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GOVERNMENT REGULATION AND MARKET OUTCOMES: A STUDY OF THE MOBILE TELECOMMUNICATIONS SECTOR IN THE KYRGYZ REPUBLIC

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Abstract
This article analyzes the impact of government regulation on the mobile communications market in the Kyrgyz Republic. By 2011, mobile penetration in the Kyrgyz Republic exceeded 100% and reached a peak of 130% over the next 5 years (*NSC, 2025*). Weak government control over the distribution and registration of SIM cards among the population has led to increased risks of fraud, cybercrime, organized crime, and significantly increased operating costs for mobile communications market participants.
The study developed a multivariate regression model to determine the degree of influence of various factors including a range of government measures related to regulation of the cellular communications industry over the past decades.

Key words: Government Regulation, State Regulation, Mobile Telecommunications, Cellular Market, Kyrgyz Republic

1. Introduction

The study is relevant due to the need to find an optimal balance between the interests of the state, telecom operators and end users, as well as issues affecting other areas of society where cellular communications have become both a source of positive and detrimental changes. The study helped to determine the degree of influence of various government regulatory measures on the cellular communications market in the Kyrgyz Republic. The developed model makes it possible to assess in advance the degree of impact and effect of the developed government initiatives. Since the Central Asian markets are very similar in their characteristics (*CABAR.asia, 2021*), the proposed model can be used not only for the Kyrgyz Republic, but also for all countries in the region and can be taken as a basis for further analysis of government regulation of cellular communications markets.

The purpose of the study is to analyze the impact of government regulatory measures on one of the key indicators of the cellular communications market, i.e. the active subscriber base. The active subscriber base is the most important indicator of the industry and a specific telecom operator since it reflects the market capacity, market share, its health, operators' income from the services provided and tax revenues to the country's budget. According to the State Tax Service data for 2022, tax revenues from communications companies amounted to 5% of all taxes or more than 3

billion soms (*State Tax Service, 2023*). The telecommunications industry closes the TOP-3 of the largest taxpayers in the Kyrgyz Republic.

To achieve the goal, the following tasks were set:

- to review regulations and analyze government measures applied in the Kyrgyz Republic between 2010 to 2024;
- to identify the factors influencing the active subscriber base of the cellular communications market;
- to collect and process open-source data;
- to build a regression model of the impact the government measures have the subscriber base and interpret the results.

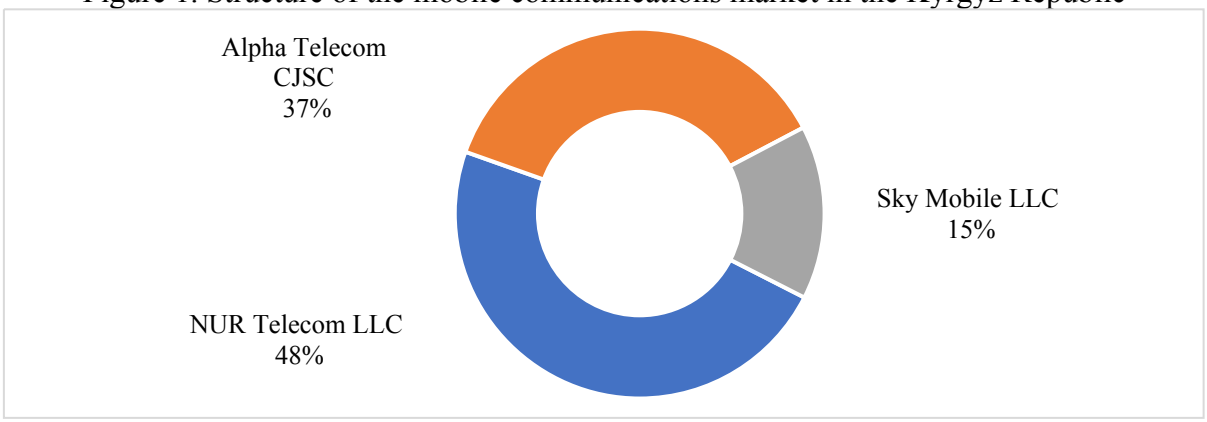
2.1. Development of the present-day mobile communications market in the Kyrgyz Republic and its state regulation until 2015

The present-day structure of the mobile communications market in the Kyrgyz Republic was finally formed by the mid-2010s, and since then, the market has been a classic oligopoly model with three active providers. By 2010, the active industry development stage was completed: providers went through a period of price wars, adapted to various forms of government regulation, and aligned their tariff policies and the range of services provided. Significant investments were allocated to the development of infrastructure, in particular, to ensure 3G and 4G network coverage which covered up to 99% of the country's populated area and ensured a high level of quality of services provided (*Gordiushina, 2024*).

According to the Open Budget portal (*Transparent Budget, 2024*) supervised by the Ministry of Finance of the Kyrgyz Republic, the market share of each provider was determined based on the amount of taxes paid (Figure 1). In 2024, the Kyrgyz Republic's mobile communications market was divided as follows:

- 48% of the market belong to the private operator O! (NUR Telecom LLC);
- 37% belong to the MEGA state-owned operator (Alpha Telecom CJSC); and
- 15% are held by the Beeline international operator (Sky Mobile LLC).

Figure 1. Structure of the mobile communications market in the Kyrgyz Republic



The development of the cellular communications market was characterized not only by operation of cellular telecom service providers, but also by the work of key industry regulatory bodies such as:

- The Ministry of Digital Development of the Kyrgyz Republic, the central state executive agency responsible for the development and implementation of state policy in the areas of digital development, communications, information technology, electronic governance and electronic services (*MDD, 2024*);

- The State Communication Agency under the Cabinet of Ministers of the Kyrgyz Republic (SCA), the main state agency responsible for implementing the state policy in the field of electric and postal communications. The Agency is responsible for licensing, monitoring of compliance with laws, managing the radio frequency range, and tariff regulation. Currently (as of 2025), SRSCS, the Service for Regulation and Supervision of the Communication Sector under the Ministry of Digital Development of the Kyrgyz Republic (*SRSCS, 2025*).

Regulatory agencies are responsible for continuous improvement of the Kyrgyz Republic laws in the communications area aimed at achieving several goals:

- adapting to the digital age realities;
- promoting innovative technology development; and
- protecting interests of market subjects and users.

An important aspect of this process is maintaining an optimal balance between the principles of freedom of information, and ensuring the rights of citizens and the national security interests.

The key documents regulating the market included the Law of the Kyrgyz Republic on Electric and Postal Communications (dated April 2, 2004, No. 57, as amended) and the Law of the Kyrgyz Republic on Personal Data (dated April 14, 2008, No. 58, as amended) (*CIIP, 2016*) which regulated the following aspects:

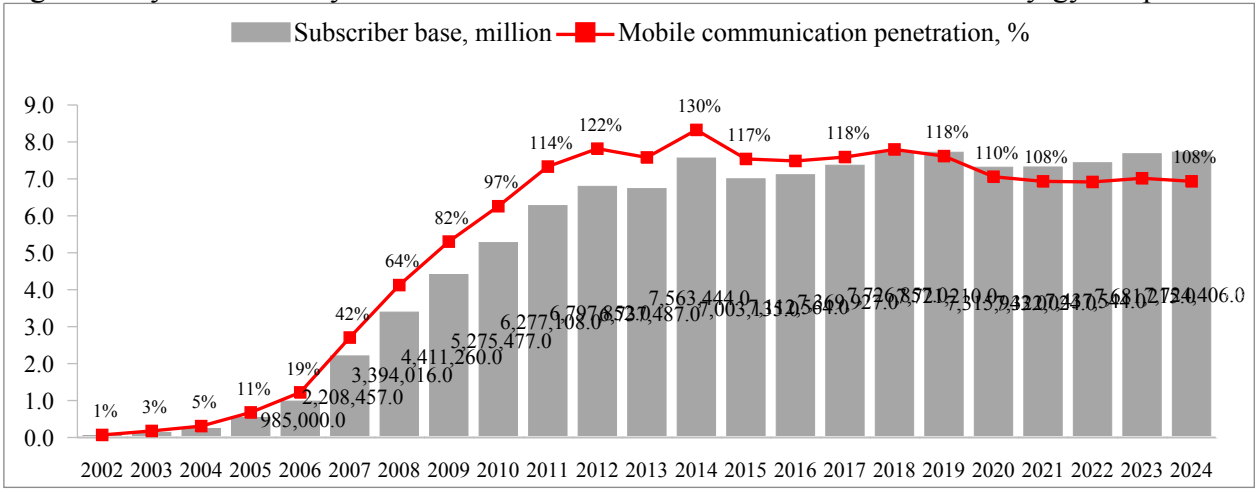
- Principles of government regulation: creating conditions for the development of communications, ensuring competition, protecting consumer rights;
- Licensing: procedures for obtaining licenses for the provision of communications services;
- Universal telecom services: ensuring the availability of basic telecom services for the entire population;
- Use of the radio frequency range: procedures for the distribution and use of frequencies;
- Interaction of telecom service providers: issues of local interconnection and shared infrastructure;
- Rights and obligations of telecom service providers and users;
- Security aspects including provisions concerning the provision of access to information by telecom service providers to law enforcement agencies;
- Collection, processing, storage and distribution of personal data;
- Requirements for the consent of data subjects to the processing of their personal data;
- Rights of personal data subjects (the right to access, correct and delete their data);
- Responsibilities of service providers and third parties working with personal data to protect such information;
- Cross-border transfer of personal data.

Although regulatory bodies were engaged in improving laws, their initiatives, for the most part, did not influence the processes of forming a subscriber base and distributing SIM cards, and the market regulated itself.

2.2. Cellular communication market regulation in 2015-2016: imperative personalization of subscribers

The next round of development of the mobile communication market in the Kyrgyz Republic was the strengthening of the regulator in 2015 which led to 130% penetration of mobile communication in 2014. Penetration of mobile communication is one of the key indicators of market development defined as the ratio of the number of active SIM cards to the total population of the country. Penetration of 130% signaled that by 2014, there were 1.3 active SIM cards per subscriber on average indicating both high competition among providers over market share and multi-SIM card behavior pattern among users. (*Gordiushina, 2024*).

Figure 2. Dynamics of key indicators of the mobile communication market in Kyrgyz Republic



High rates for local interconnection between providers were the main driver of multi-SIM card behavior of subscribers as they encouraged users to save money on offnet calls by purchasing two or more SIM cards from different mobile telecom providers. Additional factors that influenced such use of services included the low-price barrier for purchasing SIM cards, and, at the same time, the inevitability of paying for a package of services from two or more providers simultaneously as, back then, the market switched from the PAYG tariff model to bundles.

Given such market indicators, regulatory authorities implemented significant legislative changes providing for the introduction of mandatory personalization (inevitable registration) of mobile subscribers.

The requirement of mandatory registration of SIM cards was introduced long before 2015 and enshrined in the Law on Electric and Postal Communications but was not strictly enforced; it was only in 2015 that the Kyrgyz government initiated an intensive information campaign together with mobile operators to ensure full compliance of all existing SIM cards with legal requirements (*SRSCS, 2014*). The regulator set strict timeframes for mandatory re-registration of all previously purchased SIM cards that were not linked to individual passport details. Subscribers were required to ensure personal, physical presence at service centers of telecom service providers or their official dealers, provide IDs (passports), and register or re-register their SIM cards.

Throughout 2015, offices of mobile operators served thousands of subscribers daily. People came to register their SIM cards fearing to be left without communication, as was required by the state initiative which providers actively informed about. Initially, the mandatory registration of all SIM cards was to be completed by August 1, 2015. However, since many subscribers had not yet managed to register, the deadline was extended to February 1, 2016 (*SRSCS, 2017*).

By the first quarter of 2016, the SIM card personalization campaign was completed contributing to a significant decrease in number of anonymous SIM cards on the market (*SRSCS, 2017*). The legislative initiative resulted in cellular penetration decrease to 117% in 2015.

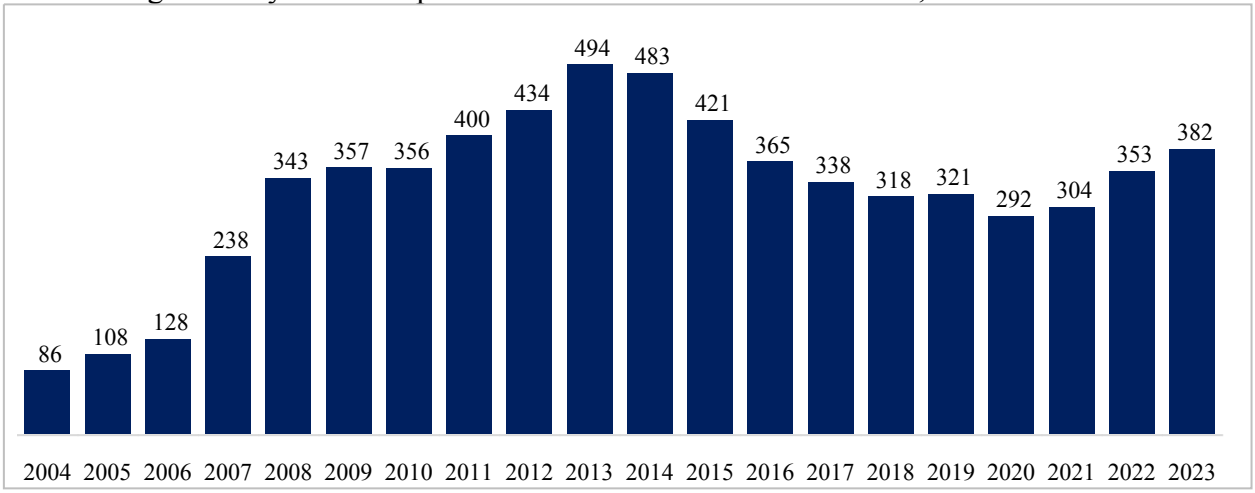
The declared objectives of personalization included the following:

- Countering terrorism and extremism: the key justification put forward by the regulator was that anonymous SIM cards facilitate activities of criminal and extremist structures by facilitating coordination of their actions, and dissemination of threats and disinformation.
- Anti-fraud: reduction in fraud incidents via voice calls and SMS messages was expected due to easier identification of fraudulent acts.
- Strengthening of national security: raising the level of government control over communication flows in the country.

- Systematization of the communication market: improving transparency and order in the telecommunication sector.

The key indicator of the market's financial condition is revenue from the provision of mobile telecom services. Analysis of the dynamics of revenue from the sale of mobile telecom services since 2015 (Figure 3) shows a downward trend turning into stagnation which is associated with both the introduction of government regulations and market saturation. (*SRSCS, 2004-2023*). Market saturation in the mobile communication industry means that the vast majority of potential consumers already use mobile communication services, and further growth of the subscriber base slows down or practically stops. The market reaches its maximum capacity in terms of the number of subscribers. In the context of market saturation, the rate of subscriber base growth slowed down which led to a transformation of the competitive strategy of operators. The main focus shifted from attracting new subscribers to retaining those existing and optimizing revenue per user (ARPU). At the same time, rate reduction due to intense competition and the high cost of supporting and developing technological infrastructure (including network upgrade and introduction of new communication standards) created significant challenges in the context of maintaining the income and ensuring operating profitability (*Gordiushina et al., 2025*).

Figure 3. Dynamics of proceeds from mobile telecom services, thousands USD



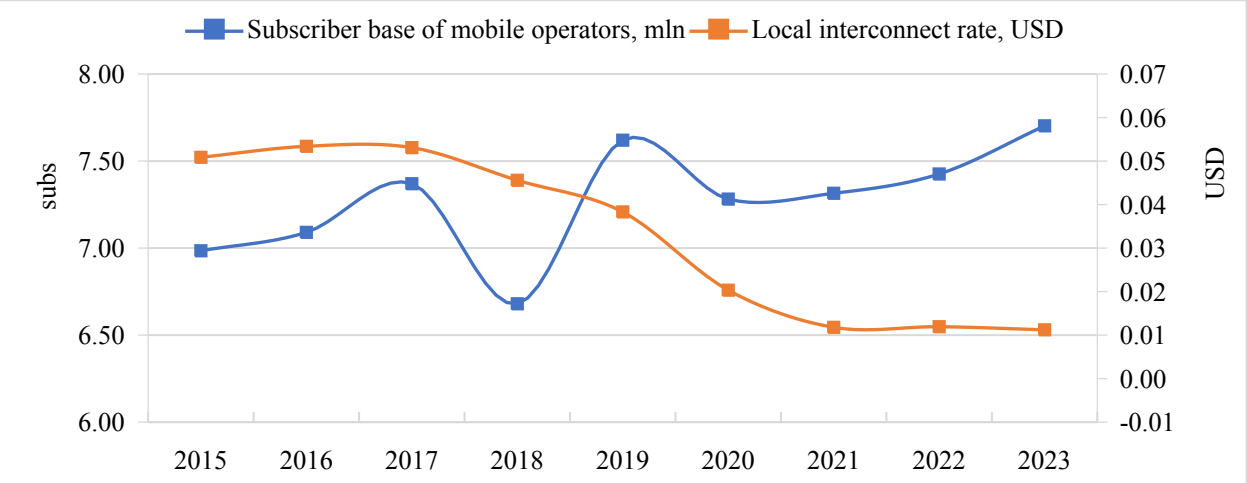
Government regulation measures played a significant role among the factors that determined such dynamics. In addition to tightening the requirements for subscriber identification, two more significant government initiatives had an impact on the structure and dynamics of the subscriber base, and therefore on the financial performance of operators. Those initiatives first included gradual reduction in the interconnect rate, and second, the introduction of strict quarantine measures during the COVID-19 pandemic which will be discussed in detail below.

2.3. Mobile communication market regulation in 2028: local interconnect rate decrease

In the context of state policy aimed at promoting competition and reducing rates in the telecommunication sector, one of the key areas in 2018 was the regulation of rates for offnet calls (interconnect) which have not been revised by the regulator since 2008 and amounted to USD0.05 including taxes. (*Economist.kg, 2020*). High offnet call rates are traditionally considered a significant barrier to the development of free competition in the market as they provide an advantage to large and long-standing operators. High inter-operator rates add to the costs incurred by subscribers, who, in turn, demonstrate multi-SIM behavior or limited inter-network communication. Back in those years, subscribers tried to choose one mobile telecom service provider for their families in order to save money on frequent calls.

In 2018, the State Agency for Antimonopoly Regulation initiated revision of local interconnect rates.

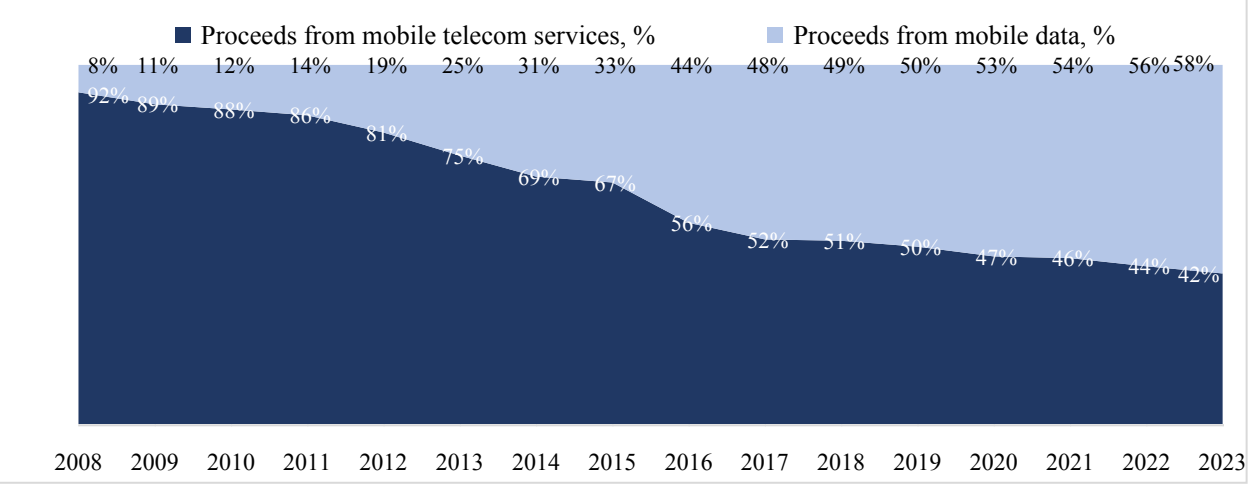
Figure 4. Dynamics of mobile operators' subscriber base and interconnect rates



For several years, the government consistently worked to reduce the local interconnect rate to bring that to an economically feasible level. The reduction was carried out in stages, according to the so-called "glide path" where the rates were reduced at certain intervals, every 6 months (*Tazabek, 2018*). In addition to rate reduction, payments were converted into the national currency, Kyrgyz som, since the USD rate was subject to sharp fluctuations due to the exchange rate. The local interconnect rate reduction resulted from a decrease in the cost of voice services inside networks due to the increased availability of mobile telecom services, while inter-operator calls remained expensive, subscribers complained to the regulator about mobile operators and continued to raise the number of SIM cards used.

The interconnect rate decrease put significant financial pressure on operators and their reduced revenue from incoming calls forced them to optimize costs and seek new income sources, for example, through the development of mobile Internet and data transmission (*Rachkovsckaya & Gordiushina, 2024*). Business models have changed, and operators have become less dependent on voice communications as the main source of income focusing rather on data transmission services. Thus, revenues from mobile data reached 54% by 2022 (Figure 5).

Figure 5. Structure of mobile operators' proceeds, %



2.4. Indirect mobile telecom market regulation in 2020: COVID-19 impact

Another government measure that indirectly affected the communication market was the declaration of a state of emergency in response to the COVID-19 pandemic in 2020 which lasted from 22 March 2020 until 27 October 2022 (*Ministry of Justice of the KR, 2020*). The measures which included lockdowns, restrictions on movement and closure of many businesses, had a multifaceted impact on the mobile communication market.

- Decline in sales and connections: restrictions on the operation of retail outlets and a decline in economic activity among the population had a negative impact on sales of new SIM cards and devices as well as on the ability to top up accounts via physical channels.
- Revenue pressure: while growth in data consumption has partially offset the losses, overall economic uncertainty, declining purchasing power, job losses and changing consumption patterns had a negative impact on operators' overall revenues as they have led to some subscribers cutting their communication costs or switching to cheaper plans.
- Decline in roaming revenue: with international tourism and business travel completely halted, operators' roaming revenues have dropped nearly to zero, a significant blow, especially for large operators.
- Unplanned expenses: the rapid growth in demand for mobile data for remote work, online learning and video communication led to a significant increase in data traffic and the load on operators' networks forcing them to urgently invest in expanding capacity and maintaining infrastructure which created serious pressure on budgets in the context of economic uncertainty. In parallel, consumption patterns have changed: usual voice calls gave way to instant messaging which reduced revenues from voice traffic but further promoted the growth of mobile data consumption.

The period 2016-2020 was the time of profound transformations for the mobile communication market in Kyrgyzstan forcing mobile operators to reconsider their strategies focusing on customer and income retention through the development of new services.

The numerous measures introduced between 2016 and 2020, with the most significant and long-term impact, according to experts, included personalization, changes in the interconnect rate, and the pandemic. Those measures were used as the main variables in constructing an econometric model that allowed us to quantify their combined and individual contribution to the development of the mobile communication market.

3. Methodology Section

The multivariate regression analysis method was chosen to build a model for quantitatively assessing the impact of government regulation (equation 1). This method allows us to establish a relationship between the dependent variable and a set of factors including the introduction of regulatory measures as dummy variables. This method also allows us to establish and quantitatively express the relationship between the regulatory measure and the mobile communication market development indicators such as the number of subscribers, internet access points, foreign investment in the industry, etc.

The size of the mobile operators' subscriber base is considered as an endogenous variable. As factors influencing the mobile communication market, 10 indicators were selected which were divided into three categories (Table 1):

- communication industry indicators;
- macroeconomic factors; and
- government measures.

Table 1. Original variables

Category	Indicator	Measure unit
Communication industry	Access points	pcs
	Mobile data speed	Mbps
	Interconnect rate	soms
	Number of landline subscribers	million people
Macroeconomic factors	Unemployment rate	%
	Foreign investment in communication industry	US dollars
	Average wage	Soms
Government regulation	*2016:* mandatory SIM card personalization	0 / 1
	2018: interconnect rate reduction	0 / 1
	2020: COVID 19 lockdown	0 / 1

The data sources included the reporting materials published by relevant ministries and departments. The data were collected for the period from 2015 to 2023, on a quarterly basis (Table 2). Observations covered 36 points (*NSC, 2025*).

Table 2. A fragment of open-source reference data for analysis

Year	Quarters	Mobile operators' subs. base	Unemployment rate	Foreign investment	Mobile data speed	Interconnect rate	…..	COVID 19 restrictions
		Y	*X1*	*X2*	*X4*	*X6*	….	*D3*
2015	I	6.65	7.87%	24 042.06	9.00	3.675	….	0.00
	II	6.84	7.75%	26 634.09	9.15	3.675	….	0.00
	III	6.95	7.62%	30 879.11	9.31	3.675	….	0.00
	IV	6.98	7.60%	33 801.44	9.50	3.675	….	0.00
2016	I	6.53	7.37%	33 410.20	10.00	3.675	….	0.00
	II	6.42	7.22%	36 784.43	10.08	3.675	….	0.00
	III	6.76	7.15%	40 824.14	10.16	3.675	….	0.00
	IV	7.09	7.20%	43 131.23	10.40	3.675	….	0.00
2017	I	7.16	7.15%	17 473.87	11.40	3.675	….	0.00
	II	7.22	7.10%	18 518.87	11.58	3.675	….	0.00
	III	7.35	7.03%	19 500.86	11.76	3.675	….	0.00
	IV	7.37	6.90%	20 427.20	12.10	3.675	….	0.00
2018	I	7.36	6.70%	26 424.20	12.50	3.675	….	0.00
	II	7.15	6.60%	24 705.62	12.70	3.675	….	0.00
	III	7.36	6.40%	29 490.07	12.90	3.675	….	0.00
	IV	6.68	6.20%	31 959.91	13.50	3.175	….	0.00
2019	I	7.22	6.15%	47 811.02	15.00	3.175	….	0.00
	II	7.56	5.58%	50 403.47	15.50	2.675	….	0.00
	III	7.69	5.49%	54 665.69	16.17	2.675	….	0.00
	IV	7.62	5.50%	56 360.82	17.00	2.675	….	0.00
2020	I	6.87	5.61%	32 919.22	20.75	2.175	….	1.00
	II	6.52	5.74%	34 423.93	21.50	2.180	….	1.00

Year	Quarters	Mobile operators' subs. base	Unemployment rate	Foreign investment	Mobile data speed	Interconnect rate	…..	COVID 19 restrictions
	III	6.92	5.89%	37 587.46	19.80	1.680	….	0.00
	IV	7.28	5.80%	38 814.89	19.00	1.680	….	0.00
2021	I	7.11	5.68%	25 818.06	15.50	1.180	….	0.00
	II	7.17	5.57%	27 375.60	15.70	1.180	….	0.00
	III	7.30	5.46%	29 792.42	15.98	1.00	….	0.00
	IV	7.31	5.30%	30 443.13	16.30	1.00	….	0.00
2022	I	7.10	5.19%	27 924.19	18.00	1.00	….	0.00
	II	7.18	5.09%	28 109.89	18.50	1.00	….	0.00
	III	7.37	4.99%	28 722.77	19.14	1.00	….	0.00
	IV	7.43	4.90%	29 063.33	20.00	1.00	….	0.00
2023	I	7.30	4.91%	32 730.18	23.00	1.00	….	0.00
	II	7.40	4.46%	32 947.84	23.50	1.00	….	0.00
	III	7.64	4.23%	33 666.21	24.43	1.00	….	0.00
	IV	7.70	4.10%	34 065.37	25.00	1.00	….	0.00

In its standard form, the regression model is recorded as follows:

$$Y = \beta_0 + \beta_1 x_1 + \ldots + \beta_n x_n + C \qquad \text{(Equation 1)}$$

where

Y is the dependent variable;

x_1, x_n are exogenous variables;

β_0 is constant term;

β_1, β_n are factor influence coefficients;

C is a random component.

In the context of regulatory measure influence, it is necessary to take into account the influence of this measure as a separate factor. For this purpose, a dummy variable is added to the model (equation 2).

Given the dummy variable, the model looks as follows:

$$Y = \beta_0 + \beta_1 x_1 + \ldots + \beta_n x_n + \lambda D + C \qquad \text{(Equation 2)}$$

where

D is the dummy variable reflecting the presence (1) or absence (0) of a regulatory measure;

λ is the coefficient reflecting the value of the measure impact on the dependent variable.

Adding a dummy variable allows us to separate the effect associated specifically with the introduction of the measure and to quantitatively assess its impact.

Since the data used in the study are time series, they must be reduced to a stationary form so that its statistical properties do not depend on time (*Dougherty, 2002*). This means that its behavior remains constant throughout the entire observation period.

Key conditions of the stationary series include the following:

1. The statistical expectation does not change over time $\mathrm{M}(Y_t) = const$
2. Dispersion is constant $Var(Y_t) = \sigma^2 = const$
3. The covariance between the values of the series depends only on the time lag k, and not on the time point (t) $Cov(Y_t, Y_{t-1}) = R(k)$

To ensure an adequate econometric analysis, the collected data require preliminary processing. At this stage, the time series were tested for stationarity, taking of logarithms or difference transformations. The Dickey-Fuller test was used for stationarity test (Table 3).

The data pre-processing allowed eliminating potential distortions associated with seasonal fluctuations and trend components, as well as to ensure the correctness and validity of the regression analysis.

Table 3. Stationarity testing of the series of mobile operators' subscriber base

Null Hypothesis: MOB_AB has a unit root Exogenous: Constant Lag Length: 1 (Automatic - based on SIC, maxlag=9)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.04	0.04
Test critical values:	1% level	-3.64	
	5% level	-2.95	
	10% level	-2.61	

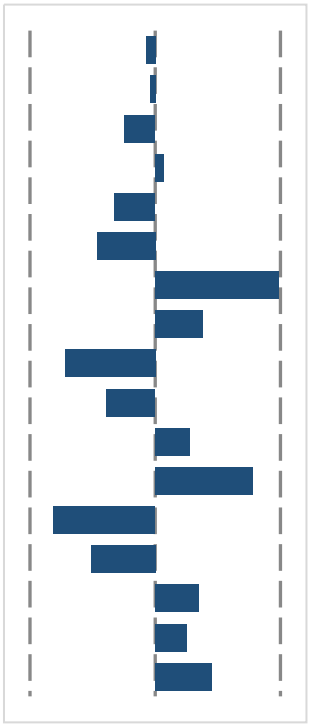
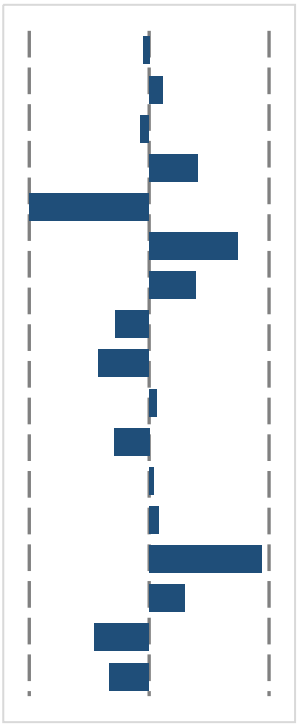
Based on the test results, it was concluded that the series was stationary since the probability of incorrectly rejecting the hypothesis of the presence of a unit root was below the critical value and the series was stationary at the 5% significance level. The stationarity test was conducted for all time series considered in the work.

Table 4. Dickey-Fuller test results

Series	***Probability of rejecting H_0***	***Conclusion***
Mob_ab	0.04	Series stationary
U_rate	0.78	Series non-stationary
Investment	0.11	Series non-stationary
I_point	0.59	Series non-stationary
I_speed	0.96	Series non-stationary
Fix_AB	0.93	Series non-stationary
Intcnct_rate	0.61	Series non-stationary
Avg_salary	0.91	Series non-stationary

Only the dependent variable series, the mobile operators' subscriber base, is stationary (Table 4). The remaining series were reduced to stationarity by taking the first difference for each indicator. After reducing the series to stationarity, a multicollinearity check was performed. When working with time series, a paired correlogram of the dependent variable with the exogenous one was constructed and significant lags were checked (Table 5).

Table 5. Cross-correlogram of subscriber base and unemployment rate

DMOB_AB,DU_RATE(-i)	DMOB_AB,DU_RATE(+i)	i	lag	lead
		16	0.11	-0.12
		15	0.06	-0.16
		14	0.09	0.10
		13	-0.13	0.33
		12	-0.20	0.03
		11	0.19	0.01
		10	0.07	-0.10
		9	-0.10	0.02
		8	-0.18	-0.15
		7	0.09	-0.10
		6	0.28	0.14
		5	-0.12	0.26
		4	-0.08	-0.37
		3	0.02	0.14
		2	-0.06	-0.03
		1	-0.01	0.04
		0	-0.02	-0.02

The above correlogram shows that there are no significant lags, and therefore, there is no relationship between the variables. After that, paired cross-correlograms were constructed for the remaining exogenous variables.

Table 6. Lag significance check of exogenous variables

Exogenous variable	Significant lag
U_rate	missing
Investment	(0)
Internet_point	(0)
Internet_speed	(0)
Fix_AB	(0), (-1)
Interconnect_rate	(0)
Avg_salary	(0)

The check of correlation between insignificant variables detected no multicollinearity, therefore, building a model is feasible under such conditions.

4. Results

At the initial parameterization stage, the model included all factors described in this paper. Afterwards, indicators that did not influence the endogenous variable were successively excluded. Since the socio-economic area is considered, the significance level was set at 5%.

The regression model initially included all variables for which significant lags were expected (Table 6). The mobile operators' subscriber base was selected as the dependent variable.

The classical approach to estimating the parameters of a multiple regression model is based on the least squares method (LSM). LSM allows obtaining parameter estimates in which the sum of the squares of the deviations of actual values of the outcome variable Y from the estimated Y is minimal (equation 3) (*Dougherty, 2002*).

$$\sum_{i=1}^{n} (y_i - \bar{y}_i)^2 \rightarrow min \qquad \text{(Equation 3)}$$

Table 7. Initial model parameterization

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DINVEST	0.0000	0.0000	2.1810	4.0%
DI_POINT	0.0002	0.0002	1.0469	30.6%
DI_SPEED	-0.0290	0.0441	-0.6578	51.7%
DFIX_AB	0.0040	0.0036	1.1073	28.0%
DFIX_AB(-1)	0.0003	0.0048	0.0535	95.8%
DI_RATE	0.2238	0.2562	0.8733	39.2%
DAVG_SALARY	0.0000	0.0001	-0.7907	43.7%
SIM_PERSNFCTN	-0.5020	0.1710	-2.9346	0.7%
INTCNCT_REDUCTION	-0.2180	0.1668	-1.3070	20.4%
COV_19	-0.3994	0.2002	-1.9948	5.8%
C	0.1639	0.0663	2.4700	2.1%

R-squared	59%	Mean dependent var	0.0253
Adjusted R-squared	41%	S.D. dependent var	0.2827
S.E. of regression	0.2168	Akaike info criterion	0.0365
Sum squared resid	1.0810	Schwarz criterion	0.5303
Log likelihood	10.3798	Hannan-Quinn criterion	0.2049
F-statistic	3.3132	Durbin-Watson stat	2.0647
Prob(F-statistic)	0.8%		

- The Coefficient column describes the quantitative effect of the exogenous variable on the dependent one. These coefficients show how much the dependent variable will change if the exogenous variable changes by 1 unit.
- The Std. Error column displays the accuracy of the coefficient estimate: the lower the value, the more valid the model prediction. It reflects the potential deviation of the estimated coefficient from its actual value.
- The t-Statistic column measures the statistical significance of the coefficient: if its absolute value exceeds the critical one, 1.96 in this case (for a 5% significance level), then the factor has a significant effect on the dependent variable; if the indicator is below the critical level, this indicates the insignificance of the variable in the model.
- The Prob column indicates the probability that the coefficient estimate is not statistically significant in the model. The probability should be less than 5%.

5.1 Factor significance testing and regression quality indicators

The practical significance of the multiple regression equation is assessed using the multiple correlation indicator and its square, the determination indicator (*Dougherty, 2002*). The determination coefficient R^2 shows what proportion of the variability of the dependent variable is explained by the model taking values from 0 (the model explains nothing) to 1 (it explains all changes). Unlike the usual R^2, the adjusted indicator can decrease when uninformative variables are included which helps to avoid overfitting the model.

The Durbin-Watson statistic serves as an indicator of the autocorrelation of residuals in regression models. The closer the indicator is to 2, the more random the model residuals are.

To bring the model to the correct form, it is necessary to exclude one by one all exogenous variables that turned out to be insignificant in the initial parameterization.

Table 8. Final model parameterization

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DINVEST	0.0019	0.0000	3.0932	0.4%
DI_POINT	0.0258	0.0002	1.7186	3.6%
SIM_PERSNFCTN	-0.4796	0.1609	-2.9801	0.6%
INTCNCT_REDUCTION	-0.2759	0.1447	-1.9061	4.7%
COV_19	-0.4603	0.1652	-2.8036	0.9%
C	0.0739	0.0407	1.8167	5.0%

R-squared	75.7%	Mean dependent var	0.0300
Adjusted R-squared	72.2%	S.D. dependent var	0.2799
S.E. of regression	0.2085	Akaike info criterion	-0.1427
Sum squared resid	1.2610	Schwarz criterion	0.1239
Log likelihood	8.4971	Hannan-Quinn criterion	-0.0507
F-statistic	26.4557	Durbin-Watson stat	2.0895
Prob(F-statistic)	0.0%		

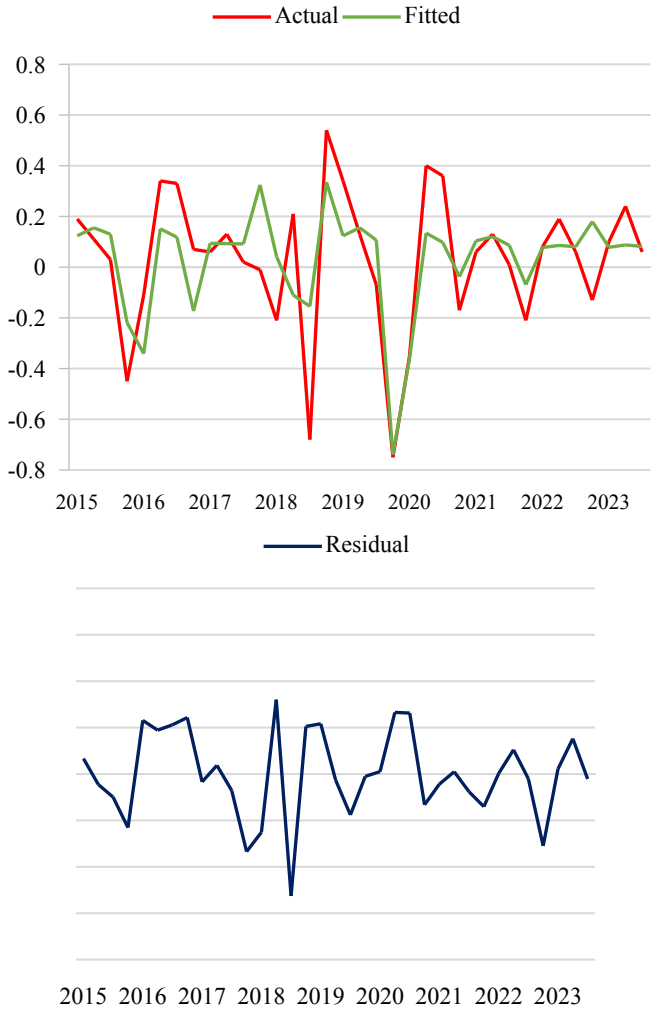
The resulting model is significant at the 5% level (Table 8). Out of the macroeconomic indicators, only the factor "inflow of foreign investment into the communication and information sector" turned out to be significant. As for the telecommunication indicators, almost all of them turned out to be insignificant; only the number of internet access points has a small impact on the subscriber base.

The most influential factors included the government influence on the mobile communication market; all the listed measures remained in the model:

1. Mandatory SIM card personalization;
2. Interconnect rate reduction; and
3. COVID 19 impact.

The resulting values of R^2 (75.7%) and adjusted R^2 (72.2%) show that the model explains a significant part of the variability of the dependent variable, although it does not reach the high accuracy level. This indicates an average but quite satisfactory model quality: the included variables describe the behavior of the dependent indicator quite correctly despite the presence of unaccounted factors. For clarity, the graph below (Figure 6) displays the ratio of actual and simulated values. The residuals graph suggests absence of autocorrelation, and the Durbin-Watson coefficient value confirms that residuals are of random nature in the model.

Figure 6. Comparison of actual and simulated values



The constructed model is considered adequate ***(equation 4)***, and the regression equation looks like this:

$$\Delta Mob\ AB = 0.00191\Delta Investment + 0.02580 * \Delta Internet\ point - 0.480 * SIM\ personalization - 0.276 * Interconnect\ rate\ reduction - 0.463\ Covid19 + 0.074 * C$$

(Equation 4)

where

- $\Delta Mob\ AB$ is the mobile operators' subscriber base growth rate;
- $\Delta Investment$ is the growth rate of the foreign investment inflow in the communication and information sector;
- $\Delta Internet\ point$ is the growth rate of the number of internet access points;
- $SIM\ personalization$ is the dummy variable designating the personalization campaign;
- $Interconnect\ rate\ reduction$ is the dummy variable designating the measure requiring mobile operators to reduce the interconnect fee rate;
- $Covid19$ is the dummy variable designating introduction of restrictive measures during the COVID 19 pandemic;
- C means factors not accounted for in the model.

5.2 Interpretation of the model

The dynamics of the mobile operators' subscriber base in the Kyrgyz Republic have been most affected by all the above described government regulation measures such as the campaign for mandatory SIM card personalization, the decree on reducing the local interconnect fee rate, and the introduction of travel restrictions during the Covid-19 pandemic. Macroeconomic and telecommunication factors have also affected the dynamics, although to a small extent.

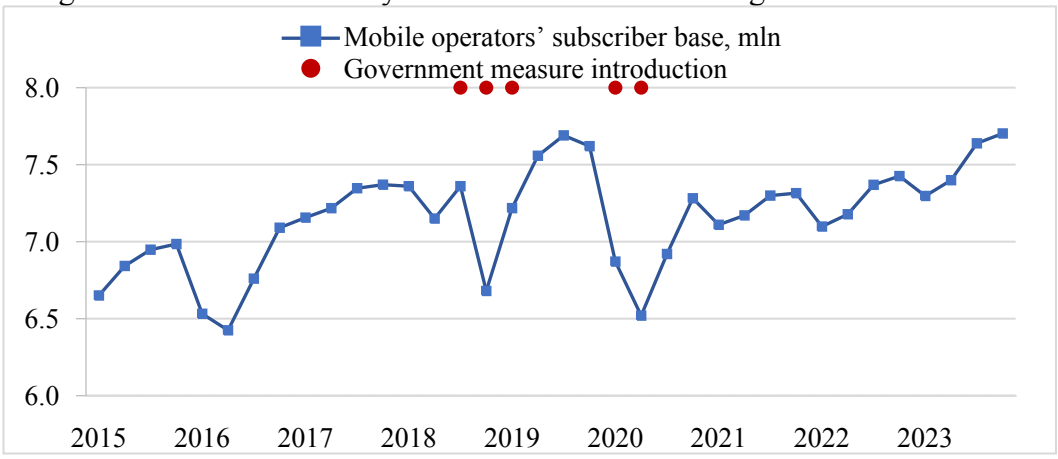
The final model included 5 significant factors: two of them have had a positive impact, and three have had a negative one.

1. The increase of foreign investment in the communication and information sector by 1,000 US dollars in the current quarter has led to mobile operators' subscriber base growing by 1,900 subscribers on average. Such a weak impact might be due to the fact that the investment indicator is aggregated which did not allow assessing the impact of foreign investment on the cellular communication market only since investments in the communication industry as a whole were taken into account.
2. Given the increase in the number of internet access points by 1 unit in the current quarter, the mobile operators' subscriber base grew by 25.8 thousand users. This is explained by the fact that access points expand the network coverage area making services available to a larger number of users. The infrastructure upgrade has improved the connection quality and stability.
3. As the SIM card personalization campaign ends in the current quarter, the subscriber base will decrease by 480,000 users. Mobile operators were forced to disconnect non-personalized subscribers to ensure protection against scammers by disabling anonymous numbers.
4. The order of the State Communications Agency to reduce the interconnect fee rate led to a decrease in the subscriber base by 276,000 users. In this case, the decrease in the number of subscribers was due to the fact that calls between different operators became cheaper and there was no longer a need to use more than 1 active SIM card.
5. The introduction of travel restrictions during the Covid 19 pandemic in the current quarter also led to a significant decrease in the mobile operators' subscriber base, by 463,000 users. This was caused by several key factors. First of all, the mass transition to remote work and learning reduced the need in active use of voice services especially service numbers which were often disconnected due to the suspension of companies' activities. Secondly, people began to use home internet to a greater extent and the need in cellular communication reduced. Together, these changes created a negative effect on the subscriber base during the lockdown period.

5. Discussion

In the course of the study, a multifactor regression model was developed that identified key factors influencing the dynamics of the mobile operators' subscriber base in the Kyrgyz Republic. The results have demonstrated the high influence of government measures on the indicators of the country's mobile communication market. Figure 7 shows sets of points reflecting the periods of introduction of government measures and their impact on the subscriber base volume.

Figure 7. Subscriber base dynamics and introduction of government measures



Following the introduction of government measures, telecom service providers adapted to the new context by developing strategies which resulted in the subscriber base starting to grow again (Figure 7).

Assessment of government regulation: loss and gain

The measures taken affected not only the market statistics but also the activities of the key players, i. e. people and operators (Table 9).

People benefited from improved security and lower costs but were also affected by the complicated SIM card purchase process and disconnection of some users.

As for the operators, the introduced measures reduced the cost of SIM card purchase and distribution and simplified mutual payments but also led to reduced traffic capacity and loss of some subscribers.

Table 9. Assessment of government regulation: loss and gain

Market players	Gain, "+"	Loss, "-"
People	Improvement of national security: protection against scam and terrorism	Subscriber disconnection
	Price regulation in favor of the population: no need to buy another SIM card	More barriers in SIM card purchase
Mobile operators	Reduced costs associated with SIM card purchase, logistics and distribution	Subscriber disconnection
	Mutual payments made in the national currency, without the US dollar peg	Reduced offnet traffic

6. Conclusion

The research has achieved its main goal, i. e. completion of a comprehensive analysis of the impact of government regulation on the development of the cellular communication market in the Kyrgyz Republic. To solve the research problem, methods of economic analysis were used including statistical data processing and construction of a multifactor regression model.

As a result of review and analysis of factors influencing the cellular communication market, a set of key variables was formed reflecting both the internal characteristics of the industry and external

macroeconomic context. Each of the described variables was substantiated in terms of their potential impact on market indicators. In aggregate, the selected factors have provided a comprehensive approach to assessing the impact of regulatory measures on the cellular communication market.

The conducted research has shown that Kyrgyzstan made significant steps in formation and improvement of the legislative base in the area of cellular communication over the last decades. The adoption of a number of important laws served as the foundation for the industry's healthy development.

Each of the statutes undoubtedly deserves a deep and comprehensive analysis as a separate research task. Their impact on all market participants such as telecom service providers, consumers, the state, investors and related industries, is the key to understanding the evolution of the sector, identifying its strengths and weaknesses, and predicting future trends. Due to its limited scope, the research only considered the following three government initiatives:

1. The campaign for mandatory SIM card personalization;
2. Decree on reducing the local interconnect fee rate; and
3. Introduction of travel restrictions during the COVID 19 pandemic.

Although this has made it possible to identify certain patterns and trends in the impact of government regulation on the industry, the potential for further study is enormous.

Further work could be productively continued in several areas, both as part of developing a universal model of the impact of government measures on the communication industry (which will allow systematizing approaches to assessing the effects of legislative changes not only in Kyrgyzstan but also in other countries), and through an in-depth analysis of other laws and regulations not included in this study but significant for the development of the Kyrgyzstan's telecommunications sector. For example, the Law of the Kyrgyz Republic on Cybersecurity adopted in 2017 or the introduction of a mandatory system for registering mobile devices using IMEI codes (*Cabinet of Ministers, 2024*). Such studies would contribute to a deeper understanding of market dynamics, development of effective regulatory strategies and creation of a favorable environment for innovation and sustainable growth in the area of mobile communication.

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