

UDC 004.41:330.341.1

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GROWTH OF GITHUB DEVELOPER COMMUNITIES IN KAZAKHSTAN, UZBEKISTAN AND KYRGYZSTAN, 2020-2026: EVIDENCE FROM THE GITHUB INNOVATION GRAPH

Abstract: This study asks how the number of software developers on GitHub changed in Kazakhstan and Uzbekistan from 2020 to 2026, which country grew faster, and whether programming languages such as Python grew at the same pace as the developer base. Kyrgyzstan is added as a third Central Asian country. The data are the open GitHub Innovation Graph, which reports quarterly counts of developer accounts, repositories, git pushes and language users for each economy, for 25 quarters from 2020 Q1 to 2026 Q1, combined with World Bank population figures. Developer accounts in Kazakhstan rose from 69,649 to 463,403 (6.7 times), in Uzbekistan from 24,575 to 395,040 (16.1 times, the fastest growth among the 121 economies that had at least 10,000 accounts in 2020 Q1) and in Kyrgyzstan from 14,440 to 121,507 (8.4 times). Per million residents Kazakhstan still leads, with 22,232 accounts against 10,661 in Uzbekistan, but its lead fell from 4.9 times to 2.1 times. Yearly git pushes grew in step with accounts in Kazakhstan and Uzbekistan but not in Kyrgyzstan. In Kazakhstan and Uzbekistan the number of developers pushing to Python repositories grew faster than both the developer base and the number of pushes. Kazakhstan's code activity drops in every third quarter: in 2020-2025 git pushes were on average 19.6% below the level of the neighbouring quarters (about 15% below trend) and Python users 28.5% below, while Uzbekistan shows a much smaller drop (3.5% in git pushes, not significant, and 8.7% in Python users). An exploratory comparison of 146 economies shows that this summer drop is common in the Northern Hemisphere and weaker or reversed in the Southern Hemisphere, and the north-south contrast is sharper outside the tropics, so it is consistent with the northern summer holiday season rather than a problem specific to Kazakhstan's IT sector.

Keywords: GitHub, software developers, open data, Kazakhstan, Uzbekistan, Kyrgyzstan, Python, seasonality, digital economy.

Introduction

Software is now a visible part of the economies of Central Asia. Kazakhstan reported 1.142 billion US dollars of IT service exports in 2025 [11], and the official statistics of Uzbekistan show that the service exports of IT Park participants grew from 276.3 million US dollars in 2022 to 728.4 million in 2025 [10]. Such figures say little about the people who write code: how many there are, how fast their number grows and which technologies they use.

Data from GitHub, the most widely used public platform for git projects [3], give a direct trace of these people. Researchers have used GitHub data to map where open source developers live [3], to measure the software capabilities of countries [4] and to estimate the effect of new

tools on programming activity [5]. GitHub also publishes the Innovation Graph, an open dataset that counts developer accounts, repositories, code uploads (git pushes) and users of each programming language for every economy and every quarter since 2020 [1, 2].

A first look at this dataset shows a clear picture for Central Asia. At the start of 2020 Kazakhstan had 69,649 developer accounts on GitHub and Uzbekistan had 24,575, about a third as many. By the first quarter of 2026 Kazakhstan had 463,403 and Uzbekistan 395,040, so Uzbekistan had almost caught up. This paper asks a simple question about that picture: how did the number of developers in Kazakhstan and Uzbekistan change on GitHub since 2020, which country grows faster, and do different programming languages, for example Python, grow at the same pace? Kyrgyzstan is added as a third country, as a smaller neighbour with a similar post-Soviet background.

Two earlier papers in this journal compared Kazakhstan with Uzbekistan using official statistics on inflation, unemployment and taxes [7, 8]. This paper uses the same side-by-side design, but applies it to open data on software development. Among the studies reviewed for this paper, Kazakhstan and Uzbekistan appear only as rows in cross-country tables [4, 6]; none of them follows the two countries quarter by quarter.

Literature review

Wachs, Nitecki, Schueller and Polleres located more than half a million active GitHub contributors in early 2021, mostly from the location that users write in their profiles, and compared the result with earlier snapshots [3]. The share of developers in Asia, Latin America and Eastern Europe grew, while the share of the United States fell from 38.7% in 2010 to 24.6% in 2021.

Juhász, Wachs, Kaminski and Hidalgo used the Innovation Graph, in which a developer is assigned to a country by IP address rather than by a self-reported location, for 163 countries and 150 programming languages in 2020-2023 [4]. From the mix of languages each country uses they built a software economic complexity index and showed that it helps to explain differences in income per person, inequality and emissions. In their 2020 ranking Uzbekistan is 70th, Kazakhstan 71st and Kyrgyzstan 92nd among the 126 countries listed (supplementary Tables S6.1-S6.2 of the arXiv version of [4]). By this measure the two neighbours started the period at almost the same level.

Quispe and Grijalba used the same dataset to compare countries where ChatGPT was available with countries where it was not [5]. With difference-in-differences and synthetic control methods they found a positive effect on git pushes, repositories and developers per 100,000 people, strongest for high-level general-purpose languages such as Python and JavaScript and for shell scripting.

Two more sources help to read the time pattern of the data. Wachs studied developers who left Russia after the invasion of Ukraine in 2022 [6]. His sample consists of highly active developers, who made at least 100 commits to public projects in 2019-2020. By November 2022, 11.1% of those previously located in Russia listed a new country, against 2.8% in comparable countries. Arrivals from Russia and Belarus equalled 13% of the highly active developers he had located in Kazakhstan in 2021, 8% in Uzbekistan and 7% in Kyrgyzstan (Table 3 of [6]). Finally, GitHub's own analysis of the timing of contributions reported changes in activity "during different holiday seasons and (sometimes correlatingly) when students are out of school" [12].

None of these studies follows Kazakhstan, Uzbekistan and Kyrgyzstan over time or checks whether their growth in accounts is matched by growth in actual code.

Data and methods

Data. The main source is the GitHub Innovation Graph, version 1.0.11 (repository state of 1 September 2026, downloaded on 11 October 2026) [1]. It is released under the CC0 licence, which allows any use. Four files were used. The developers file counts developer accounts located in an economy on the last day of each quarter; it excludes bots and spam accounts but includes accounts that are no longer active. The repositories file counts public software projects at the end of each quarter. The git pushes file counts how many times developers in an economy uploaded code during the quarter. The languages file counts, for each programming language, the unique developers who made at least one push to a repository in that language during the quarter [2]; below, "Python users" means developers who pushed to at least one repository in which GitHub detects Python. GitHub assigns a developer to an economy by the most frequent location of his or her IP address in the quarter and does not publish a number when fewer than 100 developers performed the activity [2]. The data cover 25 quarters, from 2020 Q1 to 2026 Q1. The author also viewed and saved the git push charts for Kazakhstan and Uzbekistan on the Innovation Graph website.

Population comes from the World Bank indicator SP.POP.TOTL (mid-year population) for 2020-2025 [9]. Each quarter uses the population of its calendar year; the quarter 2026 Q1 uses the 2025 value, the latest published. In 2025 the populations were 20,843,754 in Kazakhstan, 37,053,428 in Uzbekistan and 7,343,064 in Kyrgyzstan.

Plan. The analysis plan was written and agreed on 6 October 2026, after the first two charts (Figures 1 and 4 for Kazakhstan and Uzbekistan) had been drawn, but before the per-resident comparison and the check were computed. It had two parts. First, developer accounts per quarter were divided by population to compare the countries per million residents, to see who grows faster and in which years the gap between Kazakhstan and Uzbekistan widened. Second, the same comparison was repeated for repositories and git pushes, to check that the growth is not only new accounts without code. The language comparison follows the second half of the research question.

Measures. Growth is reported as a multiple (last value divided by first) and as a compound annual growth rate over the six years from 2020 Q1 to 2026 Q1; git pushes and language users, which change with the season, are compared as yearly totals or averages, 2020 against 2025. Activity per account is the number of git pushes in a year divided by the average number of developer accounts in that year. Comparisons with "all economies" use every economy in the Innovation Graph except the European Union aggregate, so they include Taiwan, which is not in the World Bank country list.

Exploratory analyses. Three analyses were added after a third-quarter dip was noticed in the charts, so they are exploratory and not part of the original plan; their p-values are descriptive. (1) Third-quarter test: for every year the value of the third quarter was compared with the midpoint of the second and fourth quarters on a logarithmic scale, $d = \ln(Q3) - [\ln(Q2) + \ln(Q4)] / 2$. A smooth series gives d close to zero, a negative d is a dip, and $(e^d - 1) \times 100$ gives its size in percent. The mean of d over the six years 2020-2025 was tested against zero with a two-sided one-sample t-test; for the nine tests in Table 4 Holm-adjusted p-values are also given. Because a peak in the second quarter also lowers d , the second and third quarters were in addition compared with a centred 2×4 moving average of the logarithms (second quarters 2021-2025, third quarters 2020-2025). (2) The same measure was computed for git pushes in every economy with all 25 quarters reported and a capital city with a latitude in the World Bank list: 146 economies (Taiwan, Réunion and the West Bank and Gaza have full series but no latitude

there and are excluded), and the same measure was computed for the first quarter (2021-2025, five years, since 2020 Q1 has no previous quarter). Northern and Southern Hemisphere economies were compared with the Mann-Whitney U test, also for economies outside the tropics only (capital latitude of at least 23.44 degrees north or south), and the size of the dip was correlated with growth in pushes (Spearman correlation). (3) The growth of accounts in 2022 Q4 in each country was compared with the same country's growth in the other quarters of 2021-2023 and with the growth of all economies together; the change in git pushes in 2022 Q4 was compared with the same country's fourth quarters of 2020-2025 and with all economies; and the jump of 2026 Q1 was compared with all economies that had at least 20,000 pushes in 2025 Q4.

Software. The calculations were made in Python 3.13 with pandas 3.0, SciPy 1.18 and matplotlib 3.11.

Results

Developer accounts: Uzbekistan grows faster, Kazakhstan stays ahead

In Figure 1 the developer accounts of all three countries rise in every quarter, but at different speeds. From 2020 Q1 to 2026 Q1 accounts in Kazakhstan grew 6.65 times, in Kyrgyzstan 8.41 times and in Uzbekistan 16.07 times, which is 37.1%, 42.6% and 58.9% per year (Table 1). Among the 121 economies that had at least 10,000 developer accounts in 2020 Q1, Uzbekistan's growth was the fastest; Kyrgyzstan was 8th, Kazakhstan 27th, and the median economy grew 5.06 times.

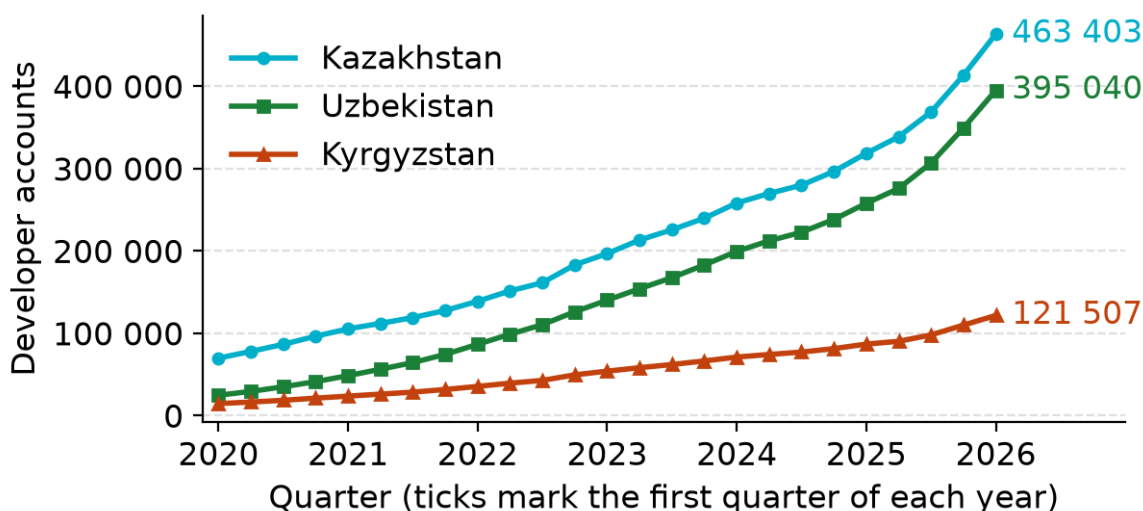


Figure 1 - Developer accounts on GitHub by quarter, 2020 Q1 to 2026 Q1 (source: GitHub Innovation Graph [1]; first version for Kazakhstan and Uzbekistan produced by the author, Kyrgyzstan added)

Uzbekistan grew faster than Kazakhstan in every single year, but the difference became smaller. On average, Uzbekistan's accounts grew by 18.7% per quarter in 2020 against 11.4% in Kazakhstan, and by 10.0% per quarter against 8.7% in 2025.

Table 1 - Size and growth of GitHub activity in Kazakhstan (KZ), Uzbekistan (UZ) and Kyrgyzstan (KG)

Indicator	KZ	UZ	KG
Developer accounts, 2020 Q1	69,649	24,575	14,440
Developer accounts, 2026 Q1	463,403	395,040	121,507
Growth, times (per year)	6.65 (37.1%)	16.07 (58.9%)	8.41 (42.6%)

Accounts per million residents, 2026 Q1	22,232	10,661	16,547
Repositories, 2020 Q1 → 2026 Q1	132,186 → 944,642	49,782 → 1,254,862	44,258 → 415,407
Git pushes per year, 2020 → 2025	433,047 → 1,813,424	190,401 → 1,837,684	174,311 → 490,975
Growth of yearly pushes, times	4.19	9.65	2.82
Growth of accounts, 2020 Q4 → 2025 Q4, times	4.29	8.49	5.21
Pushes per account per year, 2020 → 2025	5.24 → 5.04	5.86 → 6.18	9.92 → 5.11
Python users per quarter (yearly mean), 2020 → 2025	1,452 → 7,419	453 → 6,407	467 → 1,922

Note. Source: GitHub Innovation Graph [1], World Bank [9]; calculations for this study. Pushes and Python users are compared as yearly totals or yearly means because they change with the season.

Per million residents: the gap widened, the ratio narrowed

Uzbekistan has almost twice as many people as Kazakhstan, so the raw numbers hide a large difference in density (Figure 2 and Table 2). In 2020 Q1 Kazakhstan had 3,575 developer accounts per million residents and Uzbekistan 732, a ratio of 4.89. By 2026 Q1 the figures were 22,232 and 10,661, and the ratio had fallen to 2.09. Kyrgyzstan stood between the two, with 16,547 accounts per million.

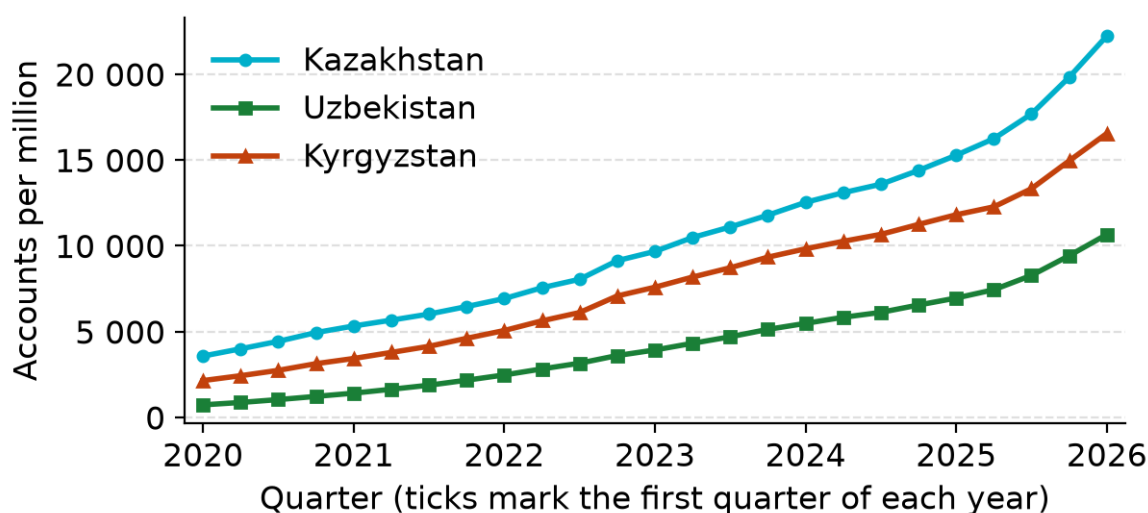


Figure 2 - Developer accounts per million residents (source: GitHub Innovation Graph [1], World Bank [9]; calculations for this study)

The answer to the question "in which year did the gap begin to grow" depends on how the gap is measured. The absolute gap, Kazakhstan minus Uzbekistan per million residents, grew in every year, from 3,719 at the end of 2020 to 10,399 at the end of 2025. It grew most in 2022 (by 1,238) and in 2025 (by 2,554). The relative gap moved the other way: Kazakhstan's lead shrank every year, from 4.04 times at the end of 2020 to 2.10 times at the end of 2025. In other words, Uzbekistan is catching up in proportion, while Kazakhstan, starting from a higher base, still adds more accounts per resident each year.

Table 2 - Developer accounts per million residents at the end of each year

Quarter	KZ	UZ	KG	Gap KZ – UZ	Change of the gap	Ratio KZ / UZ
2020 Q4	4,944	1,225	3,132	3,719	n/a	4.04
2021 Q4	6,460	2,168	4,610	4,291	+573	2.98
2022 Q4	9,135	3,606	7,079	5,529	+1,238	2.53
2023 Q4	11,787	5,131	9,339	6,657	+1,127	2.30
2024 Q4	14,396	6,550	11,247	7,845	+1,189	2.20
2025 Q4	19,825	9,425	14,953	10,399	+2,554	2.10
2026 Q1	22,232	10,661	16,547	11,571	+1,171	2.09

Note. Source: GitHub Innovation Graph [1], World Bank [9]; calculations for this study. The change of the gap is computed from unrounded values; for 2026 Q1 it is the change over one quarter.

The check: is there code behind the accounts?

The developer count includes unused accounts, so it could grow even if nobody writes more code. The planned check therefore looked at repositories and git pushes (Figure 3 and Table 1).

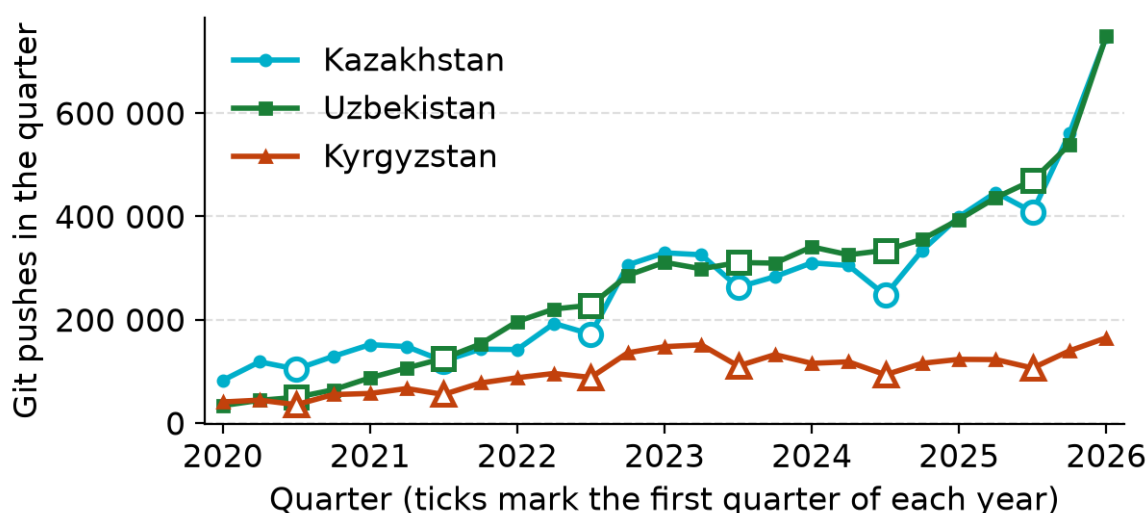


Figure 3 - Git pushes by quarter; open symbols mark the third quarters (source: GitHub Innovation Graph [1])

In Kazakhstan and Uzbekistan the check is passed. Yearly git pushes grew 4.19 times in Kazakhstan between 2020 and 2025 while accounts grew 4.29 times, and 9.65 times in Uzbekistan while accounts grew 8.49 times. Pushes per account per year therefore stayed almost flat in Kazakhstan (5.24 in 2020, 5.04 in 2025) and rose slightly in Uzbekistan (from 5.86 to 6.18). Uzbekistan first had more pushes than Kazakhstan in 2021 Q3 and has had more repositories than Kazakhstan in every quarter since 2023 Q1. In 2025 the two countries made almost the same number of pushes (1,813,424 and 1,837,684), and in 2026 Q1 the difference was only 1,626 pushes.

In Kyrgyzstan the check fails. Its accounts grew 5.21 times between the end of 2020 and the end of 2025, but its yearly pushes grew only 2.82 times, so pushes per account fell by almost half, from 9.92 to 5.11. In Kyrgyzstan, a large part of the growth in accounts was not matched by more uploaded code.

Languages: Python grew faster than the developer base

Figure 4 shows the number of developers who pushed to Python repositories in each quarter. In Kazakhstan the yearly average rose from 1,452 in 2020 to 7,419 in 2025 (5.11 times), faster than accounts (4.29 times) and pushes (4.19 times). In Uzbekistan it rose from 453 to 6,407 (14.15 times), again faster than accounts (8.49 times) and pushes (9.65 times). In Kyrgyzstan Python users grew more slowly than accounts (4.11 against 5.21 times) but faster than pushes (2.82 times).

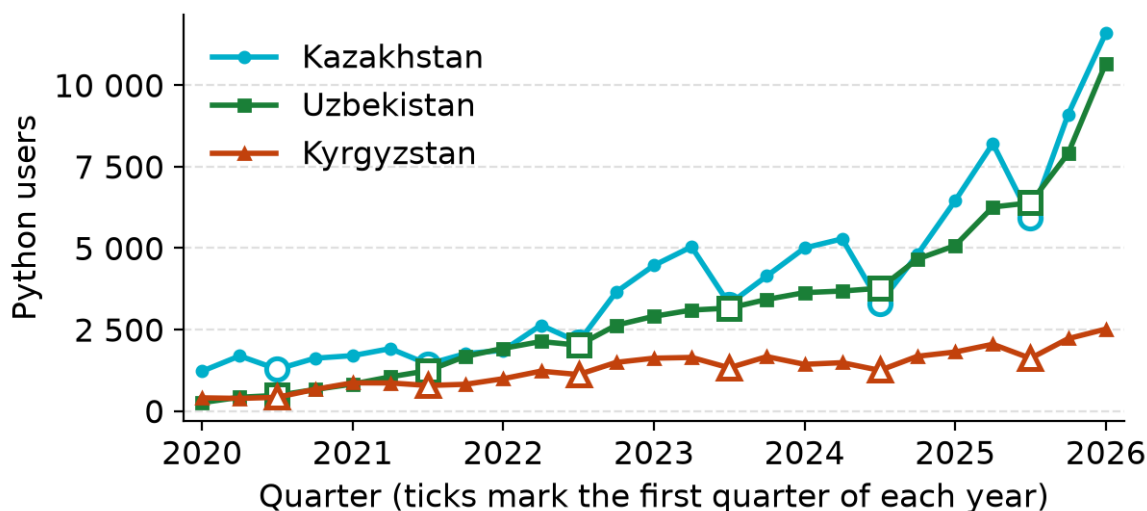


Figure 4 - Developers who pushed to Python repositories, by quarter; open symbols mark the third quarters (source: GitHub Innovation Graph [1]; first chart for Kazakhstan and Uzbekistan sent by the author, Kyrgyzstan added)

Table 3 places Python among the ten languages with the most users in Kazakhstan in 2025. The languages did not grow at the same pace. In Kazakhstan the web trio HTML, CSS and JavaScript grew about 3.5 times, Java and Shell 2.8 times and Python 5.1 times, while TypeScript (8.1 times) and Dockerfile (8.7 times) grew fastest. Every language in the table for which the growth in Uzbekistan can be computed grew faster there than in Kazakhstan, and TypeScript in Uzbekistan grew more than 29.6 times. By 2025 the six most used languages were the same in both countries and in the same order: HTML, CSS, JavaScript, Python, TypeScript and Dockerfile. In 2020 the lists had differed: Kazakhstan had Java in fifth place, and Uzbekistan had PHP in fourth place, ahead of Python.

Table 3 - Developers who pushed to repositories in each language, yearly mean per quarter, 2020 and 2025

Language	KZ 2020	KZ 2025	KZ growth, times	UZ 2020	UZ 2025	UZ growth, times
HTML	3,542	12,228	3.45	2,033	13,465	6.62
CSS	2,660	9,389	3.53	1,553	11,194	7.21
JavaScript	2,566	9,076	3.54	1,422	10,433	7.34
Python	1,452	7,419	5.11	453	6,407	14.15
TypeScript	452	3,675	8.13	127*	3,754	more than 29.56*
Dockerfile	340	2,958	8.71	132	1,984	15.06
Java	973	2,711	2.79	293	1,111	3.79
Shell	891	2,488	2.79	451	1,752	3.89

C++	339	1,356	4.00	137*	1,106	more than 8.07*
Go	198	1,340	6.76	not published	376	not available

Note. Source: GitHub Innovation Graph [1]; calculations for this study. The ten languages with the most users in Kazakhstan in 2025. * In 2020 the number for Uzbekistan was published for only some quarters (TypeScript three, C++ one), because in the other quarters fewer than 100 developers used the language; the mean of the published quarters is shown, and the true growth is larger than the number given. Go in Uzbekistan was below this threshold in all quarters of 2020.

The third-quarter dip (exploratory)

The Python chart has a clear pattern: Kazakhstan's line drops in every third quarter (July to September) and recovers in the fourth. The git push charts for Kazakhstan on the Innovation Graph website show the same drop for all code uploads. Table 4 measures it.

Table 4 - Third-quarter dip, 2020-2025: the third quarter compared with the midpoint of the second and fourth quarters

Country and series	Years with Q3 below Q2	Years with a dip	Mean dip, %	t	p	p (Holm)
KZ, git pushes	6 of 6	6 of 6	-19.6	-7.39	0.0007	0.005
KZ, Python users	6 of 6	6 of 6	-28.5	-11.32	0.0001	0.0008
KZ, developer accounts	0 of 6	6 of 6	-1.1	-2.35	0.065	0.20
UZ, git pushes	0 of 6	5 of 6	-3.5	-2.08	0.092	0.20
UZ, Python users	1 of 6	6 of 6	-8.7	-5.28	0.003	0.016
UZ, developer accounts	0 of 6	5 of 6	-0.6	-2.08	0.092	0.20
KG, git pushes	6 of 6	6 of 6	-22.6	-14.61	< 0.001	< 0.001
KG, Python users	5 of 6	6 of 6	-17.9	-6.86	0.001	0.006
KG, developer accounts	0 of 6	6 of 6	-1.2	-2.64	0.046	0.18

Note. Source: GitHub Innovation Graph [1]; calculations for this study. "Years with a dip" counts years in which the third quarter was below the midpoint of its two neighbours on a logarithmic scale; t and p are from a two-sided one-sample t-test of the six yearly values against zero (5 degrees of freedom). The p-values are descriptive, because the test was chosen after the dip had been seen; the last column adjusts them for the nine tests in this table (Holm method).

In Kazakhstan the third quarter was below the second in every year from 2020 to 2025, both for git pushes and for Python users. On average, git pushes in the third quarter were 19.6% below the midpoint of the neighbouring quarters, and Python users 28.5% below; both stay clearly below 0.05 after the Holm adjustment. Without 2022, when the third quarter was followed by an unusual jump (see below), the mean dip in pushes is 17.6%. Part of this contrast comes from a spring peak: against a centred four-quarter moving average, which spreads one high neighbour over a whole year, the second quarter in Kazakhstan (2021-2025) is 6.8% above trend for pushes and 18.6% for Python users, and the third quarter is 15.2% below trend for

pushes and 22.0% for Python users. Kyrgyzstan shows a dip of similar size in pushes (22.6% below the midpoint, 17.5% below trend). In Uzbekistan the dip in pushes is small (3.5%) and not statistically significant, and pushes never fell from the second to the third quarter; a smaller but regular dip appears in Python users (8.7%, Holm-adjusted $p = 0.016$). The number of accounts barely reacts to the season (dips of about 1%, not significant after adjustment), which is expected for a count that includes inactive accounts.

Is this dip special to Kazakhstan? The comparison of 146 economies (Figure 5) says no. Across all of them the median third-quarter value of git pushes was 5.3% below the midpoint of its neighbours, and 63.0% of economies had a dip. The dip is a Northern Hemisphere pattern: the median was -6.5% for the 120 northern economies and $+4.6\%$ for the 26 southern ones (Mann-Whitney $U = 863$, $p = 0.0004$), although 9 of the 26 southern economies still dip. Most southern capitals in the data lie in the tropics, where the seasons differ little; outside the tropics the contrast is sharper, -11.9% for 76 northern economies against $+4.8\%$ for 9 southern ones ($p = 0.003$). The mirror test points the same way: outside the tropics the first quarter, which is summer in the south, is below its neighbours in the southern economies (-6.9%) but not in the northern ones ($+1.3\%$, $p = 0.008$), while across all economies this first-quarter difference is not significant ($p = 0.45$). Kazakhstan's dip is the 15th deepest of the 146; in the World Bank's Europe and Central Asia region (47 economies, median third-quarter dip 15.7%) Kazakhstan ranks 12th, next to Poland (19.7%) and Finland (19.6%), and Kyrgyzstan 4th; the unusual country is Uzbekistan, which ranks 46th of 47. Across all 146 economies, faster growth in pushes from 2020 to 2025 went together with a smaller dip (Spearman $\rho = 0.55$, $p < 0.001$; $\rho = 0.59$ among the northern economies alone), and Uzbekistan had the 9th fastest growth in pushes of the 146.

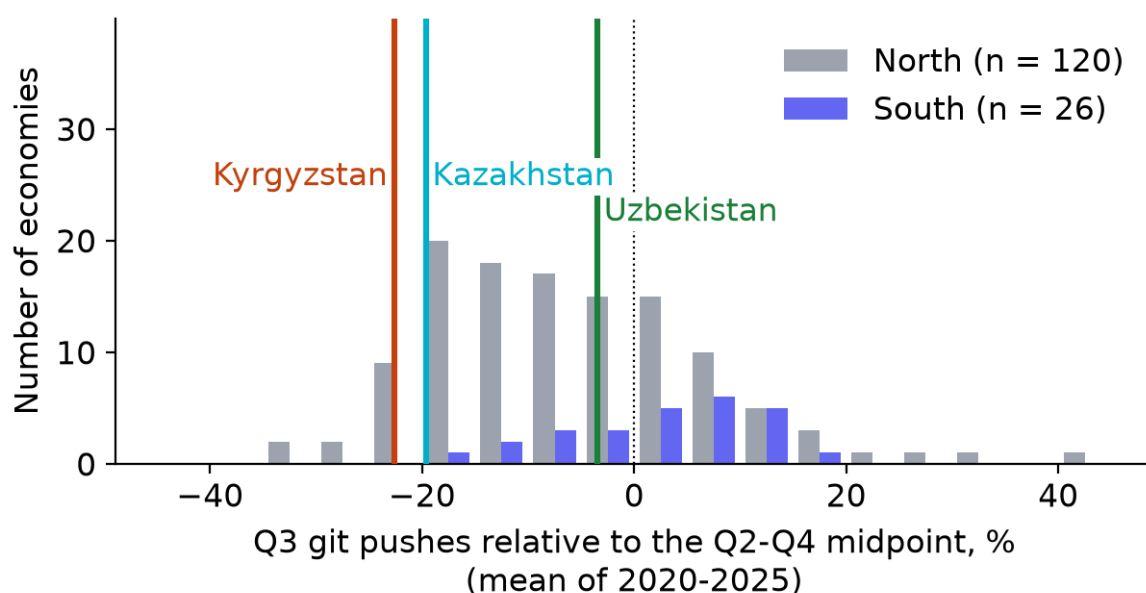


Figure 5 - Third-quarter dip in git pushes in 146 economies, mean of 2020-2025, by hemisphere of the capital city (source: GitHub Innovation Graph [1], World Bank [9]; calculations for this study)

Two unusual quarters (exploratory)

In 2022 Q4 developer accounts grew by 13.5% in Kazakhstan and by 15.8% in Kyrgyzstan in one quarter. For both countries this was the fastest quarter of 2021-2023 (the next fastest were 9.2% and 11.8%), and it was 8.0 and 10.3 percentage points above the growth of

all economies together (5.5%). Fourth quarters are often strong in both countries, however: Kazakhstan's accounts also grew by 11.5% in 2020 Q4 and 12.1% in 2025 Q4, and Kyrgyzstan's by 14.1% and 12.2%. In Uzbekistan the 2022 Q4 growth (14.1%) was in line with its own pace in 2021 and 2022 and ranks only 7th of its twelve quarters in 2021-2023. In the same quarter git pushes rose by 78.1% in Kazakhstan, 70.3 percentage points above all economies together and the largest quarterly change in its whole series, and by 54.3% in Kyrgyzstan, within the range of its other fourth quarters (20.0-55.7%); Kazakhstan's other fourth quarters rose by 7.8-37.3%, so only part of its rise is the usual recovery after the third-quarter dip. In 2026 Q1 git pushes rose by 33.4% in Kazakhstan and 39.1% in Uzbekistan, but the total of all economies rose by 29.6% and the median economy by 31.7%, so this last jump is a global event rather than a Central Asian one.

Discussion

The answer to the research question is that Uzbekistan grows faster and has nearly reached Kazakhstan in absolute numbers, while Kazakhstan still has 2.1 times more developer accounts per resident, and that languages do not grow at the same pace. The planned check matters for how these numbers should be read: in Kazakhstan and Uzbekistan code activity grew together with accounts, so the growth is not just empty registrations. Kyrgyzstan is different: its accounts grew faster than its code, and the average account made about half as many pushes in 2025 as in 2020. The data cannot say why.

The third-quarter dip is the clearest pattern in Kazakhstan's data, and the comparison with other economies changes how it should be read. It is not specific to Kazakhstan: it is typical of the Northern Hemisphere, where the main summer holidays fall in July and August. In the Southern Hemisphere it is much weaker or reversed, and outside the tropics, where July to September is winter in the south, the southern economies show a dip in their own summer quarter instead. This fits GitHub's own observation that activity changes in holiday seasons and when students are out of school [12]. The dip in Kazakhstan is deeper for Python users than for all pushes, which would be consistent with Python users including many students, but the Innovation Graph does not show who the developers are, so this remains an interpretation. The more surprising result is that Uzbekistan has only a small summer dip. Across economies, fast growth goes together with weaker dips, so one explanation is that so many new developers join Uzbekistan's community every quarter that the summer drop is partly hidden; this is a correlation, not a proof.

The fast growth of accounts in Kazakhstan and Kyrgyzstan in 2022 Q4 coincides in time with the relocation of highly active developers from Russia and Belarus documented by Wachs, who estimated arrivals equal to 13% of Kazakhstan's and 7% of Kyrgyzstan's highly active developers [6]. Because both countries also had strong fourth quarters in 2020 and 2025, this is a coincidence in time, not a test of cause, and it is not visible in Uzbekistan's data, although Wachs's estimates for Uzbekistan and Kyrgyzstan were similar (8% and 7%, based on 15 and 9 developers).

Limitations. The Innovation Graph covers only public activity on GitHub and only counts above the threshold of 100 developers, and because location is assigned by IP address, VPN use and travel can move activity between countries [2]. The third-quarter test uses six years, enough to show a regular pattern but not to study how it changes over time. Population for 2026 Q1 uses the 2025 value. The seasonal and cross-economy analyses were added after the dip was noticed and should be read as exploratory. Finally, the growth on GitHub coincides

with growing official IT export figures in both countries [10, 11], but this paper does not test whether more developers lead to more exports.

Conclusion

Between 2020 and 2026 the number of GitHub developer accounts grew 6.7 times in Kazakhstan, 8.4 times in Kyrgyzstan and 16.1 times in Uzbekistan. Uzbekistan has nearly caught up with Kazakhstan in absolute numbers, but Kazakhstan still has about twice as many developers per resident. In Kazakhstan and Uzbekistan the growth in accounts is backed by a similar growth in code, which is not the case in Kyrgyzstan. Developers pushing to Python repositories grew faster than the developer base in both Kazakhstan and Uzbekistan. Kazakhstan's activity drops every summer, by about a fifth against the neighbouring quarters and about 15% against trend, but the exploratory comparison of 146 economies suggests it is a seasonal pattern shared by most Northern Hemisphere economies, deep but typical for Europe and Central Asia; the exception that needs explaining is Uzbekistan, where the summer dip is much smaller.

Author contributions and use of AI tools

Yerganat Mukhamedzhan chose this topic from five research directions proposed by his mentor, agreed the research question, and proposed Kyrgyzstan as the third country. He produced the first version of Figure 1 (Kazakhstan and Uzbekistan) by running, on the GitHub Innovation Graph data, a script that was written by an AI assistant (Claude, Anthropic); his mentor changed its file paths so that it ran on his computer. He also sent the first chart of Python users for Kazakhstan and Uzbekistan, from a language file supplied by his mentor. He found and summarised in Russian, with the help of an AI assistant, three of the studies reviewed here [3, 4, 5], and he viewed and saved the git push charts for Kazakhstan and Uzbekistan on the Innovation Graph website. The third-quarter dip was first noticed by his mentor in the author's Python chart; the push charts he saved later showed the same drop. The data sources and the other studies cited were found by his mentor. His research mentor proposed the five directions, chose the target journal and wrote the analysis plan, which the author approved. The final data processing, the statistical tests, the exploratory analyses, the final figures and tables, the English text of the manuscript (including translation of the author's summaries) and the checking of references were carried out by the mentor with the help of an AI assistant (Claude, Anthropic).

Data and code availability

The GitHub Innovation Graph is openly available at <https://github.com/github/innovationgraph> under the CC0 licence; population data are from the World Bank. The analysis scripts, the exact data files used and all result tables are kept by the author's research mentor and are available on request.

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