Czech University of Life Sciences in Prague

Faculty of Economics and Management

Department of Economics

Bachelor Thesis

The relationship between GDP Growth and Unemployment.
Testing the Okun's Law in Kazakhstan

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BACHELOR THESIS ASSIGNMENT

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Objectives of thesis

In modern economy unemployment rate accepted as one of the most important indicators for measuring the quality of economy's performance. Employment and job creation is linked to economic growth of the economy; therefore, the high employment rate can be related to low rates of economic growth. The Okun's law is known as relationship of economy output and unemployment level. The study of economy output and unemployment relation is significant for policymakers to provide efficient economic policies and improve country's general wellbeing. The thesis is going to investigate the relationship between GDP and unemployment in Republic of Kazakhstan for the period of 2000-2019

Kazakhstan has made significant progress over the past decades in economic system transformation. Since 1999, there has been significant rise of Kazakhstan's economic performance, primarily due to expansion of the oil sector production. As a result of the positive changes in the real sector of the economy, the labor market has also experienced positive changes. The GDP growth was associated with decrease of unemployment, so in the period of 1999-2004, unemployment declined from 950 thousand people up to 660 thousand people. Due to the fact that the growth of Kazakhstan's GDP is associated with the rise in prices for oil, there is a hypothesis that Kazakhstan in general and its enterprises will face serious difficulties in the provision of working places. Given the relationship between economic growth and unemployment, studying the effects of unemployment on the economy and the subsequent change in economic policy is an important thing for a developing state, especially one that is at the beginning of its path of independence.

In economics, Okun's law is an empirically observed relationship between unemployment and change in GDP per capita. It was empirically tested, that every 1% increase in unemployment will result in approximately 2% decrease in GDP, meaning that the linear coefficient between GDP growth and change in unemployment is approximately equal to 2 (for the USA). However, this relationship (and the coefficient) is heavily contingent on technological, political, financial, social and other events, that influence the decision to be employed, productivity of labor and overall production in a country. The aim of this paper is to describe
1)the prerequisites and assumptions of Okun's law
2) the economic development of country A over last 20-30 years (upon the availability of the data) related to the Okun's law

3) the empirical literature on testing the Okun's law

4) to test the Okun's law in Kazakstan over the period of last 20 years on available data on GDP per capita and unemployment and to find the relevant coefficient.

5) Based on the first two chapters to explain why the coefficient is different from 2.

Methodology

The theoretical part of the thesis will briefly present historical development of Kazakhstan's economy, fluctuations in economic output and its effect on social well-being. The effectiveness of economic policies related to unemployment and its short-term and long-term results will be studied. This part will provide literature review of similar research based on different countries and various results of relationship investigation. The chosen research will provide us examples of proven and rejected hypothesis about economic output-unemployment relationship. Moreover, the theoretical background of Okun's law, as well as its empirical relationship models will be presented.

In the practical part of the thesis, the multiple regression analysis on unemployment rate, economic output (real GDP), demographic and other control variables for Kazakhstan, for period of 2000-2019, will be employed. The panel data analysis of Okun's law for Kazakhstan will explore the relationship of economic growth and unemployment and its variation over period. The model will be optimized for the best fit, for any potential multicollinearity issues. The model might be sophisticated by studying the relationship for different age, gender, and regional groups.

The data for econometric model will be drawn from the official reports of Agency for Strategic planning and reforms of the Republic of Kazakhstan Bureau of National statistics.

The proposed extent of the thesis

40 pages

Keywords

Unemployment, Economic growth, Kazakhstan, Okun's Law, Economic policy.

Recommended information sources

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Declaration

 I declare that I have worked on my bachelor thesis titled " The relationship between GDP Growth and Unemployment. Testing the Okun's Law in Kazakhstan" by myself and I have used only 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 15.03.2023   _____

              Rustem Mukhanov

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The relationship between GDP Growth and Unemployment. Testing the Okun's Law in Kazakhstan

Abstract

The main purpose of the thesis is to determine the level of unemployment in Kazakhstan, as well as its impact on the economic situation of the country. In addition, the goal is to try to prove the applicability of Okun's law on the relationship between the Gross Regional Product and unemployment in Kazakhstan based on the calculations of past years. The theoretical part describes all kinds of unemployment, as well as the current situation in terms of the level of the unemployed in Kazakhstan and their causes.

The practical part includes the estimation of Okun's models based on Kazakhstan's case. The dataset is presented in form of panel data; therefore, panel regression models were constructed by using R studio software. All calculations are done on a regional level; therefore we use the regional rate of unemployment for each region and Gross Regional Product to express economic growth. The first Okun's model is the first-difference model, which contains the simultaneous correlation between variables and is considered a "classical version" of Okun's law model. The second Okun's model or the "dynamic" model includes lagged values of explanatory and dependent variables. As a result, the estimated models proved the assumption that economic growth is associated with a decline in the unemployment rate and that Okun's law applies to the case of Kazakhstan.

Keywords: Unemployment, Economic Growth, Kazakhstan, Okun's Law, Economic Policy

Vztah mezi růstem HDP a nezaměstnaností.
Testování Okunova zákona v Kazachstánu

Abstrakt

Hlavním cílem mé teze je určit úroveň nezaměstnanosti v Kazachstánu a její dopady na ekonomickou situaci země. Dalším cílem je pokus o dokázání aplikability Okunova zákona ve vztahu mezi Hrubým Regionálním Produktem a nezaměstnaností v Kazachstánu na základě propočtů z minulých let. Teoretická část popisuje vícero druhů nezaměstnanosti spolu s nynější situací co se nezaměstnanosti v Kazachstánu týče a jejich příčin.

Praktická část obsahuje odhad Okunových modelů na základě případu Kazachstánu. Datový soubor je prezentován ve formě panelových dat; proto byly panelové regresní modely konstruovány pomocí softwaru R studio. Všechny výpočty jsou prováděny na regionální úrovni; proto k vyjádření ekonomického růstu používáme regionální míru nezaměstnanosti pro každý region a hrubý regionální produkt. První Okunův model je model prvního rozdílu, který obsahuje současnou korelaci mezi proměnnými a je považován za „klasickou verzi" modelu Okunova zákona. Druhý Okunův model nebo „dynamický" model obsahuje zpožděné hodnoty vysvětlujících a závislých proměnných. V výsledku toho odhadované modely potvrdily předpoklad, že ekonomický růst je spojen s poklesem míry nezaměstnanosti a že Okunův zákon je aplikovatelný na případ Kazachstánu.

Klíčová slova: Nezaměstnanost, Ekonomický Růst, Kazachstán, Okunův zákon, Ekonomická Politika

Contents

Introduction

Research conducted in 1962-1963 by Arthur Okun revealed an empirical pattern, such as a negative linear relationship between the unemployment rate affecting the country's GDP. Unemployment is one of the main indicators of labor market productivity, showing the ratio of the employed population to the total number of able-bodied.

Okun considered that there is a sufficient effect on the level of employment in response to changes in aggregate supply demand. These alterations in demand lead to changes where employers adjust the level of employment. He suggested that changes in economic performance and the labor force, especially in the number of unemployed people, are interconnected. This interconnection might work as a great foundation or threat to the social and economic well-being of the nation.

Unemployment is a broad definition that allows a more detailed study of the negative relationship between demand conditions and unemployment rates, as well as the vulnerability of some segments of the population concerning others. For example, Hutengs and Stadtmann (2013) found in their calculations that the vulnerability of the young population to unemployment is twice as high as that of the adult population. This proves that young people are less interested in work than the adult generation.

According to Slimane (2015), usually, not sufficient economic growth and a resulting shortage of jobs are considered the main reasons for a high share of unemployed people. The changes in employment rate, based on better human capital development can be seen as a great tool in the eradication of poverty and a general increase in living conditions. Changes in GDP have an immediate rebound effect on the unemployment rate (Okun, 1962). This theory is used to this day, despite the date of publication, it is suitable for the economies of many countries, showing the most accurate impact.

Most developed countries pay attention to reducing the unemployment rate, increasing the overall level of economic growth of the country. Despite being stable over time, Okun's rule is nonetheless prone to variations, which are represented by the residuals in the regression. These variations can occasionally be significant. For instance, during the start of the US Great Recession in 2008 and 2009, unemployment was greater than anticipated (Ball et al., 2017). Then, it dropped to historically low levels while production growth in the US and the euro area was only moderate. Deviations are more obvious when utilizing real-time data, but they are still significant even when using amended data.

In his work, Okun identified two empirical versions of the relationship between unemployment and to country's economic performance. The consideration of his study was the unemployment rate in the USA between the 40s and the 60s of the last century. The main finding of his work was the estimated relationship between unemployment and GDP growth, which suggested that a 1% increase in the unemployment rate is associated with a 3% decrease in the GDP growth rate. This estimated relationship varies based on the chosen country and time period; however, the existence of a strong relationship was concluded for market-oriented countries.

This relationship can be studied in the example of economic expansion. The considerable expansion leads to a higher need for the workforce and positively affects the general employment level. On the other hand, in economic stagnation or even crisis, the industries and individual firms' response diminishes this need and lead to higher rates of unemployment.

Since the publication of Okun's research, there were plenty of discussions regarding this topic and a significant number of theories completed the initial theory. However, the initial assumptions of Okun's law are the following:

- The first dubbed the "difference" variant, connects shifts in output (measured as changes in the log of real GDP or real GDP change as a percentage) to shifts in the unemployment rate: $\Delta u_t = a + \Delta y_t$ where a and b are estimates of 0.3 and -0.3, respectively.
- The second, known as the "gap" variant, connects the difference between actual and natural unemployment to the production gap (the difference between current and long-term output): $u_t = c + d$ Output Gap, with estimated values for c and d of 3.72 and 0.36 respectively.

The above indicators are the main instruments for proving the assumption of this thesis, studying the connection of the economic situation of the country through the influence of unemployment rates based on econometric analysis. Determine how reliable the consequence of a low economic performance due to unemployment, and the negative effects of lower economic development on labor market conditions.

Kazakhstan is a young rapidly developing state that has undergone many changes since its independence. Since the period of 1991, Kazakhstan has had great economic problems from the transition from a planned to a market economy, which took a long time. The transition to common world prices caused unprecedented inflation, which affected the general state of the economy and the country's GDP (Kulekeyev, 2016). The crisis and the construction of a new economy, adaptive to other countries, exposed the country to a high rate of unemployment for a long time. Over 30 years of the formation of the country, Kazakhstan fluctuated sharply from

high development to a sharp increase in inflation. For example, according to the Bureau of National Statistics, the inflation rate in 1992 exceeded 2962,81%, which also caused an increase in unemployment due to a lack of wages. For the study of Okun's law, Kazakhstan is a good example, as it is possible to identify real examples of change over time compared to the Eurozone and to prove the effectiveness of empirical models in any type of economy.

In my work, there will be a trend analysis of employment of the population during the period of the most significant events of 1991-2022. The annual dataset includes the periods when many significant events occurred, such as the Great Recession, Covid, and significant inflation rate periods. The thesis tries to highlight the patterns and applicability of Okun's law, whether it is still applicable to the provisions of countries, or whether it is already an outdated model that is not able to identify meaningful answers.

In his research, Okun created many variations widely used in macroeconomics. The main material for the study of this article is unemployment. The uniqueness of this work lies in the absence of a detailed study on the example of Kazakhstan, as well as a comparison with other countries, which allows for finding possible policy implications for the future development of the country, as well as risks in the future, identified at an early stage.

The theoretical part of the work includes several points. The first part consists of general theory of unemployment and its types, the historical part of the change in the unemployment rate and economic conditions of Kazakhstan, with a detailed description of the most significant events in the country's economy. In addition, this part describes methods and results previously used by other authors in various observations. In the end, all this will be explained by Okun's theory of empirical correlation, namely the "Gap Model" and the "First-Difference Model."

Despite the main findings and their application to Kazakhstan's case, the thesis will consider various factors influencing labor market conditions and economic performance. The practical part of the thesis focuses on econometric models constructed based on the Okun's models, as well as their interpretation.

Chapter 1 -Economy of Kazakhstan & Okun's Law (Unemployment)

Unemployment

One of the main indicators of the level of the economy of each country is the level of employment. Unemployment is an indicator of social problems, which reduces the possibility of improving the material component of the population (Zidong et al., 2019). In the modern world, financial resources such as money work as an important factor in supporting the conditions of human life and satisfying their needs. According to Maslow's pyramid which was stated in his

"A theory of human motivation" (1943), each stage depends on the financial component of a person, and the more money, the person is fulfilled and ready to develop on a higher level. Therefore, its possible limitation as unemployment should be studied very deeply.

Unemployment can be divided into several categories (Amadeo, 2022). Unemployment increases when a person who is actively looking for a job cannot find one. In other words, unemployment shows the health and integrity of a country's economy. The main indicator of unemployment is the unemployment rate. The unemployment rate is the ratio of the unemployed to the total number of able-bodied populations in the labor market.

Regardless of society, origin, and social stratum, the opportunity for every citizen of the country is employment for the full social security of himself and his family. Several types of unemployment can negatively affect a person's employment, but not all types depend only on the person's characteristics and preferences (Weber, 1995). In some cases, people are not able to get the advantage of their education and qualifications due to the lack of proper development of a labor market. Some types of unemployment are detailed here:

- **Seasonal Unemployment**

A category of unemployment that creates a shortage of work during certain seasons of the year. In other words, people lose their jobs and earnings regularly at certain times of the year. Most often, in the Kazakhstani labor market, this type of unemployment can be attributed to the agricultural sector of the country (Zholdaskyzy, 2018). For example, crop production in the south of the country is highly developed, so from sowing in April-May until the end of September, people are provided with work, but the rest of the year they must use their savings until the next season. Seasonal unemployment is more common in manual jobs that require physical activity.

- **Disguised Unemployment**

A category of unemployment in which the labor force is not used in the labor market, but the employment contract with the employer is maintained. It can be assumed that the main difference between open and hidden unemployment is that with open unemployment, a person actively searches for work, turns to the labor exchange, and tries to get a job. Consequently, a person loses income and tries to find a solution, which shows the reasons for the search, but with hidden unemployment, the labor market cannot fix the impact of this type on the unemployment rate, since information on this matter is not recorded. Such examples include:

1. Part-time or part-time people
2. Employees on unpaid leave

3. Employees who are employed by the firm but do not work at the current location.
4. Workers with delayed wages
5. People of pre-retirement age
6. People who are not looking for a job although they are unemployed.

Most often, this type of unemployment occurs during an economic downturn or crisis (Altonji and Blank, 1999). The exact level of unemployment, in this case, is difficult to determine since people are engaged in activities in the shadow sector. This greatly harms the economy, as productivity falls at enterprises, and the number of specialists decreases. This type of unemployment is developed in Kazakhstan due to the raw materials industry (Doskeyeva et al., 2019). Often there are moments of depletion of oil reserves at one field, but what to do with the workers? Due to the lack of work, they are sent on unpaid leave, in which people hope for a new field and a further amount of work, and so they must wait. The contract is not violated, but the search for another job is impossible. In addition, Kazakhstan is a developing country since it gained independence in 1991. In such a short time, laws on small and medium-sized businesses have not yet been developed, so people are often employed illegally, and their job performance is not recorded properly according to the law. This is another problem of the significance of this type of unemployment in the country.

- **Cyclical Unemployment**

This type of unemployment is associated with a reduction in production and mass layoffs of workers. During the recovery period, cyclical unemployment dissolves. In addition, cyclical unemployment indicates the underutilization of productive resources (Apergis, 2003). According to the Ministry of Labor and Social Protection, this type is not particularly observed in Kazakhstan, since the country is only increasing the pace of production. The presence of cyclical unemployment can be tested theoretically. It is necessary to compare actual GNP with potential. The lower the actual rate, the higher the cyclical unemployment, and if they are close to each other, then the unemployment is minimal.

- **Structural Unemployment**

Type of unemployment expresses the discrepancy between the demand and supply of a particular profession in the market. Often there is an excess of specialists in one area for the number of vacancies offered on the market, or vice versa, a shortage of workers with an abundance of supply. According to Boulton (2010), this problem is often caused by technological changes (for example, process automation). The consequence is the long-term persistence of the problem in society since retraining for a new profession or moving to another region takes a long time for people, so they remain unemployed for a long time. It is impossible to completely eradicate this

type of unemployment since technological progress lead to changes in a human's life and it leads to changes in industries and the appearance of new jobs (Knotek, 2007).

- **Technological Unemployment**

I would call this type of unemployment one of the causes of other types of unemployment, but in the modern world, it is becoming a more sufficient barrier in the process of looking for work (Postel-Vinay, 2002). This is a type of unemployment that causes a shortage or destruction of a profession due to the modernization of technology. Now, when looking for jobs, employers require skills and knowledge of information systems, since almost all work is based on this. An example is Covid-19, due to which all work switched to online mode, and people learned to work more with technology for transmitting data and communicating with colleagues. Automation is happening at a fast pace, so it is extremely difficult for most people to quickly catch and study what they need. Often this is a barrier for the older generation in finding a job.

- **Frictional Unemployment**

Employment takes some time, regardless of whether an experienced specialist or just graduated from the university. Changing jobs also takes a certain amount of time, which means a person is unemployed for a certain amount of time. The described type of unemployment is frictional (search unemployment). According to Simon (1988), this type of unemployment can be considered voluntary, since it is not caused by a shortage of jobs, and the person himself is looking for better employment options. The reason for such unemployment is relevant in Kazakhstan since there are issues of poor working conditions, low wages, job responsibilities, and so on. More frequently, there are no clear working rules, employers can often force them to work overtime, where extra working hours are not paid. In this type of unemployment, it is necessary to create well-defined rules on the labor market, which will increase the quality of its conditions so that people have better opportunities in finding a job, as well as reduced time for their search.

- **Vulnerable Unemployment**

The admission of new workers to the company means the process of signing an agreement and discussing all the formalities upon admission. Every company keeps a record of workers. Despite this, many employers are increasing the level of vulnerable employment, in which people do not sign a contract and work illegally. Such people are not listed as employed and cannot be protected by legal law. This is all done to reduce costs, as employers do not pay taxes, or insurance premiums for workers and they are not officially responsible for such workers. In addition, they can fire a person at any time. Workers can be vulnerable from all sides, and their

duration depends on the level of work performed. It is also dangerous for the state since workers can receive unemployment benefits and illegal wages, even in the case of being employed.

- **Regional Unemployment**

Kazakhstan possesses a considerably huge territory, where separate industries develop in each part of the country. For example, in West Kazakhstan, the oil and gas industries are developing, while in the north, there is a developed extraction of rare metals such as gold, and in the south, agriculture is a major sector (Karatayev, 2016). Regional unemployment explains the lack of work in some parts of the country. For example, in the south, people are actively developing agriculture, and in winter they are forced to work in other regions due to the absence of work in their region. These options are all temporary, as they often depend on the natural conditions of the region. People often try to earn during the season of work, and then save. In this regard, the government of the Republic of Kazakhstan is actively developing various programs for moving the population from one region to another with guaranteed payment to decrease the difference in employment rates among regions. Regional unemployment disappears with the beginning of a new agricultural season, which allows the business to continue until the next season.

- **Voluntary Unemployment**

This type of unemployment describes a person's desire not to work of their own free will. Often people do not want to work because of dissatisfaction with duties, workplace, and conditions. People can receive unemployment benefits from the state, which simplifies their lives and provide more opportunities for being unemployed for a longer period. This also applies to types of voluntary unemployment, and the solution to it will be encouraging the population to apply for a permanent job.

- **Open Unemployment**

Open unemployment is the most extensive type since most of the country's population is not able to find work. Despite the high training of personnel and education, a considerable part of the population is not able to find a job. Due to the scarcity of jobs, these people are forced to get an undesirable profession and try jobs that are available but not suitable for them (Zakirova, 2019). There are several actual reasons causing unemployment. One is people's ignorance of work processes and responsibilities, where people have no idea if they're qualified for a certain position. Thus, there is lower actual labor productivity and lower growth of final output, which leads to the labor force growing much faster than the growth of the economy. According to Kussainova et al. (2020), the possible solution to this problem is to provide more opportunities to get better qualifications and develop skills of employees, regardless of the stratum of the

population, and origin. Every level of the employee must have an equal right to employment opportunities.

Kazakhstan

Kazakhstan gained independence in 1991, which is a unique case for studying the dependences of Okun's law from the formation of the country to its current result. During this time (1991-2022) several global moments affected all countries, which can also reveal deviations. In addition, the number of the working population does not change much over the years, since in the period from the independence of the country to 2022, the population did not change much, 2014 there was a constant figure of about 16 million of the total population, and in 2022, it is 19.6 million humans (Statistics Committee, 2020).

At the beginning of its journey, in Kazakhstan (1991-1997) there was a smooth transition of the administrative-command system to a market economy. At this stage, Kazakhstan was in the stage of a long production and financial crisis, which required an early solution to problems (Kalyuzhnova et al., 2016). In those years, the unemployment rate in Kazakhstan was the highest, which affected all the economic spheres of the country. During the hardest period of economic transition, there was a boom in the unemployment rate. For example, the unemployment rate dramatically increased from 1.11% in 1993 to 7.54% in 1994 (Figure 1). This sharp increase happened just in one year period. Therefore, long-term anti-crisis goals were created, through economic reforms in the first years of independence.

The main focus and approach of those reforms were willingness to increase competitiveness in the market by supporting entrepreneurship, investment, and development of various manufacturing industries (Raihan and Tuspekova, 2022). These attempts laid the foundation for new job creation and as a result positive dynamics in the overall employment rate. Despite the government's attempts to decrease the unemployment rate, it reached high rates in 1999 (13.46%) and only then started to decrease. The stability of the national unemployment rate was reached only in 2015, after almost 25 years of independence and implementation of the market-oriented economic model. Since then, the unemployment rate did not exceed 5%.

Figure 1. The unemployment rate in Kazakhstan (1991-2021).

Kazakhstan Unemployment Rate - Historical Data					
Year	Unemployment Rate (%)	Annual Change	2006	7.79%	-0.34%
2021	4.90%	0.01%	2005	8.13%	-0.27%
2020	4.89%	0.09%	2004	8.40%	-0.38%
2019	4.80%	-0.05%	2003	8.78%	-0.55%
2018	4.85%	-0.05%	2002	9.33%	-1.10%
2017	4.90%	-0.06%	2001	10.43%	-2.32%
2016	4.96%	0.03%	2000	12.75%	-0.71%
2015	4.93%	-0.13%	1999	13.46%	0.33%
2014	5.06%	-0.14%	1998	13.13%	0.12%
2013	5.20%	-0.09%	1997	13.01%	0.05%
2012	5.29%	-0.10%	1996	12.96%	1.98%
2011	5.39%	-0.38%	1995	10.98%	3.44%
2010	5.77%	-0.78%	1994	7.54%	6.43%
2009	6.55%	-0.08%	1993	1.11%	0.11%
2008	6.63%	-0.63%	1992	1.00%	0.10%
2007	7.26%	-0.53%	1991	0.90%	0.10%

Source: World Bank

Employment of the population is one of the main aspects of the development of economic reforms. According to the Bureau of National Statistics, the average working population is 8.7 million. The working-age population starts from 15 years old. The main part of the unemployed population can be divided by place of residence (city/town), region, gender, age, and level of education. The category of the unemployed includes the population producing products in private households for their consumption. The term unemployment itself consists of subtypes. The most common are natural unemployment (frictional, structural) and cyclical/seasonal. The natural appearance depends on natural causes, such as demographics and employee turnover. Seasonal unemployment is associated with seasonal opportunities to fulfill the volumes of certain areas.

Figure 2. The unemployment rate in Kazakhstan from 1991-2021
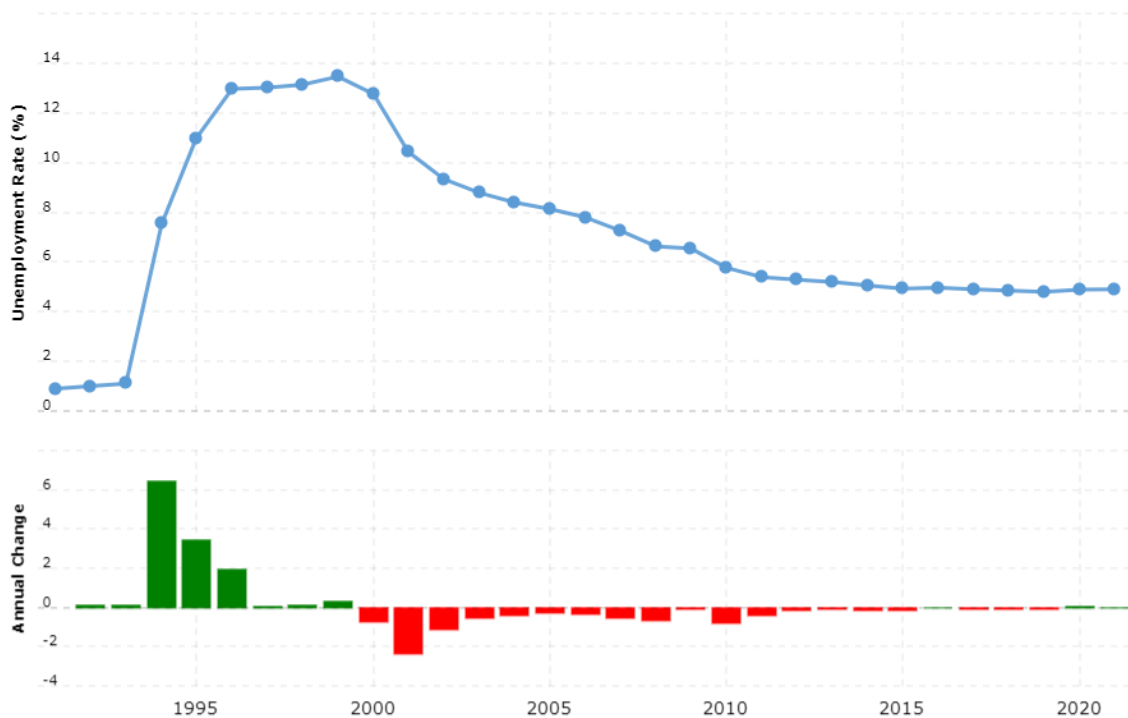
Kazakhstan's nature is highly diverse; thus, each region is conditioned by different spheres. In the south, the development of seasonal agriculture, in the north and east the raw materials extractive industries, and in the west the oil industry prevails (Karatayev, 2016). Most often, there is a mismatch between supply and demand in the labor market in the specialty, where specialists do not have the opportunity to find a suitable area. From a regional point of view, the causes of unemployment are most visible. According to the comparison of the annual statistical report, the highest unemployment rate from year to year is observed in the southern part of the country. This region is the most densely populated and labor-abundant, where the unemployment rate is higher than in other parts of the country. In this part, self-employment prevails, as well as the supply and demand of employers do not correspond to the indicators. The busiest region of Kazakhstan is the western part, dominated by the oil industry, on which the country's economy largely depends. The process of urbanization in the country has also affected the unemployment rate in the country. 58% of the unemployed live in cities, and more than 42% in rural areas (Bureau of National Statistics, 2022).

Another component of unemployment is the level of employment in the rural sector, where more than 41% of the country's population lives. Unemployment is much higher here, which is the reason for the sharp outflow of the population to big cities. Compared to the salaries of urban

people, the minimum wages in rural areas are 35–50 thousand tenge (approximately 70–100 Euros). Due to the abundance of certain specialties, such as lawyers and economists, there is an acute shortage of agriculture specialists. Compared to Europe, where people can live in rural or suburban areas and easily commute to work in neighboring cities, the situation in Kazakhstan is different due to the large territory and undeveloped infrastructural system. The distance between villages is on average about 100-150 kilometers, and to cities 200-250, in some cases it can be 500 kilometers. People will have to spend several hours commuting in one way, which makes this option almost impossible.

There is a growing tendency to support villages by large companies (Kenzhetayeva et al., 2022). Some large enterprises employ the entire population of the village in their factory and ensure the vital activity of the entire village, making it possible to develop. In addition, due to its geographical position, Kazakhstan is the largest country in Central Asia, where international projects are carried out, which means an influx of specialists from other countries. According to the Ministry of Economy of the Republic of Kazakhstan, more than 309 thousand specialists worked in the country. China is considered the leader in terms of foreign workers since the road to Europe passes through Kazakhstan. It was a foundation for the project of the international highway in Eastern Europe-Western China (Sultanov et al., 2019).

On the other hand, there is a growing trend of youth migration and change of permanent residence to study and build a career in another country (Zakirova et al., 2019). For example, in 2017, 37.7 thousand people left the country, of which 54% are qualified specialists. During the last few years, there was a significant problem of devaluation of the currency, which led to the collapse of the local economy and high inflation rates (Zholamanova et al., 2018). Thus, many specialists decided to leave the country, since their actual salaries on their level were several times higher than in other countries. As a result, there was a significant outflow of the valuable labor force, which negatively affected many other spheres of the economy. The government of Kazakhstan tried to replace the outflow of the labor force with labor from other countries. The abundance of workers comes from countries: India, Bangladesh, China, and Uzbekistan. Foreign specialists cover the lack of specialists but increase local unemployment.

From a gender perspective and according to Statistics Committee, the proportion of men is 45% and women 55%. The proportion of the young population aged 15–28 is 19%. The most vulnerable to unemployment is the stratum of the population aged 29–34 years, accounting for 28% of the total percentage of the unemployed population. In comparison with the level of education, more than 71% of the unemployed population have higher education, and 26% have

secondary education. When compared by gender, women work more in their specialty than men (57% women, 53% men).

There is a big imbalance in the market between specialists and demand in the labor market. Perhaps one of the reasons is that the system of education and training of personnel for the labor market is underdeveloped (Zakirova et al., 2019). As I said earlier, there are inconsistencies in demand in the labor market. The country is dominated by a population with education in social sciences, but there is a clear lack of technical specialists, which is one of the reasons for such rates of unemployed population. The lack of professional staff can be observed from the situation, where in September of 2022, on the website of the Ministry of Labor and Social Protection of the Republic of Kazakhstan, 115.6 thousand ads were published on the platform of the Electronic Labor Exchange. The difference between the proposed job advertisements and the number of submitted CVs was about 29%, and the approximate number of submitted CVs was 82.3 thousand applications.

As previously reported, the shortage of specialists is observed in large cities such as Almaty (the difference between supply and demand is more than 7.4 thousand vacancies), Astana (5.2 thousand), Kostanay (6.6 thousand), Karaganda (6.5 thousand). There is an acute shortage in education and construction. According to Semenyuk (2020), this is due to the growing level of urbanization in large cities. People strive for ambitions in big cities, and in Kazakhstan, most cities are only being built and developed without strict allocation, so due to densely populated areas there are not enough specialists in nearby schools and kindergartens.

In the suburbs of Astana, there is a secondary school number 2, where in 2022 more than 4,700 students came to classes, although the school accommodates 1,200 students in one shift ("The problem of three-shift education", 2022). For such a large number of students, there are only 320 teachers. The school has to work in three shifts, where students can stay until 10 pm. There is only one school in this area, as there are not enough workers and specialists in the construction industry due to a sharp increase in the local population. According to Sultanova et al. (2018), the profession of teachers is not in demand among young people due to low wages. According to the Bureau of National Statistics of the Republic of Kazakhstan, the average salary of a teacher is 312 thousand tenges (approximately 550 Euros), and the minimum wage is 60 thousand tenges (120 Euros). Compared to 2019, the average salary was 115 thousand tenges (220 euros). This is lower than the overall average wage in the country - 168 thousand tenges (315 euros).

Another problem is that in three years, the inflation rate has been observed with an indicator of more than 20.3%. These indicators point to the need for various programs that must increase the

prestige of work among the young population, but there are shortcomings. The salary of specialists in the field of education directly depends on several factors:

- Level of qualification
- Category
- Work experience
- Compensation payments

If the young specialist does not have sufficient experience, then his salary will be close to the minimum monthly indicators, since the young specialist will not be given many working hours, on which the salary in the first months of work directly depends.

There are many reasons for the lack of the necessary personnel, but from my point of view, one of the main reasons is the problem with the training and education of future personnel, which covers several areas. For example, in comparison with many countries where, in addition to various scholarships and grants for studying at universities for any program, there are various types of financing and loans for education from leading banks, which makes it quite affordable for the younger generation. Unfortunately, there are no such programs in Kazakhstan, and limited possibilities of getting sponsorship for education (Sultanova et al., 2018). There are scholarships from the state due to the successful passing of after-school testing, but there are not many other opportunities. Therefore, all young are limited in choosing their professions.

In addition, due to urbanization, people tend to develop in cities and do not want to engage in other industries like agriculture, thereby increasing the mismatch of interests. It is quite difficult to get into technical specialties, and because of the economic situation and limited possibilities of sponsorship, people are not able to pay the cost of education, as a result, there is a lack of specialists in this area.

Okun's Law: Literature review

In recent times, the main objective of every country is stable and significant economic growth that provides the stability for other spheres. On the other hand, there is an important requirement of providing a sufficient amount of work for all citizens. Maintaining a balance between these two indicators is a constant challenge for politicians.

Sometimes, the calculation of Okun's law might be puzzling due to the specific characteristics of the country. Based on the case of India, the overpopulation of the country introduces new obstacles to labor conditions, where its long-run impact on the economy is unclear (Abubakar

and Nurudeen, 2019). The labor market goes through tough times that make Okun's law calculation almost impossible and the overall prognosis useless.

The estimated Okun's law rates prove the interconnection between a better economy's output and even the provision of work for all citizens, but the exact estimations of Okun's law are highly dependent on the specific characteristics of a country. Even before Okun's publications, economists agreed with a generalized assumption that there is a relationship between total production and the unemployment rate. However, Arthur Okun was the first who developed this idea more deeply and studied it empirically in 1962.

Okun's studies created the foundation for future research in this field. New models and theories were built around the relationship between the unemployment rate and economic growth. New economic models were constructed based on the original Okun's models and many of them made a great contribution to the development of economic thought.

Christian Weber (1995) in his "Cyclical output, cyclical unemployment, and Okun's coefficient: A new approach" work tried to study the unemployment rate and output relationship based on the example of the post-war USA. The specific feature of his work was that it was constructed based on cyclical unemployment and cyclical Gross National Product. The result was that the estimated coefficient of relationship was -0.25, which is considerably lower than all other studies that conducted a similar econometric analysis. The focus on specific unemployment significantly influenced the final findings of his work but he agreed that there is a significant relationship between those two variables and Okun's law applies to his chosen case. Another point of his work was that the scale of Okun's coefficient highly depends on the measurement technics of unemployment and total output.

Another research based on the example of the US economy is Prachowny's "Okun's Law: Theoretical Foundations and Revised Estimates", published in 1993. His work focuses on the period between 1967 and 1986. His main finding was the assumption about the instability of Okun's coefficient and the significant impact of other variables on unemployment as well as economic performance. He highlighted that even small factors such as weekly hours worked might drastically change Okun's coefficient. Therefore, the study suggests the introduction of "Okun's theory" instead of Okun's law due to its dependence on other factors and variability due to changes in these factors.

Knotek (2007) tried to test the significance of the relationship between the unemployment rate and the economy's output level. He chose to test it in more short and more long periods to compare its variability. The study included the period from 1948 to 2007, which made it possible

to consider major economic events and external factors change. Based on this analysis, he proved the idea of the variability of Okun's coefficient and its drawback for forecasting. However, despite the high variety in results and some deviation from Okun's initial assumption, he considered Okun's law as an applicable model and useful tool for forecasting. Knotek's recommendation was to consider Okun's law as a principle in the economy but not a strong theoretical base of macroeconomics.

Okun's law was tested not only on US Economy but other various economies as well. Makun and Azu (2015) applied the analysis of Okun's law to the example of Fiji. Fiji experienced the problem of a high unemployment rate at the end of the last century, so testing its relationship with economic performance was significant. The Fijian example corresponded to the previously published works and proved the correlation between a decrease in the unemployment rate and a better economy's output. Another important conclusion of their work was the assumption about the high influence of investment on economic results. This provided a foundation for further research on interconnection investment and the unemployment rate decline.

Later, when studying US macroeconomics, Okun's Law was also studied by Freeman (2001). He used quarterly reports from 1958-1998 as the basis of his calculations, as well as statistical information from 1977 to 1997 by using band-pass filters. This paper clarifies the constancy of the law and what, even to this day, is the closest in macroeconomics. Using these filters, you can see structural changes, but not changes in regions. For example, Apergis and Rezitis (2003) studied the economy of Greece and its unemployment from 1960-1977 using band-pass filters, which did not reveal much difference between regions, except for two nearby islands. After 1981, due to the growth of economic growth around the world, the unemployment rate does not affect the macroeconomics of many countries so much. Detailed calculations for the regions of Greece were used to reveal the difference between labor markets in different regions on the volume of local production. Statistically significant coefficients were identified for each specific coefficient.

Theory of Okun's Law.

There are two different methods (versions) for interpreting Okun's law:

$$\Delta U_t = \beta_1 + \beta_2 * \Delta Y_t + \varepsilon_t$$

Equation 1. First-difference model

The first is a first-difference model, which implies the regression of changes in the unemployment rate and economic performance on annual basis. The modified and more complex versions of Okun's model are mostly based on this first-difference model. This model does not

include other demographic or macroeconomic variables except the unemployment rate and the economy's output. The most important point of this model is the estimated "beta" parameters. The intercept coefficient provides the figure of the unemployment rate in case of no economic growth. The "Okun's coefficient" is pictured as β_2 in this equation and it is the main focus of this thesis. Based on above stated research findings, it is expected that Okun's coefficient is a negative number. Of course, there is a possibility of a positive number in case of the high influence of external factors.

Another version of Okun's model is based not on the first differences of variables but on the output gap. Based on this equation, the difference between the actual and potential economy's output. The second equation is the following:

$$U_t = \beta_1 + \beta_2 * \text{production gap} + \varepsilon_t$$

Equation 2. Based on the production gap

The output gap or production gap in this equation also shows the cyclical output values. When it comes to unemployment, it is shown in way of a cyclical level of unemployment, which is the difference between the actual and natural levels of unemployment. The natural level of unemployment is the rate at which employment can be increased only at the cost of higher inflation. The natural level of unemployment is a desirable level of unemployment for well-functioning the whole economy. Same as in the first type of equation, β_2 stands for Okun's coefficient, which is the main focus of studying the relationship between the economy's output and unemployment rate, and which is expected to be a negative number. Compared to the first equation, the intercept term is a rate at full employment in case of no existing output gap.

The limitations of this law analysis are difficulties in measuring the exact figures of output and unemployment. There are plenty of methods of calculating the total output that might lead to different results and estimations. Unemployment also includes a high variety of types that are calculated very differently as it was stated in this thesis before. This variability influences the final estimation. Another significant point is the existence of technological, institutional, and other macroeconomic and demographic factors, that might affect the final results very drastically.

Chapter 2. Econometric models

1. Data

The data set is collected from the databases of the Bureau of National statistics of the Agency for Strategic planning and reforms of the Republic of Kazakhstan. It contains annual observations on the regional level for 17 regions and the period 2000-2021. The data frame was chosen based on the availability of the data and annual frequency was used for avoiding the impact of seasonal unemployment in some regions. 22 years can be seen as an acceptable time frame for the analysis of time series and the chosen period correspond with the full transition to the market economy.

2. Significance of analysis

Unemployment rate influence almost all spheres of society's life. This rate has a comparable high predictive rate and can be a great foundation for future policy implications. Even a great rate of other economic indicators does not dimmish the significance of the overall employment rate in the country. The share of unemployed people can suffer from financial difficulties; therefore, it affects their consumer spending and circulation of money in the economy. As a result, unemployment negatively affects consumption and buying power, which ends in a worse economic situation for the whole country.

Proving Okun's law for the case of Kazakhstan demonstrates the available forecasting ability. It can be considered as a helpful guide for policy implication, which can positively influence the economic situation of the country and improve socio-economic indicators.

3. Hypothesis

Based on the example of previous studies related to other countries and patterns of unemployment rates, this analysis will try to prove the applicability of Okun's law on the relationship between the Gross Regional Product and unemployment in Kazakhstan. The examined hypothesis is that unemployment is inversely proportional to the Gross Regional Product, and therefore the Gross Domestic Product of Kazakhstan. The explanation of the testing relationship is lower productivity due to the lower rate of the economically active population.

4. Methodology

The R studio software was used for statistical analysis. The dataset is presented in form of panel data; therefore, panel regression models were constructed. All calculations are done on a regional level, therefore we use the regional rate of unemployment for each region and Gross Regional Product to express economic growth. The advantage of the panel regression model is its control over time-influence factors. The first-panel regression model is the first-difference model, which

contains the simultaneous correlation between variables and is considered a "classical version" of Okun's law model. The disadvantage of this model is omitting of some sufficient variables and the low explanatory power of unemployment variation. This model can be expressed as the following formula:

$$\Delta u_t = \beta_0 + \beta_1 \Delta y_t + e_t,$$

Where Δu_t demonstrates a change in the unemployment rate, Δy_t shows a change in yearly GRP figures and β_1 is "Okun's coefficient" or the linear effect of economic performance changes on the unemployment rate. The ratio of $- \beta_0/\beta_1$ demonstrates which output growth rate is associated with a stable unemployment rate, or to what extent the economy has to grow to maintain the stable unemployment rate - "employment threshold".

All three types of panel data models such as pooled regression, random effects, or fixed effects models have been analyzed in the practical part to estimate the relationship between the economy's output and unemployment rate in Kazakhstan. The disadvantage of the pooled model is that it omits the panel data structure and does not include time effects. Due to being treated as a cross-sectional data model, this model does not count the significant effect of panel data regression.

All panel regression models were calculated based on the chosen dataset and the most preferable model was chosen by running the model specification test. Since chosen panel regression models are fixed effects and random effect models, the conducted model specification test was the Hausman test. The hypothesis and result of this test suggest that in the case of the test, significance concludes that the fixed effect model is preferable compared to the second one.

The second-panel regression model is a "dynamized" version of the first model. To "dynamize" the initial model, the lagged variables of the explanatory and the lagged variables of the dependent variable were added. Thanks to this improvement, it is possible to study the influence of previous periods' factors on the current state. The set of explanatory variables of this model consists of previous unemployment rate changes and previous and current economic growth changes. According to Christl et al. (2017), the attempt to include past periods' values is aimed to decrease the probability of serial correlation in the error term. The model can be expressed as:

$$\Delta u_t = \beta_0 + \beta_1 \Delta y_t + \beta_2 \Delta y_{t-1} + \beta_3 \Delta y_{t-2} + \gamma_1 \Delta u_{t-1} + \gamma_2 \Delta u_{t-2} + e_t$$

According to Meyer et al. (2012), another approach to eliminate the instability problem of the "classical model" is applying non-linear relationship regression. This thesis is focused on two

stated linear models, the non-linear model can be tested as suggested improvements of this research.

5. Variables' overview

Unemployment rate. This variable demonstrates the rate of unemployed people out of the whole labor force. This variable is extracted at an annual rate. The previous theory of Okun's law assumes the interconnection of this variable with the economic performance of the country. The employment rate plays important role in the performance rates of various macroeconomic factors. The unemployment rate data is collected on *the regional level*, for all 17 regions separately. The unemployment rate observations are collected in absolute values. Therefore, they are transformed into yearly changes by using their 1st differences.

Gross Regional Product growth. The data was collected for all 17 regions, for the above-stated period of 2000-2021. To exclude the inflation impact, the GRP values were adjusted by using a GDP deflator, and only then the GRP growth rate was calculated. This approach helped to exclude the impact of inflation and show the pure economic growth or decrease. Since it is a growth rate, the values are presented in percentages. This variable is chosen as the most accurate available economic snapshot of economic production and stability. This variable is already collected as a yearly change and does not require 1st difference transformation.

6. Distribution of variables

The variability and observation location of the dataset has a significant impact on the quality of the model. The collected data must be checked for skewness, which assumes the measurement of the existence or non-existence of symmetry. In the case of skewness, the mean of the dataset is different than zero and different than the case of normal distribution.

Our dataset includes observations of 2 variables: *Gross Regional Product growth* and *Unemployment rate on a regional level*. The results of the distribution calculation for GRP growth demonstrated an almost symmetric distribution (Figure 3). Therefore, this variable is used in its original form.

Figure 3. Distribution of the "GRP_growth" variable
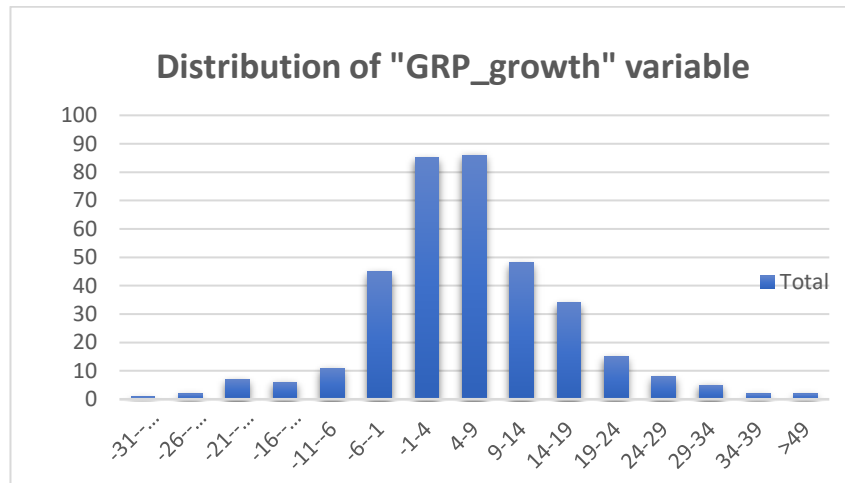
Source: Own calculations in Excel using the dataset

The second explanatory variable is ***the Unemployment rate on a regional level***. We can see capturing of the data concerning time in Figure 4. The data is available for each region separately; therefore we calculate the average national unemployment rate to graph its changes over time. We can see that the average national unemployment rate was declining over the last 20 years, and it has been showing an almost constant rate for the last 10 years.

Figure 4. "Unempl_rate" variable concerning the time
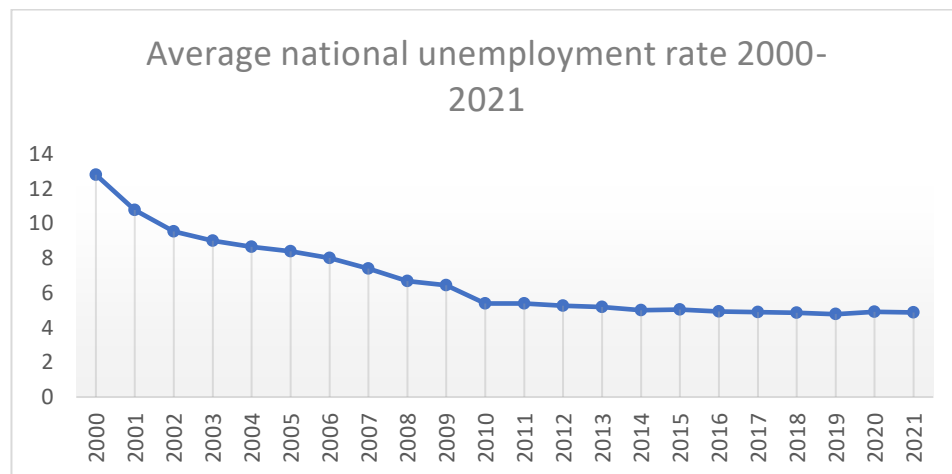
Source: Own calculations in Excel using the dataset

The picturing of distribution helped to test possible noise or outlier issues. There is no drastic outlier in the dataset, which can negatively affect the quality of the econometric model.

7. Descriptive statistics

The descriptive statistics summary includes 3 rows, which include 2 explanatory variables ("GRP_growth" and "unempl_rate"), and 1st difference of the "unempl_rate" variable (Table 1).

The initial focus of descriptive statistics is "GRP_growth" and the original form of the unemployment rate variable. Both variables are represented in percentage form. The 1st difference of the unemployment rate variable is included in the panel regression model; therefore, it was added as an explanatory variable to the calculation of descriptive statistics. The missing value for 2000 was calculated from the difference between 1999 and 2000 with the purpose to avoid missing data for this variable.

Table 1. Descriptive statistics

```
=====================================================
Statistic        N     Mean    St. Dev.   Min     Max
-----------------------------------------------------
unempl_rate     357   6.724     2.358     4.210  15.500
GRP_growth      357   5.933    10.397   -30.040  52.630
D.unempl_rate.  357  -0.359     0.749    -4.600   4.700
-----------------------------------------------------
```

Source: calculations in R.

The table demonstrates that the mean (average values) of Gross Regional Product growth is 5.93 percentage points, while the mean of the unemployment rate is 6.72 percentage points. When it comes to 1st difference in the unemployment rate, its mean is -0.359 percentage points, which is very close to zero. It assumes that changes in the unemployment rate for the given period fluctuate around zero and there is no strong trend of growth or decrease in unemployment. Another significant point of descriptive statistics is that number of observations in the dataset for each variable is equal, so there is no issue of missing data.

The standard deviation parameter shows the range of value fluctuation and variability for the given variable. The result table of the chosen dataset proves relatively low fluctuation of the unemployment rate in the country since its value is slightly above 2%. It assumes that the labor market has relatively similar conditions in all regions of Kazakhstan and has been showing a similar trend during the last two decades. The standard deviation of 1st difference of the unemployment rate is even lower – 0.749 percentage points. Based on this, it can be concluded that the unemployment rate change was relatively stable for 22 years.

The standard deviation of Gross Regional Product growth is slightly above 10%, which suggests more variability in the economic performance of each region. This situation might be driven by various characteristics such as investment level, industry development, rational policy implication, etc. Another assumption is that the significant value of standard deviation might be driven by changes in the economy during the chosen period, full transition to a market economy, and the impact of economic shock events such as the financial crisis.

The minimum rate of the unemployment rate is 4.2%, which was stated in the capital city in 2019, while the maximum rate was stated in the Atyrau region in 2000 (15.5%). When it comes to Gross Regional Product growth, there is a significant difference between the minimum and maximum stated indices. The highest rate was registered in the East Kazakhstan region in 2004, while the lowest was stated in the Turkestan region in 2018. The maximum change in the unemployment rate in absolute value was 4.6-4.7 percentage points.

8. Empirical results

- *"Classical model" - Pooled Model*

The first estimated type of panel regression model is pooled model, where the effect of region and period is not considered. The initially stated equation is:

$$\Delta u_{it} = \beta_0 + \beta_1 \Delta y_{it} + e_{it},$$

where "t" reflects the corresponding period, while "i" is responsible for each region's corresponding number.

Table 2. Pooled OLS "classical model".

```
Unbalanced Panel: n = 17, T = 5-22, N = 357

Coefficients:
              Estimate Std. Error t-value  Pr(>|t|)
(Intercept) -0.2889413  0.0450794 -6.4096 4.646e-10 ***
GRP_growth  -0.0117791  0.0037699 -3.1245  0.001928 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    199.49
Residual Sum of Squares: 194.15
R-Squared:        0.026764
Adj. R-Squared: 0.024022
F-statistic: 9.76247 on 1 and 355 DF, p-value: 0.0019277
```

Source: calculations in R

The given equation: Δu_{it} = -0.289 – 0.0118 x GRP change rate

The estimated equation suggests that the change in the Gross Regional product growth rate is linked to a decline in unemployment. The p-value of the main focus variable "GRP_growth" is approximately 0.002, and the main coefficient of our focus is statistically significant at a 99% confidence level. The economic growth rate is shown in fractional form, where 1 point means 100%. To obtain the percentage point change, the estimated parameters have to be increased by 100. The modified equation looks the following way:

Δu_{it} = -28.89 – 1.18 x GRP change rate

The interpretation of the relationship is that increase in the Gross Regional Product growth rate by 1 percentage point is associated with a decrease in unemployment rate growth by -1.18 percentage points, ceteris paribus. The intercept term shows that in case of no GRP change, the unemployment rate change is -28.89 percentage points.

The "employment threshold" or - β_0/β_1 ratio is -24.53, which concludes that a stable employment rate requires the GRP growth rate to be almost -25%. This value is relatively unrealistic and works as a support for the assumption that the "classical" version of Okun's law and pooled regression model does not include all necessary characteristics of the relationship and makes it too simple to be able to include them.

The main assumption of the negative relationship between economic growth and an increase in the unemployment rate is proved in this model since the estimated coefficient of the β_1 parameter is a value with a minus sign. The estimated coefficient of the GRP growth rate, as well as the whole model, is statistically significant on a 99% confidence level.

- ***"Classical model" - Fixed Effect Model***

For this type of panel regression model, the intercept term tends to vary across individuals or groups. This regression model aims to capture the intrinsic characteristics of individuals, in this research case the characteristics of each region. In the examined dataset, the intercept varies across Kazakhstan's regions. The initial equation of the pooled model is modified into the following equation:

$\Delta u_{it} = \alpha_i + \beta_1 \Delta y_{it} + e_{it},$

where α_i replace the usual β_0 and express the fixed effect of each region.

Table 3. Fixed effect "classical model".

```
Unbalanced Panel: n = 17, T = 5-22, N = 357


Coefficients:
             Estimate Std. Error t-value Pr(>|t|)
GRP_growth -0.012489    0.003849 -3.2448 0.001293 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    191.4
Residual Sum of Squares: 185.63
R-Squared:       0.030122
Adj. R-Squared: -0.018515
F-statistic: 10.5286 on 1 and 339 DF, p-value: 0.0012925
```

Source: calculations in R

This estimated model captures only the estimated coefficient of the independent variable – "GRP_growth" as it is shown in Table 3. This change is driven by the alteration that the intercept term is replaced by the fixed effect of each region, which will be pictured in a separate table (Table 4). The estimated coefficient's sign demonstrates that the fixed effect model, as well as pooled regression model, proves that GRP growth is associated with a negative impact on the unemployment rate and can have a positive contribution to the labor market. Based on the result, the increase of the Gross Regional Product change rate by 1 percentage point is associated with a decrease in the unemployment rate growth by 1.25 percentage points. The p-value of the explanatory variable is 0.0013, and it points out that the variable is significant at a 99% confidence level. Moreover, the p-value is lower than in the case of pooled regression. It shows that in the fixed effect model, the same economic growth variable demonstrated a higher significance level and a more significant effect on employment conditions. The model includes only one explanatory variable; thus, the F-test's result is in line with the t-test result of the explanatory variable. The p-value shows the significance of the variable, and it leads to the that the model is significant as well.

The fixed effect of each region demonstrates significant variance. 10 regions' fixed individual effect is negative, while 7 regions' fixed effect is positive. The common characteristic is that values are less than 1; however, the GRP growth rate is shown in fractional form, where 1 point means 100% and the regression coefficients have to adjust by being multiplied by 100. Therefore, the maximum value of the regional fixed effect is 37.72, which is being recorded for the East Kazakhstan region. While the Turkestan region demonstrated the minimum value (-12.76).

Table 4. Fixed effects of regions.

	Estimate	Std. Error	t-value	Pr(>|t|)	
1	0.0396002	0.1595682	0.2482	0.80415	
2	-0.0716673	0.1589109	-0.4510	0.65229	
3	-0.1098557	0.1591948	-0.6901	0.49062	
4	-0.1167212	0.1609335	-0.7253	0.46878	
5	0.3771683	0.1603175	2.3526	0.01921	*
6	-0.0961147	0.1595983	-0.6022	0.54742	
7	-0.0881817	0.1588071	-0.5553	0.57907	
8	-0.0715479	0.1589153	-0.4502	0.65283	
9	-0.0928578	0.1597531	-0.5813	0.56145	
10	-0.1083701	0.1583284	-0.6845	0.49415	
11	-0.0871261	0.1591949	-0.5473	0.58454	
12	0.0025662	0.1591452	0.0161	0.98714	
13	-0.1275869	0.1581929	-0.8065	0.42050	
14	0.3240908	0.1586092	2.0433	0.04179	*
15	0.0045066	0.1608429	0.0280	0.97766	
16	0.1630790	0.1637220	0.9961	0.31993	
17	0.2596807	0.3309648	0.7846	0.43323	

Source: calculations in R

- *"Classical model" - Random Effect Model*

The main but not significant difference between the random effect and fixed effect model is that the region-specific effects in the fixed effect model are distributed separately from the dependent variables and it is a part of the error term. In this type of Okun's panel regression, shown in Table 5, Gross Regional Product growth and 1st difference in unemployment rate show a considerable interconnection. Similar to previous panel regression models, the "focus" variable is significant at a 99% confidence level. The p-value is better in the random effect model and it is 0.0018. The result suggests that there is less than a one in a thousand chance of obtaining an incorrect result.

The findings demonstrate that an increase in the GRP rate growth by 1 percentage point is associated with a decrease in the unemployment rate growth by 1.18 percentage points. The originally obtained figure is multiplied by 100 due to the previously stated specific interpretation of changes in the explanatory variable.

Table 5. Random effects "classical model".

```
Unbalanced Panel: n = 17, T = 5-22, N = 357

Effects:
                var std.dev share
idiosyncratic 0.5476  0.7400     1
individual    0.0000  0.0000     0
theta:

Coefficients:
             Estimate Std. Error z-value  Pr(>|z|)
(Intercept) -0.2889413  0.0450794 -6.4096 1.459e-10 ***
GRP_growth  -0.0117791 0.0037699 -3.1245   0.001781 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    199.49
Residual Sum of Squares: 194.15
R-Squared:       0.026764
Adj. R-Squared: 0.024022
Chisq: 9.76247 on 1 DF, p-value: 0.0017811
```

Source: calculations in R

The random effect model's result is like the results of the pooled model. The theta is shown as zero as well. The possible reason behind that the estimate of the variance of the unobserved effect is negative and it is being treated as zero. As a result, the Fixed-effect model is identical to Pooled regression model. The usage of first differences leads to a negative serial correlation and a negative estimate of the error variance.

Another possible reason for no explicit difference between Pooled regression and the Random-effect model is a relatively small dataset, with 22 time periods and 17 regions. This

size of the dataset is not enough to estimate that fixed effects may vary from one observation to another and prove the existence of the random effect.

- *Model Specification test*

In the context of a statistical model, specification (misspecification) tests evaluate the reliability of the probabilistic premises that make up the statistical model. In a regression model, the Hausman Test (also known as the Hausman specification test) can identify endogenous variables. This test is required in the case of conducting several types of panel regression models to identify more preferred models.

Null hypothesis: The preferred model is random effects.

Alternative hypothesis: The preferred model is fixed effects.

Table 6. Model Specification test.

```
            Hausman Test

data:  D.unempl_rate. ~ GRP_growth
chisq = 0.83687, df = 1, p-value = 0.3603
alternative hypothesis: one model is inconsistent
```

Source: calculations in R

The p-value is 0.3603 as it is shown in Table 6. Based on this, we can conclude that even on applying the 90% confidence level for testing, the null hypothesis cannot be rejected, and the random effect model is the preferred model. But based on the previous assumption that the model results do not detect any difference between random effect and pooled regression model, the initial pooled regression model is the most suitable.

- *Result*

Due to the small dataset and only one explanatory variable in the model, the model does not require panel data analysis and can be treated as a cross-sectional dataset. Despite this fact, the pooled regression model estimates a statistically significant relationship between unemployment rate change and Gross Regional Product growth. This result corresponds with the theory of Okun's law regarding that production growth is associated with a decrease in the unemployment rate.

- ***"Dynamic" model** – *Pooled model*

Due to the limitations of the "classical" Okun's model, the second dynamic model was introduced. In this model, besides the impact of current economic growth, which is expressed in the Gross Regional Product growth rate, we included the lagged variables of economic growth and unemployment rate. The equation is the following:

$$\Delta u_t = \beta_0 + \beta_1 \Delta y_t + \beta_2 \Delta y_{t-1} + \beta_3 \Delta y_{t-2} + \gamma_1 \Delta u_{t-1} + \gamma_2 \Delta u_{t-2} + e_t,$$

where "t" reflects the corresponding period, while "i" is responsible for each region's corresponding number.

Table 7. Pooled OLS "dynamic model".

```
Pooling Model

Unbalanced Panel: n = 17, T = 5-22, N = 357

Coefficients:
              Estimate Std. Error t-value  Pr(>|t|)
(Intercept)  -0.1460795  0.0530338 -2.7545  0.006185 **
GRP_growth   -0.0102530  0.0036041 -2.8448  0.004705 **
lag.GRP.1.   -0.0024381  0.0036184 -0.6738  0.500876
lag.GRP.2.   -0.0119297  0.0036443 -3.2735  0.001168 **
lag.unmpl.1.  0.2904512  0.0523765  5.5454 5.776e-08 ***
lag.unmpl.2. -0.1046324  0.0522991 -2.0007  0.046199 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    199.49
Residual Sum of Squares: 171.64
R-Squared:       0.13961
Adj. R-Squared: 0.12735
F-statistic: 11.391 on 5 and 351 DF, p-value: 3.3596e-10
```

Source: calculations in R

Table 7 shows that the result of the "dynamized" pooled regression model corresponds to the previously stated significant inverse relationship between economic growth and the unemployment rate growth. There is a need of applying the rule of multiplying the coefficients by 100 since the unemployment rate is calculated in fractions. In the end, an increase of Gross Regional Product growth by 1 percentage point is associated with a 1.03 percentage points decrease in the unemployment rate change rate. If we compare the "dynamic" and "classical" models, we can see that the estimated coefficient of changes in economic performance in the "dynamic" model is lower compared to the "classical" model. The possible explanation is the division of total impact in the "classical" model to current and lagged variables' impact in the "dynamic" model. Another important point regarding the explanatory variable – the p-value is 0.0047 with corresponding statistical significance at a 99% confidence level.

There is a clear trend of an inverse relationship between lagged variables of the Gross regional product change rate with the unemployment rate change. The model demonstrates that the increase of Gross Regional Product growth one period before by 1 percentage point is associated with a decrease in unemployment rate change by 0.24 percentage points. In case of an increase of Gross Regional Product growth two periods before by the same 1 percentage point, the associated unemployment rate change is lower by 1.2 percentage points. The Gross Regional Product growth lagged by 1 period and has a relatively insignificant coefficient estimation as well as a high p-value. These conditions make this variable insignificant in the model. A fun fact is that the same variable lagged by two time periods has a higher estimated coefficient and is statistically significant on a 99% significance level. Possible explanation: the impact of the Gross Regional Product change rate lagged by one variable can be already expressed by the current indicators of Gross Regional Product.

There are various impacts of lagged variables of the unemployment rate change. The unemployment rate growth by 1 percentage point in the previous period is correlated with an unemployment rate growth increase of 29.04 percentage points, while the impact of the same variable increase that is lagged by two periods is associated with a 10.46 percentage points decrease in an unemployment rate change. These variables are significant on a 95% confidence level, while the lagged by a one-period variable is significant even on a 99.9% confidence level. The difference between the coefficient and their directions might be explained by the existence of business cycles and possible severe delays in the unemployment rate.

The overall significance of the model shows that the p-value is extremely low and there is proven joint significance.

- ***"Dynamic" model – Fixed-Effect model***

In the Fixed-Effect model, the intercept term is not constant for each observation but varies across individuals or groups. Same as in the "classical" model example, the fixed effects are intended to capture the individual effect of each region of Kazakhstan. In the equation term, the constant and universal β_0 is replaced by individualistic α_{it}:

$$\Delta u_t = \alpha_{it} + \beta_1 \Delta y_t + \beta_2 \Delta y_{t-1} + \beta_3 \Delta y_{t-2} + \gamma_1 \Delta u_{t-1} + \gamma_2 \Delta u_{t-2} + e_t$$

Table 8. Fixed effect "dynamic model".

```
Oneway (individual) effect Within Model

Unbalanced Panel: n = 17, T = 5-22, N = 357

Coefficients:
              Estimate Std. Error t-value  Pr(>|t|)
GRP_growth   -0.0116081  0.0036678 -3.1649 0.0016939 **
lag.GRP.1.   -0.0043362  0.0037002 -1.1719 0.2420856
lag.GRP.2.   -0.0137867  0.0037381 -3.6882 0.0002635 ***
lag.unmpl.1.  0.2559133  0.0532290  4.8078 2.309e-06 ***
lag.unmpl.2. -0.1383461  0.0531135 -2.6047 0.0096046 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    191.4
Residual Sum of Squares: 164.28
R-Squared:       0.14169
Adj. R-Squared: 0.087881
F-statistic: 11.06 on 5 and 335 DF, p-value: 7.1314e-10
```

Source: calculations in R

In the "dynamized" fixed effect model, the coefficients of all explanatory variables are very similar to the results of the pooled regression model. The Gross Regional Product growth by 1 percentage point is associated with a decrease in the unemployment rate growth by 1.16 percentage points. The p-value of the "GRP_growth" variable is only 0.0017, which makes it statistically significant. The lagged variables of GRP growth have a similar negative impact on the unemployment rate change, while the lagged by one period "GRP_growth" is associated with a 0.043 percentage points decrease in the unemployment rate growth, while lagged by two periods "GRP_growth" is associated with 1.38 percentage points decrease in the unemployment rate growth". The similar characteristic to the pooled regression model is that there is no statistical significance of lagged by one period "GRP_growth".

The lagged variable of unemployment by one period has a positive impact on unemployment rate growth in the current period. The increase of the unemployment rate by 1 percentage point is associated with an increase in current unemployment rate growth by 25.6 percentage points. The same lagged variable in two periods inversely influences the current unemployment rate, so an increase in the unemployment rate two periods before is associated with a decrease in the unemployment rate growth by 13.84 percentage points. Both variables demonstrate statistical significance at a 99% confidence level.

Compared to the Pooled regression model, the intercept term is not included. The intercept term is replaced by regional fixed effects, which can be seen in Table 9. Same as in the case of the "classical" model, there are different signs of fixed effects, as well as their coefficients. The majority of fixed effects (11 regions) have negative signs and only 6 regions show a

coefficient with a positive sign. To compare and interpret the coefficients, we multiply them by 100. The maximum fixed regional effect is 35.82, which corresponds to the East Kazakhstan region. In the case of the "classical" model, the East Kazakhstan region also demonstrated the maximum fixed regional effect. The minimum fixed regional effect is -13.78, which corresponds to the Turkestan region. This extreme parameter is similar to the "classical" model; however, the extreme values in the "dynamic" model are relatively lower and show lower variance.

Table 9. Fixed regional effects of "dynamic model".

```
     Estimate Std. Error t-value Pr(>|t|)
1    0.0232593  0.1540303   0.1510  0.88006
2   -0.0702955  0.1539842  -0.4565  0.64832
3   -0.1168149  0.1546173  -0.7555  0.45047
4   -0.0505205  0.1593476  -0.3170  0.75141
5    0.3582662  0.1565183   2.2890  0.02270 *
6   -0.0797479  0.1558456  -0.5117  0.60919
7   -0.1069049  0.1535132  -0.6964  0.48667
8   -0.0846644  0.1537184  -0.5508  0.58215
9   -0.0466363  0.1570601  -0.2969  0.76670
10  -0.1378123  0.1527705  -0.9021  0.36766
11  -0.1044142  0.1540764  -0.6777  0.49844
12  -0.0072616  0.1539537  -0.0472  0.96241
13  -0.1682022  0.1525483  -1.1026  0.27099
14   0.2596938  0.1518561   1.7101  0.08817 .
15   0.0569807  0.1588313   0.3587  0.72001
16   0.2475391  0.1648170   1.5019  0.13406
17   0.1211571  0.3133051   0.3867  0.69922
```

Source: calculations in R

- **"Dynamic" model – Random effect model**

  The comparison of fixed effect and random effect models shows that there is no significant difference. Even more, the random effect model does not sufficient alterations comparing to the pooled regression model. This characteristic is like a situation in the "classical" model. It seems that the usage of first differences is a source of negative serial correlation and a negative estimate of the error variance. Moreover, the small dataset is still affecting the possibility of the model process and the possible variance of fixed effects of all observations. The inclusion of more explanatory variables did not dramatically change the situation.

  As in previous types of panel data models, the explanatory variable GRP growth and dependent variable unemployment rate growth show a significant inverse relationship (Table 10). The intercept, "GRP_growth" variable, and its lag by two periods are significant on a 99% confidence level. The lagged-by-one-period version of this variable is not demonstrating the significance of this model.

Table 10. Random effect "dynamic model".

```
Unbalanced Panel: n = 17, T = 5-22, N = 357

Effects:
                var std.dev share
idiosyncratic 0.4923  0.7016     1
individual    0.0000  0.0000     0
theta:

Coefficients:
              Estimate Std. Error z-value  Pr(>|z|)
(Intercept)  -0.1460795  0.0530338 -2.7545 0.005879 **
GRP_growth   -0.0102530  0.0036041 -2.8448 0.004444 **
lag.GRP.1.   -0.0024381  0.0036184 -0.6738 0.500432
lag.GRP.2.   -0.0119297  0.0036443 -3.2735 0.001062 **
lag.unmpl.1.  0.2904512  0.0523765  5.5454 2.932e-08 ***
lag.unmpl.2. -0.1046324  0.0522991 -2.0007 0.045430 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    199.49
Residual Sum of Squares: 171.64
R-Squared:       0.13961
Adj. R-Squared: 0.12735
Chisq: 56.9549 on 5 DF, p-value: 5.1664e-11
```

The lagged variables of the unemployment rate growth are statistically significant; however; they are showing different signs of coefficients. The lagged variable by one period positively affects the current unemployment rate growth, which means that it contributes to the worsening of labor conditions in the market. On the other hand, the lagged variable of the unemployment rate growth by two periods is associated with a decrease in the unemployment rate and the end of better labor market conditions.

The result of the F-test shows that the p-value is extremely low and concludes that the estimated model is statistically significant, even if one of the predetermined variables has no statistical significance (GRP_growth lagged by one period).

- *Model specification*

The Hausman test is used to identify the model with better explanatory power and statistical significance between the fixed effect model and the random effect model.

Null hypothesis: The preferred model is random effects.

Alternative hypothesis: The preferred model is fixed effects.

Table 11. Model Specification test

```
        Hausman Test

data: D.unempl_rate. ~ GRP_growth + lag.GRP.1. + lag.GRP.2. + lag.unmpl.1. +  ...
chisq = 14.541, df = 5, p-value = 0.01252
alternative hypothesis: one model is inconsistent
```

Source: calculations in R

Based on the specification test results, the p-value is 0.01252. It implies that on a 95% confidence level, we can reject the null hypothesis regarding the higher preference for the random effect model and accept the alternative hypothesis regarding the more explanatory power of the fixed effect model in panel data analysis. There is a difference between the model specification tests of 2 Okun's models. The classical" model suggests that the random-effect model is more suitable, while the "dynamic" model and lagged transformation of variables positively influenced the significance of fixed regional effects.

- *Results*

Even with a small dataset, the "dynamic" model was processed as panel data analysis and the Fixed-effect model demonstrated a better explanation. Same as in the "classical" model, the chosen model estimates a statistically significant relationship between unemployment rate change and Gross Regional Product growth. This result corresponds with the theory of Okun's law regarding the correlation between economic growth and a decrease in the unemployment rate.

When it comes to lagged variables, the lagged variable of unemployment rate change by two periods negatively impacts the current unemployment rate and leads to more employment, and positively contributes to the economic parameters. The possible explanation is that the unemployment rate activates automatic stabilizers such as unemployment insurance. More money circulation might positively influence the performance of the economy and lead to better labor market conditions.
No statistical significance of lagged Gross Regional Product growth can be explained by its delayed impact and the significance of this lagged variable by two periods supports the idea that the impact of previous economic growth will be seen with 2 or more period delays but not the exact next one.

9. Possible improvements

The main weakness of estimated models is the small dataset, which contains only 22 years. This period is not enough to analyze time-relevant changes in variables; however, there is no available data on a regional level for older periods.

Another possible improvement is to include more lagged variables because the impact of economic growth or unemployment rate might affect not only the next 2 periods but might have an influence on a longer period. This improvement will provide the basis for analysis of possible delays that might modify the interpretation of the relationship between economic growth and the unemployment rate.

Conclusion

To conclude, on the example of 22 years of development in Kazakhstan, we can draw several conclusions that prove the initial assumption. The hypothesis was the inverse relationship between unemployment and Gross Regional Product. The higher the GDP, the lower the unemployment rate since a higher unemployment rate causes less productivity and vice versa. Our other goal was to test Okun's law in the example of Kazakhstan. Okun's law is confirmed by the result of panel regression models, on explicit examples we saw a significant relationship between the unemployment rate and economic growth.

The result of constructed panel regression models demonstrated that there is an inverse relationship between economic growth and the unemployment rate. The "classical" and "dynamic" Okun's model had very similar results with high statistical significance of economic growth in the calculated equation of its impact on the unemployment rate. The exact rate of impact, and the estimated coefficient of economic growth variable concerning the unemployment rate varied in all types of panel regression models, however, it remained statistically significant in all estimated models.

The "dynamization" of the model, which means the inclusion of lagged variables of explanatory, as well as dependent variables did not change the estimated impact of economic growth on the unemployment rate drastically. However, it proved the assumption that there is a significant influence of current economic growth and unemployment rate on future parameters. Another modification due to model "dynamization" was that the Fixed-Effect model is preferable in case of inclusion of lagged variables. This suggests that the "dynamic" model is better at capturing the fixed regional effect.

There is a possible contribution to this thesis since the answers received in practice were close to theoretical ones. The estimated result might vary by the main variables that were taken for the sample; therefore, the estimated effect might vary based on sample specifics. There are additional variables that are difficult to take into account that also can modify the estimated relationship For example, there are positive types of unemployment, where people move from one job to another to better working conditions. In this scenario, the variables are constantly changing, as the statistics differ every day.

Predicting the future, I would say that the situation will be about the same as all these years. As discussed earlier, it is impossible to get rid of unemployment due to several reasons. The main finding of this thesis is that unemployment in Kazakhstan is highly dependent on its economic growth, therefore labor market conditions depending on the overall economic performance of the

country. Moreover, it suggests that better labor market conditions in Kazakhstan might work as a foundation for an increase in the total productivity of the country.

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