



## EARLY WARNING INDICATORS OF ECONOMIC CRISES: EVIDENCE AND IMPLICATIONS FOR UZBEKISTAN

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**Abstract:** *This paper examines whether macroeconomic and financial indicators can provide timely warnings of economic vulnerability, with a particular focus on Uzbekistan. The study combines a structured review of established early-warning research with descriptive analysis of publicly reported indicators. Historical annual data for Uzbekistan in 2015-2023 are drawn from World Bank country indicators, while more recent estimates are discussed separately using IMF reporting. Real GDP growth, consumer-price inflation and private-sector credit relative to GDP are presented graphically. The analysis finds rapid financial deepening, persistent price pressures and a sharp pandemic-era slowdown followed by recovery. It proposes a monitoring dashboard combining credit conditions, inflation, external debt, foreign exchange reserves, external balances and banking soundness. These indicators can identify vulnerabilities, but none should be interpreted as a definitive forecast of crisis. The study offers policy-relevant monitoring priorities while acknowledging limitations of annual data and the absence of a validated Uzbekistan-specific prediction model.*

**Keywords:** *early warning indicators; economic crises; economic security; Uzbekistan; credit growth; inflation; macroeconomic stability.*

**Annotatsiya:** *Ushbu maqolada iqtisodiy inqirozlarning dastlabki ogohlantiruvchi ko'rsatkichlari O'zbekiston misolida o'rganiladi. Tadqiqotda xalqaro ilmiy adabiyotlar tahlili va ochiq statistik ma'lumotlarning tavsifiy tahlili birlashtirilgan. Jahon bankining 2015-2023-yillarga oid ma'lumotlari asosida real*



yalpi ichki mahsulot o'sishi, iste'mol narxlari inflyatsiyasi va xususiy sektorga berilgan kreditlarning YAIMga nisbati grafiklarda ko'rsatilgan. Keyingi davr ko'rsatkichlari Xalqaro valyuta jamg'armasi ma'lumotlari yordamida alohida baholangan. Natijalar moliyaviy vositachilikning kengayishi, narxlar bosimining davom etishi va pandemiya davridagi iqtisodiy sekinlashuvdan keyingi tiklanishni ko'rsatadi. Kreditlash, inflyatsiya, tashqi qarz, valyuta zaxiralari, tashqi balans va bank tizimi barqarorligini birgalikda kuzatish tavsiya etiladi. Mazkur ko'rsatkichlar xatarlarni aniqlashga yordam beradi, ammo inqiroz yuz berishini aniq bashorat qilmaydi.

**Kalit so'zlar:** erta ogohlantirish indikatorlari; iqtisodiy inqirozlar; iqtisodiy xavfsizlik; O'zbekiston; kredit o'sishi; inflyatsiya; makroiqtisodiy barqarorlik.

**Аннотация:** В статье исследуются индикаторы раннего предупреждения экономических кризисов с особым вниманием к Узбекистану. Исследование сочетает обзор международной научной литературы с описательным анализом открытых статистических данных. На основе показателей Всемирного банка за 2015-2023 годы представлены динамика реального роста ВВП, инфляции потребительских цен и кредитования частного сектора в процентах к ВВП. Более поздние оценки Международного валютного фонда рассматриваются отдельно. Результаты показывают расширение финансового посредничества, сохраняющееся инфляционное давление и восстановление после замедления экономики в период пандемии. Предлагается совместный мониторинг кредитной активности, инфляции, внешнего долга, валютных резервов, внешнего баланса и устойчивости банковской системы. Эти показатели помогают выявлять уязвимости, но не позволяют однозначно предсказать кризис. В статье также отмечаются ограничения годовых данных и необходимость дальнейшей проверки прогностических моделей для Узбекистана.



*Ключевые слова: индикаторы раннего предупреждения; экономические кризисы; экономическая безопасность; Узбекистан; рост кредитования; инфляция; макроэкономическая стабильность.*

## Introduction

Economic crises can develop gradually even when headline output continues to grow. Rapid lending, persistent inflation, increasing external financing needs and deteriorating bank balance sheets may accumulate before a visible disruption. An early warning system (EWS) aims to recognize these vulnerabilities early enough for policymakers to respond. For economic security, this is especially important because a banking, currency or debt crisis can affect household purchasing power, public services, employment and confidence in institutions.

The 1997-1998 Asian financial crisis and the 2008-2009 global financial crisis motivated extensive research on leading indicators. Early models emphasized exchange-rate pressures and reserve losses; later studies incorporated bank lending, asset prices, leverage, international exposures and global financial conditions. Different crisis types have different mechanisms. An indicator useful for identifying banking stress may be less informative about a sudden external financing interruption.

Uzbekistan offers a relevant case study. Economic reforms, credit expansion and growing international integration have created opportunities for investment and productivity growth while increasing the importance of financial surveillance. An economy can remain resilient and still carry vulnerabilities that deserve attention. The objective here is not to label Uzbekistan as being in crisis but to identify measurable conditions that could warrant preventive action.

The research asks: Which early warning indicators are supported by international research, how have selected Uzbek macroeconomic indicators evolved, and what monitoring framework would be appropriate for Uzbekistan? The contribution is a transparent synthesis connecting established international evidence with a country-specific, reproducible descriptive assessment. The paper explicitly



separates observed historical data from newer estimates and from hypothetical warning thresholds.

## **International literature and research gap**

Kaminsky, Lizondo and Reinhart (1998) established a widely cited signals approach for currency crises, evaluating whether variables crossed thresholds before a crisis. Kaminsky and Reinhart (1999) showed how banking and balance-of-payments difficulties can interact in “twin crises.” Their work demonstrates why an EWS should include both financial-sector and external-sector variables.

Berg and Pattillo (1999) investigated the predictive performance of currency-crisis models and highlighted the importance of out-of-sample evaluation. A model that fits historical events may perform poorly when confronted with new episodes. This distinction matters for countries undergoing structural reform, where statistical relationships may change over time.

Babecký et al. (2012), writing for the Czech National Bank, investigated crisis timing and intensity across advanced economies. They highlighted house-price developments, external debt and global variables as important signals. Their related ECB working paper analyzed banking, debt and currency crises and emphasized that indicator performance differs across crisis types. These studies provide conceptual guidance but their estimates should not be mechanically transferred to Uzbekistan.

Borio and Drehmann (2009) examined indicators of banking crises and argued that the joint behavior of credit and asset prices is especially informative. Drehmann, Borio and Tsatsaronis (2011) compared leading indicators for the build-up of financial vulnerabilities. Such evidence helps motivate monitoring of credit-to-GDP gaps, while also warning that a rising credit ratio may reflect normal financial development.

The research gap addressed by this paper is practical rather than econometric: published advanced-economy models do not directly provide a validated Uzbekistan-specific forecasting tool. A defensible first step is to map international findings onto



consistent national indicators, document their movements and identify the additional data needed for credible prediction.

## Materials and Methods

The study uses a mixed documentary and descriptive design. First, a focused literature review identifies indicators repeatedly emphasized in peer-reviewed and central-bank research. Second, selected macroeconomic series for Uzbekistan are presented graphically. Third, a qualitative vulnerability matrix links indicators to potential transmission channels and policy responses. No original interviews, household surveys or confidential supervisory data were used.

The historical dataset is the World Bank Uzbekistan selected-indicators table for 2015-2023. The 2024 values in that publication are estimates and are therefore excluded from the historical charts. The series used are real GDP growth (annual percent), average consumer-price inflation (annual percent), and domestic credit to the private sector (percent of GDP). For the recent period, the IMF 2026 Article IV mission statement reports separate estimates for 2025 and observations/estimates for 2023-2024; these are discussed as a distinct vintage rather than spliced into the World Bank historical series.

The indicators were selected for economic relevance, source accessibility and interpretability. GDP growth is a coincident measure of activity and an outcome of shocks, not a consistently leading predictor. Inflation captures price pressure but may reflect supply shocks or administered-price reforms. The credit-to-GDP ratio reflects financial deepening and potential leverage risk; its interpretation requires information on credit quality, asset prices and the credit gap. External debt, current account balance, reserves and non-performing loans are examined using reported aggregate figures and the international literature.

For reproducibility, annual series are transcribed directly from the World Bank selected-indicators table. Charts plot observed values without interpolation, smoothing or estimated confidence intervals. The paper does not calculate statistical



significance, optimize warning thresholds or train a predictive model. This choice avoids presenting descriptive correlations as validated forecasts.

The proposed monitoring approach uses three layers: (1) the level and recent change of each indicator; (2) confirmation from other indicators and institutional context; and (3) supervisory judgment about the transmission mechanism. A signal should trigger investigation, not an automatic declaration of crisis. A full future EWS would require quarterly or monthly data, an independently defined crisis chronology and out-of-sample validation.

## Indicator definitions and expected warning mechanisms

| Indicator               | Potential warning mechanism                        | Important qualification                                     |
|-------------------------|----------------------------------------------------|-------------------------------------------------------------|
| Credit-to-GDP ratio     | Rapid leverage growth may precede loan losses      | Financial deepening can raise the ratio without crisis      |
| Inflation               | Persistent price pressures weaken purchasing power | Supply and tariff reforms may create temporary spikes       |
| Current account balance | Large deficits increase external financing needs   | FDI-financed deficits differ from short-term debt financing |
| External debt/GDP       | Rollover and exchange-rate exposure                | Maturity, currency and borrower matter                      |
| Reserves / imports      | Limited buffers may magnify external shocks        | Adequacy depends on debt and exchange-rate regime           |
| NPL ratio / capital     | Loan deterioration weakens banks                   | Reported ratios can lag underlying distress                 |



## Results

### Economic growth and shock absorption

Figure 1 presents Uzbekistan's annual real GDP growth from 2015 through 2023. The series shows a pronounced slowdown to 1.6% in 2020, followed by a rebound to 8.0% in 2021. This pattern is consistent with the pandemic shock and subsequent recovery, but the annual data alone cannot identify the contribution of individual policy interventions. Positive growth in most years indicates continued expansion; it does not, by itself, exclude accumulated financial vulnerabilities.

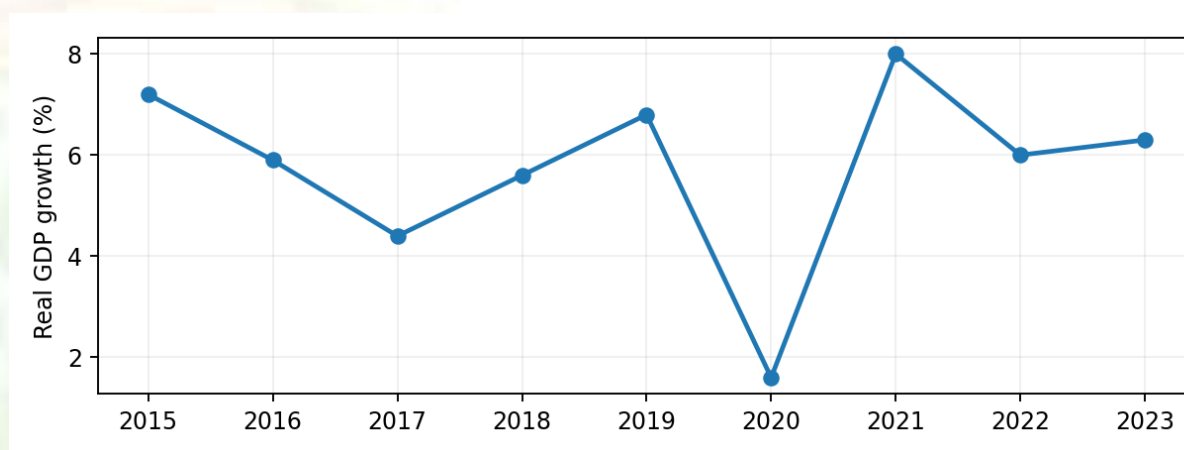


Figure 1. Uzbekistan: real GDP growth, 2015-2023 (%). Source: World Bank, Uzbekistan Selected Indicators (2024 report).

### Inflation and price stability

Figure 2 shows annual-average consumer-price inflation. Inflation rose from 8.0% in 2016 to 17.5% in 2018 and remained in double digits through 2023. Such persistence is relevant to economic security because households and firms face uncertainty in real income, savings and planning. However, high inflation is not synonymous with an imminent banking or currency crisis; structural changes, administered prices and supply-side shocks can affect observed inflation.

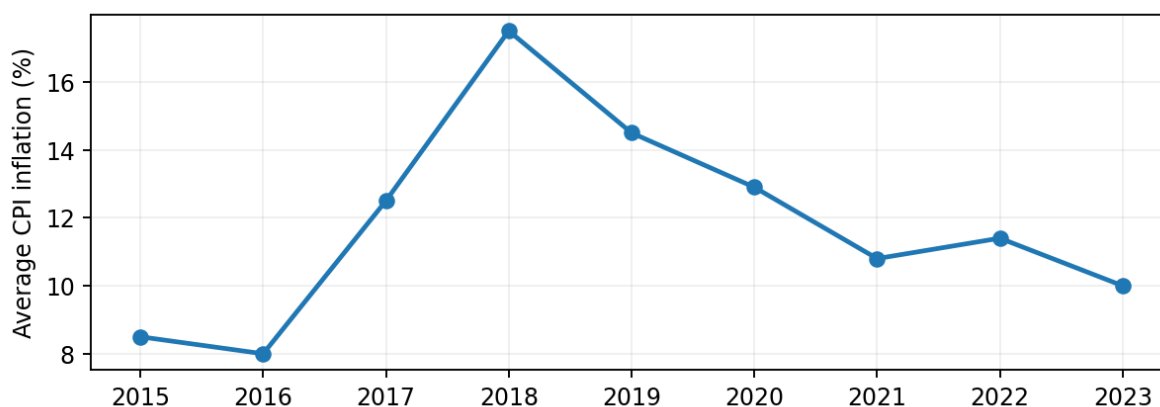


Figure 2. Uzbekistan: average annual CPI inflation, 2015-2023 (%). Source: World Bank, Uzbekistan Selected Indicators (2024 report).

### Credit expansion and financial deepening

The domestic credit-to-private-sector ratio increased from 10.3% of GDP in 2015 to 38.8% in 2023. The increase is substantial, but a higher ratio can reflect broader access to finance and banking-sector development. The correct warning question is whether lending grows faster than sustainable incomes and repayment capacity, particularly when collateral values and loan underwriting deteriorate. The credit-to-GDP gap, household debt-service burden and loan-quality indicators would be necessary to evaluate this risk more rigorously.

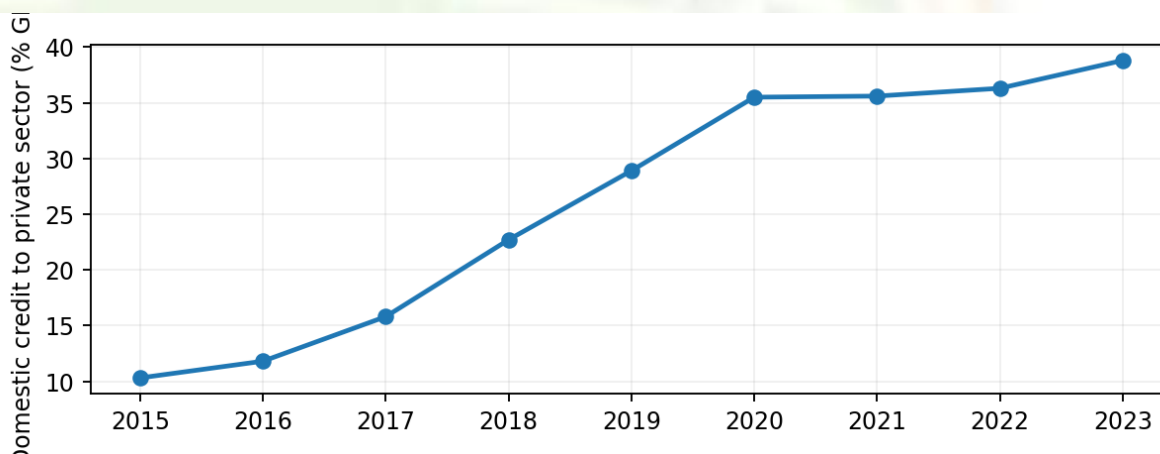


Figure 3. Uzbekistan: domestic credit to the private sector, 2015-2023 (% of GDP). Source: World Bank, Uzbekistan Selected Indicators (2024 report).



## Recent external and macrofinancial conditions

The IMF's 2026 Article IV mission statement reports 2025 real GDP growth of 7.7%, end-of-period inflation of 7.3%, a current account deficit of 3.9% of GDP and external debt of 54.2% of GDP. These are estimates in a newer statistical vintage and should not be interpreted as directly comparable with the older historical chart series without methodological checks. They illustrate why strong output growth should be assessed together with external financing requirements and balance-sheet exposure.

| IMF indicator                   | 2023 | 2024 | 2025 estimate |
|---------------------------------|------|------|---------------|
| Real GDP growth (%)             | 6.3  | 6.7  | 7.7           |
| Inflation, end of period (%)    | 8.8  | 9.8  | 7.3           |
| Current account balance (% GDP) | -7.3 | -4.7 | -3.9          |
| External debt (% GDP)           | 50.8 | 53.1 | 54.2          |
| Credit to economy, growth (%)   | 23.2 | 14.0 | 15.3          |

Table 2. Selected economic indicators from the IMF 2026 Article IV mission statement. Values represent the source's reporting vintage; 2025 is explicitly an estimate.

## Proposed monitoring dashboard

| Risk area    | Indicator to track                      | Illustrative interpretation / action                              |
|--------------|-----------------------------------------|-------------------------------------------------------------------|
| Credit cycle | Credit growth, credit gap, debt service | Investigate persistent acceleration alongside weaker underwriting |



|                     |                                            |                                                             |
|---------------------|--------------------------------------------|-------------------------------------------------------------|
| Price stability     | Headline/core inflation, expectations      | Assess persistence and monetary-policy transmission         |
| External resilience | Current account, short-term debt, reserves | Stress-test financing interruptions and currency mismatches |
| Banking sector      | NPLs, capital, liquidity, FX loans         | Use supervisory stress tests and early intervention         |
| Real economy        | GDP, industrial output, unemployment       | Cross-check slowdown with financial stress                  |
| Global spillovers   | Commodity prices, partner growth, rates    | Evaluate trade and refinancing transmission                 |

Table 3. Author's proposed qualitative early-warning dashboard, synthesized from the cited literature. These are monitoring priorities, not statistically estimated thresholds.

## Discussion

The results point to three complementary findings. First, the observed slowdown in 2020 confirms the importance of resilience to external shocks. However, GDP growth is primarily useful for assessing realized stress and recovery rather than providing a long advance warning. A well-designed EWS must therefore combine macroeconomic outcomes with variables that may change before a downturn.

Second, credit deepening deserves sustained attention. The Uzbek credit ratio rose considerably over the historical period, but it would be analytically incorrect to interpret the increase alone as evidence of an impending crisis. Countries transitioning from shallow financial systems may expand credit rapidly for legitimate reasons. The more informative combination is unusually fast credit growth together



with falling lending standards, excessive property-price appreciation, currency mismatches and rising debt-service burdens.

Third, external indicators can reveal exposures that are not visible in domestic growth figures. A current account deficit is not inherently dangerous: its financing structure matters. Stable long-term foreign direct investment has different risk implications from short-term foreign-currency borrowing. Likewise, total external debt must be interpreted by maturity, interest-rate structure, sector and repayment capacity. Foreign exchange reserves provide a buffer but cannot eliminate every possible liquidity shock.

International literature supports the use of several indicators and multiple models. Babecký et al. emphasize external debt, housing prices and global variables, while the credit-cycle literature stresses leverage and asset-price interactions. For Uzbekistan, these lessons favor a multi-indicator system with transparent data definitions and supervisory judgment. A single universal threshold imported from advanced economies would risk both false alarms and missed vulnerabilities.

Policy implications include publishing consistent high-frequency financial indicators, developing borrower-level and sectoral stress tests, monitoring foreign-currency exposures, and evaluating reserve adequacy against short-term external liabilities. Authorities should communicate the difference between an early-warning signal and a forecast of crisis. Clear communication can support confidence while encouraging preventive measures.

Several limitations constrain interpretation. The historical figures are annual, and annual aggregation may conceal sudden changes. Some indicators are contemporaneous or lagging rather than genuinely leading. The sample contains too few independently labeled crisis events to estimate predictive accuracy for Uzbekistan. The historical World Bank figures and more recent IMF estimates come from different reporting vintages. The analysis cannot establish causality or quantify the probability of a crisis. Future work should use quarterly banking data, a



documented crisis-event definition, threshold selection based on training data, and genuine out-of-sample testing.

An additional issue is the trade-off between missing crises and generating false alarms. Lower thresholds may improve sensitivity while also creating unnecessary warnings. A policy-relevant EWS should evaluate both errors, taking account of the relative social cost of each. Such an evaluation is not possible with the limited descriptive dataset used here; it remains a research priority rather than a claimed result.

## Conclusion

Early warning indicators are most useful when treated as a structured system for detecting vulnerabilities rather than a mechanism for predicting the exact date of the next crisis. International research identifies credit conditions, asset prices, external debt and global financial developments as important sources of information, but their predictive usefulness varies by country and crisis type.

Uzbekistan's historical data show a large increase in private-sector credit relative to GDP, persistent inflation and a sharp pandemic-era growth slowdown followed by recovery. More recent IMF estimates combine strong economic growth with continuing external financing exposures. These findings justify regular monitoring; they do not demonstrate that a crisis is imminent.

For Uzbekistan's economic security, the recommended approach is a transparent dashboard covering credit, inflation, banking soundness, external debt, current account balance, reserve adequacy and global shocks. The next step is to validate the dashboard using higher-frequency data and clearly defined historical stress episodes. Preventive policy depends not only on detecting signals but also on understanding their causes and responding proportionately.

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Data and transparency note. All figures are author-created visualizations of the cited published series. Tables 1 and 3 are analytical summaries; Table 2 reproduces selected IMF-reported figures with attribution. No model accuracy or country-specific crisis probabilities are claimed.