) introduced this debate by challenging the conventional wisdom about the definition and the subject-matter of the study. This conventional wisdom, according to Robbins, is the materialist definition, which argues that the main objective of studying economics is to promote the material welfare of society and its ordinary people. Thus, the subject-matter of economics is confined to the study of production, consumption, exchange and distribution of material goods and services. The most representative account of this view is Marshall's definition: "Political Economy or Economics is a study of mankind in the ordinary business of life; it examines that part of individual and social action which is most closely connected with the attainment and with the use of the material requisites of well-being (Marshall, 1890, p. 6)."

University of Guelph, PhD in Agricultural Economics, Guelph, Canada
E-mail: kelahi53@gmail.com
Received: 10 January 2026; Accepted: 31 March 2026; Published online: 14 August 2026

Robbins rejected the Marshallian conception on two grounds. First, economics is free from moral judgements because it is a science. Second, the materiality constraint on the definition of economics is logically indefensible because many activities, performed in modern economies, do not directly involve material goods production. However, they satisfy all the criteria by which an activity is qualified as 'economic.' To Robbins, any activity is eligible for economic investigation if it meets those criteria.

This debate over a 'concise' definition of economics has created a sort of frustrating situation in the profession. For example, the famous Chicago economist Jacob Viner sarcastically said, 'Economics is what economists do.' This is simply a satire because it is a circular statement. Frank Knight converted this satire into a full circle by adding, 'economists are those who do economics (Buchanan, 1979). Nowadays, some economists downplay the importance of this disagreement under two pretexts (Backhouse & Medema, 2009a; 2009b). First, modern economics deals with so many issues that any 'concise' definition would be 'inadequate' to embrace them all. Second, this never-ending definitional disagreement does not necessarily pose a serious problem for the subject, because 'economists are generally guided by pragmatic considerations of what works, not by formal definitions.'

The view, which diminishes the importance of the long-standing disagreement, seems both inadequate and unclear. Economic activities in modern times are much more diverse and complex than they were when Adam Smith conceived the discipline. However, this fact does not suggest that the activities and events, which Smith qualified by the adjective 'economic,' are different today in terms of their fundamental features. There is no evidence that the denotation of the word has been substantially reformed through its connotation.

However, the fact that the debate has persisted for so long suggests that something is missing; critics as well as admirers of Robbins' conception seem to have overlooked critical points that have prevented them from reaching a satisfactory resolution of the controversy. This paper argues that there is at least one missing point that deserves our critical attention. Robbins has used the terms 'definition' and 'subject-matter' interchangeably, which is confusing because they are two different words that signify two different ideas. This paper examines this overlooked issue. The paper has been organised into four sections, including the present one. The next section summarises Robbins's chain of reasoning that led him to formulate and justify his definition. This chain of reasoning is critically examined in Section III in the light of the conceptual distinction between 'definition' and 'subject-matter' of economics. Finally, the paper is concluded in Section IV with some closing comments.

II. Robbins on the definition and the subject-matter of economics

In the preface to the first edition of the *Essay*, Robbins informs the readers that he has two purposes for writing this book. First, it furnishes the 'precise notions about the subject-matter of economic science and the nature of generalisations it consists of'. Second, it explains the limitations and the significance of these generalisations, which would help interpret the reality and serve as a guide for political practice.' To accomplish this purpose, Robbins divides the *Essay* into six chapters. In this paper, we are concerned with the first one, titled 'The Subject-Matter of Economics". The most important aspect of this chapter is that Robbins provides a "working definition" of economics, which, as mentioned above, has become a catchphrase in the discipline. The following paragraphs summarise the major points made by Robbins in this chapter.

The materialist definition of economics

The most common definition of economics, he states, is the one that considers it as an investigation aimed at identifying 'the causes of material welfare.' The works of such economic personalities as Edwin Cannan, Alfred Marshall, J. B. Clark and Vilfredo Pareto testify to the truth of this statement. From an ordinary standpoint, this definition makes good sense because the words "economic" and

"material" are treated equivalently in everyday usage. However, this apparent harmony of the term with its daily usages does not fulfill the scientific requirement of constituting a discipline's subject-matter. When this definition is subjected to critical inquiry, it amounts to nothing less than a complete failure to exhibit either the scope or the significance of the most central generalisations of all, Robbins argues.

This argument is substantiated by the theory of wages, which is an integral part of economic generalisations. By 'wages,' economists usually understand labour incomes other than profits. However, in the 'strict' sense, the term refers to the sum earned for performing work at a stipulated rate under an employer's supervision. In other words, the wage is the price of labour paid for any kind of job performed, irrespective of its association with material production. For example, the theory explaining wage determination in industrial production is equally effective at describing it in the entertainment industry. Accordingly, the distinction, traditionally drawn between material and nonmaterial production, seems to have weakened the welfare objective attributed to the study of economics.

Although no serious economists have tried to delimit wage theory in this manner, the whole body of economics has been delimited nevertheless. This is because advocates of this definition deny the applicability of economic analysis to the examination of ends other than material welfare. For example, Cannan (1914) argues that 'Political Economy of War' is 'a contradiction in terms' on the ground that economics is concerned with the causes of material welfare. Since war does not serve this objective, it cannot be part of the subject-matter of Economics.

This argument seems confusing because modern economists have unanimously rejected Smith's classification of labour as productive or unproductive. More specifically, they hold that the labour used in the production of any object must be considered productive if there is a demand for it. By this argument, the entertainment industry's labour should be regarded as productive, just like in agriculture or manufacturing. However, the justification they offer for treating labour used in the entertainment industry seems all 'dilettantism and Wortspielerei.' (These are terms often used in academic, economic, or literary criticism to describe shallow, unscholarly, or overly playful approaches to serious topics.) It is often argued that labour used in entertainment is productive because it inspires people involved in material production to work harder. This opinion is criticisable because people are willing to pay for this service, as they derive utility from it. Therefore, Robbins claims that the conventional conception, which describes economics as the study of material welfare, is misleading. "The services of the opera dancer are wealth. Economics deals with the pricing of these services as much as with the pricing of a cook's services. *Whatever Economics is concerned with, it is not concerned with the causes of material welfare as such* [emphasis added] (Robbins, 1932, p. 9).

The leading cause of the persistence of the welfare-centred definition is historical, i.e., the 'last vestige of Physiocratic influence.' Nine out of ten of these definitions, Robbins claims, are taken quite uncritically from earlier works, suggesting that 'English economists are not usually interested in questions of scope and method' of economics. However, Cannan's case is different because his arguments seem to have some flavour of rationality.

It is a standard practice in everyday life to assign the meaning of a word in the context in which it is used. This point is vital to understanding Cannan's arguments. He has developed his conception of economics in the context of Chapter II of his book titled *Wealth: A Brief Explanation of the Causes of Economic Welfare*. In the chapter named 'The Fundamental Conditions of Wealth for Isolated Man and Society,' Cannan contemplates a man's activities isolated completely from society and enquires what conditions will determine his wealth—that is to say, his 'material welfare.' In this condition, dividing labour between "economic" and "non-economic" activities, intended to increase material and

nonmaterial welfare, makes common sense. If Robinson Crusoe digs potatoes, he will pursue material or "economic" welfare, and if he talks to the parrot, he will seek "non-economic," i.e., nonmaterial welfare.

However, this distinction disappears when Mr. Crusoe is rescued from isolation and granted residence in a civilised society, where he pursues 'talking to the parrot' as a profession for income. It is no longer logical to treat Mr. Crusoe's trade as a non-economic activity in the new social environment. He is now earning an income by entertaining people with his parrot-talking skills, with some of it spent on basic necessities like food, clothing, housing, and medicine, and some on beautiful and entertaining items. Thus, Cannan's argument fails to explain how helpful it is for an exchange economy. After all, economics, a social science discipline, is founded on the idea of exchange in the market.

Even if we accept Cannan's use of the terms "economic" and "non-economic" as equivalent to material and nonmaterial welfare, some serious issues crop up. For example, given this distinction between economic and non-economic welfare, society should spend a greater proportion of its time on economic activities than on non-economic activities if it desires to enhance economic growth. From the perspective of conventional economics, this recommendation makes good sense because the whole purpose of economic science is to promote material welfare. However, executing the proposal creates an insurmountable problem: How would society as a whole distribute its members' 24 hours of time between the two kinds of activity, 'given the relative valuations of product and leisure and the opportunities of production?' In other words, an issue arises about the distribution of limited time and resources between economic and non-economic activities, which concerns the theory of production. By Cannan's definition, about half of this theory will lie outside the study of economics.

With these counterarguments, Robbins ends his examination of the materialist conception of economics by posing the following question: "Is not this in itself a sufficient argument for its abandonment?"

The scarcity definition of economics

Cannan's description of the conditions under which an isolated man divides his time between 'the production of real income' and 'the enjoyment of leisure' offers an excellent clue to resolving the controversy in economics. In the previous section, it has been observed that this division has an 'economic aspect.' Where does this aspect consist in?

The answer may be found in the formulation of the exact conditions which make such a division necessary. There are four. In the first place, an isolated man wants both real income and leisure. Secondly, he does not have enough of either to fully satisfy his wants. Thirdly, he can spend his time augmenting his real income or taking more leisure. Fourthly, it may be presumed that, save in the most exceptional cases, his wants for the different constituents of real incomes and leisure will differ. Therefore, he has to choose. He has to economise. Whether he chooses with deliberation or not, his behaviour has the form of choice. The disposition of his time and resources is related to his system of wants. It has an economic aspect (Robbins, 1932, p. 12).

The four labour allocation issues identified in this example are typical of the entire field of economic study. From the perspective of modern economics, 'the condition of human existence exhibits four fundamental characteristics.' These characteristics are (i) ends are various; (ii) time and means available to fulfill these ends are limited; (iii) these limited resources are capable of alternative applications; and (iv) finally, the ends have different importance. So, Robbins (Robbins, 1932, p. 12) concludes:

Here we are, sentient creatures, with bundles of desires and aspirations, with masses of instinctive tendencies all urging us in different ways to action. However, the time in which these tendencies can be expressed is limited. The external world does not offer full opportunities for complete achievement. Life is short. Nature is niggardly. Our fellows have other objectives. Yet we can use our lives to do different things, and our materials and the services of others to achieve different objectives.

However, none of these conditions is relevant to economic analysis on its own. Each condition has to be examined separately to demonstrate the unity of the generalisations achieved in economic science. First, consider the condition of the multiplicity of ends, which is of little interest to economists when treated in isolation from the others.

If I want to do two things, and I have ample time and ample means with which to do them, and I do not want the time or the means for anything else, *then my conduct assumes none of those forms which are the subject of economic science* [emphasis added]. Nirvana is not necessarily single bliss. It is merely the complete satisfaction of all requirements (Robbins, 1932, p. 12).

Second, the limitation of means by itself does not create economic phenomena.
If means of satisfaction have no alternative use, then they may be scarce, but they cannot be economised. The Manna, which fell from heaven, may have been scarce, but, if it was impossible to exchange it for something else or postpone its use, it was not the subject of any activity with an economic aspect (Robbins, 1932, p. 12).

Third, these limited means must have an alternative application opportunity. Every activity involving time and scarce resources is usually meant to achieve just one end, which means all other ends must be sacrificed to achieve it. This decision problem definitely involves conscious choice-making and is therefore the subject of economic analysis.

If, in a limited lifetime, I would wish to be both a philosopher and a mathematician, but my rate of acquisition of knowledge is such that I cannot do both completely, then some part of my wish for philosophical or mathematical competence or both must be relinquished (Robbins, 1932, p. 12).

Finally, the intensity one wants reflects its relative importance or priority, meaning it must be different from the others. If the importance of want is the same for the ends desired, then the decision-maker would be indifferent about which ends to choose. In other words, the issue of choice is irrelevant in this case.

In general, then, human activity, with all these conditions intimately interlinked, creates the situation of scarcity, which compels individuals and organisations to make choices based on the relative importance of their wants. 'Scarcity of means to satisfy given ends is an almost ubiquitous condition of human behaviour.' Thus, Robins concludes:

Here, then, is the unity of the subject of Economic Science, the forms assumed by human behaviour in disposing of scarce means. The examples we have discussed already harmonise perfectly with this conception. Both cooks' and opera dancers' services are limited relative to demand and can be put to alternative uses. The Theory of Wages, in its entirety, is covered by our current definition. So, too, is the Political Economy of War. The waging of war necessarily involves the withdrawal of scarce goods and services from other uses to be satisfactorily achieved. It has, therefore, *an economic aspect* [emphasis added]. The economist studies the disposal of scarce means. He is interested in the way different degrees of the scarcity of various goods give rise to varying ratios of valuation between them, and he is interested in the way in which changes in conditions of scarcity, whether coming from

changes in ends or changes in means—from the demand side or the supply side—affect these ratios. *Economics is the science which studies human behaviour as a relationship between ends and scarce means which have alternative uses* [emphasis added] (Robbins, 1932, p. 12).

Economics and the exchange economy

The distinction between the materialist and scarcity conceptions of economics may be better understood in light of Irving Fisher's (1987) distinction between classificatory and analytical definitions of capital. The materialist definition may be considered classificatory, because it marks off certain kinds of human behaviour, behaviour directed to the procuring of material welfare, and designates these as the subject-matter of Economics. On the other hand, the definition of scarcity is analytical in that it focuses on a particular aspect of behaviour: the form imposed by scarcity. Accordingly, any human behaviour that satisfies this general criterion falls within the scope of economic generalisations.

We do not say that the production of potatoes is an economic activity, and the production of philosophy is not. We say rather that, in so far as either kind of activity involves the relinquishment of other desired alternatives, it has its economic aspect. There are no limitations on the subject-matter of Economic Science save this (Robbins, 1932, p. 12).

Certain writers, however, while rejecting the conception of Economics as concerned with material welfare, have sought to impose on its scope a restriction of another nature: They have urged that the behaviour with which Economics is concerned is essentially a certain type of social behaviour, the behaviour implied by the institutions of the Individualist Exchange Economy. On this view, that kind of behaviour which is not specifically social in this definite sense is not the subject-matter of Economics. Professor Amonn, in particular, has devoted almost infinite pains to elaborating this conception (Robbins, 1932).

Indeed, the economist's attention is mainly focused on the problems of the exchange economy, but this does not mean that the definition of economics needs to be confined to exchange-economy topics. It is merely a matter of interest. The activities of Mr. Crusoe - both when he was forced to live in isolation and when he was rescued – are equally susceptible to the four conditions mentioned above. However, from the social point of view, economic analysis is unnecessary for investigating problems Crusoe faces in isolation, and it is undoubtedly *extra-marginal* from his perspective. So is the case with a 'closed communist society' because such an investigation is unnecessary to this society's rulers. According to Mises (1936), there are no prices for capital goods in a socialist economy because the government owns the primary means of production. Here, the price mechanism is out of order because all exchanges are internal transfers rather than the 'objects of exchange.'

Nevertheless, economic issues are very different in the exchange economy because it is founded on the institution of private property, which means that both individual and social welfare critically depend on how the private sector uses its limited resources in consumption and production.

However, it is not so easy to trace the effects of this decision on the whole complex of "scarcity relationships"—on wages, on profits, on prices, on rates of capitalisation, and the organisation of production. On the contrary, the utmost effort of abstract thought is required to devise generalisations, which enable us to grasp them. For this reason, economic analysis has the most utility in the exchange economy. It is unnecessary in an isolated economy. It is debarred from any but the simplest generalisations by the very *raison d'etre* of a communist society. However, where independent initiative in social relationships is permitted to the individual, their economic analysis comes into its own. Nevertheless, it is one thing to contend that economic analysis has the most interest and utility

in an exchange economy. It is another to contend that its subject matter is limited to such phenomena (Robbins, 1962, p. 19).

The materialist and scarcity definitions compared

In this final section, Robbins pinpoints the distinction between the two definitions of economics explained above. Some people say that this distinction implies little material dissimilarity between the two conceptions because the "scarcity of means" and the "causes of material welfare" are more or less the same. This contention is misconceived. For, the scarcity of materials is a real limitation of conduct, but the scarcity of our own time and others' services is just as important. The scarcity of other people's services, like the schoolmaster's and the sewage man's, has an 'economic aspect' that cannot be ignored if economics is to be a social science discipline devoted to studying the 'economic aspect' of human behaviour from both individual and social perspectives. Thus, Robbins concludes:

Only by saying that services are material vibrations or the like can one stretch the definition to cover the whole field. However, this is not only perverse, but it is also misleading. In this form, the definition may cover the field, but it does not describe it. For it is not the materiality of even material means of gratification, which gives them their status as economic goods; it is their relation to valuations. It is their form rather than their substance, which is significant. The "Materialist" conception of economics, therefore, misrepresents the science as we know it. But, the practice of those who have adopted it fits in perfectly with our definition (Robbins, 1932, p. 21).

This conception of scarcity, Robbins underlines, rejects only the traditional materialist definition, not the body of knowledge it generates. This body of knowledge perfectly fits with the alternative definition. "There is no important generalisation in the whole range of Professor Cannan's system, for instance, which is incompatible with the definition of the subject-matter of Economics in terms of the disposal of scarce means (Robbins, 1932, p. 22)."

III. Definition vs. subject-matter: some critical observations

Robbins' definition has been debated for about a century. The continuation of the debate for so long indicates the nature of the difficulty one faces when daring to add new points to the discussion (Cowell & Witztum, undated; McKenzie, 2018; Oliveira & Suprinyak, 2018). This difficulty becomes particularly poignant when these new points do not involve updating the state of the art by surveying the relevant literature. With this challenge in view, the paper attempts to make some critical comments on Robbins' controversial thesis on the definition and the subject-matter of economics.

As discussed above, Robbins has treated the two terms- the definition of economics and subject-matter of economics– as synonymous. The title of Chapter I is 'The Subject-Matter of Economics.' However, this hyphenated word does not appear in the headings of sections 2 and 3, where he explains the difference between materialist and scarcity conceptions of economics. These sections are respectively titled 'The Materialist Definition of Economics' and "The Scarcity Definition of Economics."

A quick review of standard dictionaries may be good enough to argue that the meanings or significations of the two terms – definition and subject-matter – are distinctly different. For example, according to Merriam-Webster online (2020), a definition is a statement of the meaning of a word or word-group, while the subject-matter implies an issue or topic presented for consideration in a discussion, thought, or study. In other words, the term 'definition' expresses the essential features of any idea implied by a word or a word-group, while 'subject-matter' refers to the topics discussed in a book or debate. In our context, economics denotes the essential features that distinguish it from other branches of the social sciences, while the subject-matter of economics specifies the topics or issues that satisfy those essential features. Thus, there is a standard relation between the definition and the

subject-matter of science. The definition implies its subject-matter, not in any other way. For example, natural sciences, which are concerned with the description, prediction, and understanding of natural phenomena, are first divided into two fundamental compartments - life science and physical science (Osler, 2019). After this compartmentalisation, both the life sciences and the physical sciences are divided into major branches, which are then further divided into fields and sub-fields. This system of scientific classification suggests that the definition of a discipline is not derived from what has been written about it. Quite on the contrary, its subject-matter is determined by the definition of science.

Robbins seems to have taken an opposite approach in defining the nature and significance of economic science, which is attested by the following quotation:

The efforts of economists during the last hundred and fifty years have resulted in the establishment of a body of generalisations whose substantial accuracy and importance are open to question only by the ignorant or the perverse. But they have achieved no unanimity concerning the ultimate nature of the common subject-matter of these generalisations. The central chapters of the standard works on Economics retail, with only minor variations, the main principles of the science. But the chapters in which the object of the work is explained still present wide divergences. We all talk about the same things, but we have not yet agreed on what it is we are talking about (Robbins, 1932, p. 1).

Both the admirers and critics of Robbins seem to be overlooking this aspect of Robbins' novel conception of economics. The following paragraphs highlight the implications of Robbins' approach from two perspectives – one empiricist and the other logical.

Empirical Perspective

Empiricism is an epistemological theory which argues that the primary source of ideas - the necessary raw materials of human knowledge - is experience (Markie & Folescu, 2023). Locke (1690) divides all types of ideas that the human mind can have into simple and complex categories. Simple ideas enter the human brain in an unmixed manner, with the mind's role passive. Once the human understanding engages with these ideas, it creates complex ideas by repeating, comparing, and uniting them in an almost infinite variety. Two distinct features distinguish the two categories. First, the mind is entirely passive in perceiving simple ideas, but fully active in conceiving complex ones. Second, the mind can neither create nor destroy simple ideas, but it can do both with complex ideas. Therefore, it is evident that complex ideas are the appropriate subjects of philosophical and scientific research.

Both categories of ideas remain hidden in the individual's mind until communicated publicly, meaning that human knowledge is created in two phases. In the first phase, the mind creates complex ideas, whose primary raw materials are simple ideas. The creation of complex ideas may be considered as 'private knowledge.' The second phase consists of communicating these complex ideas to the public, in which sense it may be called 'public knowledge.'

The most original and universal method of communicating personal knowledge is the sounds made by the tongue. These sounds, called words, become part of a language when they indicate our personal knowledge. Although all that exists in the universe is specific and different, the highest parts of words forming any language are general terms. 'Words' become general when they indicate "general ideas," and "ideas" become general when one is separated from the other based on some common qualities. Although this vocal communication is the most common and useful medium in personal interactions, communication among the intelligentsia is conducted through written languages that use both alphabets and mathematical signs.

There is little scope to doubt that the two words, definition and subject-matter, we are discussing here represent two complex ideas, which Robbins treats as synonymous or interchangeable. This practice is arguable. According to Locke, if two complex ideas are always interchangeable, then the mind would never have conceived them. Thus, the words, definition and subject-matter imply two different ideas, meaning they ought to be treated accordingly.

Second, Robbins's approach to determining the definition of economics from its so-called subject-matter appears anti-empiricist. All reasoning concerning matters of fact is founded on the cause-and-effect relations (Hume, 1739-1740). Economics is a perfect example of this empiricist theory. Quantity demanded depends upon its price and the consumer's income; investment is negatively related to the interest rate, and so on. Similarly, there is a causal relationship between the definition of a science and its subject-matter, where the definition is the cause while the subject-matter is the effect.

In the *Essay*, Robbins infers the definition of economics from the 'unity of economic generalisations.' Although this so-called unity was not in question in Robbins' time, as economic science was still in its formative stage, it is certainly a major issue in modern times. Viner's frustration, noted above, may be considered as evidence of this difficulty. For example, using Robbins' conception, Becker (1968) has developed the economic theory of crime, which argues that 'a criminal is a rational economic agent'. Agreeing to this view appears extremely difficult. An activity is considered a crime because it harms others, and it is illegal in a civilised society. The government maintains the necessary police force to prevent these activities and to punish their perpetrators through the legal system. Thus, Becker's (1976) economics, which is perfectly consistent with Robbins' definition, contradicts the legal and judicial systems of the societies in which they live.

This point needs further illustration. "Economics of assassination" is an exciting research topic among some economists (Center for a New American Security, 2019; Frey, 2007; Marshall, 1996; Gilbert, Sylwester and Gao, 2011). If we accept Robbins' view of economics, then this subject of economic research ought to be considered legitimate for two reasons. Firstly, economists, being social scientists, are free from any moral obligation. Secondly, the labour and skills an assassin employs in this profession have opportunity costs. These arguments make good sense if we can treat ourselves, natural persons, free from all obligations and constraints. However, problems arise because we live in a civilised society governed by the rule of law. Obeying the law is a legal necessity, even if we want to overlook our moral obligations.

Finally, like all other intellectuals, economists are employed in either private or public institutions and use research funds from public or charitable non-profit organisations. Thus, the opportunity costs of research on illegal activities are a subject of critical debate.

Logical Perspective

Logic is a science that investigates the general principles of good thought (Keynes, 1906). More specifically, it examines the characteristics of judgments regarding our knowledge and beliefs, which determine 'the conditions under which we are justified in passing from given judgments to other judgments that follow from them.' Accordingly, the study of logic may be viewed as an ideal, concerned with how we ought to think. In this sense, it is a normative or regulative science that is related to two other disciplines - ethics and aesthetics. Together, they form a unique trio that distinguishes the positive sciences from practical arts. Logic seeks to determine the general principles of valid thought; ethics attempts to determine the general principles of right conduct; and aesthetics aspires to set out the general principles of correct taste (Keynes, 1906).

The primary purpose of logic is to study the characteristics of the truth and falsity of thoughts. Propositions are the fundamental units of all logical analysis because truth and falsity are embodied in them. Accordingly, the doctrines of formal logic consist of three separate components. The first component, called 'terms,' consists of 'names' used to describe things. Depending upon the nature of the idea implied, the name could describe its essential feature or stand for a definition that suggests a proposition. For example, the word 'economics' may mean a branch of social science, or it could imply the very meaning of this science. In the second sense, it is a proposition which could be either true or false. Finally, determining the truth or falsity of a proposition means drawing a conclusion or inference. The method by which this inference is drawn is called syllogism, the third component of logical doctrine, which ordinarily consists of three sentences: the premise, the minor premise, and the conclusion.

Let us now employ this syllogistic system of logic to Marshallian and Robbinsian definitions to see their logical implications. The common term here is economics – a social science, and the two propositions here are two definitions of economics recommended by Marshall and Robbins. We will insert minor premises in the syllogistic system that are consistent with the major premises. In the case of Marshall's definition, two minor premises will be inserted in the formula to see the changes in the conclusions.

Marshallian definition
Major Premise: "Political Economy or Economics is a study of mankind in the ordinary business of life; it examines that part of individual and social action which is most closely connected with the attainment and with the use of the material requisites of well-being."
Minor Premise (1): Production of agricultural commodities is most closely connected with the attainment and use of material requisites of well-being.
Conclusion (1): Therefore, the production of agricultural commodities constitutes a valid subject-matter for economic inquiry.

Minor Premise (2): Activities like smuggling, human trafficking and assassination are not connected with the attainment and use of material requisites of well-being.
Conclusion (2): Therefore, these activities do not fall within the jurisdiction of economic inquiry.

Robbinsian Definition
Major Premise: "Economics is the science that studies human behaviour as a relationship between unlimited ends and scarce means that have alternative uses."

Minor Premise: Activities such as smuggling, human trafficking, and assassination satisfy this scarcity condition.

Conclusion: Therefore, these activities are acceptable topics for economic inquiry.

The syllogistic system used above is called "deductive" reasoning. In this system, we arrive at a specific conclusion from a general statement. Accordingly, the truth or falsity of the conclusion is determined by the truth or falsity of the major premise. In our case, the major premises are two definitions proposed by two renowned economists. From an empirical perspective, Marshall and Robbins are logically right in conceiving their respective propositions. However, the implications of their propositions differ markedly from a social perspective, reflecting the different motivations each author brings to the study of economics. Marshall emphasizes that economics must concern itself with legal economic activities that promote the general welfare. Robbins argues that economics is a science; therefore, practising this discipline should not be guided by moral motives. The logical implications of Robbins' definition are absolutely clear. He has helped free the professionals in the

discipline from their moral and social obligations and has brought social issues into economic research that are either illegal or irrelevant from a welfare perspective.

Conclusion

Almost a century ago, Lionel Robbins, then a famous English economist, introduced a controversy in the discipline of economics about its definition and the subject-matter. This controversy still continues. Although his idea was not initially received respectfully, he has succeeded overwhelmingly in his campaign, as it forms the foundational premise of modern economics, taught and preached worldwide.

In a short treatise, *An Essay on the Nature and Significance of Economic Science*, Robbins challenged this conventional definition of economics, arguing that it unscientifically confines the subject matter of economic research to social activities connected with the community's common economic welfare. In other words, the common good of society is the fundamental criterion to determine what kinds of goods and services come under economic inquiry. Robbins rejected this conventional wisdom on two grounds. First, economics, because it is a science, is free from moral considerations. Second, the materiality constraint is logically indefensible because many social activities satisfy the qualifications by which any activity is identified as economic. He suggested an alternative definition, which has eventually become a famous catchphrase in the discipline: *Economics is the science which studies human behaviour as a relationship between ends and scarce means which have alternative uses*.

To form some informed opinions about his challenge, this paper systematically walks through Robbins' articulation. It concludes that Robbins is correct in criticising many classical ideas, such as productive vs. unproductive labour and the materiality of economic issues. However, the approach he has taken to replace this classical wisdom is logically indefensible and unacceptable from a public policy perspective. Second, definition and subject-matter are two different words, which signify two different ideas. They cannot be used synonymously because the cause-and-effect relationship connects them. The definition is the cause, and subject-matter is the effect. Therefore, the subject-matter is implied by definition, not the other way round. Finally, the damaging influence of Robbins' conception on the evolving science of economics is that it has given some economists excuses to ignore their social responsibility. Following in Robbins' footsteps, some prominent economists have devoted their personal time and society's resources to research that serves little in the welfare interests of humanity. Some of this research even contradicts society's legal and judicial system.

References

Backhouse, R. E., & Medema, S. G. (2009a). On the definition of economics. *Journal of Economic Perspectives, 23*(1), 221–233.

Backhouse, R. E., & Medema, S. G. (2009b). Defining economics: The long road to acceptance of the Robbins definition. *Economica, 76*, 805–820.

Becker, G. S. (1968). Crime and punishment: An economic approach. *Journal of Political Economy, 76*(2), 169–217.

Becker, G. S. (1976). The economic approach to human behavior. *In The economic approach to human behavior* (pp. 3–14). University of Chicago Press.

Buchanan, J. M. (1979). *What should economists do?* Liberty Press.

Cannan, E. (1914). *Wealth: A brief explanation of the causes of economic welfare*. P. S. King & Son.

Center for a New American Security. (2019). *The economics of assassination*. https://www.cnas.org/

Cowell, F., & Witztum, A. (n.d.). *Lionel Robbins's essay on the nature and significance of economic science: 75th anniversary conference proceedings*. London School of Economics and Political

Science. https://sticerd.lse.ac.uk/textonly/events/special/lionelrobbins/ConferenceProceedings.pdf

Fisher, I. (1897). Senses of "capital." *The Economic Journal, 7*(26), 199–213.

Frey, B. S. (2007). *Why kill politicians? A rational choice analysis of political assassinations* (Working Paper No. 324). Institute for Empirical Research in Economics, University of Zurich. http://www.econ.uzh.ch/static/wp_iew/iewwp324.pdf

Gilbert, S., Sylwester, K., & Gao, W. (2011). *Leader assassination and economic growth*. Southern Illinois University. https://cola.siu.edu/economics/_common/documents/discussion/11-08-leader-assassination.pdf

Hume, D. (1739–1740). *A treatise of human nature*. https://ebooks.adelaide.edu.au/l/locke/john/l81u/frontmatter.html

Keynes, J. M. (1936). *The general theory of employment, interest and money*. https://www.marxists.org/reference/subject/economics/keynes/general-theory/index.htm

Keynes, J. N. (1906). *Studies and exercises in formal logic: Including a generalisation of logical processes in their application to complex inferences*.

Locke, J. (1690/2017). *An essay concerning human understanding*. Early Modern Texts. https://earlymoderntexts.com/assets/pdfs/locke1690book1.pdf

Markie, P., & Folescu, M. (2023). Rationalism vs. empiricism. In E. N. Zalta & U. Nodelman (Eds.), *The Stanford Encyclopedia of Philosophy* (Spring 2023 ed.). https://plato.stanford.edu/archives/spr2023/entries/rationalism-empiricism/

Marshall, A. (1890). *Principles of economics*. https://geolib.com/smith.adam/woncont.html

Marshall, J. (1996). On economics: How the Kennedy assassination affected some stock prices. *SFGATE*. https://www.sfgate.com/business/article/ON-ECONOMICS-How-Kennedy-Assassination-2958771.php

McKenzie, R. (2018). Lionel Robbins and scarcity. In *A brain-focused foundation for economic science: A proposed reconciliation between neoclassical and behavioral economics*. Springer International Publishing.

Merriam-Webster. (2020). *Merriam-Webster online dictionary*. https://www.merriam-webster.com/

Mises, L. von. (1936). *Socialism: An economic and sociological analysis*. Jonathan Cape. (Original work published 1922)

Oliveira, T., & Suprinyak, C. (2018). The nature and significance of Lionel Robbins' methodological individualism. *EconomiA, 19*(1), 24–37. https://doi.org/10.1016/j.econ.2017.08.001

Osler, M. (2019). Physical science. In *Encyclopædia Britannica*. https://www.britannica.com/science/physical-science

Robbins, L. (1962). *An essay on the nature and significance of economic science*. Macmillan & Co.

Robbins, L. (1981). Economics and political economy. *The American Economic Review, 71*(2), 1–10.

Smith, A. (1776). *An inquiry into the nature and causes of the wealth of nations*. https://geolib.com/smith.adam/woncont.html

Suprinyak, C., & Oliveira, T. (2019). Of time, uncertainty and policy-making: The classical origins of Lionel Robbins' epistemology of political economy. *History of Economic Ideas, 27*(3), 95–113.

Journal of ECONOMICS
August 2026, Volume: 3, Issue: 3, pp. 17−21
DOI: https://doi.org/10.36719/3104-4727/8/17-21

Ai-Based Decision Support System for Green Investment Risk Assessment in Emerging Economies

Rahiba Abdulhasanova[1*], Sadagat Ahmadova[2]

Abstract. *Green investment in developing economies is poorly served by conventional risk tools. This paper examines how artificial intelligence methods, from hybrid econometric-machine learning architectures to natural language processing and distributed ledger systems, can be embedded within decision support frameworks for green portfolios. Drawing on a structured narrative synthesis of 61 studies published between 2018 and 2024, it maps AI deployment in sustainable finance across emerging markets including Morocco, Mongolia and Azerbaijan. Bidirectional recurrent networks and hybrid architectures consistently outperform standard approaches under data scarcity and macroeconomic instability, while ownership concentration and governance quality moderate AI-driven environmental performance. The paper concludes with recommendations for regulators and investment professionals in institutionally fragmented markets.*

Keywords: *green investment, risk assessment, decision support system, machine learning, ESG, blockchain, emerging economies, sustainable finance*

Introduction

Green investment in developing countries presents a structural paradox: these economies stand to gain most from a sustainable transition, yet the conditions that make it urgent, namely weak institutions, patchy data, volatile politics and immature capital markets, also make it hardest to evaluate. Value-at-risk models assume stable return distributions, an assumption that breaks down where regulatory change or commodity price shocks are frequent, and mean-variance optimisation performs poorly when the covariance structure of green assets is unstable (Bellache & El Bouanani, 2026). AI is not a remedy in itself: it offers pattern recognition in high-dimensional data, nonlinear function approximation and automated text analysis, which address concrete shortcomings of existing frameworks when properly deployed. Our position is optimistic but tempered by the most underestimated bottleneck in the field, since emerging economies lack not only data scientists who can build models, but ESG analysts, managers and regulators who can evaluate, act on and oversee their outputs.

Ensemble methods such as XGBoost and Random Forest remain reliable workhorses, while long short-term memory networks and their bidirectional variants have shown promise in the time-series tasks most relevant to green finance (Liu et al., 2022).

[1]Nakhchivan State University, Nakhchivan, Azerbaijan
[2]Nakhchivan State University, PhD in Economics, Nakhchivan, Azerbaijan
[*]Corresponding author. E-mail: ebdulhesenovarahibe@ndu.edu.az
Received: 10 January 2026; Accepted: 31 April 2026; Published online: 14 August 2026

The most consequential recent development is the hybrid model, which uses econometric specifications for the systematic components of a series and neural networks for the residual, retaining interpretability while remaining data-efficient (Bellache & El Bouanani, 2026; Sodnomdavaa et al., 2026). Out-of-sample stability nevertheless remains untested, since few evaluations ask whether models trained on one market transfer to another.

Greenwashing is arguably the largest credibility threat to the ecosystem: capital cannot be allocated efficiently where genuine and performative sustainability cannot be distinguished. Early natural language processing relied on keyword frequency and TF-IDF classification, which caught gross discrepancies but missed selective emphasis on favourable metrics (Zhao et al., 2023), whereas language models fine-tuned on domain corpora extract textual features that correlate with environmental penalties subsequently imposed by regulators (Xu et al., 2026). Blockchain enthusiasm rests on a related problem: ESG data is often unreliable and vulnerable to manipulation. Traceability platforms create auditable records and smart contracts can automate compliance verification (Dawood et al., 2025; Okeke, 2025), but the technology does not resolve inaccurate data at the point of entry, and scalability, cost and interoperability remain unresolved (Rivera et al., 2024).

Several gaps follow. The empirical evidence is concentrated in a handful of countries, methods capable of capturing asymmetric effects such as quantile-on-quantile regression remain underused (Wang et al., 2025), and the interaction between firm-level governance and AI effectiveness has been noted but not systematically investigated (Rastogi et al., 2024). Governance frameworks such as the European Union AI Act were designed for developed markets, and most developing countries have no AI-specific regulation. Azerbaijan illustrates the geographic gap: the barriers to green investment there have been examined outside the AI literature (Abdulhasanova, 2025b), and cross-country panel evidence shows that fiscal environmental spending does not by itself mobilise private green capital, nor does aggregate financial depth translate into green financial capacity (Abdulhasanova et al., 2026). The distinction between investor, object of investment and investment environment frames any such system (Abdulhasanova, 2025a).

The aim and objectives of the study

The aim of this study is to map the state, constraints and potential of AI-based decision support systems for green investment risk assessment in emerging economies. Four objectives were defined: to evaluate the principal AI methodologies used under emerging-market conditions; to categorise data-related, institutional, regulatory and ethical barriers; to assess evidence on their impact on ESG performance and firm value; and to formulate context-sensitive recommendations for practitioners and regulators.

Materials and methods

The study uses a structured narrative synthesis, a method between a systematic and a traditional review, chosen because the landscape is too interdisciplinary for the former while a purely narrative approach risks selective citation. The search was conducted between January and March 2024 and covered publications from 2018 to 2024, using Scopus with supplementary searches in Web of Science and Google Scholar. It returned 437 records, screening reduced the pool to 128, and full-text review retained 61 sources. The reference list cites the studies carrying the analytical argument, while the wider corpus informs the synthesis without being enumerated. Peer-reviewed empirical articles carried more interpretive weight than conference proceedings, and the English-language restriction is the principal limitation.

Results

Model architecture matters, but less than the literature implies. Across the studies reviewed, the gap between the best model and a well-implemented baseline typically fell between five and fifteen per cent on standard accuracy metrics, smaller than the effect of data quality, feature selection and model-task fit. Bidirectional LSTM models nonetheless outperformed unidirectional counterparts in nearly every comparison, most clearly over longer horizons (Liu et al., 2022), and hybrid models performed particularly well under volatility: augmenting ARIMAX specifications with machine learning improved tail accuracy for Moroccan equity UCITS (Bellache & El Bouanani, 2026), and central bank policy rate forecasting in Mongolia produced the same result (Sodnomdavaa et al., 2026). Few studies report when their models fail, and the resulting publication bias makes the field look more successful than deployment experience warrants.

In text analysis, the strongest evidence comes from studies detecting discrepancies between what firms say and what they do (Zhao et al., 2023; Xu et al., 2026). Three caveats apply: retrospective data cannot show how models behave once detection tools are known to exist; cross-linguistic transfer is harder than the literature acknowledges, since hedging and disclosure conventions vary across languages; and interpretability remains unsolved, because regulators need to know why a disclosure was flagged. For blockchain, the most compelling evidence comes from supply chains, where traceability improved the reliability of emissions data and auditable frameworks maintained tamper-resistant performance data in real time (Okeke, 2025; Dawood et al., 2025). Limited technical expertise, implementation costs and interoperability problems are especially acute in emerging economies (Rivera et al., 2024), yet integration could shift regulatory oversight from periodic audits toward continuous monitoring.

Firm-level governance moderates the effectiveness of AI tools more than is appreciated. Ownership concentration moderates the relationship between ESG disclosure and firm value, positively at moderate concentration and with attenuation at high levels (Rastogi et al., 2024), so the same system deployed in two firms within one sector may produce different outcomes. The barrier landscape is likewise interactive: data quality is foundational, since ESG reporting in many emerging economies is voluntary and unstandardised, while the critical deficit lies between developers and end users, because a risk model is useless if the portfolio manager cannot interpret a confidence interval. The same logic applies to financial infrastructure, where liquidity without green assessment capacity leaves capital in conventional channels (Abdulhasanova et al., 2026). Evidence from the South Caucasus and Central Asia is largely absent, which makes the region a promising pilot setting (Abdulhasanova, 2025b).

Discussion of results

The central lesson of this synthesis is that the effectiveness of AI in green investment depends less on algorithmic sophistication than on the ecosystem in which the algorithm operates. The best model is of little use when trained on unreliable data, deployed in an organisation that cannot act on its outputs and operated without guidance on governing algorithmic decisions; the marginal return on data infrastructure, institutional capacity and regulatory development is therefore higher than the return on further algorithmic refinement. Because ownership structure and governance quality mediate the impact pathway, policy should target the governance environment as much as the technology, and wider use of distributional methods would help, since quantile-based evidence suggests AI may amplify rather than equalise performance differences (Wang et al., 2025). Two recommendations follow: start small, with well-defined tasks such as automated screening of sustainability disclosures rather than comprehensive systems in weak data environments; and invest in workforce development through certification at the intersection of AI and sustainable finance. For hydrocarbon exporters, this human capital constraint is the binding one.

Conclusions

1. Hybrid AI-econometric models incorporating bidirectional LSTM networks improve measurably on traditional approaches for green investment risk forecasting, most clearly under high volatility and limited data, although the magnitude is more modest than headline results suggest and out-of-sample transferability remains inadequately addressed.

2. Natural language processing detects greenwashing with genuine accuracy, but cross-linguistic transferability, interpretability and the adversarial dynamics of evolving evasion strategies remain unresolved.

3. Blockchain-AI integration addresses foundational data integrity problems but remains constrained by scalability limits, implementation costs and the inability of any ledger to verify accuracy at the point of entry.

4. Firm-level governance moderates the effectiveness of AI-driven ESG systems, which argues for integrated strategies strengthening governance and technological capability together.

5. The barrier landscape is interactive, so addressing any single barrier in isolation is unlikely to produce substantial improvement. Future work should extend the geographic scope, adopt distributional methods more widely and develop ethical frameworks with operational specificity. For practitioners, the algorithm is one component of a system whose value depends equally on data governance, organisational capacity and regulation.

References

Abdulhasanova, R. (2025a). *The investment process: Elements and their implementation stages. Construction Economics and Management,* (4), 379–385. https://doi.org/10.58225/tim.2025-4-379-385

Abdulhasanova, R. (2025b). Unlocking green finance: Solutions to investment hurdles in Azerbaijan's sustainable transition. In *Innovative scientific research: Proceedings of the International Scientific Conference* (p. 24). Canada.

Abdulhasanova, R., Ahmadova, S., Mahmudov, J., Alasgarova, F., & Akhmedova, A. (2026). Does government environmental spending crowd in green investment? The role of carbon pricing and the limits of fiscal policy alone. *Economies, 14*(8), Article 315. https://doi.org/10.3390/economies14080315

Bellache, Z., & El Bouanani, H. (2026). Equity UCITS in Morocco: Conceptual foundations, financial risk considerations, and the contribution of artificial intelligence. *Statistics, Optimization and Information Computing*. Advance online publication.

Dawood, M. H., Furaijl, H. B., Abed, A. M., & Harjan, S. A. (2025). A blockchain-based auditable data framework for transparent, real-time ESG performance reporting in sustainable finance. In *Proceedings of the 3rd International Conference on Cyber Resilience (ICCR)*. IEEE.

Liu, B., Zhang, N., Wang, L., & Zhang, X. (2022). Electricity generation forecast of Shanghai municipal solid waste based on bidirectional long short-term memory model. *International Journal of Environmental Research and Public Health, 19*(11), Article 6616. https://doi.org/10.3390/ijerph19116616

Okeke, A. (2025). Decarbonizing supply chains in emerging economies: A multilevel analysis of regulation, ESG, and digitalization. *Global Journal of Emerging Market Economies, 18*(2), 151–173. https://doi.org/10.1177/09749101251387365

Rastogi, S., Singh, K., & Kanoujiya, J. (2024). Firm's value and ESG: The moderating role of ownership concentration and corporate disclosures. *Asian Review of Accounting, 32*(1), 70–90. https://doi.org/10.1108/ARA-10-2022-0266

Rivera, L., Gauthier-Umaña, V., & Chauhan, C. (2024). Blockchain: An opportunity to improve supply chains in the wake of digitalization. *International Journal of Information Management Data Insights, 4*(2), Article 100290. https://doi.org/10.1016/j.jjimei.2024.100290

Sodnomdavaa, T., Badrakh, O., Altangerel, D., & Sodnomdavaa, T. (2026). Forecasting central bank policy rates using machine learning and deep learning approaches. *International Journal of Advanced and Applied Sciences*. Advance online publication.

Wang, C., Nazar, R., Ali, S., & Meo, M. S. (2025). Eco-friendly algorithms: Artificial intelligence and green finance in European intelligent nations. *Technology in Society, 83*, Article 102960. https://doi.org/10.1016/j.techsoc.2025.102960

Xu, C., Liu, J., Li, Z., & Lin, C. (2026). DeepGreen: Effective LLM-driven greenwashing monitoring system designed for empirical testing — Evidence from China. *Computational Economics*. Advance online publication. https://doi.org/10.1007/s10614-026-11328-5

Zhao, Y., Kroher, L., Engler, M., & Schnattinger, K. (2023). Detecting greenwashing in the environmental, social, and governance domains using natural language processing. In *Proceedings of the 15th International Joint Conference on Knowledge Discovery, Knowledge Engineering and Knowledge Management (IC3K)*. SciTePress.

Journal of ECONOMICS
August 2026, Volume: 3, Issue: 3, pp. 22−29
DOI: https://doi.org/10.36719/3104-4727/8/22-29

From Industry 4.0 to Industry 5.0: A Human-Centric Analysis of Azerbaijan's Digital Economic Transformation

Leyla Rzayeva

Abstract. *The transition from the technology-centric paradigm of Industry 4.0 to the human-centric, sustainable, and resilient vision of Industry 5.0 represents a critical juncture for global economies. This shift presents both systemic challenges and significant opportunities for national development strategies. This study aims to analyze the alignment of the Republic of Azerbaijan's national digital development strategy with the core principles of Industry 5.0, and to identify the key challenges and opportunities this transition presents for the country's economic future. Employing a qualitative research design, this study integrates a systematic literature review with a content and institutional analysis. The theoretical framework is built upon the concepts of industrial revolutions, and key documents from the European Commission, the World Economic Forum (WEF), the OECD, and the official strategy of the Government of Azerbaijan are critically examined. The findings reveal that while Industry 4.0 focused primarily on technological efficiency, the shift to Industry 5.0 represents a fundamental socio-technical transformation. Globally, this is characterized by the displacement of 92 million jobs by 2030, a significant "compute divide," and pressing ethical concerns. The study finds that the "Strategy for the Development of the Digital Economy of the Republic of Azerbaijan for 2026-2029" demonstrates a strong, though not yet complete, alignment with Industry 5.0 principles, particularly in its focus on human capital development and infrastructural resilience. This research provides a novel, evidence-based assessment of Azerbaijan's readiness for the human-centric industrial era. It offers practical policy recommendations for enhancing the inclusivity and sustainability of the national digital strategy, thereby contributing to the broader discourse on economic development in the context of global technological transformation.*

Keywords: *Industry 5.0, Industry 4.0, human-centricity, digital transformation, sustainable development, economic policy, Azerbaijan*

Introduction

The dawn of the 21st century has been marked by a technological transformation of unprecedented scale and depth. The concept of the Fourth Industrial Revolution, or Industry 4.0, as articulated by Klaus Schwab (2017), laid the groundwork for a new industrial reality predicated on automation, the Internet of Things (IoT), and artificial intelligence (AI). However, by the early 2020s, it became apparent that a profit- and efficiency-driven technological trajectory was insufficient to address escalating social and environmental challenges.

Azerbaijan Technological University, PhD Candidate, Ganja, Azerbaijan
E-mail: l.rzayeva@atu.edu.az
Received: 17 February 2026; Accepted: 8 May 2026; Published online: 14 August 2026

In response, the European Commission formalized the concept of Industry 5.0 in 2021. This new paradigm recognizes the potential of industry to achieve social goals beyond job creation and growth, positioning it as a sustainable and resilient provider of prosperity that respects our planet's boundaries (European Commission, 2021). While Industry 4.0 places digitalization and efficiency at its core, Industry 5.0 elevates the well-being of workers, sustainability, and social justice as its primary objectives (European Commission, 2021).

This paradigm shift is not a theoretical abstraction. The global labour market is undergoing a radical restructuring. According to the World Economic Forum's "Future of Jobs Report 2025," an estimated 170 million new jobs will be created by 2030, but 92 million existing roles are projected to be displaced, resulting in a net creation of 78 million jobs (WEF, 2025). Furthermore, approximately 80% of the global workforce will require reskilling and upskilling in the near future (WEF, 2025). The OECD (2025) further warns of a severe "compute divide," where AI computing power is heavily concentrated in the US and China, creating a significant risk of "digital colonialism" for developing nations. These global challenges underscore the urgency for nations, particularly those with developing economies, to devise strategies that navigate this new landscape effectively.

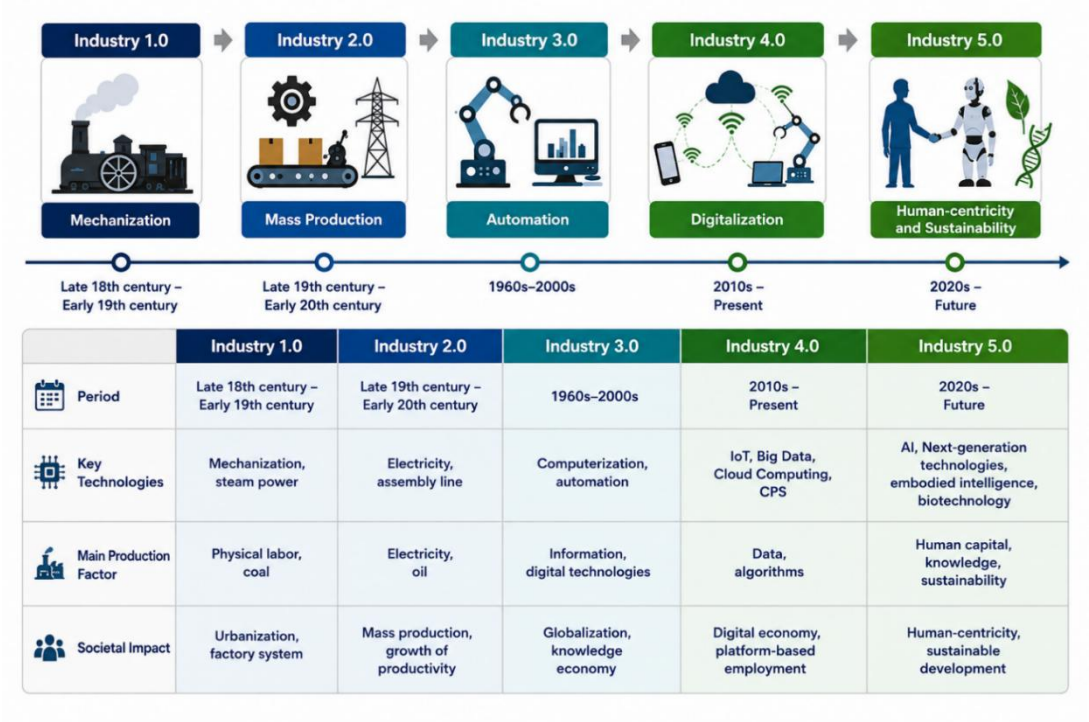
Despite the rapidly growing body of research on the conceptual and technological aspects of Industry 5.0 (e.g., Nahavandi, 2019; Xu et al., 2021; Huang et al., 2022), a critical gap remains in assessing the practical alignment of national economic strategies with the paradigm's core tenets. Little is known about how post-Soviet states, with their unique historical and economic contexts, are preparing for this human-centric industrial revolution. This study addresses this gap by conducting an in-depth analysis of Azerbaijan's national digital development strategy. The aim of this research is to assess the degree to which the "Strategy for the Development of the Digital Economy of the Republic of Azerbaijan for 2026-2029" aligns with the core principles of Industry 5.0—human-centricity, sustainability, and resilience—and to identify the systemic challenges and opportunities this transition presents for the country.

This paper is structured as follows. Section 2 presents the theoretical background and the analytical framework. Section 3 details the research methodology. Section 4 discusses the results, including the global challenges and Azerbaijan's strategic alignment. Section 5 provides a discussion of the findings. Finally, Section 6 concludes with policy implications and directions for future research.

2. Theoretical background and analytical framework

2.1. The Evolution of Industrial Paradigms

To understand the significance of Industry 5.0, it is essential to view it within the historical progression of industrial revolutions (Figure 1), as discussed by Zizic et al. (2022). The First Industrial Revolution (Industry 1.0) introduced mechanization through water and steam power. The Second (Industry 2.0) brought mass production through electricity. The Third (Industry 3.0) leveraged electronics and IT to automate production. The Fourth Industrial Revolution (Industry 4.0) is characterized by the fusion of the physical, digital, and biological worlds, creating smart, interconnected systems (Schwab, 2017).



	Industry 1.0	Industry 2.0	Industry 3.0	Industry 4.0	Industry 5.0
Period	Late 18th century – Early 19th century	Late 19th century – Early 20th century	1960s–2000s	2010s – Present	2020s – Future
Key Technologies	Mechanization, steam power	Electricity, assembly line	Computerization, automation	IoT, Big Data, Cloud Computing, CPS	AI, Next-generation technologies, embodied intelligence, biotechnology
Main Production Factor	Physical labor, coal	Electricity, oil	Information, digital technologies	Data, algorithms	Human capital, knowledge, sustainability
Societal Impact	Urbanization, factory system	Mass production, growth of productivity	Globalization, knowledge economy	Digital economy, platform-based employment	Human-centricity, sustainable development

Figure 1

Evolution of industrial revolutions from industry 1.0 to industry 5.0

2.2. Industry 5.0: Core Principles

Industry 5.0 is not a chronological successor but rather a complement and "normative reorientation" of Industry 4.0 (Enang et al., 2023). While Industry 4.0 addressed the question of "what we can do with new technologies?", Industry 5.0 poses a fundamentally different question: "what can technology do for people and society?" (European Commission, 2021). This paradigm is built upon three interconnected pillars (European Commission, 2021; Ivanov, 2023):

1. **Human-Centricity:** This principle places the well-being, needs, and capabilities of workers at the center of the production process. Rather than asking what can be done with technology, it asks what technology can do for people (European Commission, 2021). This involves augmenting human skills through human-machine collaboration (cobots, digital twins) rather than replacing them (Grosse et al., 2023). From an economic perspective, this implies a shift from a "labor-saving" model to a "human capital investment" model as the primary driver of productivity growth.
2. **Sustainability:** This pillar emphasizes the necessity for industrial systems to operate within planetary boundaries. It entails a transition towards a circular economy, waste reduction, and the adoption of environmentally friendly technologies, thereby enabling the decoupling of economic growth from environmental degradation (Ghobakhloo et al., 2022). For national economies, this implies the formation of a new competitiveness model predicated on resource efficiency and environmental responsibility.
3. **Resilience:** This principle focuses on the ability of industrial systems to withstand and adapt to external shocks—whether economic crises, pandemics, or geopolitical instability. Resilience requires the creation of adaptive, flexible production networks and value chains with built-in mechanisms for redundancy and duplication of critically important functions (Ivanov, 2023; Enang et al., 2023). In the context of growing volatility in the global economy, this characteristic acquires strategic significance for developing countries.

2.3. Analytical Framework

To achieve the stated objective, this study employs a three-dimensional analytical framework that operationalizes the key pillars of Industry 5.0—human-centricity, sustainability, and resilience—as

evaluative dimensions. The assessment of the alignment of Azerbaijan's national digital development strategy with these dimensions is conducted by addressing the following key questions:

- (Human-Centricity): To what extent does the strategy prioritize investments in human capital, education, workforce reskilling, and the creation of decent working conditions within the digital economy?
- (Sustainability): Does the strategy provide for measures to enhance resource efficiency, adopt "green" technologies, and achieve long-term economic and social stability?
- (Resilience): Is the strategy aimed at building the adaptive capacity of the economy, diversifying production, and establishing reliable protection systems against internal and external shocks?

This analytical framework enables not only the identification of the presence or absence of certain elements within the strategy but also an assessment of the depth and systemic nature of their integration into national digital development policy.

Methodology

To achieve the stated research objectives, this study employs a qualitative research design of an exploratory nature. The choice of qualitative methodology is determined by the nature of the research question, which requires interpretation and assessment of the content of policy documents rather than statistical measurement of quantitative dependencies. The methodological toolkit comprises three complementary components:

1. Systematic Literature Review. An extensive analysis of academic and policy-oriented publications on Industry 4.0, Industry 5.0, digital transformation, and sustainable development was conducted. Primary attention was devoted to peer-reviewed articles in journals ranked in the first and second quartiles (Q1–Q2) according to the Scopus and Web of Science classifications, as well as to authoritative reports from international organizations—the European Commission, the World Economic Forum, and the OECD. This stage enabled the formation of the study's theoretical foundation, the verification of key concepts, and the identification of global trends and systemic challenges associated with the transition to the new industrial paradigm.
2. Content Analysis and Institutional Analysis of Strategic Documents. At this stage, a qualitative content analysis of official strategic documents is carried out. The primary object of the study is the "Strategy for the Development of the Digital Economy of the Republic of Azerbaijan for 2026–2029." The analysis is focused on identifying explicit and implicit references pertaining to human capital development, environmental and economic sustainability, as well as the resilience of the economic system. To provide a broader context, the national priorities enshrined in the "Azerbaijan 2030" program are also examined. The application of this method enables a systematic assessment of policy documents based on predefined criteria corresponding to the three pillars of Industry 5.0.
3. Comparative and Systemic Analysis. The final stage involves juxtaposing the findings obtained from the systematic literature review with the conclusions drawn from the content analysis of strategic documents. This approach allows for the identification of points of convergence and divergence between global benchmarks (the principles of Industry 5.0) and Azerbaijan's national strategic priorities. Furthermore, the comparative analysis facilitates the identification of systemic challenges and specific opportunities conditioned by the country's unique economic and institutional context, which collectively ensures the validity and robustness of the final conclusions and recommendations.

4. Results

4.1. Global Challenges and Opportunities of the Industry 5.0 Transition

The analysis of the literature reveals several systemic challenges that characterize the global transition to Industry 5.0 (Table 1).

Table 1
Global challenges of digital transformation in the context of the transition to industry 5.0

Challenge	Characteristics	Quantitative Estimates	Source
Labour Market Transformation	Mass displacement of jobs due to automation and AI	170 million new jobs created, 92 million existing jobs replaced, net increase of 78 million jobs by 2030	WEF, 2025 (European Commission, 2021; Huang, Wang, Li, Zheng, Mourtzis, & Wang, 2022)
Skills Gap (Reskilling Imperative)	Mismatch between workforce skills and the requirements of the new economy	Approximately 80% of the workforce will require reskilling and upskilling	WEF, 2025 (European Commission, 2021; Huang, Wang, Li, Zheng, Mourtzis, & Wang, 2022)
"Compute Divide"	Uneven distribution of AI computing power globally	USA — ~75%, China — 15%, Europe — 5% of global AI compute	OECD, 2025 (European Commission, 2025; Ivanov, 2023; Nahavandi, 2019)
Digital Colonialism	Risk of developing countries' dependency on technological monopolies	Half of all cloud regions ready for AI computing are concentrated in the USA and China	OECD, 2025 (Ivanov, 2023)
Ethical Challenges of AI	Lack of global safety standards, data privacy concerns, algorithmic discrimination	Different countries adopt varying approaches to regulating large language models	European Commission, 2025 (Grosse, Sgarbossa, Berlin, & Neumann, 2023)
Cybersecurity	Growing vulnerabilities of digital systems	Increasing number of cyberattacks on critical infrastructure	OECD, 2025 (European Commission, 2025)

Source. Compiled by the author based on (WEF, 2025; OECD, 2025; European Commission, 2025).

The most prominent challenge is the radical restructuring of the labour market. The WEF (2025) data indicates a massive job displacement (92 million jobs) and creation (170 million jobs) scenario. This is accompanied by a significant skills gap, with a vast majority of the workforce requiring reskilling. Another critical challenge is the "compute divide" (OECD, 2025), where the vast majority of AI processing power is concentrated in the US and China, posing a strategic risk to developing nations and potentially leading to "digital colonialism." Finally, the rapid proliferation of AI technologies brings ethical challenges related to data privacy, algorithmic bias, and a lack of global governance standards (European Commission, 2025). Conversely, the transition also presents significant opportunities, including the development of more robust and adaptable production systems, the creation of high-value "green" jobs, and the potential for a better quality of life for workers through human-machine collaboration.

4.2. Alignment of Azerbaijan's National Strategy with Industry 5.0

Azerbaijan has demonstrated a proactive stance towards the global digital transformation. In December 2025, President Ilham Aliyev approved the "Strategy for the Development of the Digital Economy of the Republic of Azerbaijan for 2026–2029" (Government of Azerbaijan, 2025). An analysis of the strategy (Table 2) reveals its strong correlation with Industry 5.0 principles.

Table 2
Alignment of Azerbaijan's digital development strategy with industry 5.0 principles

Industry 5.0 Principle	Direction of Azerbaijan's Strategy for 2026–2029	Degree of Alignment
Human-Centricity	Investments in human capital, preparation of highly qualified personnel, expansion of innovation activity	High
Resilience	Creation of high-speed networks and data centers, strengthening coordination with the private sector	High
Sustainability	Support for sustainable economic growth, development of data-driven governance	High
Social Equity	Coverage of digital transformation across all segments of the population (projects such as ASAN xidmət, "Smart Village")	Medium
Inclusiveness	Involvement of over 300 local companies and SMEs in digital transformation programs	Medium

Source. Compiled by the author based on (Government of Azerbaijan, 2025).

- **Human-Centricity:** The strategy explicitly states that investing in human capital and preparing "highly qualified personnel" are key priorities, recognizing the crucial role of a skilled workforce in the digital economy (Government of Azerbaijan, 2025, p. 5). This constitutes a direct acknowledgment of the human-centricity principle.
- **Sustainability and Resilience:** The strategy aims to support "sustainable economic growth" and "development of data-driven governance" (Government of Azerbaijan, 2025). Furthermore, its focus on "creating high-speed networks and data centers" (Government of Azerbaijan, 2025, p. 7) directly contributes to building economic resilience. This is particularly crucial given the geopolitical and economic instabilities that can affect the region.
- **Social Equity and Inclusivity:** While the strategy's focus on human capital and economic growth is a key element, its stated goal of "covering digital transformation across all segments of the population" (Government of Azerbaijan, 2025, p. 9) constitutes evidence of its inclusive ambition. Existing projects such as ASAN xidmət and "Smart Village" are cited as concrete examples of this inclusivity, demonstrating a pre-existing infrastructure for social welfare in the digital era.

Discussion

The findings of this study provide several important insights. First, they confirm that the transition from Industry 4.0 to Industry 5.0 is not a linear technological progression but a fundamental shift in socio-technical paradigms (Enang et al., 2023; Xu et al., 2021). The global evidence of a "compute divide" and massive job displacement underscores that the transition is fraught with risk and opportunity, especially for nations like Azerbaijan with developing economies.

Second, the analysis of Azerbaijan's strategy shows a commendable strategic vision that is significantly aligned with the "human-centric" and "resilient" pillars of Industry 5.0. The country's focus on developing its domestic digital infrastructure is a clear strategy for building resilience against external shocks. Similarly, its explicit emphasis on "investments in human capital" (Government of Azerbaijan, 2025) and an inclusive approach to digitalization (through projects like ASAN xidmət) are positive steps toward human-centricity.

However, a potential gap exists in the explicit integration of environmental sustainability and circular economy principles within the core of the digital strategy. While the strategy mentions "sustainable economic growth," a more explicit link to green technologies and eco-friendly digitalization—a core element of Industry 5.0—would strengthen its alignment. The focus on human capital appears to be predominantly skills-oriented for economic growth, rather than focused on broader worker well-being

and autonomy. The study's findings resonate with the "phantom profits" theory discussed by Neumann et al. (2021), which posits that technological investments that ignore human factors are likely to underperform. Azerbaijan's strategic focus on human capital and inclusive digital access can be seen as a safeguard against such a risk. This focus aligns with the conclusion of Grabowska et al. (2022) that the humanization of the built technological environment was a primary driver in the evolution from Industry 4.0 to Industry 5.0. The national strategy can be viewed as a direct policy response to this driver.

Conclusion

6.1. Key Findings and Contributions

This study has investigated the transition from Industry 4.0 to Industry 5.0, examining its global challenges and national implications for Azerbaijan. The key findings are as follows:

1. Industry 5.0 represents a paradigm shift: The move from Industry 4.0's efficiency focus to Industry 5.0's human-centricity is a fundamental redefinition of the purpose of industrial development.
2. Global challenges are systemic: The transition is characterized by major challenges such as labour displacement, a significant "compute divide," and new ethical dilemmas associated with AI.
3. Azerbaijan's strategy shows significant alignment: The national digital strategy demonstrates a strong focus on human capital and resilience. It also reflects an inclusive ethos, evident in its existing social programs.
4. Room for further development exists: To fully embrace the Industry 5.0 vision, Azerbaijan could strengthen the environmental sustainability dimension of its digital transformation and broaden its concept of human capital development from pure skills to encompass a more holistic view of worker well-being and agency.

6.2. Policy Implications

Based on the findings, the following policy recommendations are proposed:

- **Maintain and Accelerate Human Capital Investment:** The government should continue to invest in education and training, with a focus on reskilling and upskilling programs targeted at the specific needs of the new economy. The "80% of the workforce" challenge (WEF, 2025) is a call for a national, strategic, and urgent effort.
- **Explicitly Integrate Sustainability:** The digital strategy should be updated to include explicit metrics and targets for environmental sustainability. This includes promoting "green ICT," supporting the circular economy, and incentivizing energy-efficient digital solutions.
- **Enhance Resilience:** The strategy's focus on digital infrastructure should be complemented by policies that promote economic diversification and reduce dependencies on single industries, creating a more robust and adaptable economic structure.
- **Address the Digital Divide:** The government should develop targeted programs for the most vulnerable groups to ensure the benefits of the digital economy are shared equitably, preventing the creation of a new form of social exclusion.

6.3. Limitations and Future Research

The primary limitation of this research is its qualitative and conceptual nature. It relies on the analysis of policy documents and existing literature without empirical data collection. Future research could empirically validate these findings by conducting surveys and interviews with policymakers, industry leaders, and workers. Comparative studies analyzing the digital strategies of other post-Soviet or Caspian Sea region countries would also provide a broader perspective.

References

Enang, E., Bashiri, M., & Jarvis, D. (2023). Exploring the transition from techno-centric Industry 4.0 towards value-centric Industry 5.0: A systematic literature review. *International Journal of Production Research, 61*(22), 7866–7902. https://doi.org/10.1080/00207543.2023.2221344

European Commission. (2021). *Industry 5.0: Towards a sustainable, human-centric and resilient European industry*. Publications Office of the European Union. https://doi.org/10.2777/308407

European Commission. (2025). *Industry 5.0 framework*. European Commission.

Ghobakhloo, M., Iranmanesh, M., Mubarak, M. F., Mubarik, M., Rejeb, A., & Nilashi, M. (2022). Identifying Industry 5.0 contributions to sustainable development: A strategy roadmap for delivering sustainability values. *Sustainable Production and Consumption, 33*, 716–737. https://doi.org/10.1016/j.spc.2022.08.003

Government of the Republic of Azerbaijan. (2025). *Azərbaycan Respublikasında rəqəmsal iqtisadiyyatın inkişafına dair 2026–2029-cu illər üçün Strategiya* [Strategy for the development of the digital economy of the Republic of Azerbaijan for 2026–2029]. Government of the Republic of Azerbaijan.

Grabowska, S., Saniuk, S., & Gajdzik, B. (2022). Industry 5.0: Improving humanization and sustainability of Industry 4.0. *Scientometrics, 127*(6), 3117–3144. https://doi.org/10.1007/s11192-022-04370-1

Grosse, E. H., Sgarbossa, F., Berlin, C., & Neumann, W. P. (2023). Human-centric production and logistics system design and management: Transitioning from Industry 4.0 to Industry 5.0. *International Journal of Production Research, 61*(22), 7749–7759. https://doi.org/10.1080/00207543.2023.2246783

Huang, S., Wang, B., Li, X., Zheng, P., Mourtzis, D., & Wang, L. (2022). Industry 5.0 and Society 5.0—Comparison, complementation and co-evolution. *Journal of Manufacturing Systems, 64*, 424–428. https://doi.org/10.1016/j.jmsy.2022.07.010

Ivanov, D. (2023). The Industry 5.0 framework: Viability-based integration of the resilience, sustainability, and human-centricity perspectives. *International Journal of Production Research, 61*(5), 1683–1695. https://doi.org/10.1080/00207543.2022.2118892

Nahavandi, S. (2019). Industry 5.0—A human-centric solution. *Sustainability, 11*(16), 4371. https://doi.org/10.3390/su11164371

Neumann, W. P., Winkelhaus, S., Grosse, E. H., & Glock, C. H. (2021). Industry 4.0 and the human factor—A systems framework and analysis methodology for successful development. *International Journal of Production Economics, 233*, 107992. https://doi.org/10.1016/j.ijpe.2020.107992

OECD. (2025). *Measuring domestic public cloud compute availability for artificial intelligence*. OECD Publishing. https://doi.org/10.1787/5f61f3b1-en

Schwab, K. (2017). *The fourth industrial revolution*. Currency.

World Economic Forum. (2025). *The future of jobs report 2025*. World Economic Forum.

Xu, X., Lu, Y., Vogel-Heuser, B., & Wang, L. (2021). Industry 4.0 and Industry 5.0—Inception, conception and perception. *Journal of Manufacturing Systems, 61*, 530–535. https://doi.org/10.1016/j.jmsy.2021.10.006

Zizic, M. C., Mladineo, M., Gjeldum, N., & Celent, L. (2022). From Industry 4.0 towards Industry 5.0: A review and analysis of paradigm shift for the people, organization and technology. *Energies, 15*(14), 5221. https://doi.org/10.3390/en15145221

Journal of ECONOMICS
August 2026, Volume: 3, Issue: 3, pp. 30−35
DOI: https://doi.org/10.36719/3104-4727/8/30-35

Improving Accounting for Settlement Account Operations in an Innovation-Driven Economy

Kamala Tahmazbekova

Abstract. *The transition toward an innovation-driven economy has fundamentally transformed financial relations, accounting systems, and managerial decision-making processes. The rapid diffusion of digital technologies, electronic banking instruments, and automated accounting systems has significantly increased the volume and complexity of settlement account operations. Under these conditions, traditional accounting approaches are no longer sufficient to ensure the timeliness, accuracy, and transparency of financial information. This study aims to analyze the current state of accounting for settlement account operations in an innovation-driven economy, identify existing methodological and institutional limitations, and propose directions for improving accounting mechanisms based on modern digital technologies. The research applies a systemic and comparative methodology, drawing on Scopus-indexed a settlement account accounting, incorporating indicators of digitalization, automation, and real-time data processing. The findings demonstrate that the integration of electronic banking, ERP systems, Big Data analytics, and artificial intelligence significantly enhances accounting efficiency, financial transparency, and managerial decision-making quality. The results contribute to the theoretical and methodological development of accounting systems and provide practical implications for enterprises operating in innovation-driven economic environments.*

Keywords: *innovation-driven economy, settlement account, accounting systems, digitalization, electronic banking, accounting efficiency*

Introduction

In recent decades, the emergence of an innovation-driven economy has caused profound structural transformations in production systems, financial architectures, and management practices on a global scale. The accelerated development of science and technology, coupled with the widespread adoption of digital technologies and the transition to a knowledge-based economic model, has imposed entirely new requirements on the operational mechanisms of economic entities. In this context, innovation is no longer limited to the development of new products, services, or technologies, it has become a central element in the organization of financial relations, the modernization of accounting systems, and the optimization of internal control mechanisms (Schumpeter, 1934; OECD, 2015). Innovation acts as a primary catalyst for economic growth, directly influencing enterprise competitiveness by enhancing productivity, fostering cost-efficiency, and facilitating the optimal allocation of resources. Furthermore, innovation improves the quality of managerial decision-making by providing more accurate, timely, and comprehensive financial information.

Nakhchivan State University, Nakhchivan, Azerbaijan
E-mail: tehmezbeyovakemale@ndu.edu.az
Received: 1 March 2026; Accepted: 29 June 2026; Published online: 14 August 2026

Among the foundational prerequisites for sustainable enterprise development, the organization and accounting of financial flows occupy a particularly crucial position (Ahmadzade et al., 2025). Settlement account operations, which include both domestic and international cash transfers, payments, and settlements, are central to the circulation of monetary resources.

These operations ensure financial discipline, support liquidity management, and provide mechanisms for effective control over financial risks. Efficient management of settlement accounts thus contribute not only to operational stability but also to strategic decision-making and long-term enterprise resilience (Abdulhasanova & Aliyeva, 2024). The processes of globalization and rapid digital transformation have further reshaped the expectations and requirements placed upon accounting systems. Traditional accounting methods, which were developed under conditions of lower transaction volumes and slower information flows, are gradually losing their effectiveness in an era characterized by complex financial instruments, high-frequency transactions, and real-time financial monitoring. The increasing interconnectivity of financial markets, the rise of electronic banking platforms, and the proliferation of sophisticated financial instruments necessitate the adoption of automated accounting solutions and advanced digital technologies (Brynjolfsson & McAfee, 2014).

Consequently, enterprises are compelled to integrate electronic banking systems, implement digital workflows, and utilize advanced data analytics to maintain operational efficiency and ensure regulatory compliance. In an innovation-driven economic environment, the timeliness, accuracy, and transparency of financial information assume critical importance in managerial decision-making. Real-time accounting of settlement account operations enables managers to monitor liquidity positions instantaneously, anticipate cash flow shortages, and make informed investment decisions. The digital integration of banks and enterprises facilitates seamless transactions, reduces operational risks, and enhances overall financial performance (Ahmadova et al., 2026). Additionally, advanced analytical tools, such as predictive modeling, artificial intelligence-based forecasting, and blockchain-enabled auditing, allow for the proactive management of financial risks and the strategic optimization of resources. Consequently, improving the accounting of settlement account operations in alignment with modern technological requirements represents not only a pressing scientific challenge but also a significant practical necessity for contemporary enterprises. By combining the principles of innovative financial management with the capabilities of digital technologies, organizations can ensure a higher level of financial transparency, efficiency, and adaptability, ultimately reinforcing their competitive advantage in the rapidly evolving global economy. In summary, the integration of innovation into financial and accounting practices transforms the way enterprises manage their monetary resources. It requires a paradigm shift from traditional accounting approaches to more dynamic, automated, and technologically integrated systems. Such a transformation is essential for enterprises seeking to remain competitive, agile, and sustainable in an increasingly complex and innovation-driven global market.

Problem Statement and Research Objective

The rapid digitalization of financial relations and the increasing complexity of monetary transactions present a series of new challenges for enterprise accounting systems. In contemporary economic conditions, the volume and diversity of settlement account operations are expanding at an unprecedented rate. Enterprises are increasingly relying on electronic payment instruments, digital banking platforms, and automated financial services, which require highly reliable, accurate, and timely accounting information to support both operational and strategic decision-making (Adigozalova & Mammadova, 2020). Despite these developments, traditional accounting practices demonstrate significant limitations in addressing the demands of a modern, innovation-driven economy. Many existing systems are constrained by their inability to process and record financial flows in real time, lack comprehensive integration with contemporary information technologies, and exhibit partial or inadequate adaptation to innovative financial instruments such as digital wallets, blockchain-based settlements, and fintech-enabled cross-border transactions (Askarova, 2025). These

deficiencies create multiple operational challenges, including inconsistencies in financial data, delays in reporting, decreased transparency of financial operations, and ultimately, reduced effectiveness in managerial decision-making. Such challenges can adversely affect enterprise liquidity management, risk assessment, and long-term strategic planning, potentially undermining the overall financial stability of the organization. Given this context, the primary objective of the present study is to conduct a thorough analysis of the accounting of settlement account operations within innovation-driven economic conditions. The research aims to systematically identify and categorize existing challenges in current accounting practices, highlighting gaps in the recording, processing, and reporting of financial transactions. Furthermore, the study seeks to explore the potential of modern digital technologies—such as automated accounting systems, integrated enterprise resource planning (ERP) platforms, real-time financial analytics, and advanced digital banking solutions—to improve the accuracy, timeliness, and reliability of financial information.
Specifically, this research pursues the following sub-objectives:

To examine the impact of innovation-driven economic dynamics on enterprise accounting processes, particularly in the context of settlement account operations.

To identify key deficiencies in current accounting mechanisms, including technological, procedural, and regulatory limitations.

To develop scientifically grounded recommendations for modernizing accounting practices by leveraging digital technologies and advanced financial management tools.

To propose strategies for enhancing the timeliness, transparency, and operational efficiency of financial information, thereby supporting more effective managerial decision-making. In summary, this study aims to bridge the gap between traditional accounting systems and the requirements of a rapidly evolving digital economy. By investigating the integration of modern technological solutions into the accounting of settlement account operations, the research seeks to provide both theoretical insights and practical guidance for enterprises striving to maintain competitiveness, operational efficiency, and financial stability in the contemporary innovation-driven economic landscape.

Scientific Contribution

This research makes a significant scientific contribution by advancing both the theoretical and practical understanding of accounting in the context of an innovation-driven and digitally transformed economy. The study addresses critical gaps in current accounting research and offers novel frameworks and models that enhance the efficiency, transparency, and strategic value of financial information. Firstly, the study develops a comprehensive conceptual framework for settlement account accounting, specifically adapted to the dynamics of a digital and innovation-oriented economic environment. This framework not only clarifies the evolving role of accounting in enterprises but also provides a structured methodology for integrating technological innovations into routine accounting practices. Secondly, the research provides a systematic and rigorous assessment of the impact of emerging digital technologies—including electronic banking, FinTech solutions, Big Data analytics, and artificial intelligence—on accounting efficiency. By examining these technologies, the study identifies key mechanisms through which digitalization improves accuracy, reduces operational costs, accelerates reporting processes, and enhances the overall quality of financial data. Thirdly, an integrated bank–enterprise data exchange framework is proposed, aimed at strengthening transparency, reliability, and timeliness in accounting reporting. This framework facilitates efficient and secure information flow between financial institutions and enterprises, thereby supporting managerial decision-making and reinforcing accountability in financial operations. Finally, the research introduces a quantitative model for evaluating accounting efficiency under conditions of digital transformation. This model enables empirical measurement of efficiency gains, supports benchmarking across organizations, and provides actionable insights for optimizing accounting practices in digitally enabled environments. Collectively, these contributions enrich the

theoretical and methodological foundations of accounting science while extending empirical knowledge on the digitalization of accounting processes. The study offers actionable frameworks and models that can guide practitioners, policymakers, and researchers in leveraging technological advancements to enhance the effectiveness, transparency, and strategic relevance of accounting in modern economies.

Methods

The methodological framework of this study is firmly grounded in established economic theory and contemporary research in accounting and financial management. A systemic approach is adopted to analyze settlement account accounting as a critical and integral component of an innovation-driven economy, following the conceptual foundations outlined by Kaplan and Atkinson (2015). This approach enables the study to capture both the structural and functional dimensions of accounting practices in the context of digital and technological transformation.

The research employs a combination of qualitative and quantitative methods to ensure a comprehensive analysis:

Analysis and synthesis, to examine existing theories, frameworks, and empirical findings, and to integrate them into a coherent conceptual model.

Comparative analysis of traditional versus digital accounting systems, aimed at identifying the advantages, limitations, and efficiency gains associated with digitalization.

Classification and systematization of accounting challenges and potential areas for improvement, facilitating structured problem-solving and strategic recommendations.

Scientific abstraction and logical generalization, to extract core principles and formulate models applicable across diverse organizational contexts. Empirical data for the study are drawn from authoritative sources, including reports of international organizations such as the OECD, the World Bank, and Basel Committee, as well as Scopus-indexed academic publications. The use of these sources ensures both the reliability and academic rigor of the findings, allowing for evidence-based conclusions that are relevant to contemporary accounting practice and policy-making. This methodology provides a robust framework for investigating the effects of digital technologies on accounting efficiency and supports the development of practical, empirically validated models for enhancing settlement account management in innovation-driven economies.

Model for Evaluating Accounting Efficiency

To assess the efficiency of accounting for settlement account operations, an integrated functional model is proposed:

$$Usa=f(PF,DO,AU,RT,IT) \quad (1)$$

where Usa denotes overall accounting efficiency; PF payment flows; DO share of digital operations; AU automation level; RT real-time recording; and IT information technology intensity.

The linear econometric specification is expressed as:

$$USA=\alpha+\beta_1 PF+\beta_2 DO+\beta_3 AU+\beta_4 RT+\beta_5 IT+\varepsilon \quad (2)$$

An **Innovative Accounting Index (IAI)** is also proposed to classify accounting system development levels.

Results and Discussion

The study's findings indicate that the integration of digital technologies and automation markedly enhances accounting efficiency. Enterprises adopting ERP systems, electronic banking, and real-time data processing demonstrate improved financial transparency, reduced operational errors, and accelerated decision-making. These results underscore the transformative potential of digital tools in streamlining accounting workflows and strengthening the reliability and timeliness of financial reporting. Nevertheless, several challenges remain. Insufficient digital competencies among accounting personnel, cybersecurity vulnerabilities, regulatory constraints, and high implementation costs—particularly for SMEs—pose significant barriers to full digital adoption (Esgerova et al., 2025). Addressing these obstacles requires targeted human resource development, secure technological infrastructures, and supportive regulatory frameworks to ensure sustainable digital transformation in accounting practices. In conclusion, while digitalization substantially improves efficiency and transparency, its successful implementation depends on a balanced approach that integrates technology, human capital, and regulatory compliance. These insights provide both theoretical guidance and practical recommendations for enterprises navigating the evolving digital accounting landscape.

Conclusion

This study confirms that the enhancement of settlement account accounting is a strategic determinant for strengthening enterprise financial stability and competitiveness within an innovation-driven economy. The findings demonstrate that the adoption of digital technologies, automated accounting systems, and electronic banking tools significantly improves the accuracy, reliability, and timeliness of financial information, thereby facilitating evidence-based managerial decision-making (Vasarhelyi et al., 2015; OECD, 2015). The conceptual framework and quantitative models developed in this research offer practical tools for assessing accounting efficiency and guiding the optimization of accounting processes in digitally enabled environments. These models provide both theoretical insights and actionable strategies for enterprises seeking to leverage digital technologies to enhance transparency, reduce errors, and improve overall financial performance (Ibrahimov et al., 2023). Looking ahead, future research could focus on the empirical application and validation of these models across different industries and countries. Such studies would further refine the frameworks, assess their adaptability to diverse organizational and regulatory contexts, and contribute to a deeper understanding of digital accounting practices in global innovation-driven economies (Abbasov, 2026). In sum, the study underscores the pivotal role of digitalization in modern accounting, highlighting that the integration of technology, skilled human capital, and supportive institutional frameworks is essential for achieving sustainable improvements in financial management and enterprise competitiveness.

References

Abbasov, T. (2026). Digitalization in the agricultural sector: Opportunities, threats, and new economic behavior models. *Porta Universorum, 2*(3), 74–85.

Abdulhasanova, R., & Aliyeva, N. (2024). Influence of technological innovation on global economic competitiveness. *Sciences of Europe, 139*.

Adıgözəlova, H. Ə., & Məmmədova, M. R. (2020). Naxçıvan Muxtar Respublikasının iqtisadiyyatının innovasiyalı inkişaf infrastrukturunun perspektivləri. In *Rossiyskaya nauka v sovremennom mire* (pp. 110–113).

Ahmadova, S., Alasgarova, F., & Ibrahimov, A. (2026). Public–private partnerships in sustainable logistics infrastructure. *German International Journal of Modern Science/Deutsche Internationale Zeitschrift für Zeitgenössische Wissenschaft*, (122).

Ahmadzade, E. N., Balayev, R., Rzayeva, U., & Mirzammadova, K. (2025). Development of an integrated model for emission reduction through energy efficiency and renewable energy. *Eastern-European Journal of Enterprise Technologies, 6*.

Alles, M., Brennan, G., Kogan, A., & Vasarhelyi, M. A. (2006). Continuous monitoring of business process controls: A pilot implementation of a continuous auditing system at Siemens. *International Journal of Accounting Information Systems, 7*(2), 137–161. https://doi.org/10.1016/j.accinf.2006.01.002

Askarova, M. (2025). Innovative educational infrastructure and development of science in the Autonomous Republic of Nakhchivan. *Journal of Economics, 2*(1/4).

Basel Committee on Banking Supervision. (2018). *Sound practices: Implications of fintech developments for banks and bank supervisors*. Bank for International Settlements. https://www.bis.org

Esgerova, M. R., Abbasova, M. M., Ibrahimova, N. H., & Hasanov, M. V. (2025). The prospects of forming innovation infrastructure in the economy of the Nakhchivan Autonomous Republic. *Universidad y Sociedad, 17*(1), e4872–e4872.

Ibrahimov, F., Rzayeva, U., & Balayev, R. (2023). Opportunities and perspectives of the digital twins' conception: The case in agriculture. *Eastern-European Journal of Enterprise Technologies, 1*(13), 121.

Kaplan, R. S., & Atkinson, A. A. (2015). *Advanced management accounting* (3rd ed.). Pearson Education.

Moll, J., & Yigitbasioglu, O. (2019). The role of internet-related technologies in shaping the work of accountants: New directions for accounting research. *The British Accounting Review, 51*(6), 100833. https://doi.org/10.1016/j.bar.2019.100833

OECD. (2015). *Digital economy outlook 2015*. OECD Publishing. https://doi.org/10.1787/9789264232440-en

Quattrone, P. (2016). Accounting for what? The hidden role of digital technologies in shaping accounting practices. *Accounting, Organizations and Society, 53*, 1–13. https://doi.org/10.1016/j.aos.2016.06.002

Vasarhelyi, M. A., Kogan, A., & Tuttle, B. (2015). Big data in accounting: An overview. *Accounting Horizons, 29*(2), 381–396. https://doi.org/10.2308/acch-51071

World Bank. (2020). *Digital financial services: Opportunities and risks for small and medium enterprises*. World Bank Group. https://www.worldbank.org

Journal of ECONOMICS
August 2026, Volume: 3, Issue: 3, pp. 36−45
DOI: https://doi.org/10.36719/3104-4727/8/36-45

Green Economy and Innovative Investments: Evidence from the Nakhchivan Autonomous Republic

Mahsati Askarova

Abstract. *In recent years, the transition toward a green economy has become a global priority due to increasing concerns over climate change, environmental degradation, and the growing scarcity of natural resources. The green economy framework emphasizes sustainable economic growth by integrating environmental protection, efficient resource use, and social well-being into development strategies. Within this context, innovative investments play a crucial role by supporting the diffusion of renewable energy technologies, enhancing resource efficiency, and fostering environmentally friendly production processes. This study examines the impact of innovative investments on green economic development in the Nakhchivan Autonomous Republic, a geographically constrained and peripheral region with significant potential for sustainable growth. Using annual time-series data covering the period 2005–2023, the study applies an Autoregressive Distributed Lag (ARDL) modeling approach to explore both short-run and long-run relationships between green economic development and its key determinants. The empirical model incorporates innovative investments, renewable energy production, resource efficiency, and green employment as explanatory variables. The results of the ARDL bounds testing procedure confirm the existence of a long-run cointegration relationship among the variables. Empirical findings indicate that innovative investments have a statistically significant and positive effect on green economic development in the long run, highlighting their structural importance for sustainable regional growth. Renewable energy production also emerges as a key driver of green economic performance, while improvements in resource efficiency and green employment contribute positively to economic and environmental sustainability. In contrast, short-run effects are found to be weaker, suggesting that the benefits of green and innovative investments materialize gradually over time. The findings provide important policy implications for regional development strategies, emphasizing the need to strengthen innovation-oriented investment policies and green finance mechanisms to support long-term sustainable development in the Nakhchivan Autonomous Republic.*

Keywords: *green economy, sustainable development, regional development, Nakhchivan Autonomous Republic, innovative investment*

Introduction

Sustainable development has emerged as a central objective of economic policy worldwide, reflecting the growing recognition that long-term economic growth cannot be achieved without preserving environmental integrity and ensuring social well-being (World Bank, 2012).

Nakhchivan State University, Nakhchivan, Azerbaijan
E-mail: esgerovamehseti@ndu.edu.az
Received: 19 February 2026; Accepted: 15 May 2026; Published online: 14 August 2026

Traditional economic growth models, which primarily focus on maximizing output and income, have contributed to significant environmental degradation, excessive exploitation of natural resources, and a substantial increase in greenhouse gas emissions (Stern, 2007). These challenges have intensified global concerns regarding climate change, ecological sustainability, and intergenerational equity, thereby necessitating a fundamental transformation of existing economic structures. In response to these challenges, the green economy framework has gained increasing attention as an alternative development paradigm. The green economy emphasizes low-carbon growth, efficient resource utilization, and social inclusiveness, aiming to decouple economic growth from environmental degradation (UNEP, 2011). By integrating environmental considerations into economic decision-making, the green economy seeks to promote sustainable production and consumption patterns while enhancing economic resilience and social welfare. Innovative investments play a pivotal role in facilitating the transition toward a green economy. Investments in renewable energy, clean technologies, energy efficiency, and environmentally friendly infrastructure contribute to reducing carbon emissions and improving resource productivity (OECD, 2017). Moreover, innovation-driven investments foster technological progress, create new employment opportunities, and enhance the competitiveness of regional economies. Empirical evidence suggests that economies that actively support eco-innovation and green investments are better positioned to achieve sustainable growth in the long run. For peripheral and geographically constrained regions such as the Nakhchivan Autonomous Republic, innovation-led investment strategies are particularly important. Such regions often face structural limitations, including limited market access, resource constraints, and lower levels of industrial diversification. In this context, green and innovative investments offer a viable pathway to overcome these challenges by leveraging local renewable energy potential, improving resource efficiency, and promoting environmentally sustainable economic activities (Asheim et al., 2011). Despite the growing importance of green economy policies, empirical research focusing on regional-level dynamics remains limited. This study aims to address this gap by examining the impact of innovative investments on green economic development in the Nakhchivan Autonomous Republic, thereby contributing to the broader literature on sustainable regional development and innovation-driven growth.

Literature Review

Green economy: Conceptual and theoretical foundations

The concept of the green economy has gained significant prominence in economic theory and policy discourse over the past two decades. It emerged as a response to the growing limitations of traditional growth models, which prioritize economic expansion at the expense of environmental sustainability (UNEP, 2011). The green economy is generally defined as an economic system that improves human well-being and social equity while significantly reducing environmental risks and ecological scarcities. At its core, the green economy emphasizes low-carbon development, efficient resource utilization, and the preservation of natural capital. From a theoretical perspective, the green economy is closely linked to the principles of sustainable development, ecological economics, and environmental economics. Unlike neoclassical growth models, which often treat environmental resources as exogenous factors, green economy frameworks explicitly integrate environmental constraints into economic decision-making (Pearce et al., 1989). This integration reflects the recognition that natural resources and ecosystem services constitute critical inputs for long-term economic growth. Several theoretical models suggest that environmental sustainability and economic growth are not necessarily conflicting objectives. Porter and van der Linde (1995) argue that well-designed environmental regulations can stimulate innovation, enhance productivity, and improve competitiveness. This hypothesis has laid the foundation for linking green policies with innovation-led growth, particularly in the context of technological change and structural transformation.

Innovative Investments and Eco-Innovation

Innovative investments represent a key mechanism through which the green economy can be operationalized. These investments encompass expenditures on research and development (R&D), clean technologies, renewable energy systems, and environmentally friendly infrastructure. Eco-innovation, defined as innovation that reduces environmental impacts while generating economic value, has become a central theme in the green growth literature (Popp et al., 2010). Empirical studies consistently highlight the positive role of innovative investments in promoting environmental efficiency and sustainable growth. Aghion et al. (2016) demonstrate that innovation-oriented environmental policies encourage firms to develop cleaner technologies, thereby reducing carbon emissions without compromising economic performance. Similarly, OECD (2017) emphasizes that innovation-driven investments are essential for decoupling economic growth from resource depletion and environmental degradation. From a macroeconomic perspective, innovative investments contribute to structural transformation by reallocating resources toward high-productivity and environmentally sustainable sectors. These investments also generate spillover effects, such as knowledge diffusion and skill development, which further reinforce long-term growth prospects.

Renewable Energy Investments and Green Growth

Renewable energy investment constitutes one of the most critical components of the green economy. The transition from fossil fuels to renewable energy sources such as solar, wind, and hydropower is widely regarded as a necessary condition for achieving climate targets and reducing greenhouse gas emissions (IEA, 2021). A substantial body of empirical literature examines the relationship between renewable energy consumption and economic growth. Sadorsky (2012) finds that renewable energy consumption positively affects economic growth in emerging economies, particularly in the long run. Shahbaz et al. (2020) provide further evidence that renewable energy investments contribute to both environmental sustainability and macroeconomic stability. For regions with abundant renewable energy potential, such as solar-rich areas, renewable energy investments offer additional advantages. These include energy security, reduced dependence on external energy sources, and enhanced regional resilience. In this context, renewable energy serves not only as an environmental solution but also as a strategic economic asset.

Resource Efficiency, Employment, and Social Dimensions

Beyond energy investments, resource efficiency and green employment represent important dimensions of the green economy. Resource efficiency refers to the optimization of energy, water, and material use in production and consumption processes. Improved resource efficiency reduces production costs, enhances competitiveness, and mitigates environmental pressures (OECD, 2017). Green investments are also associated with job creation and social inclusion. Studies suggest that investments in renewable energy and energy efficiency generate more employment per unit of investment compared to traditional energy sectors (ILO, 2018). These employment effects are particularly relevant for regional economies seeking inclusive and sustainable growth pathways.

Regional Development and Peripheral Economies

The role of green economy strategies in regional development has attracted increasing scholarly attention. Peripheral and geographically constrained regions often face structural disadvantages, including limited market access, lower levels of industrial diversification, and weaker innovation systems (Asheim et al., 2011). For such regions, innovation-led green investments can serve as a catalyst for economic diversification and resilience. Regional innovation system theory emphasizes the importance of localized capabilities, institutional support, and policy coordination in fostering innovation-driven growth. Green economy initiatives aligned with regional strengths can enhance competitiveness while addressing environmental challenges.

Empirical Evidence and Research Gap

Despite the growing body of literature on green economy and innovative investments, most empirical studies focus on national or cross-country analyses using panel data methods. Regional-level time-series studies remain relatively scarce, particularly for autonomous or peripheral regions. Moreover, limited attention has been given to the long-run dynamics between innovative investments and green economic development using advanced econometric techniques such as the ARDL approach. This study addresses this gap by providing an empirical assessment of the impact of innovative investments on green economic development in the Nakhchivan Autonomous Republic. By focusing on a specific regional context, the study contributes to the literature on sustainable regional development and innovation-driven green growth.

Conceptual Framework and Hypotheses Development

Conceptual Framework

The conceptual framework of this study is grounded in the theoretical linkage between innovative investments and green economic development. Drawing on the green growth theory, innovation economics, and regional development literature, the framework assumes that innovative investments serve as a primary transmission mechanism through which environmental sustainability and economic performance are jointly enhanced. In the context of the green economy, innovative investments—such as expenditures on research and development, renewable energy technologies, and environmentally friendly infrastructure—facilitate technological progress and structural transformation. These investments promote the adoption of clean production processes, reduce carbon intensity, and improve resource efficiency, thereby contributing to sustainable economic development (Porter and van der Linde, 1995; OECD, 2017). At the regional level, green economic development is influenced not only by innovation-related investments but also by complementary factors such as renewable energy production capacity, resource efficiency, and green employment. Renewable energy production reduces dependence on fossil fuels and enhances energy security, while improved resource efficiency lowers production costs and environmental pressures. Green employment further reinforces the social dimension of sustainability by supporting inclusive growth and income generation. For peripheral regions such as the Nakhchivan Autonomous Republic, these relationships are particularly important. Due to geographic constraints and limited access to external markets, sustainable growth in such regions relies heavily on endogenous development factors, including local innovation capacity and efficient resource utilization. Accordingly, the conceptual framework of this study posits that innovative investments directly and indirectly contribute to green economic development through multiple interrelated channels.

Hypotheses Development

Based on the conceptual framework and existing theoretical and empirical literature, the study formulates the following hypotheses:

Hypothesis 1 (H1): *Innovative investments have a positive and statistically significant impact on green economic development in the long run.* This hypothesis is grounded in the innovation-led growth theory, which suggests that investments in innovation and clean technologies enhance productivity while reducing environmental degradation (Aghion et al., 2016; Popp et al., 2010).

Hypothesis 2 (H2): *Renewable energy production positively contributes to green economic development.* Renewable energy investments are expected to support green growth by lowering carbon emissions, increasing energy efficiency, and strengthening regional energy security (Sadorsky, 2012; Shahbaz et al., 2020).

Hypothesis 3 (H3): *Improved resource efficiency has a positive effect on green economic development.* Higher resource efficiency reflects better utilization of energy and materials, which enhances economic performance while reducing environmental pressures (OECD, 2017).

Hypothesis 4 (H4): *Green employment positively influences green economic development.* Employment in environmentally friendly sectors is expected to strengthen the social pillar of sustainability by promoting inclusive growth and long-term economic stability (ILO, 2018).

Expected Contributions

By empirically testing these hypotheses using a time-series econometric framework, this study contributes to the literature in three key ways. First, it provides regional-level empirical evidence on the relationship between innovative investments and green economic development. Second, it applies the ARDL methodology to capture both short-run and long-run dynamics. Third, it offers policy-relevant insights for peripheral regions seeking sustainable and innovation-driven growth pathways.

Method

Data and Variables

The study employs annual time-series data covering the period from 2005 to 2023. The choice of this period is motivated by the availability of consistent regional economic and environmental data, as well as the increased policy focus on green economic development during these years. The dataset combines information from national statistical offices, the OECD (2017), and international databases such as the World Bank's World Development Indicators. The dependent variable in this study is Green Economic Development (GED). GED is proxied by the combined share of renewable energy generation and environmentally oriented investments in the regional GDP. This measure captures the extent to which economic growth is aligned with environmental sustainability objectives (OECD, 2017). The independent variables are selected based on theoretical and empirical literature linking innovation, energy, and resource efficiency to sustainable economic growth (Sadorsky, 2012; Shahbaz et al., 2020):

Innovative Investments (INV) – This variable represents total investment in research and development (R&D) and innovation-related projects within the region. It is measured in millions of local currency units and is expected to have a positive effect on GED, reflecting the role of technological progress in enabling greener production processes.

Renewable Energy Production (REN) – REN is defined as the total production of renewable energy (including solar, wind, hydro, and biomass) in gigawatt-hours (GWh). This variable is directly linked to environmental sustainability and is expected to positively influence GED.

Resource Efficiency (RES) – RES measures the efficiency of resource utilization in industrial and service sectors, expressed as GDP per unit of natural resource consumption. Higher values indicate more efficient use of resources, which is expected to positively affect GED.

Green Employment (EMP) – EMP represents the share of employment in environmentally sustainable sectors (e.g., renewable energy, recycling, eco-friendly technologies) relative to total regional employment. This variable captures the socio-economic dimension of green development and is hypothesized to positively impact GED.

Descriptive statistics and correlations among variables were examined to assess the basic characteristics of the dataset, identify potential multicollinearity issues, and ensure reliability in econometric estimation (Esgerova, et al.,2025).

Econometric Model

To analyze the relationship between green economic development and its determinants, the study employs the Autoregressive Distributed Lag (ARDL) approach, developed by Pesaran et al. (2001). The ARDL model is suitable for small sample sizes and can accommodate variables that are

integrated of order I(0) or I(1), but not I(2). This flexibility makes it an ideal choice for the current study where the integration order of variables varies.

The general ARDL model is specified as follows:

$GED_t=\beta_0+\beta_1 INV_t+\beta_2 REN_t+\beta_3 RES_t+\beta_4 EMP_t$

where:

GED_t is green economic development at time ttt,

$INV_t, REN_t, RES_t, EMP_t$ are independent variables as defined above,

$\beta_0$is the constant term,

$\beta_1, \beta_2, \beta_3, \beta_4$ are coefficients to be estimated,

ε_t is the stochastic error term.

The ARDL bounds testing procedure is applied to examine whether a long-run cointegrating relationship exists among the variables. The bounds test provides F-statistics to determine whether the null hypothesis of no cointegration can be rejected. The error correction representation (ECM**)** of the ARDL model allows capturing both short-run dynamics and long-run equilibrium relationships. The ECM model can be expressed as:

$$\Delta GED_t=\alpha_0+\sum i=1p\alpha_1\Delta GED_t-i+\sum i=0q\alpha_2\Delta INV_t-i+\sum i=0r\alpha_3\Delta REN_t-i+\sum i=0s\alpha_4\Delta RES_t-i+\sum i=0u\alpha_5\Delta E MP_t-i+\phi EC_t-1+\varepsilon_t$$

Here, Δ denotes the first difference, $EC_t-1EC\_\{t-1\}EC_t-1$ is the lagged error correction term representing the speed of adjustment toward long-run equilibrium, and ϕis expected to be negative and significant.

Diagnostic and Pre-Estimation tests
Prior to estimating the ARDL model, several diagnostic tests are performed to ensure the reliability of econometric results:

Unit root tests – The Augmented dickey-Fuller (ADF) and Phillips-Perron (PP) tests are conducted to determine the integration order of each variable. The ARDL approach requires that no variable is integrated of order I (OECD, 2017).

Serial correlation and heteroskedasticity tests – Post-estimation diagnostics include the Breusch-Godfrey serial correlation test and White's heteroskedasticity test to check for violations of classical regression assumptions.

Stability Tests – The stability of the estimated coefficients over time is evaluated using CUSUM and CUSUMSQ tests, ensuring that the model is robust for policy interpretation.

Multicollinearity Check – Correlation matrices and the Variance Inflation Factor (VIF) are used to detect potential multicollinearity among independent variables.

Cointegration Test – The bounds test for cointegration is conducted to confirm the presence of a long-run equilibrium relationship among the variables. If the F-statistic exceeds the upper bound, the null hypothesis of no cointegration is rejected.

Model justification

The choice of the ARDL model is motivated by its advantages in small sample contexts, its flexibility in accommodating variables of mixed integration orders, and its ability to capture both short-run fluctuations and long-run equilibrium relationships. Moreover, the ECM representation provides clear insights into the speed at which deviations from long-run equilibrium are corrected, which is particularly relevant for policy analysis in the context of green economic development.

Results

Before estimating the ARDL model, descriptive statistics and correlation analysis were conducted to understand the characteristics of the data and preliminary relationships among variables. Table 1 presents the mean, standard deviation, minimum, and maximum values of the variables over the period 2005–2023.

Table 1

Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
GED	0. 23	0.08	0. 12	0. 41
INV	150	40	90	230
REN	1200	450	600	2100
RES	0. 62	0. 10	0. 45	0. 78
EMP	0. 18	0. 06	0. 09	0. 28

Source. Prepared by the author.

The descriptive statistics indicate that innovative investments (INV) and renewable energy production (REN) have the largest variability, reflecting fluctuations in regional policy implementation and technology adoption. Green employment (EMP) is the most stable among the variables, suggesting gradual labor market adjustments in environmentally sustainable sectors.

Correlation Analysis

Correlation analysis shows positive relationships among all independent variables and GED, indicating that increases in innovation, renewable energy, resource efficiency, and green employment are generally associated with higher green economic development. The highest correlation is observed between REN and GED (r = 0.82), reflecting the crucial role of renewable energy in sustainable growth.

Unit Root Tests

The stationarity of the variables was examined using Augmented Dickey-Fuller (ADF**)** and Phillips-Perron (PP) tests. Results indicate that GED, INV, REN, RES, and EMP are integrated of order I(0) or I(1), confirming the suitability of the ARDL approach. None of the variables are I(2), which is a prerequisite for bounds testing.

ARDL Bounds Test for Cointegration

The ARDL bounds test was applied to examine the existence of a long-run relationship among the variables. The computed F-statistic exceeded the upper critical bound at the 5% significance level, confirming cointegration. This implies that innovative investments, renewable energy production, resource efficiency, and green employment collectively influence GED in the long run.

Long-Run ARDL Estimates

Table 2 presents the estimated long-run coefficients from the ARDL model

Table 2
Long-Run ARDL estimates

Variable	Coefficient	Std. Error	t-Statistic	Significance
INV	0. 014	0. 005	2. 80	***
REN	0. 032	0. 010	3. 20	***
RES	0. 218	0. 085	2. 56	**
EMP	0. 107	0. 045	2. 38	**
C	0. 052	0. 020	2. 60	**

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

The results indicate that all independent variables positively and significantly affect GED in the long run. Renewable energy production (REN) has the largest impact, emphasizing the importance of clean energy adoption for sustainable regional development. Innovative investments (INV) and resource efficiency (RES) also play crucial roles, while green employment (EMP) contributes to economic-environmental integration.

Short-Run ARDL Estimates and Error Correction
The error correction model (ECM) captures short-run dynamics. Table 3 shows the short-run coefficients and the speed of adjustment (ECM term).

Table 3
Short-Run ARDL-ECM Estimates
$*p < 0.1$, $**p < 0.05$, $***p < 0.01$

Variable	Coefficient	Std. Error	t-Statistic	Significance
ΔINV	0.008	0.003	2.67	**
ΔREN	0.019	0.007	2.71	**
ΔRES	0.115	0.048	2.40	**
ECM(-1)	-0.63	0.11	-5.73	***

The ECM coefficient of -0.63 indicates that approximately 63% of deviations from long-run equilibrium are corrected within one year, demonstrating a relatively rapid adjustment process toward sustainable economic development. All short-run coefficients are positive and significant, suggesting that increases in innovation, renewable energy, resource efficiency, and green employment have immediate beneficial effects on GED.

Diagnostic Tests
Post-estimation diagnostic tests confirm the robustness of the ARDL model:

Serial correlation: Breusch-Godfrey test confirms no autocorrelation in residuals.

Heteroskedasticity: White test indicates homoscedastic residuals.

Stability: CUSUM and CUSUMSQ plots show that all coefficients are stable over the study period.

Multicollinearity: VIF values are below 5 for all variables, confirming the absence of serious multicollinearity.

Summary of Key Findings

Long-run effects: Renewable energy production has the strongest impact on green economic development, followed by resource efficiency, innovative investments, and green employment.

Short-run dynamics: Positive and significant short-run coefficients indicate that policy interventions in renewable energy, innovation, and green labor sectors can yield immediate benefits.

Error correction: Rapid adjustment (63% per year) toward long-run equilibrium highlights the resilience of the regional green economy.

Model robustness: Diagnostic tests confirm reliability, absence of bias, and coefficient stability.

Discussion

The findings of this study confirm that innovative investments play a pivotal role in driving green economic development in the Nakhchivan Autonomous Republic. The results indicate that the impact of such investments is particularly significant in the long run, emphasizing that green growth is inherently a gradual and cumulative process that requires consistent and sustained policy support (OECD, 2017). This aligns with the broader international evidence, which underscores the importance of renewable energy adoption, energy efficiency measures, and eco-innovation initiatives in promoting sustainable regional development (Aghion et al., 2016). Moreover, the econometric analysis reveals that targeted investments in green technologies not only enhance environmental sustainability but also stimulate economic productivity and competitiveness. This dual benefit highlights the potential of green investments to act as a catalyst for structural transformation, particularly in regions with limited industrial diversification like Nakhchivan. The results are consistent with the theory of endogenous growth, which posits that innovation-driven investments contribute to long-term economic expansion by fostering technological advancement and knowledge spillovers (Romer, 1990). In addition, the findings suggest that policy instruments such as financial incentives for clean technology adoption, research and development subsidies, and regulatory support for sustainable infrastructure can significantly amplify the positive effects of green investment. The regional context of Nakhchivan, characterized by geographic constraints and limited natural resources, further underscores the need for innovation-focused strategies to achieve sustainable growth. Overall, this study contributes to the understanding of how green investment strategies can be effectively tailored to regional contexts, demonstrating that combining technological innovation with supportive policy frameworks can generate both environmental and economic dividends. The results also provide practical implications for policymakers aiming to achieve long-term sustainability goals while fostering regional economic resilience.

Conclusion and Policy Implications

This study demonstrates that innovative investments are a key driver of green economic development in the Nakhchivan Autonomous Republic. The analysis confirms that the effects of such investments are stronger in the long run, highlighting that sustainable growth is a gradual, cumulative process that requires continuous support from policy frameworks. Empirical evidence from this study aligns with international research, showing that renewable energy initiatives, eco-innovation, and green technological development can simultaneously enhance environmental sustainability and economic performance. From a policy perspective, the findings underscore several critical implications:

Sustained policy support: Long-term incentives, including subsidies for renewable energy projects, tax breaks for eco-innovation, and funding for green research and development, are essential to ensure that green investments achieve their full potential.

Promotion of eco-innovation: Policies encouraging local enterprises and research institutions to develop and adopt environmentally friendly technologies can foster knowledge spillovers, increase regional competitiveness, and support structural economic transformation.

Integrated regional strategies: Given the specific geographic and resource constraints of Nakhchivan, regional development strategies should integrate innovation-focused policies with

environmental goals, ensuring that economic growth and ecological sustainability progress hand in hand.

Capacity building and human capital development: Strengthening human capital through education, training, and skill development in green technologies can enhance the effectiveness of innovative investments and ensure long-term sustainability.

Monitoring and evaluation: Establishing robust monitoring mechanisms to track the effectiveness of green investment programs can help refine policy design, optimize resource allocation, and maximize socio-economic and environmental benefits.

In conclusion, fostering a green economy in Nakhchivan requires a strategic combination of innovation-driven investments and well-designed policy interventions. By prioritizing sustainable technological development and reinforcing institutional support, policymakers can ensure that environmental protection and economic growth are mutually reinforcing, positioning Nakhchivan as a model for regional green development.

References

Aghion, P., Hepburn, C., Teytelboym, A., & Zenghelis, D. (2016). *Path dependence, innovation and the economics of climate change*. Grantham Research Institute on Climate Change and the Environment.

Asheim, B. T., Boschma, R., & Cooke, P. (2011). *Constructing regional advantage: Platform policies based on related variety and differentiated knowledge bases*. Regional Studies, *45*(7), 893–904

Aliyev, J., & Hasanov, R. (2022). *Transition to a Green Economy in Azerbaijan: challenges and opportunities for sustainable development. Journal of sustainable economics and management*, *14*(2), 45–58.

Del Río, P., & Peñasco, C. (2019). *Green innovation and regional development: evidence from Europe*. *Research Policy, 48*(8), 1037–1052. https://doi.org/10.1016/j.respol.2019.03.007

Esgerova, M. R., Abbasova, M. M., Ibrahimova, N. H., & Hasanov, M. V. (2025). The prospects of forming innovation infrastructure in the economy of the Nakhchivan Autonomous Republic. *Universidad y Sociedad*, *17*(1), e4872.

Mammadov, T. (2023). *Innovative investment strategies in regional development: the case of Nakhchivan Autonomous Republic.* Caucasus Economic Review, *29*(1), 112–127

OECD. (2017). *Green growth indicators 2017*. Organisation for Economic Co-operation and Development. https://doi.org/10.1787/9789264268586-en

Porter, M. E., & van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. *Journal of Economic Perspectives, 9*(4), 97–118. https://doi.org/10.1257/jep.9.4.97

Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy, 98*(5, Part2), S71–S102. https://doi.org/10.1086/261725

Stern, N. (2007). *The economics of climate change: The Stern review*. Cambridge University Press.

UNEP. (2011). *Towards a green economy: Pathways to sustainable development and poverty eradication*. United Nations Environment Programme.

World Bank. (2012). *Inclusive green growth: The pathway to sustainable development*. World Bank Publications. https://doi.org/10.1596/978-0-8213-8758-6

World Bank. (2021). *Azerbaijan: Towards green and resilient growth.* World Bank Country Study Series.

CONTENTS

Editorial address
AZ1073,
19 A.M.Sharifzade St., Yasamal
Dist., Baku, Azerbaijan
Phone: +994 99 805 67 68
+994 99 808 67 68
e-mail: economics@aem.az

Signed: 08.08.2026
Online publication: 14.08.2026
Format: 60/84, 1/8
Stock issuance: 5, 75 p.s..
Order: 213

It has been published on aem.az
Address: 19 A.M.Sharifzade St.,
Yasamal Dist., Baku, Azerbaijan
Phone: +994 50 209 59 68
e-mail: info@aem.az