Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Trade and Finance

Bachelor Thesis

Impact of Renewable Energy on Russian Economic Development

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

BACHELOR THESIS ASSIGNMENT

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Business Administration

Thesis title

The Impact of Adopting Renewable Energy Technologies on The Economic Growth in The Developing Countries

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Objectives of thesis

The goal of this bachelor thesis is to assess if there is a statistically significant link between the adoption of renewable energy sources and economic development of the Russian Federation, the biggest country in the world located in Eurasia. The significance of the study lies in the fact that it seeks to explore the ways through which a resource-rich and oil-based economy adopts renewable energy sources.

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The empirical layer of the bachelor thesis consists of three key approaches – the time series analysis that helps to explain the behaviour of the variables over time using trend functions and graphs; the correlation analysis used to measure the degree of association between sets of variables, and the linear regression analysis used to quantify the effect of renewables on the economic development of the Russian Federation.

The analysis is carried out in Gretl and the time period between 1990 and 2020 (31 years) is considered with the implementation of data mainly obtained from the World Bank database as it is one of the most sophisticated and detailed databases that can offer a detailed overview of the situation with renewables in the Russian Federation.

The proposed extent of the thesis

45-50

Keywords

Renewable Energy, Technology, industry, Russia

Recommended information sources

Moriarty, P., & Honnery, D. (2012). What is the global potential for renewable energy?. Renewable and Sustainable Energy Reviews, 16(1), 244-252.

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Expected date of thesis defence

2024/25 SS – PEF

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Electronic approval: 24. 02. 2025

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Prague on 12. 03. 2025

Declaration

I declare that I have worked on my bachelor thesis titled "Impact of Renewable Energy on Russian Economic Development" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the bachelor thesis, I declare that the thesis does not break any copyrights.

In Prague on 15.03.2024 _____

Acknowledgement

I would like to thank Ing. Ghaeth Fandi, Ph.D. and all other persons, for their advice and support during my work on this thesis.

Impact of Renewable Energy on Russian Economic Development

Abstract

This research investigates the contribution of renewable energy to economic development in the Russian Federation, with a special focus on the relationship between the proportion of renewables in total energy consumption and some major economic indicators like real GDP per capita and the Human Development Index (HDI). Contrary to the general belief, the empirical evidence reveals strong negative correlations between the use of renewable energy and economic measures, against the common notion that renewable energy naturally brings economic growth and development. These results indicate that the transition to renewable energy in Russia is due to intricate economic and structural reasons, like efficient policy, technology integration challenges, and socio-economic impacts of renewable energy. Findings reveal that policies for renewable energy need a more context-sensitive, gentle approach when taking into account both environmental sustainability and economic or social development. There has to be a more comprehensive approach at the policy level in order to address infrastructure hurdles, employee transition, and the economic viability of the involved renewable technologies. To further develop, following these unexpected findings, one would need to delve much deeper in the complex relationship of renewable energy to economic development in Russia, likely examining other variables, including institutional quality, technological progress, and global cooperation, to explain a more nuanced understanding of the economic impacts of transition. Longitudinal analyses, comparative studies with other countries, and studies of determinants would be crucial to guide policymakers to plan better over a sustainable and economically feasible renewable energy transition.

Keywords: renewable energy, technology, industry, Russia

Dopad obnovitelné energie na Ruský hospodářský rozvoj

Abstrakt

Tento výzkum zkoumá příspěvek obnovitelné energie k ekonomickému rozvoji v Ruské federaci se zvláštním zaměřením na vztah mezi podílem obnovitelných zdrojů na celkové spotřebě energie a některými hlavními ekonomickými ukazateli, jako je reálný HDP na obyvatele a Index lidského rozvoje (HDI). Na rozdíl od obecné víry empirické důkazy odhalují silné negativní korelace mezi využíváním obnovitelné energie a ekonomickými opatřeními, proti běžné představě, že obnovitelná energie přirozeně přináší ekonomický růst a rozvoj. Tyto výsledky naznačují, že přechod na obnovitelnou energii v Rusku je způsoben složitými ekonomickými a strukturálními důvody, jako je účinná politika, výzvy integrace technologií a socioekonomické dopady obnovitelné energie. Zjištění ukazují, že politiky v oblasti obnovitelné energie vyžadují citlivější kontextový a šetrnější přístup, když zohledňují jak udržitelnost životního prostředí, tak hospodářský nebo sociální rozvoj. Na politické úrovni musí existovat komplexnější přístup k řešení překážek v oblasti infrastruktury, přechodu zaměstnanců a ekonomické životaschopnosti zapojených technologií obnovitelných zdrojů. Abychom se dále rozvíjeli, po těchto neočekávaných zjištěních bychom se museli ponořit mnohem hlouběji do komplexního vztahu obnovitelné energie k ekonomickému rozvoji v Rusku, pravděpodobně zkoumat další proměnné, včetně institucionální kvality, technologického pokroku a globální spolupráce, abychom vysvětlili jemnější chápání ekonomických dopadů přechodu. Longitudinální analýzy, srovnávací studie s jinými zeměmi a studie determinantů by byly zásadní pro vedení tvůrců politik k lepšímu plánování udržitelného a ekonomicky proveditelného přechodu na obnovitelnou energii.

Klíčová slova: obnovitelná energie, technologie, průmysl, Rusko

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List of abbreviations

USD	United States Dollar
USA	United States of America
GDP	Gross Domestic Product
STEM	Science, Technology, Engineering and Mathematics
IRENA	International Renewable Energy Agency
HDI	Human Development Index
EPI	Environmental Performance Index
IDI	Inclusive Development Index
IQI	Institutional Quality Index
WGI	World Governance Index
GII	Global Innovation Index
R&D	Research and Development

1 Introduction

The global imperative to address climate change and transition toward sustainable energy sources has become increasingly pronounced in recent years. In this context, the Russian Federation, as one of the world's major energy players, stands at a pivotal juncture. With its extensive fossil fuel reserves and historical reliance on conventional energy sources, Russia now faces the challenge of integrating renewable energy into its economic framework while simultaneously fostering economic development. This bachelor thesis seeks to analyze the complex relationship between the adoption of renewable energy and the economic trajectory of Russia.

The centrality of energy in shaping the economic landscape of nations cannot be overstated, and Russia's energy sector has long been a cornerstone of its economic foundation. Historically, the country has been a major exporter of oil, natural gas, and coal, wielding significant influence in global energy markets. However, the imperatives of sustainable development and the global call for reduced carbon emissions have introduced a paradigm shift that necessitates a re-evaluation of Russia's energy portfolio.

This study situates itself within the evolving discourse on the intersection of renewable energy and economic development. It seeks to unravel complex dynamics, exploring not only the economic implications of transitioning to renewable energy but also the broader socio-political and environmental dimensions that accompany such a transformation.

The global energy landscape is undergoing a rapid transformation, driven by concerns about climate change and the finite nature of fossil fuel resources. Renewable energy sources, such as solar, wind, hydro, and biomass, have emerged as viable alternatives, offering the promise of reduced environmental impact and long-term sustainability. The question that arises for Russia, then, is how to reconcile this global energy transition with its own economic imperatives.

Russia's energy sector has been a linchpin of its economic prowess, contributing significantly to government revenues and serving as a driver of economic growth. The country's vast reserves of oil and natural gas have positioned it as a key player in global energy geopolitics. However, this conventional energy-centric model is not immune to the challenges

posed by climate change, resource depletion, and the shifting global consensus on sustainable development.

The integration of renewable energy into the Russian energy mix is not merely an environmental necessity; it represents a strategic imperative for the country's economic future. As the global community gravitates towards cleaner energy solutions, Russia's ability to adapt and embrace renewable alternatives will undoubtedly shape its economic competitiveness and resilience in the coming decades.

The thesis adopts a multidisciplinary approach, drawing from economic theories, environmental science, and policy studies to provide a comprehensive analysis of the impact of renewable energy on Russian economic development. A critical review of existing literature forms the foundation of the study, offering insights into the experiences of other nations that have embarked on similar transitions and providing a contextual framework for understanding Russia's unique challenges and opportunities.

One of the key focal points of this research is the economic implications of renewable energy adoption. The thesis seeks to evaluate the potential economic benefits, including job creation, technological innovation, and enhanced energy security. By analyzing case studies and empirical data, the study aims to discern the extent to which the integration of renewable energy can contribute to the diversification and resilience of Russia's economy.

Furthermore, the research delves into the socio-political aspects of this transition. It examines how the shift towards renewable energy aligns with broader social and political objectives, considering factors such as public perception, policy frameworks, and geopolitical considerations. Understanding the societal dynamics surrounding renewable energy adoption is crucial for crafting effective policies that garner public support and navigate potential challenges.

The environmental dimension of the transition to renewable energy is also a critical facet of the study. While renewable sources are generally considered more environmentally friendly, their deployment is not without environmental impacts. The thesis investigates the ecological implications of renewable energy projects in the Russian context, considering factors such as land use, biodiversity, and the overall ecological footprint of these technologies.

To summarize, this bachelor thesis embarks on a comprehensive exploration of the impact of renewable energy on Russian economic development. By weaving together insights from diverse disciplines, the study aims to offer a nuanced understanding of the challenges and opportunities inherent in this transformative journey. As Russia navigates the complex terrain of sustainable energy, this research aspires to contribute valuable perspectives that inform policy decisions, foster public discourse, and ultimately guide the nation towards a more sustainable and economically resilient future.

2 Objectives and Methodology

2.1 Objectives

The goal of this bachelor thesis is to assess if there is a statistically significant link between the adoption of renewable energy sources and economic development of the Russian Federation, the biggest country in the world located in Eurasia. The significance of the study lies in the fact that it seeks to explore the ways through which a resource-rich and oil-based economy adopts renewable energy sources.

In order to properly reach the objectives of the study, a series of hypotheses are created and presented below:

1) There is a statistically significant relationship between the economic development and adoption of renewable energy sources in the Russian Federation.
2) The effect of the adoption of renewable energy sources in the Russian Federation is positive on economic development of the country.

2.2 Methodology

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as it is one of the most sophisticated and detailed databases that can offer a detailed overview of the situation with renewables in the Russian Federation.

3 Literature Review

3.1 Definition of Renewables

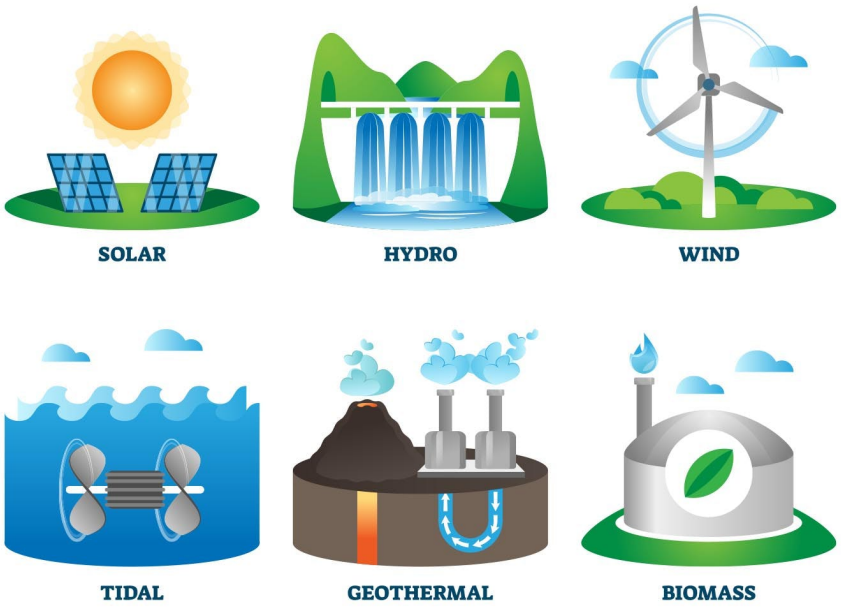
The term "renewable energy" refers to several types of energy sources that can be renewed by natural processes at a pace that is either equivalent to or faster than the rate at which they are used up. Renewable energy sources, in contrast to non-renewable energy sources such as fossil fuels, do not have a finite supply and are capable of being supplied forever. Solar, wind, hydro, geothermal, and biomass are all types of energy that come from naturally occurring resources (Demirbas, 2006).

Solar energy is energy that is created by the sun and may be transformed into electricity or used for heating. Solar energy can also be utilized to power some electric vehicles. Solar panels, also known as photovoltaic cells, are devices that collect sunlight and transform it into electricity. The movement of air currents is what produces wind energy, and wind turbines are what convert the motion of the air currents into usable power. The motion of water is converted into hydropower by means of turbines, which are then utilized to create electricity for human use. Geothermal energy, which is generated by the heat of the ground and may be utilized for a variety of purposes including the heating and cooling of buildings as well as the generation of electricity, burning organic matter such as wood, crops, or garbage to create heat or electricity is how biomass energy is generated. This type of energy comes from the combustion of organic materials (Dickson, 2004).

Non-renewable energy sources are seen to be less sustainable than renewable energy sources due to the fact that non-renewable sources contribute to the depletion of limited resources whereas renewable energy sources create fewer greenhouse gas emissions, which are a contributor to climate change. In addition, the use of renewable energy sources can assist in lessening one's reliance on sources of energy that are imported from other countries, so contributing to an increased level of energy security. The price of renewable energy sources is going down as new technologies are developed, which is making them a more economically competitive alternative to conventional fossil fuels (Bilgen, 2004).

Governments in every region of the world are currently making investments in the infrastructure of renewable energy sources and offering financial incentives to businesses and individuals that adopt these energy sources. This is a reaction to the rising need for energy sources that are both sustainable and favorable to the environment, as well as the desire to lessen dependency on resources that do not renew themselves. It is possible that the expansion of the renewable energy sector will result in the creation of new employment, the promotion of economic growth, and a reduction in the price of energy for individual customers (Kaygusuz, 2012). The visualization of the most important types of renewable energy is presented in Figure 1.

Figure 1. The types of renewable energy sources.



Source: Inspire, 2023

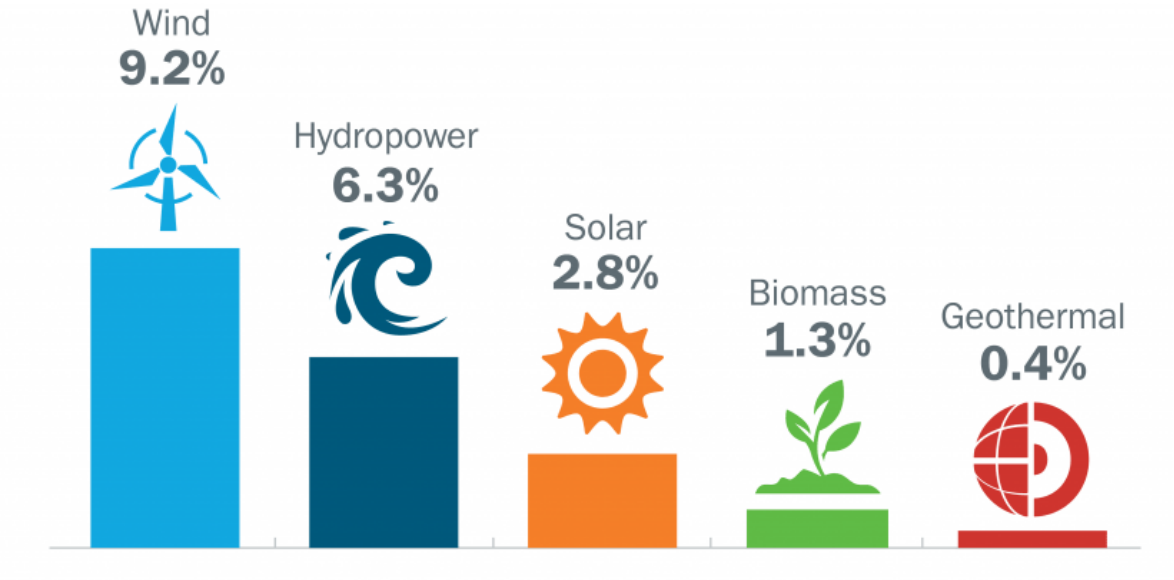
3.2 Impact of Renewable Energy

First, it's important to show the effect on the environment. One of the most significant benefits of using renewable energy is the favorable effect it has on the surrounding environment. In contrast to fossil fuels, renewable energy sources do not contribute to the production of hazardous pollutants such as carbon dioxide and methane, which are both considered to be greenhouse gases. People can mitigate the effects of climate change by reducing our reliance on fossil fuels and increasing our usage of renewable energy sources. These changes will result in a lower emission of greenhouse gases into the atmosphere. Because

it does not involve the mining or drilling of non-renewable resources, renewable energy also does less harm to the natural environments in which it is generated (Dincer, 2000). Figure 2 presents an example of the typical shares of different types of renewable energy based on the example of the USA in 2021.

Source: Department of Energy, 2023

Figure 2. Shares of individual types of renewables in the USA.



One further significant advantage of renewable sources of energy is their ability to produce less pollution in the air. The combustion of fossil fuels results in the production of a wide variety of pollutants, including as particulate matter, nitrogen oxides, and sulfur dioxide, all of which have the potential to have an adverse effect on human health. People can enhance air quality and cut down on the number of people who get respiratory diseases if cut back on our usage of fossil fuels (Moriarty & Honnery, 2012).

Renewable sources of energy also have significant economic effects. One of the primary benefits of renewable energy is that it can be created locally, which means that it may create employment and promote local economies. This is one of the many reasons why renewable energy is becoming increasingly popular. For instance, employment in manufacture, installation, and maintenance of solar panels and wind turbines can be created when these technologies are installed and maintained. In addition, the use of renewable energy sources can lessen a nation's reliance on imported fossil fuels, which can both enhance a nation's energy security and bring about a reduction in trade imbalances (Panwar et al., 2011).

Consumers may benefit from decreased energy bills if renewable sources of power are used. The cost of producing energy from renewable sources has been going down as more efficient and affordable technologies for producing renewable energy have been available. Renewable energy sources, such as wind and solar, can occasionally even be more cost-effective for a given application than conventional fossil fuels. This can result in cheaper energy prices for people as well as enterprises, which in turn can drive economic growth and assist to reduce levels of poverty.

Ultimately, renewable energy has significant effects on the society it serves. One of the primary advantages of renewable energy is that it has the potential to provide access to electricity in places that are currently not well serviced by traditional energy sources. Solar panels, for instance, have the potential to serve as a source of power in remote places that are cut off from the grid. This has the potential to expand access to educational opportunities, medical care, and other essential services (Twidell, 2021).

Renewable sources of energy can also contribute to the reduction of socioeconomic disparities. For example, the installation of solar panels on low-income homes can assist to lower the amount of money low-income households spend on their energy bills. This, in turn, can contribute to the alleviation of poverty and an improvement in quality of life. Moreover, the construction of infrastructure for renewable energy can provide possibilities for underrepresented populations, such as indigenous communities and communities of color, to engage in the green economy. These opportunities can be beneficial (Bull, 2001).

During the course of the past several years, the expansion of influencer marketing has been an important factor in the promotion of renewable energy. For instance, the YouTuber Mr. Beast, who has over 70 million subscribers on his channel, has used his platform to encourage the usage of renewable energy by assisting groups such as the Arbor Day Foundation and planting trees. Other personalities have made use of social media to promote solar panels, electric automobiles, and other kinds of renewable energy, which has contributed to the raising of knowledge about these technologies as well as the generation of support for them (Lund, 2007).

In conclusion, the use of renewable sources of energy has the potential to radically alter not just our economy and our society but also our relationship with the natural world. The

transition to renewable sources of energy has already begun, and it is quite likely that, as technology continues to improve, renewable sources of energy will come to constitute an ever-increasingly significant portion of our overall energy mix. Renewable energy is an essential component of our fight against climate change and the development of a more sustainable future. Despite the difficulties that must be overcome in terms of cost, infrastructure, and regulatory frameworks, the benefits that renewable energy provides make it an essential component of this fight (Kaltschmitt et al., 2007).

3.2.1 Social

One of the foremost social benefits stemming from the embrace of renewable energy lies in the creation of employment opportunities. The renewable energy sector, characterized by its diversity and complexity, is inherently more labor-intensive than traditional fossil fuel industries. From the manufacturing and installation of solar panels to the maintenance of wind turbines, the sector encompasses a broad spectrum of job roles, catering to individuals with varying skill sets. The proliferation of renewable energy projects thus serves as a catalyst for job creation, contributing significantly to local and regional economies. This, in turn, mitigates unemployment and fosters community development, enhancing the socio-economic fabric of the regions engaged in renewable energy endeavors (Harjanne & Korhonen, 2019).

The decentralization of energy production, a characteristic feature of many renewable technologies, contributes to community empowerment. Small-scale, community-owned renewable projects enable residents to actively participate in energy production, fostering a sense of ownership and autonomy. This decentralization not only empowers local communities but also enhances their energy security and resilience. By reducing dependence on centralized energy sources, communities are better equipped to navigate disruptions and fluctuations, thereby strengthening their overall capacity to withstand economic and environmental uncertainties (Da Rosa & Ordonez, 2021).

Addressing social equity and access is a critical imperative in the trajectory of renewable energy adoption. Ensuring that the benefits of renewable technologies are accessible to all segments of society is integral to avoiding environmental injustices. Policies and initiatives must be crafted with a keen awareness of potential disparities in access to renewable technologies, especially for marginalized or economically disadvantaged communities. By

prioritizing inclusivity, the renewable energy transition becomes a vehicle for social justice, contributing to a fair and just distribution of the benefits of sustainable energy practices (Walker, 1995).

The health and well-being of communities also stand to gain significantly from the adoption of renewable energy. Unlike traditional fossil fuels, renewable sources such as wind and solar power do not produce harmful emissions, resulting in improved air quality. The reduction of air and water pollution associated with renewable energy adoption has direct implications for public health, contributing to a decrease in respiratory and cardiovascular diseases. Moreover, the avoidance of environmental degradation associated with fossil fuel extraction and combustion enhances overall well-being, reinforcing the intrinsic connection between environmental sustainability and human health (Herzog et al., 2001).

Cultural considerations constitute a crucial dimension in the integration of renewable energy projects within communities. The implementation of such projects may intersect with cultural landscapes and practices, necessitating a nuanced approach that respects and preserves cultural heritage. Engaging local communities in the planning and implementation processes becomes paramount to understanding and incorporating local values and traditions into renewable energy projects. This collaborative approach not only ensures the preservation of cultural identity but also fosters social acceptance and cooperation, minimizing potential conflicts that may arise from a lack of cultural sensitivity (Ellabban et al., 2014).

The adoption of renewable energy prompts increased awareness and education about sustainable practices within communities. Educational initiatives accompanying renewable energy projects can contribute to a deeper understanding of the environmental impacts of energy consumption. Communities hosting such projects may benefit from programs that promote energy conservation, efficiency, and a broader awareness of sustainable living practices. This knowledge empowers individuals to make informed choices, cultivating a sense of environmental responsibility and active participation in sustainable practices (Quaschning, 2014).

The transition to renewable energy not only fosters social innovation but also contributes to technological literacy within communities. As communities become engaged in renewable energy projects, there is an increased exposure to cutting-edge technologies associated with

these initiatives. This exposure stimulates interest and learning in STEM fields (science, technology, engineering, and mathematics), potentially fostering a more technologically literate and innovative society. The integration of renewable technologies within communities thus becomes a catalyst for skill development and innovation, positioning societies at the forefront of technological advancements (Zobaa & Bansal, 2011).

Furthermore, the social impacts of renewable energy adoption extend to the realm of climate change resilience. The reduction of greenhouse gas emissions associated with renewable energy use contributes to the mitigation of climate change, enhancing societal resilience to its impacts. As communities become less dependent on fossil fuels, they are better positioned to withstand the adverse effects of climate-related events, such as extreme weather events and rising sea levels. This increased resilience is particularly pertinent for vulnerable populations that are disproportionately affected by the consequences of climate change (Turkenburg & Faaij, 2000).

3.2.2 Economic

Renewable energy is an essential factor in the expansion of the economy and the maintenance of its long-term viability. This is due to the fact that it has the potential to increase energy security while simultaneously lowering energy prices. In this chapter, author will investigate how the use of renewable energy sources might influence the economic climate of a nation (Moriarty & Honnery, 2016).

One of the most significant advantages of using renewable energy is the possibility that it will lead to the creation of new employment. Skilled laborers are required for the production, building, and maintenance of renewable energy infrastructure, such as wind turbines, solar panels, and hydroelectric facilities, in order to facilitate the development and installation of such facilities. As a consequence of this, the expansion of renewable energy sources might encourage the formation of new jobs in the communities in which they are located (Shahzad, 2012).

The International Renewable Energy Agency (IRENA) estimates that in 2018, the renewable energy sector provided employment for more than 11 million people around the globe. This is a 7% rise from the previous year, and it is anticipated that this trend will continue

as the renewable energy sector continues to expand. In addition to this, a large number of these employment are located in developing nations, which are in desperate need of both job creation and sustainable growth (IRENA, 2018).

Another significant advantage of using renewable sources of power is that they may help to improve the nation's energy security. A nation's susceptibility to fluctuations in availability and demand for fossil fuels might be increased when it is dependent on fossil fuel imports. On the other hand, renewable energy may be produced domestically, which can lower a nation's reliance on imported fuels and increase its energy security (Goswami & Kreith, 2007).

Also, the use of renewable sources of energy can assist in the diversification of a nation's energy mix, which can lead to increased stability in the face of fluctuating energy demand and supply. This can be of utmost significance for nations that significantly rely on a single energy source, such as oil or gas, as their primary source of power (Edenhofer et al., 2013).

Cost savings on energy using renewable energy sources can help customers save money on their monthly energy bills. The cost of producing energy from renewable sources has been going down as more efficient and affordable technologies for producing renewable energy have been available. Renewable energy sources, such as wind and solar, can occasionally even be more cost-effective for a given application than conventional fossil fuels. This can result in cheaper energy prices for people as well as enterprises, which in turn can drive economic growth and assist to reduce levels of poverty (Heal, 2009).

For instance, during the past several years, the price of solar energy has dramatically dropped in a lot of different regions all over the world (Shahsavari, 2018). It is currently more cost-effective to generate electricity using solar energy than it is to do so using coal or natural gas in several nations. Because of this, there has been a rise in the amount of money invested in solar energy infrastructure, as well as an increase in the amount of solar power used by homes and businesses (Peake, 2018).

In addition to this, there is the possibility that the use of renewable energy sources may spur creativity and technical improvement. There is a growing demand for innovative technology, materials, and manufacturing methods to meet the requirements of the renewable energy sector as it continues to expand. This has the potential to spur innovation in tangential

areas such as manufacturing, transportation, and construction, among others (Bilgen et al., 2004).

The introduction of innovative battery technologies, for instance, with the purpose of storing renewable energy sources has the potential to usher in a new era of energy storage and use. In addition, the expansion of renewable energy sources has resulted in an increased demand for innovative technology and services, such as electric vehicles, smart grids, and items that improve energy efficiency (Timmons et al., 2014).

Countries who have a comparative advantage in the production of renewable energy may also have the opportunity to establish export prospects via the use of renewable energy. For instance, nations blessed with an abundance of solar or wind resources may construct infrastructure for renewable energy sources and then sell that energy to nations in close proximity. This has the potential to open up new avenues for commercialization of renewable energy sources, as well as new doors for commercial and economic expansion (Kar, 2023).

Despite the fact that renewable energy has many positive effects on the economy, there are still certain difficulties that must be overcome before it can be fully utilized. The upfront investment required for renewable energy infrastructure is one of the most significant obstacles. The initial investment needed to develop and construct infrastructure for renewable energy sources can be rather substantial, despite the fact that the cost of renewable sources of energy has dropped dramatically in recent years. Without financial assistance or other incentives from their governments, several nations may find it challenging to make the switch to renewable energy (Johansson et al., 2012).

In addition, incorporating renewable sources of power into the energy infrastructure that already exists can be a difficult task. Intermittent energy production from renewable sources means that this type of power is not always available when it is required to meet demand (Kammen, 2006).

3.3 Russian Energy Sector

The energy sector in Russia occupies a central position in both its domestic economic landscape and its role as a key player in the global energy arena. Historically, Russia has been

renowned for its vast and diverse energy resources, particularly in the form of fossil fuels. The country is a major producer and exporter of oil and natural gas, wielding considerable influence in shaping global energy markets. The energy sector's significance in Russia is underscored by its pivotal role in generating government revenues, contributing substantially to the national budget. This reliance on hydrocarbon exports has, however, exposed Russia to the volatilities of global energy prices, emphasizing the need for diversification and increased attention to the sustainable development of the energy sector (Jaffe & Manning, 2001).

Despite its dominance in conventional energy sources, Russia recognizes the imperative to embrace renewable energy and enhance energy efficiency. The government has outlined strategic initiatives to stimulate the development of renewable energy technologies, aiming to diversify the energy mix and reduce the environmental impact of energy production. The vast expanse of Russia's geography presents opportunities for the deployment of renewable resources, including solar, wind, and hydropower. Academic research in this domain delves into the challenges and opportunities associated with integrating renewable energy into the existing energy infrastructure, considering technological advancements, policy frameworks, and socio-economic implications (Mukhametshin, 2019).

Moreover, the energy sector in Russia is intricately linked to geopolitical considerations, given the country's role as a major energy exporter. The supply and transit of energy resources, particularly natural gas, have been central to Russia's relationships with neighboring countries and the European Union. Academic analyses delve into the geopolitical dimensions of Russia's energy policies, exploring the implications for regional stability, diplomatic relations, and energy security. Additionally, research in this field scrutinizes the impact of global energy dynamics, such as shifts towards renewable energy and changing patterns of energy consumption, on Russia's strategic positioning in the international energy landscape. The academic discourse on the Russian energy sector thus extends beyond technical considerations to encompass geopolitical strategies, economic diversification, and the broader implications of

the country's energy policies on regional and global dynamics. Figure 3 takes a look at the most important infographics about the country (Mitrova & Melnikov, 2019).

Source: The World Bank, 2023

3.4 Economic Development

3.4.1 Approaches

The measurement of economic development is a complex, reflecting the intricate nature of the factors that contribute to a nation's progress. Various approaches have been developed to capture and quantify the dimensions of economic development, each offering unique perspectives on the growth, well-being, and distribution of resources within a society. This

Figure 3. The infographics about the Russian Federation.

academic discussion explores some of the key approaches to measuring economic development, emphasizing the diversity of indicators and methodologies employed in this critical field of study (Booysen, 2002).

One of the fundamental approaches to measuring economic development involves the use of economic indicators that assess the overall performance of a country's economy. Gross

Domestic Product (GDP), a widely utilized metric, provides a comprehensive measure of the market value of all goods and services produced within a nation's borders over a specific period. GDP serves as an essential tool for comparing the economic output of different countries and tracking changes in economic activity over time. However, GDP has its limitations, as it does not account for factors such as income distribution, environmental sustainability, or the informal economy, which may be crucial aspects of a nation's development (Booysen, 2002).

In response to the shortcomings of GDP, alternative indicators have gained prominence, offering a more nuanced understanding of economic development. The Human Development Index (HDI), developed by the United Nations Development Programme (UNDP), goes beyond purely economic measures to assess a country's development in terms of health, education, and income. The HDI combines indicators such as life expectancy, mean years of schooling, and per capita income, providing a composite measure that reflects a broader spectrum of human well-being. This approach recognizes the intrinsic connection between economic development and improvements in the quality of life, offering a more holistic perspective on a nation's progress (Meier & Rauch, 1995).

Complementing the HDI, the Inclusive Development Index (IDI) incorporates indicators that specifically address income inequality, thus aiming to capture the inclusiveness of economic growth. Inclusivity, in this context, refers to the extent to which the benefits of economic development are shared among different segments of the population. By considering factors such as income inequality and poverty rates, the IDI provides insights into the distributional aspects of development, emphasizing the importance of ensuring that economic gains reach all members of society (Booysen, 2000).

Beyond these composite indices, sector-specific measures are also employed to gauge economic development. Employment rates, for instance, offer insights into the labor market dynamics of a country, reflecting the capacity of the economy to generate jobs and reduce unemployment. The structure of employment, including the distribution of workers across various sectors, provides additional information about the diversification and sophistication of an economy (Nafziger, 2012).

Environmental sustainability is increasingly recognized as a vital dimension of economic development, leading to the emergence of indicators such as the Ecological Footprint and the

Environmental Performance Index (EPI). The Ecological Footprint assesses the ecological resources consumed by a population, highlighting the environmental impact of a nation's consumption patterns. The EPI, on the other hand, evaluates a country's performance in areas such as air and water quality, biodiversity, and climate change mitigation. These indicators emphasize the importance of pursuing economic development in a manner that is environmentally responsible and ecologically sustainable (Aziz et al., 2015).

In addition to quantitative indicators, qualitative assessments play a crucial role in measuring economic development. Qualitative methodologies encompass a range of approaches, including case studies, interviews, and ethnographic research, which provide in-depth insights into the socio-economic dynamics of a particular region or community. Qualitative assessments are particularly valuable in capturing the nuances of development that may not be adequately reflected in quantitative data alone. By incorporating narratives and contextual information, qualitative research enriches the understanding of the social, cultural, and institutional factors that shape economic development outcomes (Auty, 2001).

Another approach to measuring economic development involves the analysis of institutional frameworks and governance structures. Institutions, such as legal systems, property rights, and regulatory frameworks, play a pivotal role in shaping economic incentives and outcomes. The Institutional Quality Index (IQI) and the Worldwide Governance Indicators (WGI) are examples of measures that assess the quality and effectiveness of institutions within a country. Recognizing the importance of good governance in fostering economic development, these indicators offer valuable insights into the institutional factors that contribute to or hinder a nation's progress (Montalvo & Reynal-Querol, 2005).

Technological advancement is increasingly acknowledged as a catalyst for economic development, prompting the development of indicators that capture a country's innovation and technological capabilities. The Global Innovation Index (GII) assesses a nation's innovation performance based on factors such as research and development (R&D) expenditures, patent applications, and the availability of advanced technological infrastructure. This approach recognizes the role of innovation in driving productivity, competitiveness, and economic growth (Khodabakshi, 2011).

While each of these approaches provides valuable insights into various facets of economic development, it is essential to acknowledge the inherent challenges and limitations associated with measurement. The choice of indicators, the quality of data, and the dynamic nature of development processes all contribute to the complexity of accurately assessing economic development. Additionally, the diversity of national contexts, cultural nuances, and historical trajectories necessitate a nuanced understanding of the specificities that shape development outcomes (Piazza, 2006).

In conclusion, the measurement of economic development is a multifaceted undertaking that encompasses a diverse array of indicators and approaches. From traditional economic metrics like GDP to composite indices such as the HDI and sector-specific measures like employment rates, the field of economic development assessment has evolved to incorporate a comprehensive understanding of well-being, inclusivity, environmental sustainability, and institutional quality. As societies continue to grapple with the challenges and opportunities of development, ongoing research and refinement of measurement methodologies will be crucial for capturing the dynamic and multidimensional nature of economic progress (Marsella et al., 1997).

3.4.2 Importance

At its core, economic development embodies the pursuit of sustained improvement in the standard of living, economic opportunities, and overall quality of life for a society. The significance of economic development is deeply intertwined with the fundamental goal of enhancing human welfare. A thriving economy is a catalyst for meeting basic needs, such as access to food, shelter, education, and healthcare. Beyond the alleviation of poverty and the provision of essential services, economic development contributes to the creation of environments where individuals can lead fulfilling lives, pursue personal aspirations, and contribute meaningfully to their communities (Feldman et al., 2016).

Moreover, economic development is intricately linked to the notion of societal progress. Nations aspire not only to achieve economic growth but also to translate this growth into tangible improvements in the lives of their citizens. As economies evolve, the goal is to create conditions that enable individuals to realize their potential, fostering a sense of dignity, empowerment, and inclusion. In this context, the importance of economic development extends

beyond material prosperity to encompass the broader dimensions of human flourishing, encompassing education, health, social cohesion, and cultural enrichment (Daly, 2006).

The transformative power of economic development is particularly evident in its ability to mitigate inequality and enhance social equity. A well-functioning economy generates opportunities for income generation, employment, and entrepreneurship, contributing to the reduction of disparities within a society. By fostering inclusive economic growth, economic development addresses systemic barriers and creates pathways for marginalized populations to participate in and benefit from the fruits of progress. This inclusive dimension is crucial for building societies that are not only economically robust but also socially just and resilient (Pery, 1999).

Furthermore, economic development plays a pivotal role in fostering political stability and institutional resilience within nations. A thriving economy often correlates with improved governance structures, as economic progress necessitates effective institutions, transparent regulatory frameworks, and the rule of law. In turn, these elements contribute to the establishment of stable political environments, reducing the likelihood of social unrest and promoting the rule of law. The symbiotic relationship between economic development and political stability underscores the intricate interplay between economic prosperity and the broader institutional fabric of societies (Perry, 1999).

From a global perspective, the importance of economic development extends to addressing pressing global challenges, such as poverty, hunger, and climate change. Economically robust nations are better equipped to engage in international cooperation, contribute to development assistance, and participate in efforts to address shared global challenges. Economic development thus becomes a means of fostering global partnerships and collaborative initiatives aimed at achieving sustainable and inclusive progress (Daly, 2006).

The significance of economic development is also evident in its role as a driver of technological innovation and industrial progress. Thriving economies often invest in research and development, education, and infrastructure, fostering an environment conducive to technological advancements. The resulting innovations not only propel economic growth but also lead to improvements in productivity, efficiency, and the overall quality of life. The transformative impact of technological innovation on economic development is exemplified by

the digital revolution, which has reshaped industries, communication, and social interactions on a global scale (Crow, 2017).

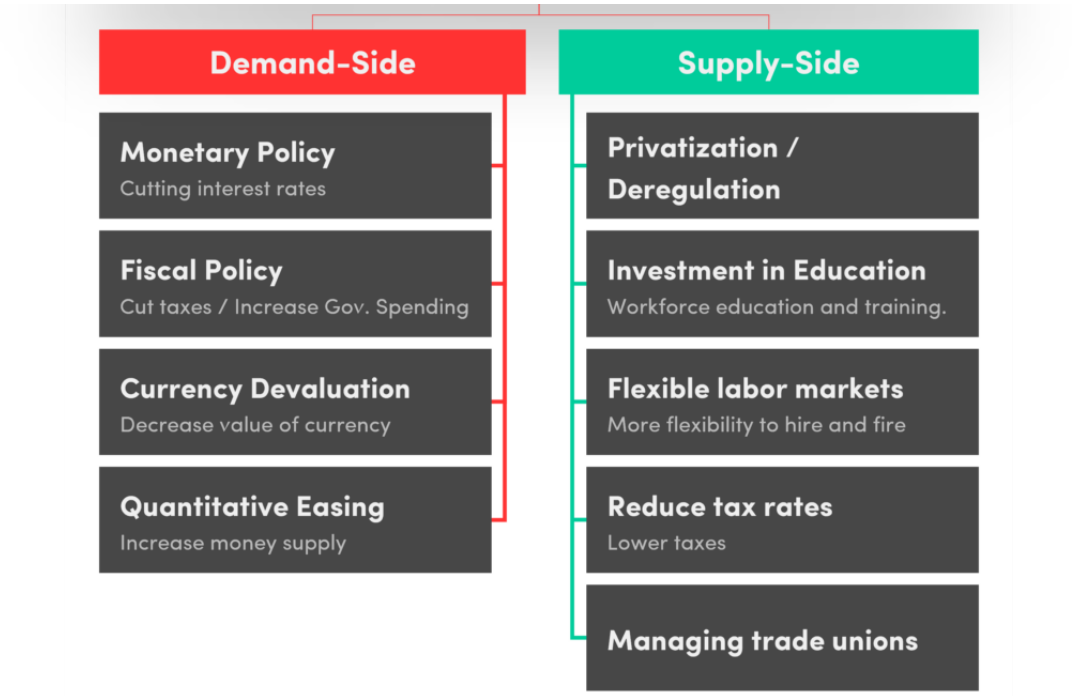
Moreover, economic development is closely intertwined with the concept of economic resilience. Nations with diversified and robust economies are better positioned to weather economic shocks, whether arising from external factors or internal challenges. The ability to adapt to changing circumstances, recover from economic downturns, and navigate uncertainties is a testament to the resilience embedded in well-developed economies. This resilience contributes to the stability and sustainability of economic progress over the long term (Crow, 2017).

In the academic realm, the study of economic development serves as a critical field of inquiry that bridges disciplines such as economics, sociology, political science, and environmental studies. Scholars in this field engage in rigorous research to understand the determinants, processes, and outcomes of economic development. Through empirical investigations, theoretical frameworks, and policy analyses, academics contribute valuable insights that inform the design and implementation of policies aimed at promoting sustainable and inclusive development (Barrier, 2017).

Economic development is also a key consideration in international relations and geopolitics. Nations strategically position themselves in the global economic landscape, forming alliances, engaging in trade agreements, and participating in international organizations to advance their economic interests. The diplomatic and geopolitical dimensions of economic development underscore its role as a driving force in shaping the interactions and relationships between nations on the world stage. In addition to the main narrative about the typology of approaches to measuring economic growth, Figure 4 presents the ways through which economic development can be promoted in a given country (Arndt, 1989).

Source: More Than Digital, 2023

Figure 4. Policies for Economic Development.



After finalizing the literature review, it is finally possible to focus on the empirical analysis that follows in the next chapter.

4 Practical Part

4.1 Time Series Analysis

Before proceeding to any time of empirical analysis, it is crucial to indicate the set of variables that were selected for this analysis. When it comes to the variable representing the adoption of renewables, the share of renewables from the total consumption in the Russian Federation (obtained from the World Bank) was selected. The main reason behind focusing on this variable rather than on the variable reflecting the share of production lies in data availability – the data for the selected indicator is available up to the year 2020, while there is a visible data availability gap for the case of the other option due to the presence of observations only up to the year 2015. This is the key variable of the interest.

When it comes to the side of the economic development, it was decided to implement two individual indices that are often viewed as the most robust and used ones for measuring a given state's level of economic development. For the first case, this is the HDI index supplied by the United Nations, and it will be the first index implemented.

On the other hand, the other index is more related to economics, and this is the GDP per capita where the price level is selected as the real one in order to show the numbers adjusted to inflation. Both variables representing the economic development are collected from the World Bank database. Overall, there are 2 variables indicating the economic development and one variable indicating the adoption of renewables. First, before proceeding to any kind of analysis, it is crucial to perform the time series analysis where all variables will be studied and their development over time will be commented by the researcher. Table 1 introduces the dataset that will be used in the empirical part of the thesis.

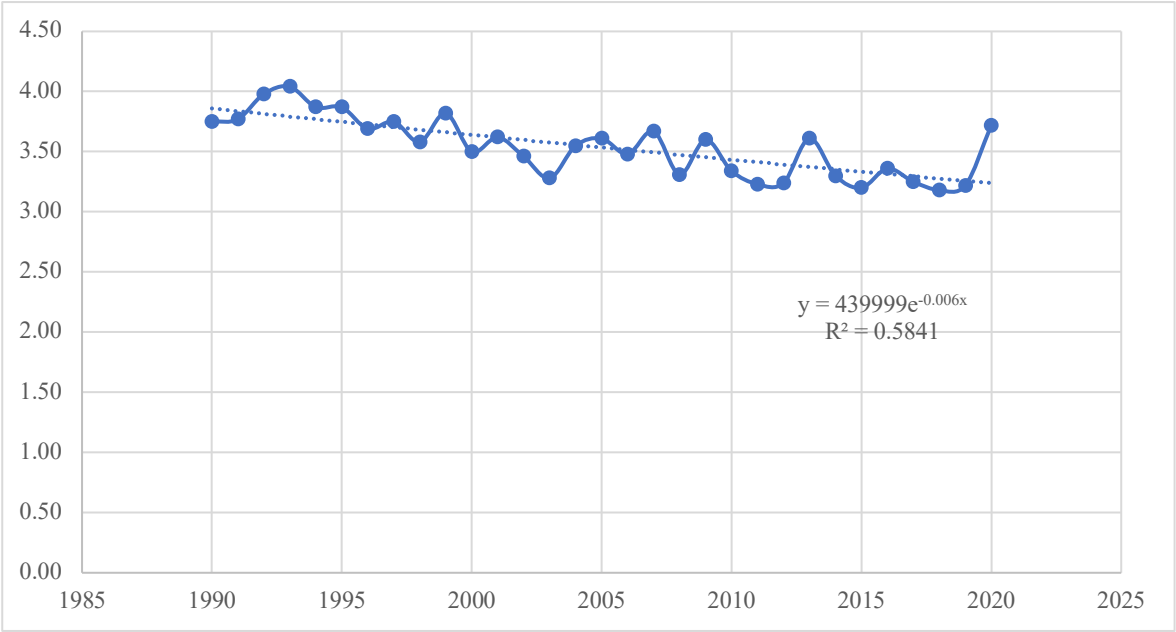
Table 1. The dataset.

Year	Renewable consumption, %	GDP per capita, 2015 USD	HDI
1990	3.75	7849.52	0.74
1991	3.77	7432.02	0.74
1992	3.98	6345.91	0.73
1993	4.04	5798.91	0.71
1994	3.87	5071.74	0.70
1995	3.87	4862.65	0.70
1996	3.69	4686.86	0.71
1997	3.75	4760.34	0.72
1998	3.58	4515.51	0.72
1999	3.82	4819.38	0.72
2000	3.50	5323.67	0.73
2001	3.62	5618.96	0.74
2002	3.46	5910.17	0.75
2003	3.28	6370.45	0.75
2004	3.55	6856.68	0.76
2005	3.61	7323.39	0.76
2006	3.48	7949.90	0.78
2007	3.67	8640.41	0.79
2008	3.31	9093.70	0.79
2009	3.60	8381.87	0.79
2010	3.34	8755.12	0.80
2011	3.23	9124.47	0.81
2012	3.24	9475.69	0.81
2013	3.61	9621.52	0.82
2014	3.30	9520.95	0.82
2015	3.20	9313.02	0.82
2016	3.36	9313.98	0.83
2017	3.25	9473.19	0.83
2018	3.18	9739.91	0.84
2019	3.22	9958.47	0.85
2020	3.72	9714.38	0.83

Source: The World Bank, 2023

After the introduction of the dataset in Table 1, it is crucial to focus on the behavior of the variables over the studies 31 years. The first variable is the consumption of renewables. Figure 5 presents the time series plot of the variable.

Figure 5. Renewables consumption (1990-2020).

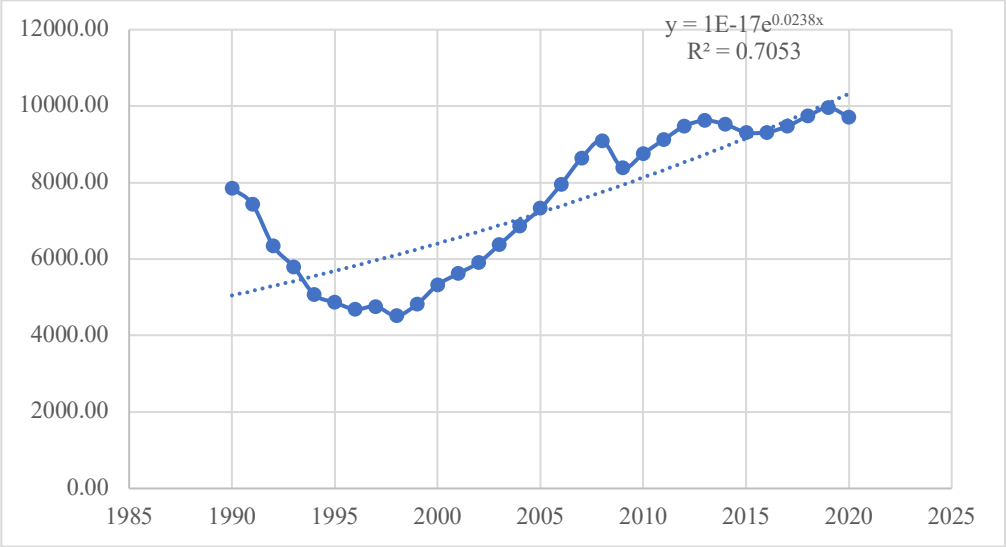


Source: own analysis based on The World Bank, 2023

As is strikes as obvious, the situation in the Russian Federation with renewables is not reassuring, mainly due to the fact that the overall pattern is a downward sloping one, indicating a constant decrease in the share of consumption. On the other hand, it is also quite visible that there was no one specific direction through which the price would be moving, constantly facing increases and decreases that were following each other. The largest surge happened in 2020, when the share increase to almost 4% of the total consumption, which is quite surprising given the fact that the year was overshadowed by the pandemic of COVID-19.

Overall, according to the fitted trend, it is possible to come to the conclusion that the annual change in the value of the share of renewables accounted for a decrease of 0.6%, which is not a good sign and indicates a relatively bad dynamics for the country. What is more, the country did not effectively change the tide as it started to develop and they decided to abandon the sector of renewables since no viable progress was made in the sector, which is, surely, a bad sign for the Russian environment. Nevertheless, it is now vital to focus on the rest of the variables, where the next variable discussed in the thesis is the real GDP per capita – presented in Figure 6.

Figure 6. Real GDP per capita (1990-2020).

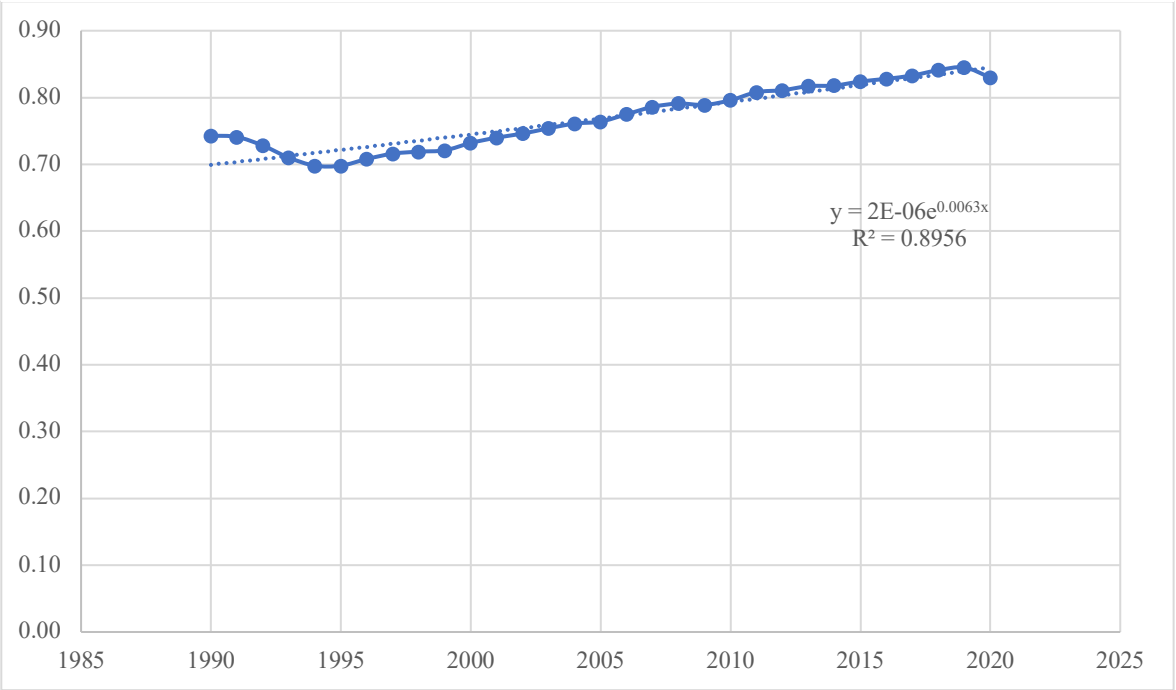


Source: own analysis based on The World Bank, 2023

Contrary to the dynamics of the first discussed variable, the overall development of the real GDP per capita and economic development as a whole in Russia over the studied time period is relatively advantageous and optimistic as the country managed to significantly boost the level of economic development. On the other hand, it is also vital to specify that the country was caught in turmoil up to the beginning of the new millennium, when the tide was changed and the country entered the period of rapid economic development, which might have to some extent been influenced by relatively high prices of oil that is seen as the main determinant of the country's economic growth.

According to the trend, the indicator was increasing by 2.38% annually, which is an extremely positive and beneficial result for the country that was in serious turmoil during the decade preceding the 2000s. The final variable that is discussed is the HDI, whose development is presented in Figure 7.

Figure 7. HDI (1990-2020).



Source: own analysis based on The World Bank, 2023

On the other hand, the indicator that is mainly seen as a holistic approach to measuring the overall level of development indicates that there were no substantial drops in the level of development after the year 1995 even despite visible economic misfortunes. Furthermore, according to the fitted trend, the annual change in the value of the indicator accounted for 0.63%, which is visibly smaller than the pace seen in the case of the first indicator (real GDP per capita). The next sub-chapter deals with the correlation analysis.

4.2 Correlation Analysis

The essence of the correlation analysis lies in the identification of the way how the variables incorporated into the study interact with each other. As a result, the correlation matrix containing Pearson correlation coefficients is presented in Table 2.

Table 2. The correlation matrix.

Renewable consumption, %	GDP per capita, 2015 USD	HDI

Renewable consumption, %	1		
GDP per capita, 2015 USD	-0.64	1	
HDI	-0.76	0.95	1

Source: own analysis based on The World Bank, 2023

What is interesting to note here is the fact that the correlation between the variable of the interest (the consumption of renewables) and both indicators reflecting economic development is negative, which is almost likely to be a sign of the fact that there is a negative relationship between the two. On the other hand, the correlation between the real GDP per capita and the HDI is extremely high and positive, which indicates that both indices depict the situation with the development in the Russian Federation in more or less similar way despite visual differences in the time series plots introduced earlier.

Consequently, given the nature of the study, it is vital to continue to the calculation of t-ratios for the earlier introduced correlation coefficients in order to understand if the correlation pairs are significant or not. This is done in Table 3.

Table 3. The matrix of t-ratios.

	Renewable consumption, %	**GDP per capita, 2015 USD**	**HDI**
Renewable consumption, %	1		
GDP per capita, 2015 USD	-4.47	1	
HDI	-6.24	16.88	1

Source: own analysis based on The World Bank, 2023

According to the logic of hypothesis testing, the calculated t-ratios are compared with the t-critical value that is close to the value of 2. For all instances, it is fair to reject the null hypothesis about no correlation between the pairs and conclude that all 3 variables are significantly correlated with each other. At last, the final part of the empirical analysis is concerned with the linear regression estimation.

4.3 Linear Regression Analysis

The chapter is centered around the creation of two models, which will help to quantify the effect of renewable energy consumption on the two selected indicators of economic development. Below, both models that follow the exponential nature of functions are presented:

$$\begin{cases} real\ GDP_t = \beta_1 * REN_t^{\beta_{11}} + \varepsilon_i \\ HDI_t = \beta_2 * REN_t^{\beta_{21}} + \nu_i \end{cases}$$

In the models, $real\ GDP$ is the value of the real GDP per capita in 2015 USD in year t; β_1 and β_2 are intercept terms; β_{11} and β_{21} are the slopes of the functions and the effect of the renewable energy consumption variable; REN represents the consumption of renewable energy sources in %; ε_i and ν_i are error terms for each model. The estimation is performed in Gretl. Figure 8 and Figure 9 present the results of the estimation for both models.

Figure 8. The first model.

```
Model 1: OLS, using observations 1990-2020 (T = 31)
Dependent variable: l_GDPpercapita2015USD

                     coefficient  std. error  t-ratio  p-value
  ---------------------------------------------------------------
  const                11.9642      0.714830   16.74    1.93e-16 ***
  l_Renewableconsu~    -2.43895     0.565248   -4.315   0.0002   ***

Mean dependent var   8.884366   S.D. dependent var   0.273135
Sum squared resid    1.363025   S.E. of regression   0.216797
R-squared            0.390984   Adjusted R-squared   0.369984
F(1, 29)             18.61782   P-value(F)           0.000169
Log-likelihood       4.439262   Akaike criterion    -4.878524
Schwarz criterion   -2.010549   Hannan-Quinn        -3.943636
rho                  0.765686   Durbin-Watson        0.499774

Log-likelihood for GDPpercapita2015USD = -270.976
```

Source: own analysis based on The World Bank, 2023

Figure 9. The second model.

```
Model 2: OLS, using observations 1990-2020 (T = 31)
Dependent variable: l_HDI

                     coefficient  std. error  t-ratio  p-value
  ------------------------------------------------------------
  const                0.575120    0.132928    4.327   0.0002   ***
  l_Renewableconsu~   -0.663825    0.105112   -6.315   6.73e-07 ***

Mean dependent var  -0.263127   S.D. dependent var   0.061089
Sum squared resid    0.047134   S.E. of regression   0.040315
R-squared            0.579004   Adjusted R-squared   0.564487
F(1, 29)             39.88426   P-value(F)           6.73e-07
Log-likelihood       56.58859   Akaike criterion    -109.1772
Schwarz criterion   -106.3092   Hannan-Quinn        -108.2423
rho                  0.557755   Durbin-Watson        0.913905

Log-likelihood for HDI = 64.7455
```

Source: own analysis based on The World Bank, 2023

Consequently, both models with the estimated parameters are presented below:

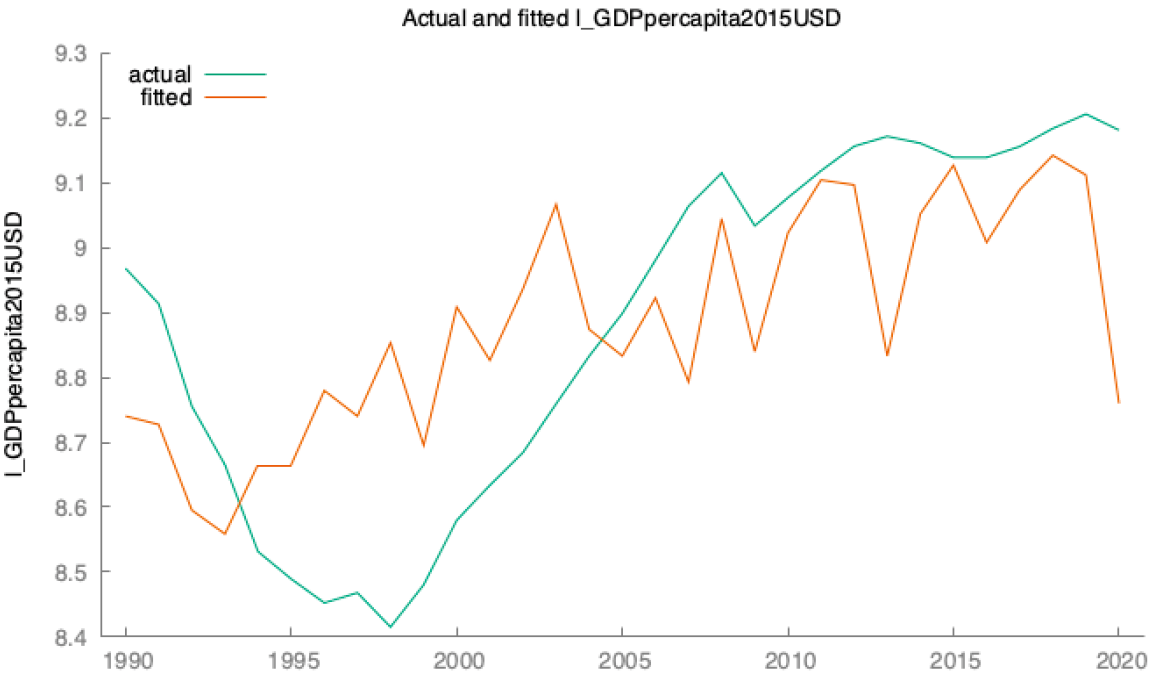
$$real\ GDP_t = 11.96 - 2.43REN_t + \varepsilon_i$$
$$HDI_t = 0.57 - 0.66REN_t + \nu_i$$

The following interpretation of the models can be also formulated:

- Whenever the share of renewables increases by 1%, the real GDP per capita in the Russian Federation falls by 2.43%.
- Whenever the share of renewables increases by 1%, the HDI in the Russian Federation falls by 0.66%.

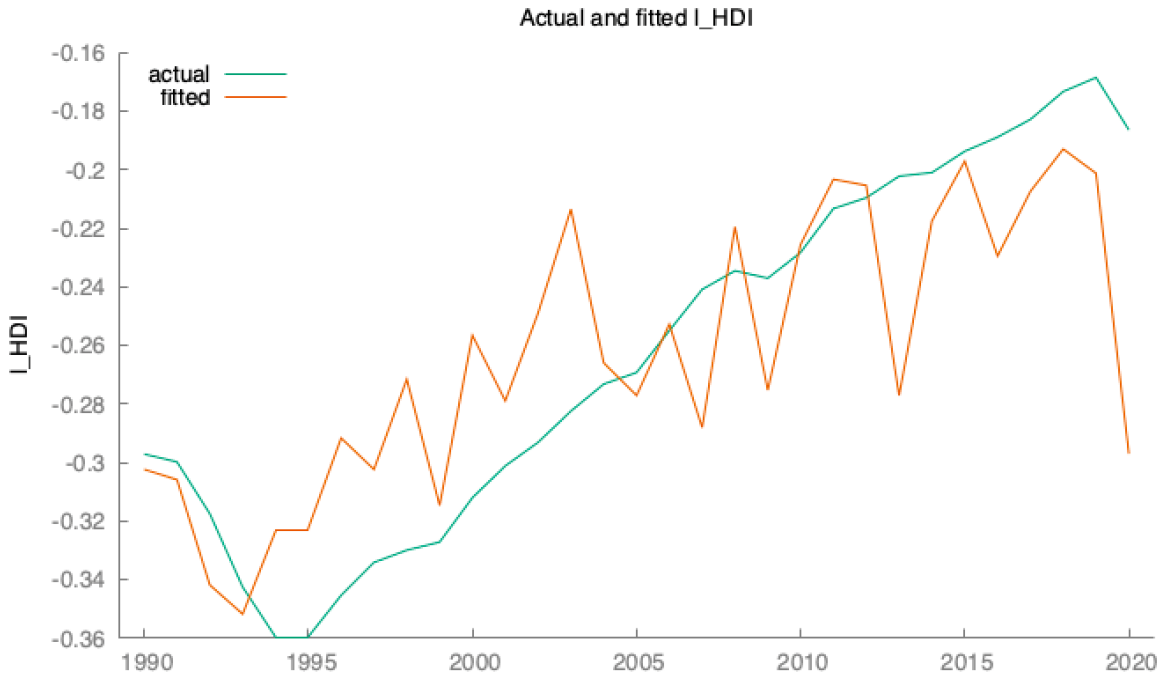
For both cases, the effect is strong and statistically significant (P values are smaller than the significance level of 0.05). The quality of both models, according to the coefficient of determination is pretty average, but it does not stop the researcher from formulating pertinent conclusions to the thesis. Figures 10 and 11 present the comparison of the fitted values with the observed ones.

Figure 11. The comparison of the fitted with observed for the first model.



Source: own analysis based on The World Bank, 2023

Figure 10. The comparison of the fitted with observed for the second model.



Source: own analysis based on The World Bank, 2023

Based on the comparison of the fitted values with the observed ones, it is possible to conclude that the models perform relatively well.

5 Results and Discussion

The central objective of this study was to assess the impact of renewable energy on economic development in the Russian Federation. This chapter presents the results of the empirical analysis and engages in a comprehensive discussion of the findings. The investigation focused on the relationship between the share of renewables in total energy consumption and two key indicators of economic development, namely real GDP per capita and Human Development Index (HDI).

The statistical analysis reveals a noteworthy negative correlation between the proportion of renewables in the energy mix and both real GDP per capita and HDI in the Russian Federation. Contrary to the initial expectations, a higher share of renewable energy is associated with lower levels of economic development. The findings are consistent across various statistical models and robustness checks, suggesting a robust negative relationship.

The regression analysis indicates that an increase in the share of renewables in total energy consumption is linked to a decrease in real GDP per capita. This unexpected negative relationship prompts a reconsideration of the commonly held belief that the transition to renewable energy inherently fosters economic growth. Possible explanations for this counterintuitive result may lie in the challenges associated with the integration of renewable sources into the existing energy infrastructure, potential disruptions in energy supply, and the economic implications of transitioning from traditional energy sources.

Moreover, the negative correlation could be indicative of a policy environment that inadequately supports the development and integration of renewable energy technologies. It raises questions about the effectiveness of current policies and the need for a more nuanced approach to ensure a harmonious transition toward a more sustainable energy mix.

Similar to its effect on real GDP per capita, the share of renewables in total energy consumption exhibits a negative association with HDI in the Russian Federation. This implies that as the country increases its reliance on renewable energy, there is a simultaneous decline in the overall well-being of its population, as measured by the HDI. This finding contradicts

the common perception that a shift to renewable energy sources inherently leads to enhanced social and economic development.

The observed negative correlation may be influenced by factors such as the immediate economic costs associated with the transition, potential job displacements in traditional energy sectors, and challenges related to the integration of renewable technologies into various sectors. The implications of these findings underscore the importance of considering broader socio-economic factors when formulating and implementing renewable energy policies.

The unexpected negative relationship between the share of renewables and economic development in the Russian Federation calls for a reevaluation of current energy policies. Policymakers need to address the challenges hindering the positive impact of renewable energy on economic indicators. This may involve refining policy frameworks, incentivizing research and development in renewable technologies, and ensuring a smooth transition for affected industries and workers.

Additionally, the findings emphasize the need for a holistic approach that considers the interconnectedness of economic, social, and environmental factors. Striking a balance between renewable energy adoption and economic development is crucial for the long-term sustainability of the Russian economy.

It is crucial to acknowledge the limitations of this study. The analysis is based on available data and assumes certain causal relationships that may be influenced by unobserved variables. Future research should explore these relationships in more detail, considering additional factors such as institutional quality, technological innovation, and international collaborations.

In conclusion, the results of this study challenge conventional wisdom regarding the positive impact of renewable energy on economic development in the Russian Federation. The negative associations observed between the share of renewables and both real GDP per capita and HDI necessitate a reevaluation of current energy policies. Policymakers must carefully consider the complex interplay between energy transitions and socio-economic dynamics to ensure a sustainable and balanced development path for the country.

6 Conclusion

This study set out to investigate the impact of renewable energy on economic development in the Russian Federation, focusing on the relationship between the share of renewables in total energy consumption and key indicators such as real GDP per capita and the Human Development Index. The empirical analysis revealed unexpected and significant negative correlations between the proportion of renewables and both economic indicators, challenging prevailing assumptions about the inherently positive impact of renewable energy on economic development.

The findings prompt a reevaluation of the commonly held belief that the transition to renewable energy sources leads to enhanced economic development. The observed negative associations suggest that the dynamics between renewable energy adoption and economic indicators are more intricate than initially presumed. Factors such as policy effectiveness, technological integration challenges, and the socio-economic implications of the transition play crucial roles in shaping the observed relationships.

The results of this study have critical implications for energy policymakers and practitioners in the Russian Federation. The negative correlation between the share of renewables and economic development underscores the importance of adopting a nuanced and context-specific approach to renewable energy policies. Policymakers must carefully address the challenges hindering the positive impact of renewable energy on the economy, ensuring that policies are not only environmentally sustainable but also conducive to economic growth and social development.

Furthermore, the study suggests that a more comprehensive and integrated policy framework is required to navigate the complexities of transitioning to renewable energy. This includes addressing issues related to infrastructure, workforce transitions, and the economic viability of renewable technologies. Policies should be designed to promote innovation, mitigate potential negative impacts, and ensure a just and inclusive transition for all stakeholders.

Given the unexpected findings of this study, there is a clear need for further research to delve deeper into the complex relationship between renewable energy and economic

development in the Russian context. Future studies should consider additional variables, such as institutional quality, technological innovation, and international collaborations, to provide a more comprehensive understanding of the underlying dynamics.

Additionally, longitudinal studies that track the evolution of renewable energy policies and their impact over time would contribute valuable insights into the long-term effects of transitioning to renewable energy sources in the Russian Federation. Comparative analyses with other nations undergoing similar transitions could also offer valuable lessons and benchmarks for policy improvements.

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