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Investment Dynamics of the Samarkand Region: Analysis and Forecast Using a Polynomial Model

Saydullaev Abbosjon

Assistant professor of the Department of "Green Economy and Sustainable Business" Samarkand branch of Tashkent State University of Economics, Uzbekistan

Sultonov Beknazar

Associate professor of the Department of "Green Economy and Sustainable Business" Samarkand branch of Tashkent State University of Economics, Uzbekistan

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Abstract: The economic development of any region relies heavily on investment since it affects growth along with employment and infrastructure development. The research examines the investment trends in Samarkand region and generates predictions through polynomial modeling. We build a polynomial regression model based on historical investment data to detect investment trends and estimate future investment directions. The investigation determines model precision through comparison against different forecasting methods and examination of primary economic elements that influence investment. The results present essential information for policymakers together with investors and economic planners to make well-informed regional investment strategy decisions.

Keywords: Investment dynamics, polynomial model, forecasting, economic development, Samarkand region.

Introduction: Investment plays a crucial role in driving economic growth, influencing industrial development, infrastructure projects, and job creation. In regional economies, the strategic allocation of investments is vital for promoting sustainable development and boosting competitiveness. The Samarkand region, recognized as one of Uzbekistan's key economic centers, has seen significant investment in recent years. However, predicting future investment flows remains a complex challenge due to the ever-changing nature of economic factors. Being able to forecast investment trends is essential for policymakers, investors, and economic planners, as it helps them create informed strategies that optimize resource allocation and support long-term economic stability.

The importance of this study arises from the growing demand for reliable forecasting methods to aid investment decisions at the regional level. Traditional forecasting approaches, like linear regression models, often struggle to capture the nonlinear patterns that characterize investment dynamics. On the other hand, polynomial models provide a more adaptable solution by accommodating complex relationships and pinpointing turning points in investment trends. Given Uzbekistan's shifting economic landscape, especially with market liberalization and investment policy reforms, a strong forecasting framework is crucial for aligning investment strategies with regional development objectives.

Several prior studies have examined the impact of investment on economic growth and the effectiveness of various forecasting models. Research focused on investment trends in transition economies has underscored the significance of policy stability, infrastructure availability, and the development of financial markets in attracting capital (Dunning, 2009; Aghion et al., 2013). Additionally, studies that have

employed polynomial regression models in economic forecasting have shown their capability to capture cyclical trends and structural changes in investment.

METHOD

This study employs a quantitative research approach, utilizing econometric modeling to analyze historical investment trends in the Samarkand region and forecast future investment flows. A polynomial regression model is chosen due to its capability to capture nonlinear trends and structural changes in investment behavior over time. The research follows a systematic process, including data collection, model specification, estimation, validation, and interpretation of results.

Data Collection and Sources

The study relies on secondary data obtained from official sources, including:

- State Committee on Statistics of Uzbekistan – providing historical investment data at the regional level.
- Ministry of Investment, Industry, and Trade of Uzbekistan – offering insights into investment policies and trends.

The dataset covers annual investment figures for the Samarkand region over the past 12 years to ensure sufficient data for trend analysis and forecasting. To forecast the volume of investment to be attracted to the regions in the coming years, we use the volume of investments made in all regions of the Samarkand region in 2012-2023.

To analyze investment trends and predict future values, a polynomial regression model of degree nnn is specified as follows:

$$y=a_0+a_1x+a_2x^2+\ldots+a_nx^n+e$$

where:

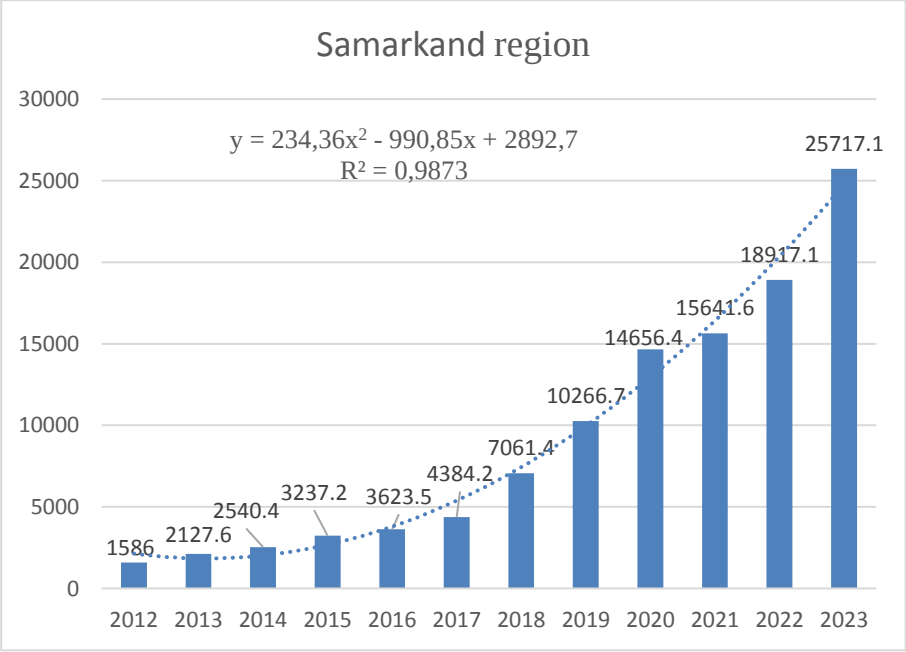
- y – dependent variable
- x – independent variable
- $a_0, a_1,\ldots,a_n$ are the estimated coefficients,
- n – degree of the polynom
- e - is the error term.

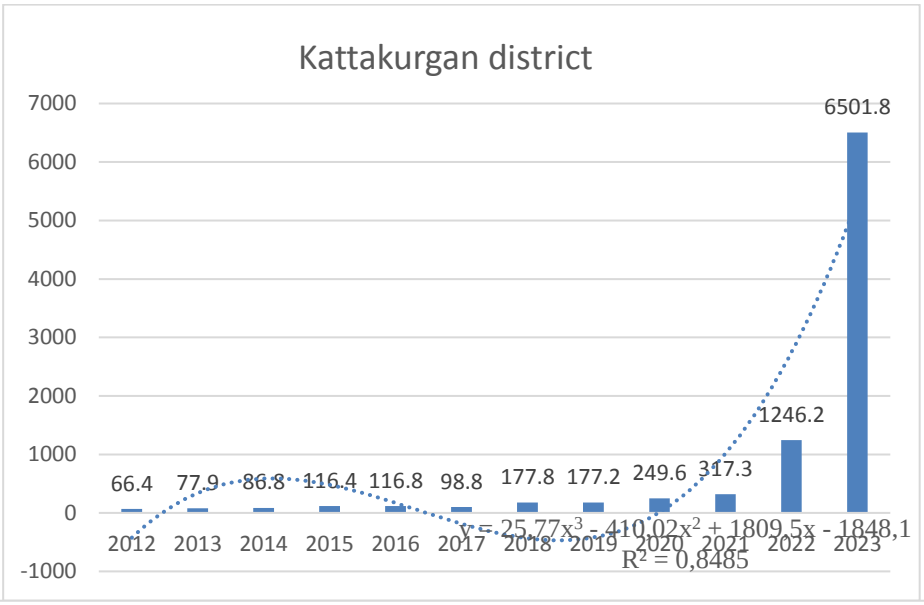
The estimation of the polynomial regression model is conducted using the Ordinary Least Squares (OLS) method. Model validation is performed through:

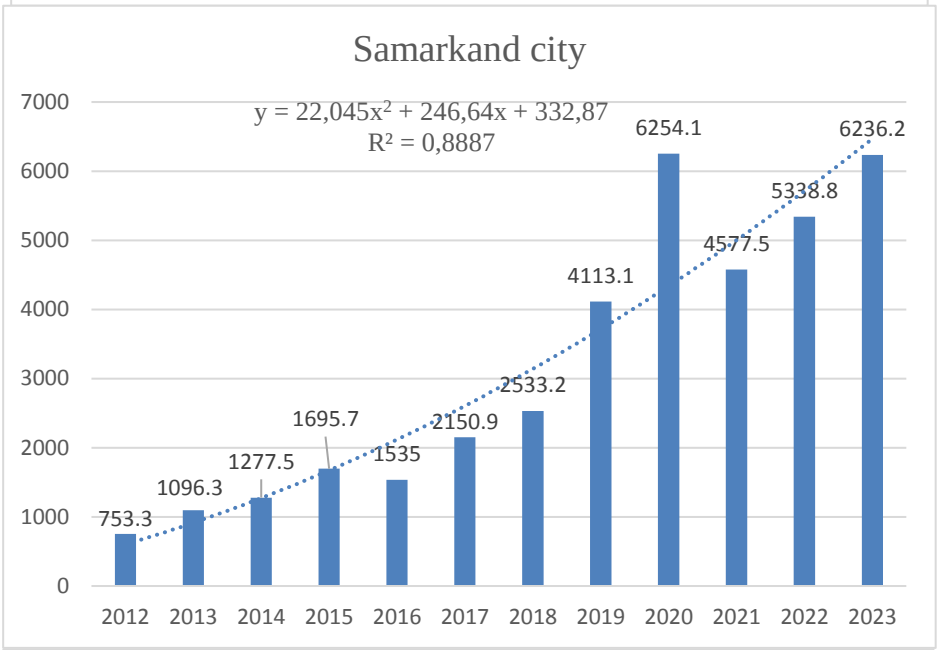
Adjusted R2 to evaluate model accuracy.

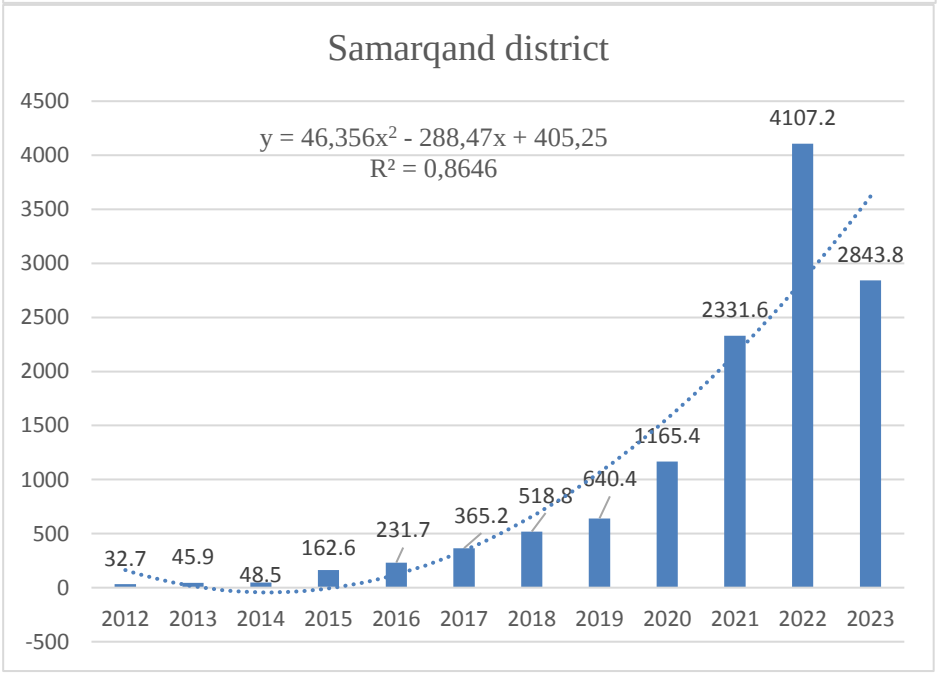
In the graph 1. above, functions were constructed using a polynomial trend for the volume of investments in fixed capital in the regions of Samarkand region in 2012-2023. However, since the polynomial model was not suitable for expressing the given indicators for investments in Payarik, Akdarya, Ishtikhon districts and the city of Kattakurgan, an exponential function was used to analyze these quantities.

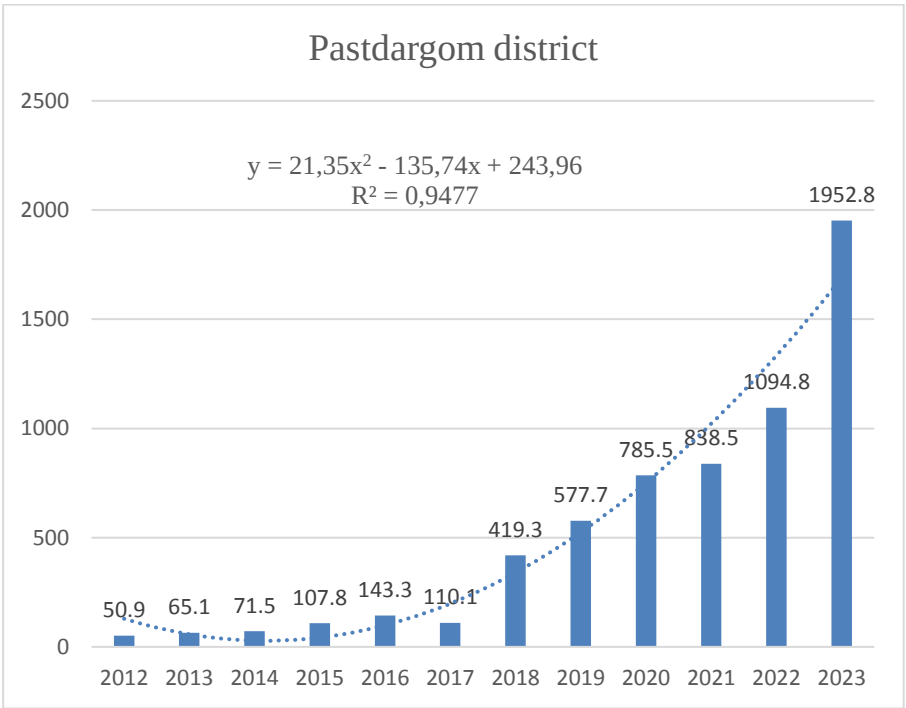
RESULT

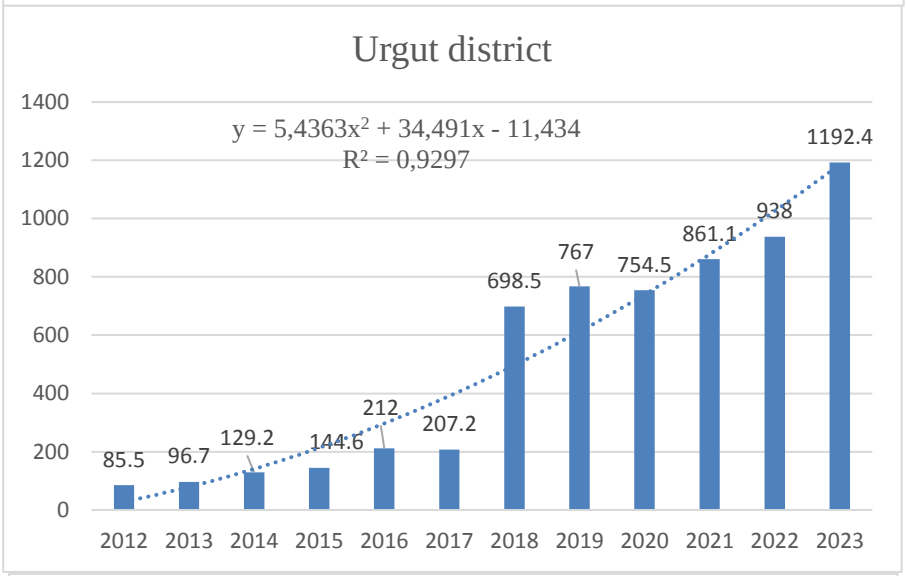


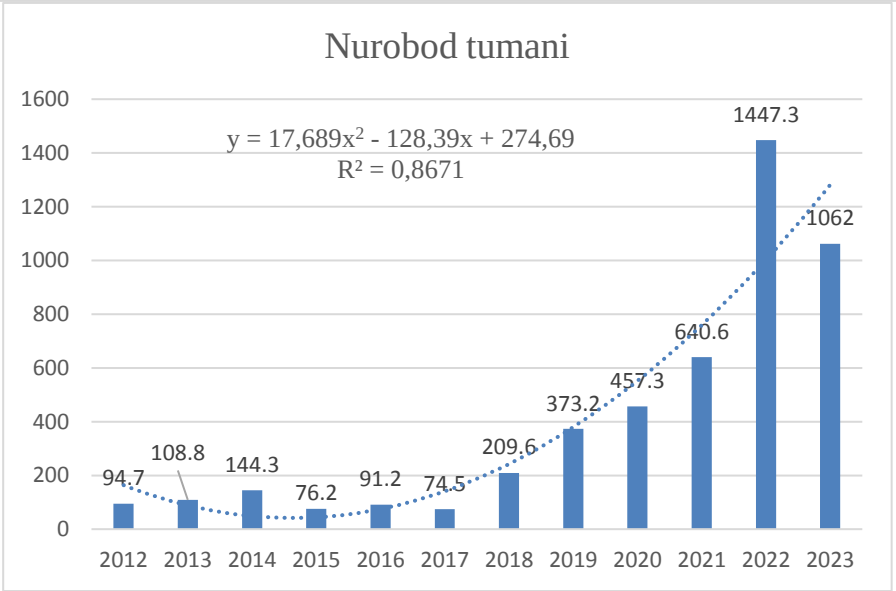

Kattakurgan district
7000
6000
5000
4000
3000
2000
1000
0
-1000
66.4
77.9
86.8
116.4
116.8
98.8
177.8
177.2
249.6
317.3
1246.2
6501.8
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
y = 25,77x³ - 410,02x² + 1809,5x - 1848,1
R² = 0,8485

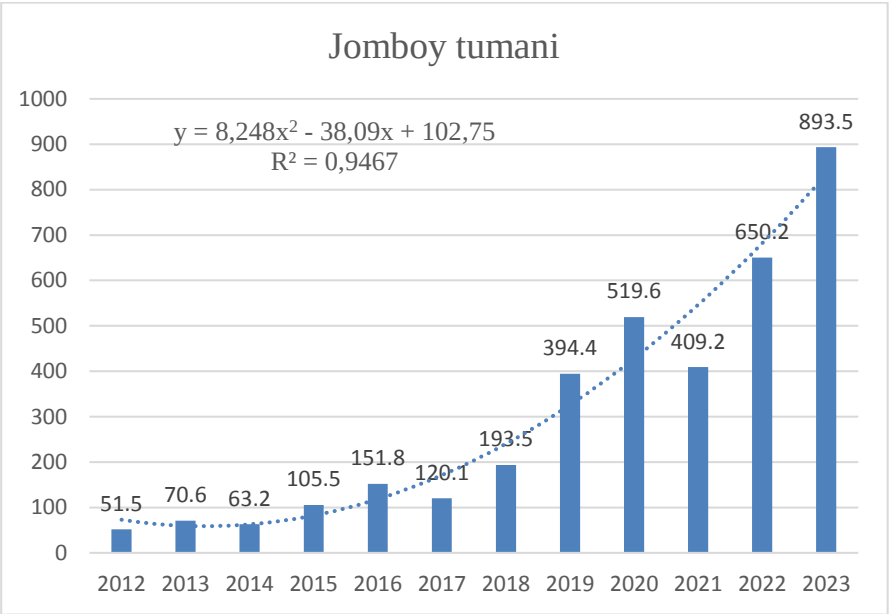

Samarkand city
y = 22,045x² + 246,64x + 332,87
R² = 0,8887
7000
6000
5000
4000
3000
2000
1000
0
753.3
1096.3
1277.5
1695.7
1535
2150.9
2533.2
4113.1
6254.1
4577.5
5338.8
6236.2
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023

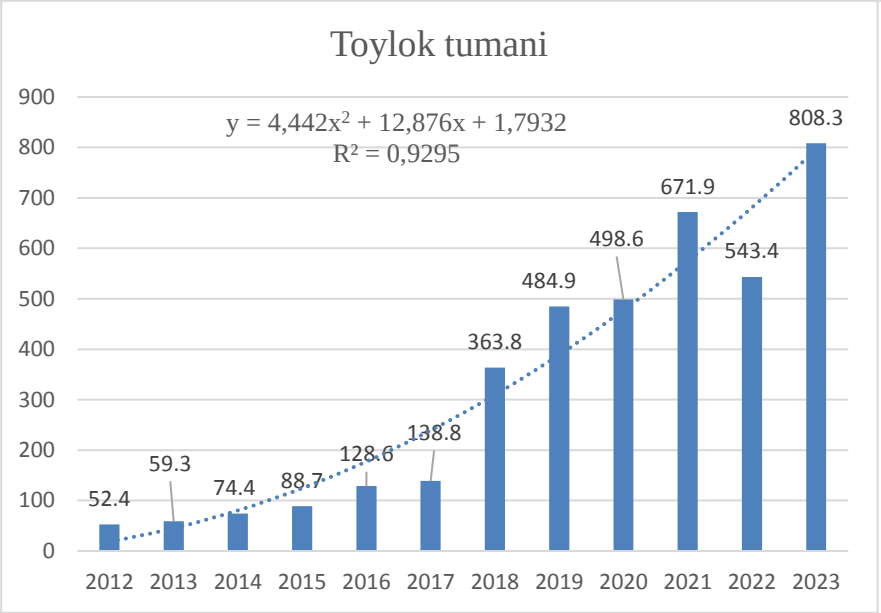

Samarqand district
y = 46,356x² - 288,47x + 405,25
R² = 0,8646
4500
4000
3500
3000
2500
2000
1500
1000
500
0
-500
32.7
45.9
48.5
162.6
231.7
365.2
518.8
640.4
1165.4
2331.6
4107.2
2843.8
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023

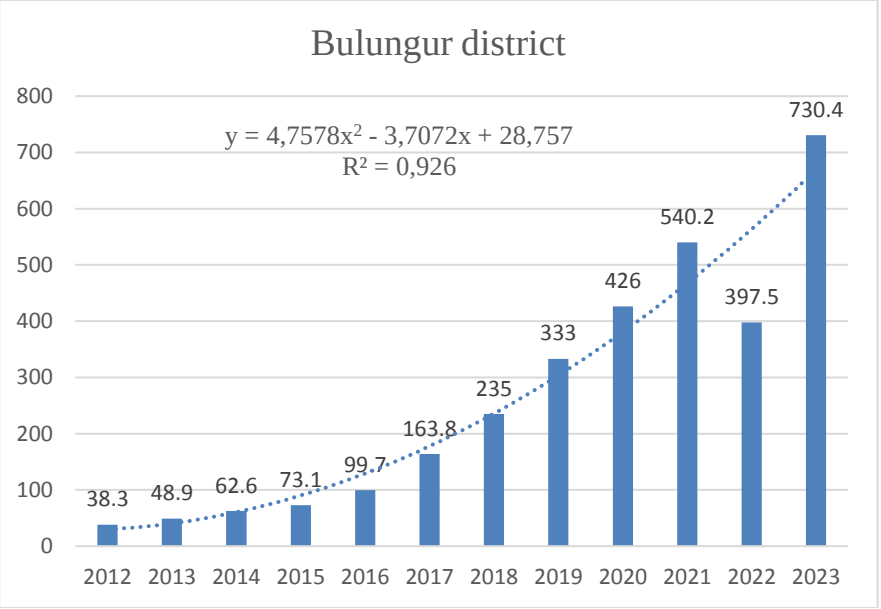

Pastdargom district
y = 21,35x² - 135,74x + 243,96
R² = 0,9477
2500
2000
1500
1000
500
0
50.9
65.1
71.5
107.8
143.3
110.1
419.3
577.7
785.5
838.5
1094.8
1952.8
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023

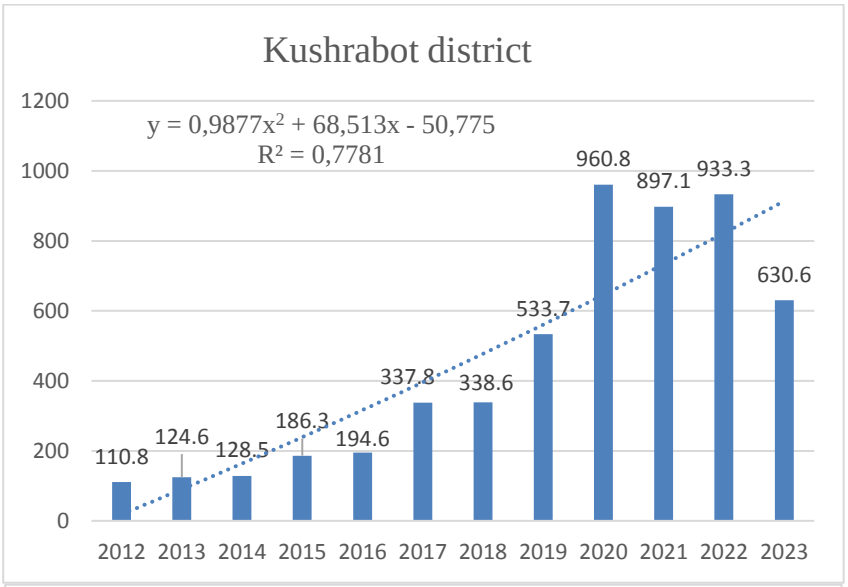

Urgut district
y = 5,4363x² + 34,491x - 11,434
R² = 0,9297
1400
1200
1000
800
600
400
200
0
85.5
96.7
129.2
144.6
212
207.2
698.5
767
754.5
861.1
938
1192.4
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023

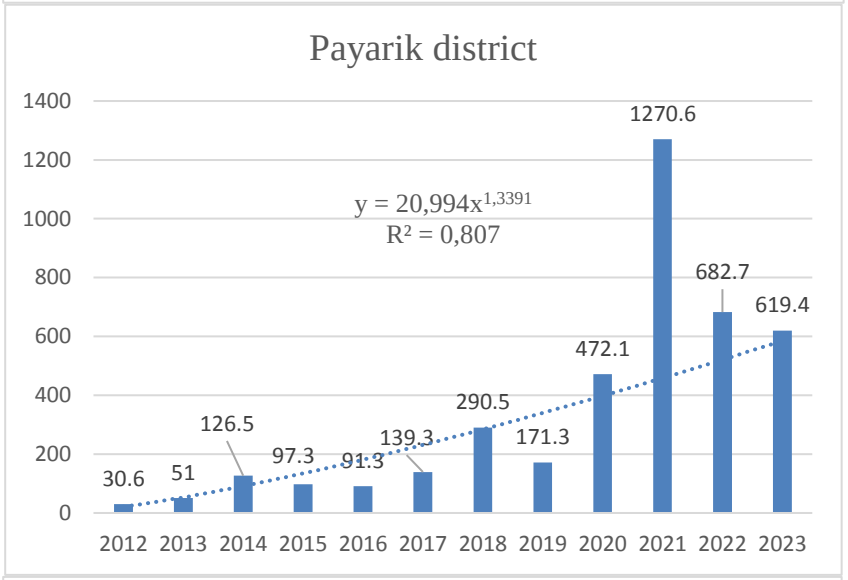

Nurobod tumani
y = 17,689x² - 128,39x + 274,69
R² = 0,8671
1600
1400
1200
1000
800
600
400
200
0
94.7
108.8
144.3
76.2
91.2
74.5
209.6
373.2
457.3
640.6
1447.3
1062
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023

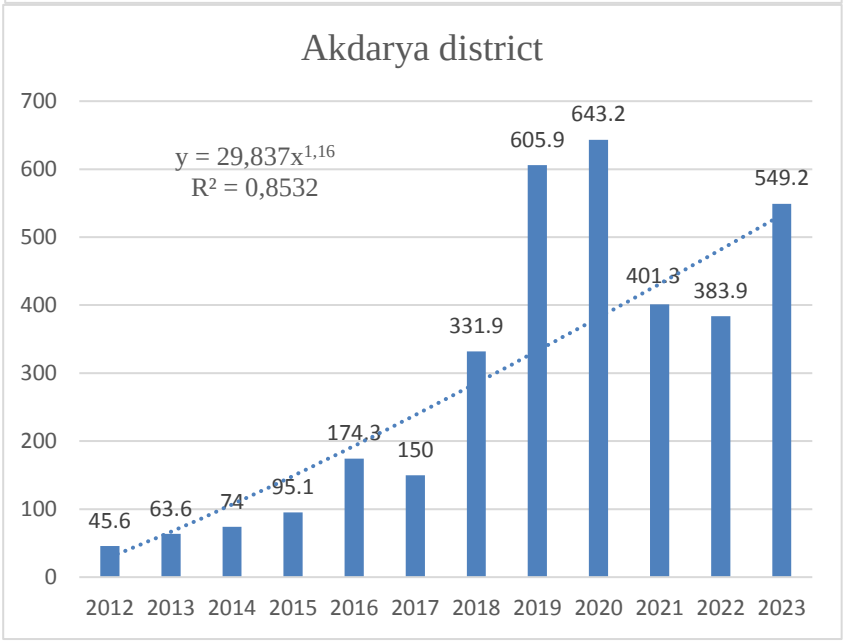

Jomboy tumani
y = 8,248x² - 38,09x + 102,75
R² = 0,9467
1000
900
800
700
600
500
400
300
200
100
0
51.5
70.6
63.2
105.5
151.8
120.1
193.5
394.4
519.6
409.2
650.2
893.5
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023

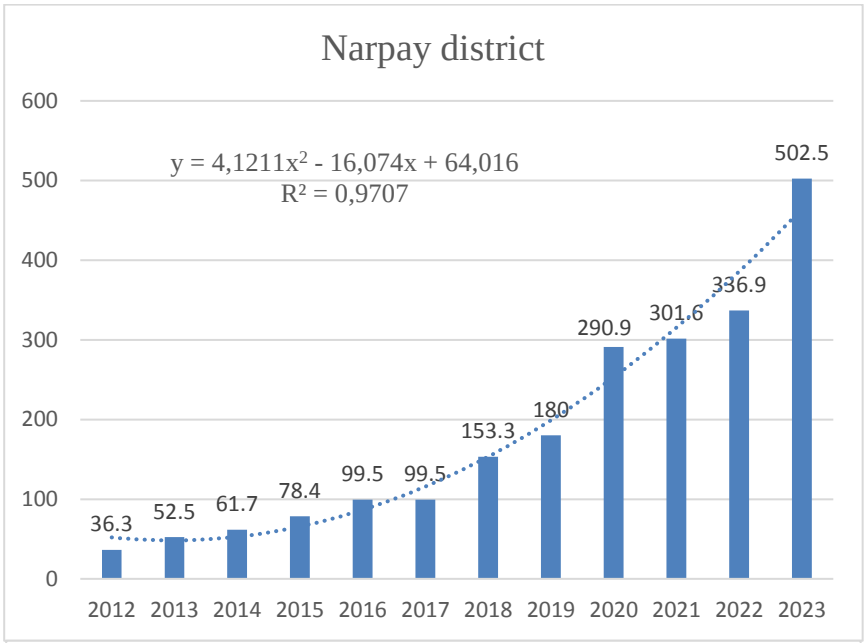

Toylok tumani
y = 4,442x² + 12,876x + 1,7932
R² = 0,9295
900
800
700
600
500
400
300
200
100
0
52.4
59.3
74.4
88.7
128.6
138.8
363.8
484.9
498.6
671.9
543.4
808.3
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023

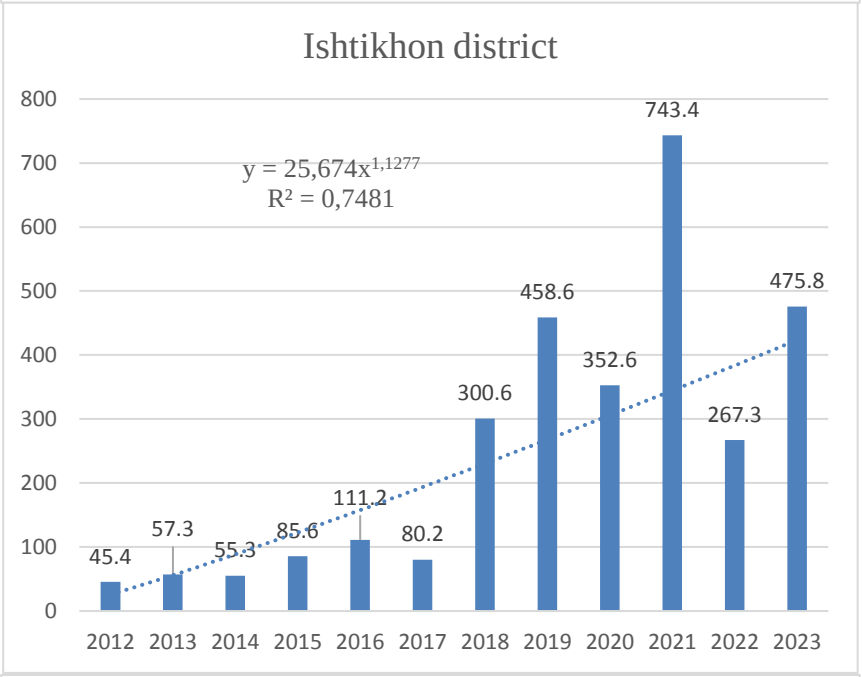

Bulungur district
y = 4,7578x² - 3,7072x + 28,757
R² = 0,926
800
700
600
500
400
300
200
100
0
38.3
48.9
62.6
73.1
99.7
163.8
235
333
426
540.2
397.5
730.4
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023

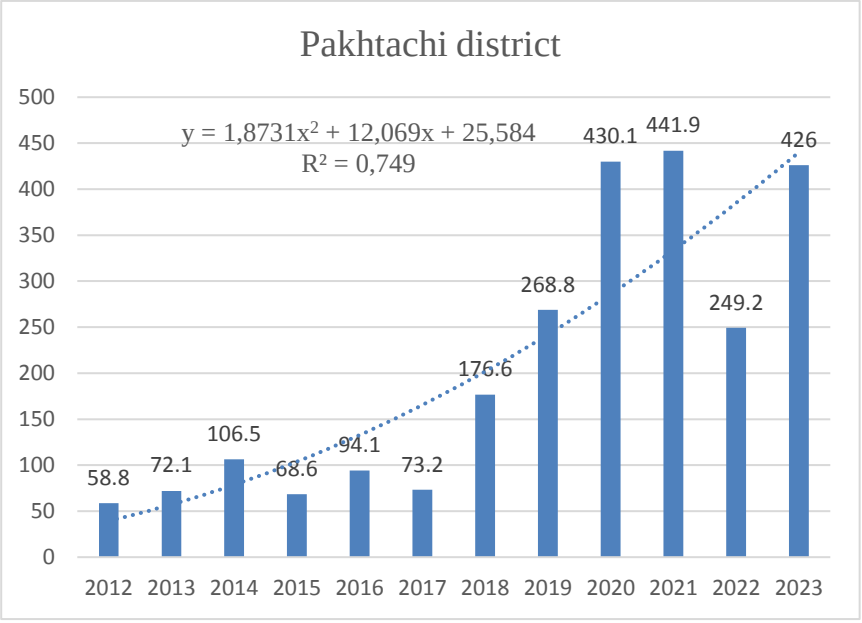

Kushrabot district
y = 0,9877x² + 68,513x - 50,775
R² = 0,7781
1200
1000
800
600
400
200
0
110.8
124.6
128.5
186.3
194.6
337.8
338.6
533.7
960.8
897.1
933.3
630.6
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023

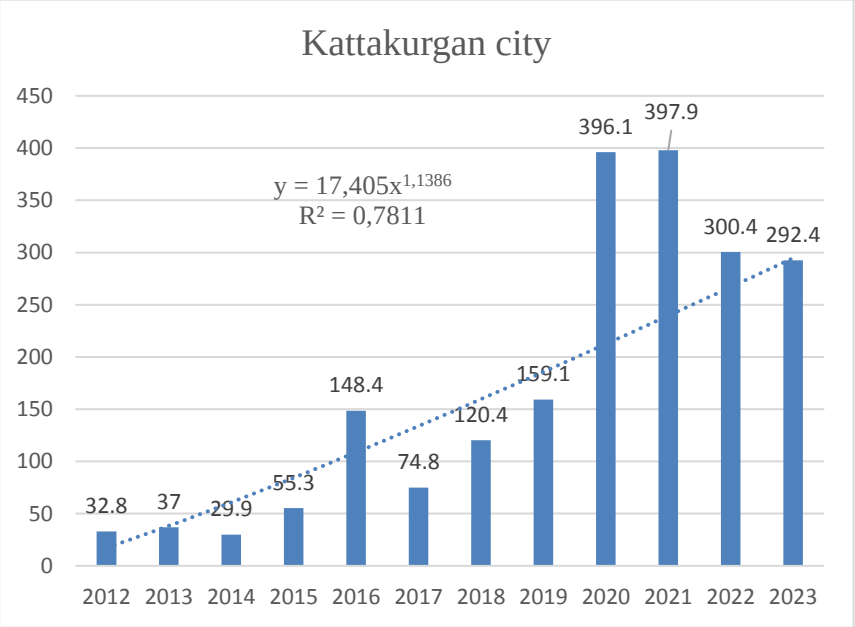

Payarik district
y = 20,994x^1,3391
R² = 0,807
1400
1200
1000
800
600
400
200
0
30.6
51
126.5
97.3
91.3
139.3
290.5
171.3
472.1
1270.6
682.7
619.4
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023


Akdarya district
y = 29,837x^1,16
R² = 0,8532
700
600
500
400
300
200
100
0
45.6
63.6
74
95.1
174.3
150
331.9
605.9
643.2
401.3
383.9
549.2
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023


Narpay district
y = 4,1211x² - 16,074x + 64,016
R² = 0,9707
600
500
400
300
200
100
0
36.3
52.5
61.7
78.4
99.5
99.5
153.3
180
290.9
301.6
336.9
502.5
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023


Ishtikhon district
y = 25,674x^1,1277
R² = 0,7481
800
700
600
500
400
300
200
100
0
45.4
57.3
55.3
85.6
111.2
80.2
300.6
458.6
352.6
743.4
267.3
475.8
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023


Pakhtachi district
y = 1,8731x² + 12,069x + 25,584
R² = 0,749
500
450
400
350
300
250
200
150
100
50
0
58.8
72.1
106.5
68.6
94.1
73.2
176.6
268.8
430.1
441.9
249.2
426
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023



Graph 1. Growth rates of investments in fixed capital by region of Samarkand region in 2012-2023, billion soum.

Hududlar	Matematik funksiya	Determinatsiya koeffitsenti, R^2	2024*	2025*	2026*	2027*
Samarkand region	$y = 234,36x^2 - 990,85x + 2892,7$	$R^2 = 0,9873$	29618,5	34955,4	40761,0	47035,3
Kattakurgan district	$y = 25,77x^3 - 410,02x^2 + 1809,5x - 1848,1$	$R^2 = 0,8485$	8998,7	13833,9	20013,7	27692,7
Samarkand city	$y = 22,045x^2 + 246,64x + 332,87$	$R^2 = 0,8887$	7264,8	8106,7	8992,6	9922,6
Samarkand district	$y = 46,356x^2 - 288,47x + 405,25$	$R^2 = 0,8646$	4489,3	5452,4	6508,3	7656,9
Pastdargom district	$y = 21,35x^2 - 135,74x + 243,96$	$R^2 = 0,9477$	2087,5	2528,2	3011,6	3537,7
Urgut district	$y = 5,4363x^2 + 34,491x - 11,434$	$R^2 = 0,9297$	1355,7	1537,0	1729,1	1932,1
Nurobod district	$y = 17,689x^2 - 128,39x + 274,69$	$R^2 = 0,8671$	1595,1	1944,3	2328,9	2748,8
Jomboy district	$y = 8,248x^2 - 38,09x + 102,75$	$R^2 = 0,9467$	1001,5	1186,1	1387,2	1604,8
Taylok district	$y = 4,442x^2 + 12,876x + 1,7932$	$R^2 = 0,9295$	919,9	1052,7	1194,4	1345,0
Bulungur district	$y = 4,7578x^2 - 3,7072x + 28,757$	$R^2 = 0,926$	784,6	909,4	1043,7	1187,4

Qushrabot district	$y = 0,9877x^2 + 68,513x - 50,775$	$R^2 = 0,7781$	1006,8	1102,0	1199,2	1298,3
Payarik district	$y = 20,994x^{1,3391}$	$R^2 = 0,807$	651,3	719,2	788,9	860,1
Aqdarya dsitrict	$y = 29,837x^{1,16}$	$R^2 = 0,8532$	584,7	637,2	690,3	743,9
Narpay district	$y = 4,1211x^2 - 16,074x + 64,016$	$R^2 = 0,9707$	551,5	646,7	750,2	861,8
Ishtikhon district	$y = 25,674x^{1,1277}$	$R^2 = 0,7481$	463,1	503,5	544,2	585,3
Pakhtachi district	$y = 1,8731x^2 + 12,069x + 25,584$	$R^2 = 0,749$	499,0	561,7	628,1	698,2
Kattakurgan city	$y = 17,405x^{1,1386}$	$R^2 = 0,7811$	322,9	351,3	380,0	409,0

Table 1.
Forecast indicators of investments in fixed capital in the regions of Samarkand region in 2024-2027, billion soums

The forecast of investments in fixed assets in Samarkand region for 2024-2027 shows a positive growth trend for the region and its districts. In 2024, investments in the region will amount to 29.6 trillion soums, and in 2027 this figure is expected to increase to 47 trillion soums. At the same time, the growth rate of investments in Kattakurgan district is high, investments starting from 8.99 trillion soums in 2024 are forecast to reach 27.69 trillion soums in 2027. The analyzed indicators by cities and districts show a significant increase in investments in each region. In regions such as Samarkand city and Samarkand district, investments are expected to increase steadily in 2024-2027, becoming the main force of economic growth. Samarkand city will reach 7.26 trillion soums in 2024 and 9.92 trillion soums in 2027.

Investments in Urgut, Pastdargam and Nurabad districts also show positive growth, but the growth rates for these regions are smaller. Urgut district will grow from 1.36 trillion soums in 2024 to 1.93 trillion soums in 2027, while Nurabad district will grow from 1.6 trillion soums in 2024 to 2.75 trillion soums in 2027.

On average, by district, for example, in Jomboy, Tayloq and Pakhtachi districts, the growth rate of investments is stable and changes relatively less. And this, in turn, indicates the need to pay more attention to regional infrastructure, digitalization, and the establishment of free economic zones to increase investment in these districts.

CONCLUSION

This study analyzed the investment dynamics of the Samarkand region and developed a polynomial regression model to forecast future investment trends.

By leveraging historical data and applying econometric techniques, the research demonstrated that polynomial modeling effectively captures nonlinear investment patterns, providing a reliable forecasting tool for policymakers and investors. The findings highlight key factors influencing investment flows and offer insights for strategic planning and resource allocation.

While the polynomial model showed strong predictive capabilities, further research could incorporate additional macroeconomic variables and alternative forecasting techniques to enhance accuracy. The study's results contribute to a data-driven approach for regional investment planning, supporting economic growth and sustainable development in the Samarkand region.

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