REPUBLIC OF TÜRKİYE
MINISTRY OF TREASURY AND FINANCE

Cash Forecasting for Treasury Cash Management

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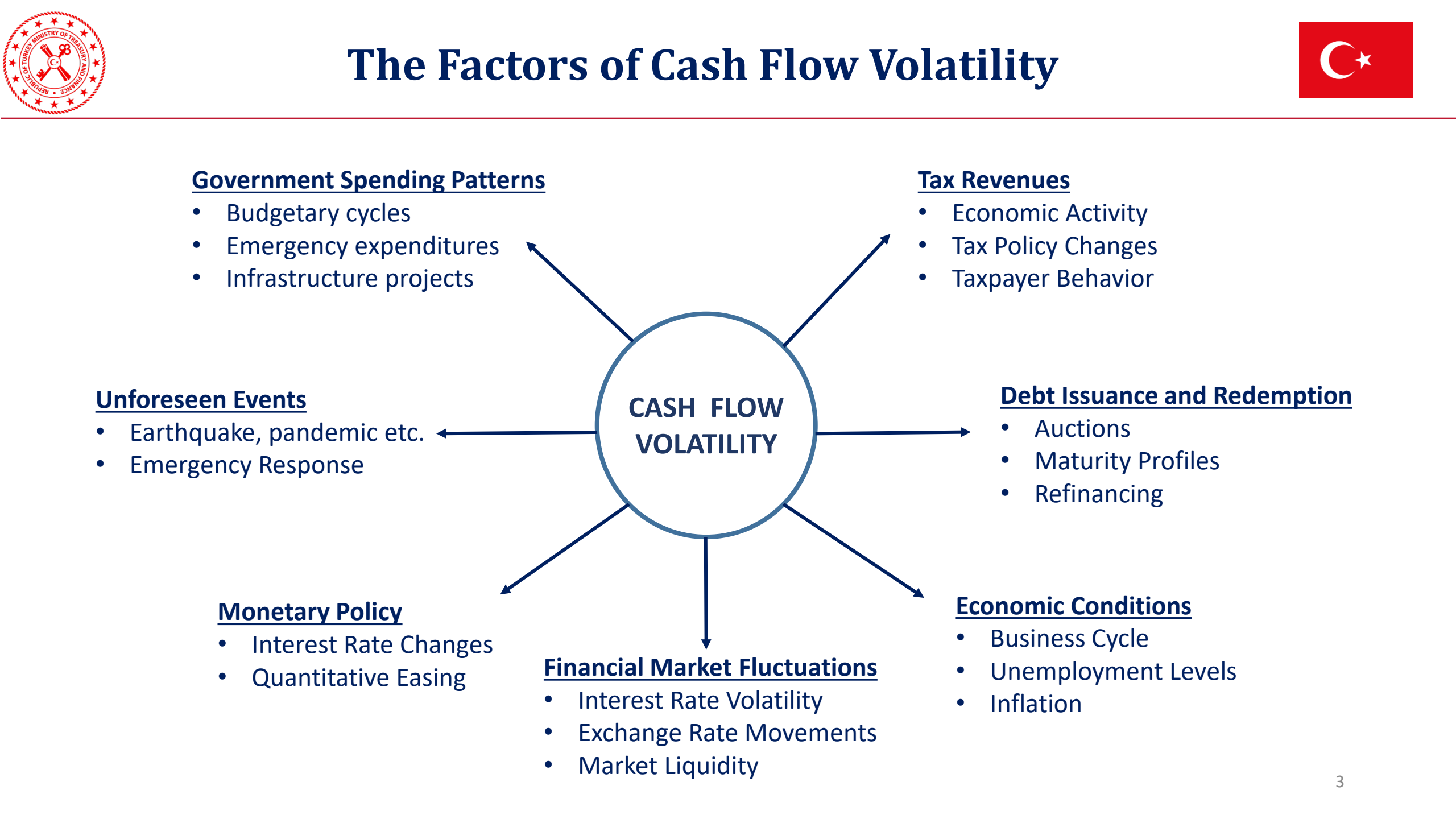
Outline

- Cash Flow Volatility
- Approach to Cash Flow Forecasting
- Enhancing the Quality of Data
- The Way Forward

The Factors of Cash Flow Volatility



Government Spending Patterns
- Budgetary cycles
- Emergency expenditures
- Infrastructure projects

Tax Revenues
- Economic Activity
- Tax Policy Changes
- Taxpayer Behavior

Unforeseen Events
- Earthquake, pandemic etc.
- Emergency Response

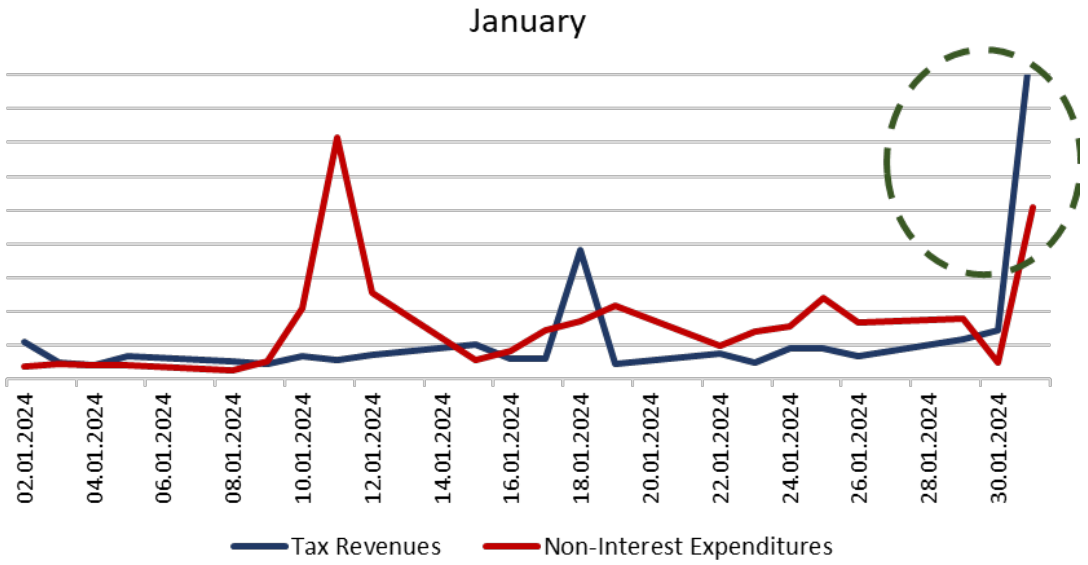
Debt Issuance and Redemption
- Auctions
- Maturity Profiles
- Refinancing

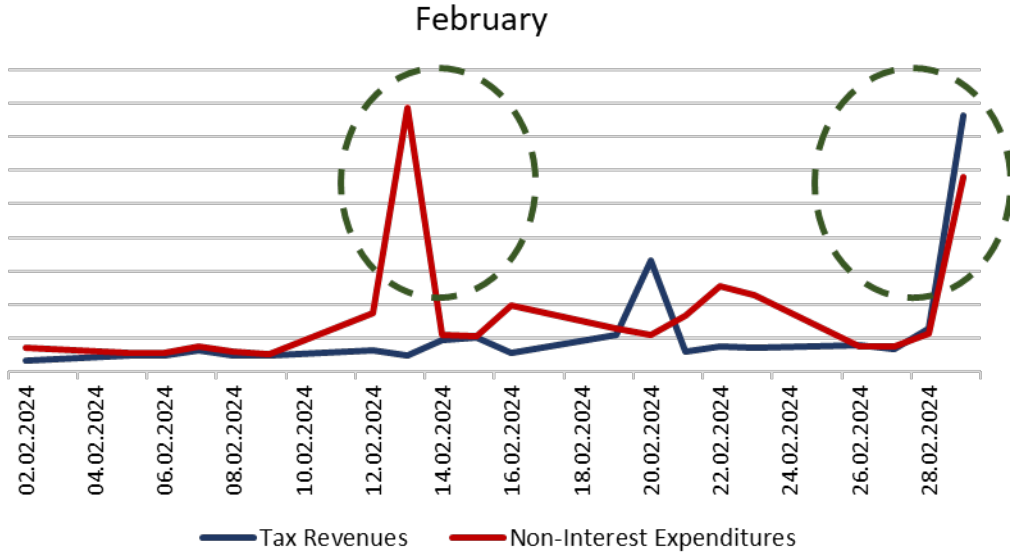
Monetary Policy
- Interest Rate Changes
- Quantitative Easing

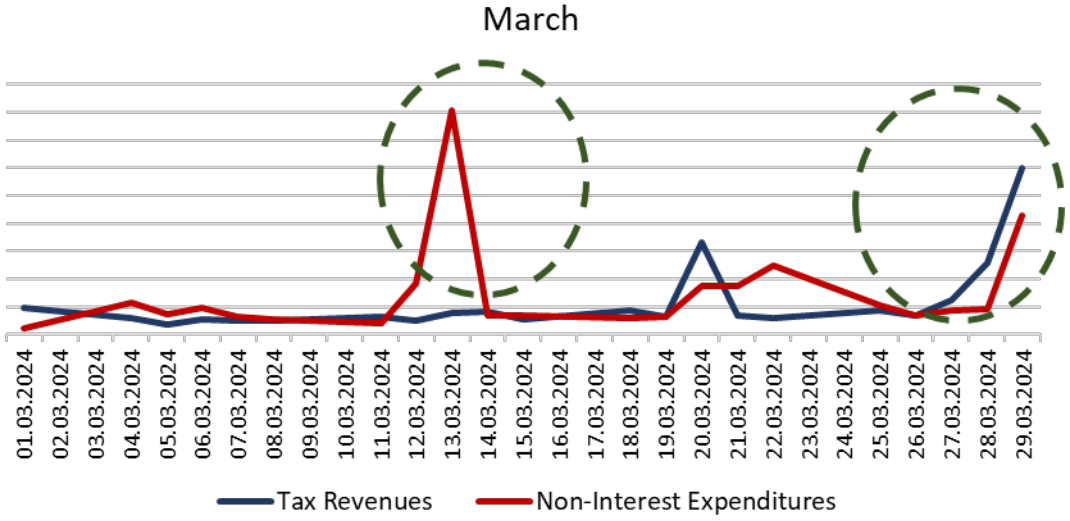
Financial Market Fluctuations
- Interest Rate Volatility
- Exchange Rate Movements
- Market Liquidity

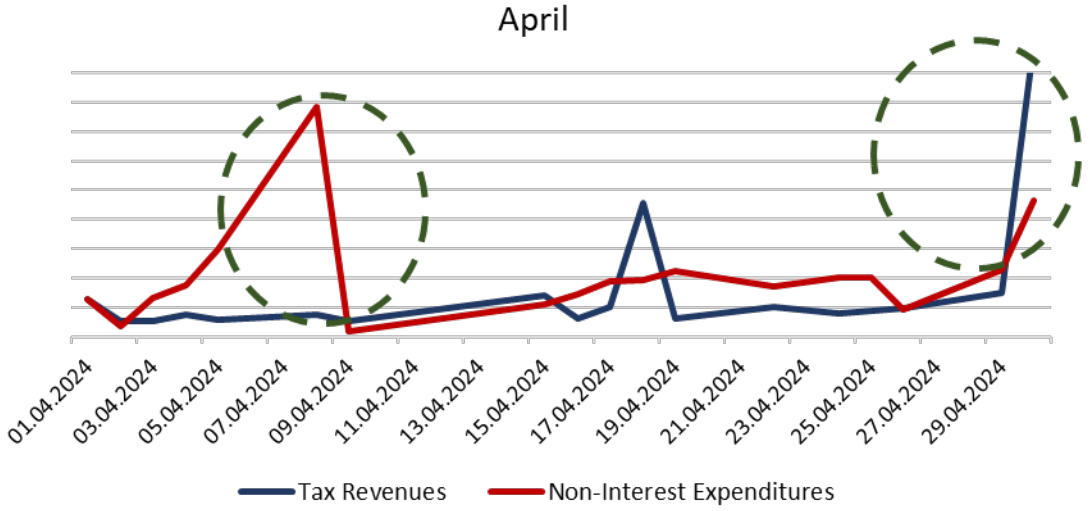
Economic Conditions
- Business Cycle
- Unemployment Levels
- Inflation

Cash Flow Volatility Example (2024)









Approach to Cash Flow Forecasting

- Forecasting Framework
- Forecasting Long-Term Horizon
- Setting KPIs
- Data Analysis

Cash Flow Forecasting Approach

Model Details
- Detailed Model = Efficiency in Cash Management
- Creating daily forecasts over a one-month period

Seasonality
- Distribution of Expenditure and Revenue Items
- Using Historical Data with Different Methods

Cash Flow Forecasting
- Top-Down Forecasts
- Revise with Bottom-Up Information

Incorporating Borrowing
- Active Communication with the Borrowing Unit
- Macro Forecasts for External Debt – Foreign Currency Liabilities

Staying Updated
- Continuously Updating Forecasts
- Data sharing with Public Institutions

Risk Controls
- Ensuring the Necessary Cash Buffer
- Maintaining Optimal Cost for the Cash Buffer

Treasury Cash Forecasting and Programming

Forecasting and Programming Period	Frequency of Update	Forecasting Horizon	Approach	Objective
Annual	End of the October - Previous Year	2+12 months (daily basis)	Top-down & Bottom-up (mixed)	Supports the development of annual financing program
Monthly	End of Each Month	Primarily - 90 days Secondarily - rest of the year	Mostly Bottom-Up	Provides greater cash planning visibility for the medium term
Daily	Every day - Twice	Primarily - rest of the month Secondarily - rest of the year	Mostly Bottom-Up	Supports operational cash management and liquidity planning

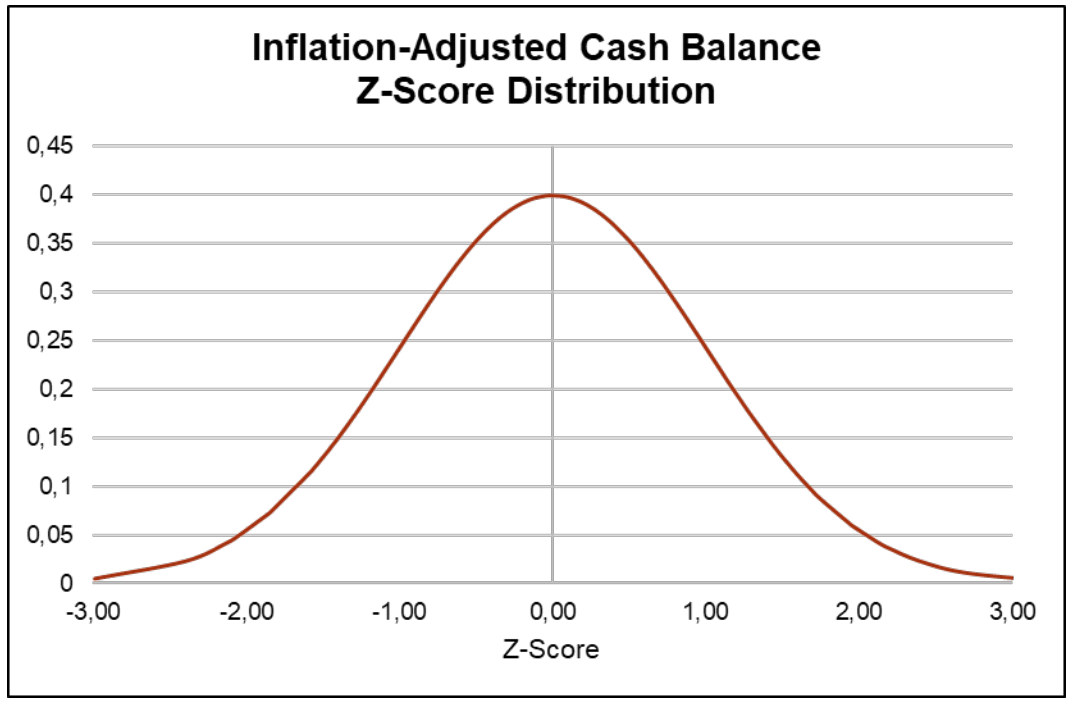
KPIs for Cash Flow Forecasting

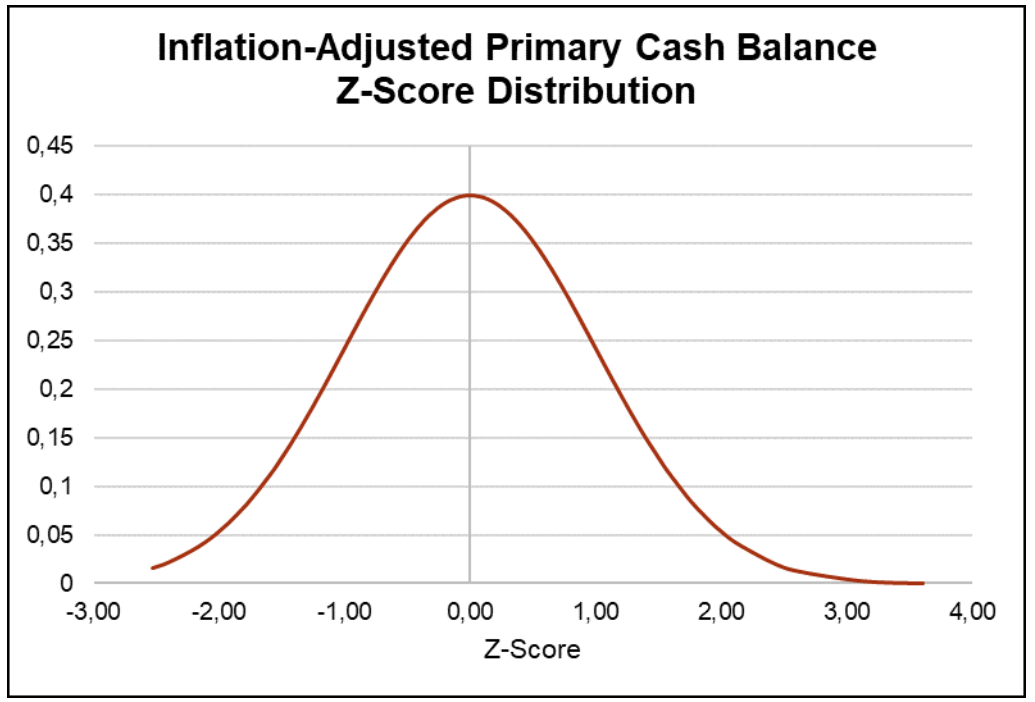
- KPIs on Cash Flow Forecasting are crucial for improving **cash flow forecasting** capacity.
- In this regard. we monitor 4 main KPIs for cash flow forecasting.

KPIs	TARGET
Daily Cash Balance Forecast Deviation	<0.5%
Monthly Revenue Forecast Deviation	<4%
Monthly Expenditure Forecast Deviation	<3%
Monthly Cash Balance Deviation Does Not Exceed Threshold X (Nominal Terms)	X

Cash Balance Analysis

- When adjusted for inflation, **cash balance realizations follows an almost normal distribution**.
- This indicates that the cash balance presents a predictable pattern with minimal deviations.

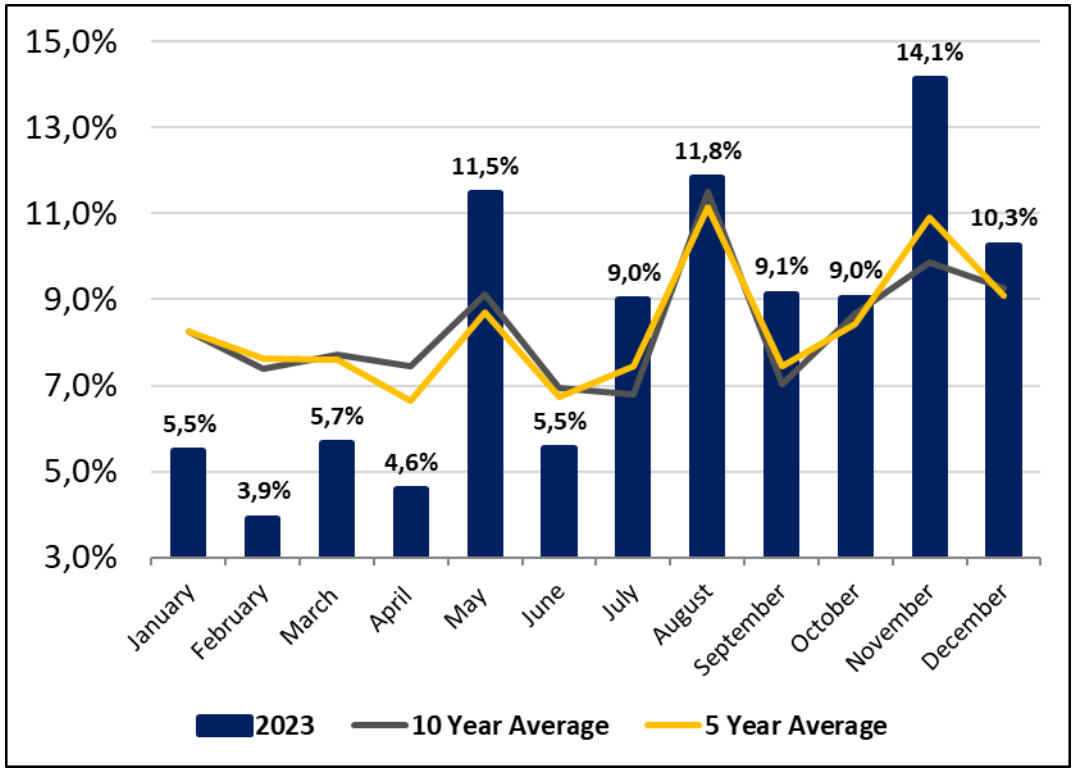




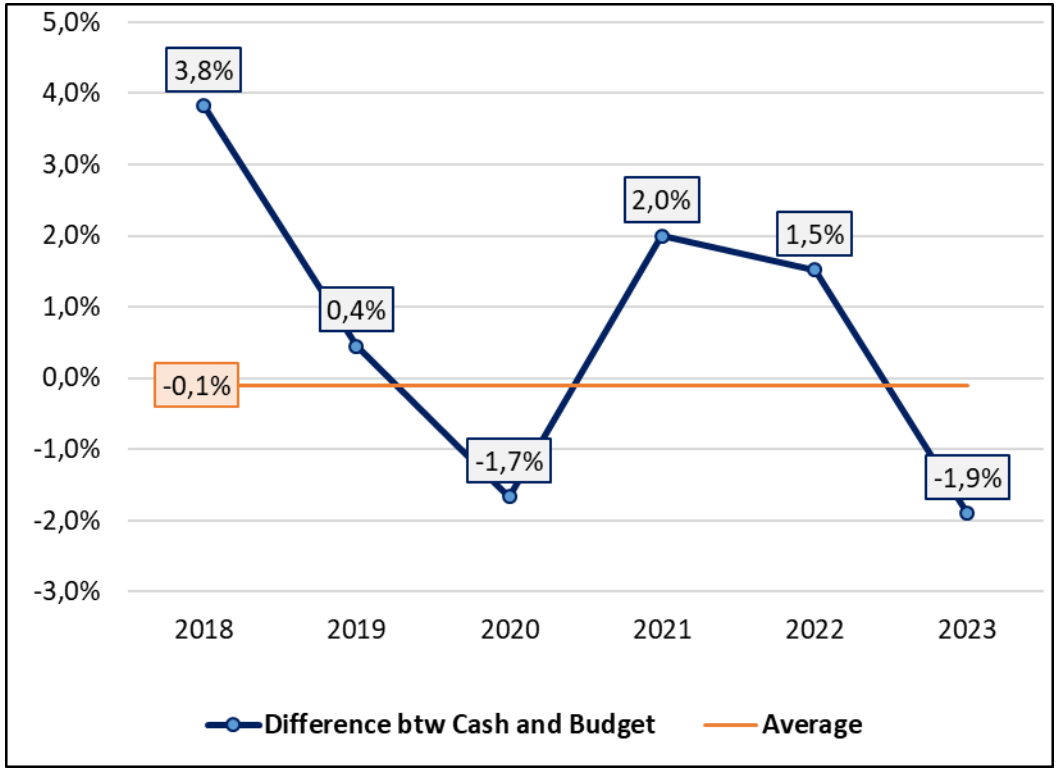
Revenue Trend Analysis

- The annual cash-based revenue programme, developed in accordance with the medium-term programme, is **analyzed based on realization trends from previous years.**
- In this regard, examples of trend analysis for revenues are provided below;

Percentage Distribution of Monthly Revenues



Revenue Growth Rates by Years



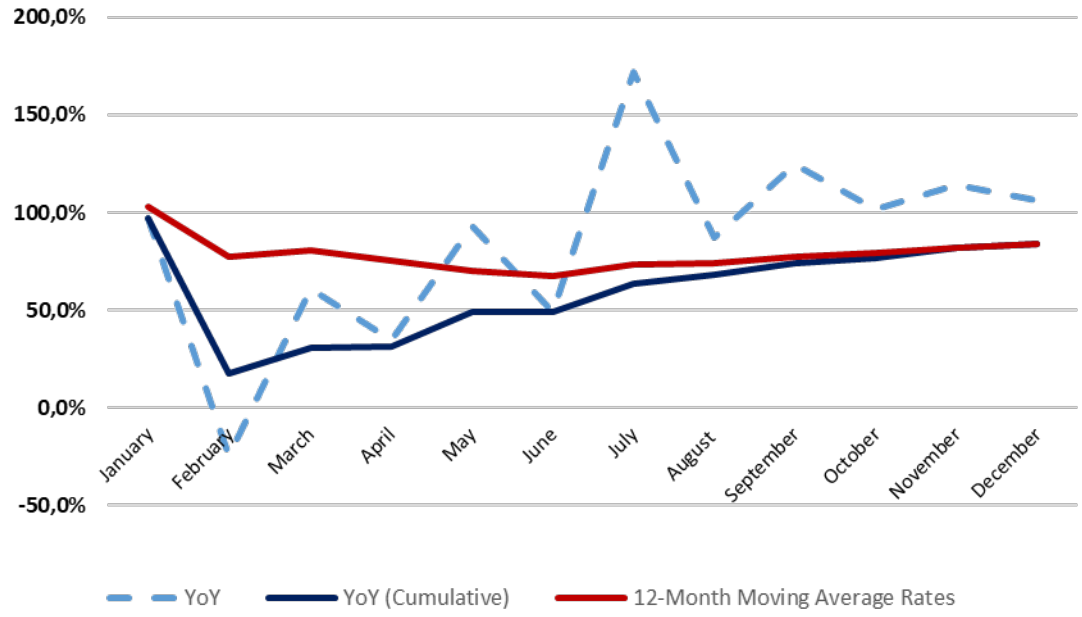
Revenue Trend Analysis

- Moving average rates, YoY rates are taken into account for monthly forecasting of revenues.

Analysis of 2023 Revenues

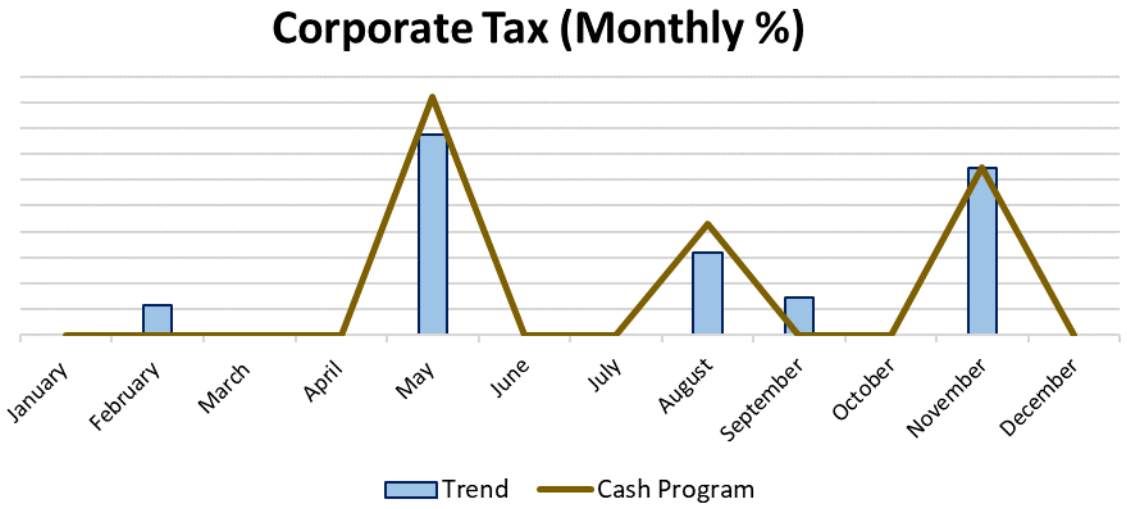
Date	Revenues	YoY	YoY (Cumulative)	12-Month Moving Average Rates
January	291.146	96,9%	96,9%	103,2%
February	208.224	-25,0%	17,4%	77,3%
March	301.535	61,0%	30,7%	80,6%
April	244.289	34,2%	31,5%	75,5%
May	609.987	92,8%	49,0%	70,0%
June	295.296	49,2%	49,0%	67,6%
July	478.296	172,3%	63,6%	73,6%
August	629.442	87,1%	68,0%	74,2%
September	486.087	124,5%	74,0%	77,6%
October	481.066	101,7%	76,9%	79,1%
November	751.351	114,1%	81,8%	81,8%
December	546.148	106,2%	84,1%	84,1%

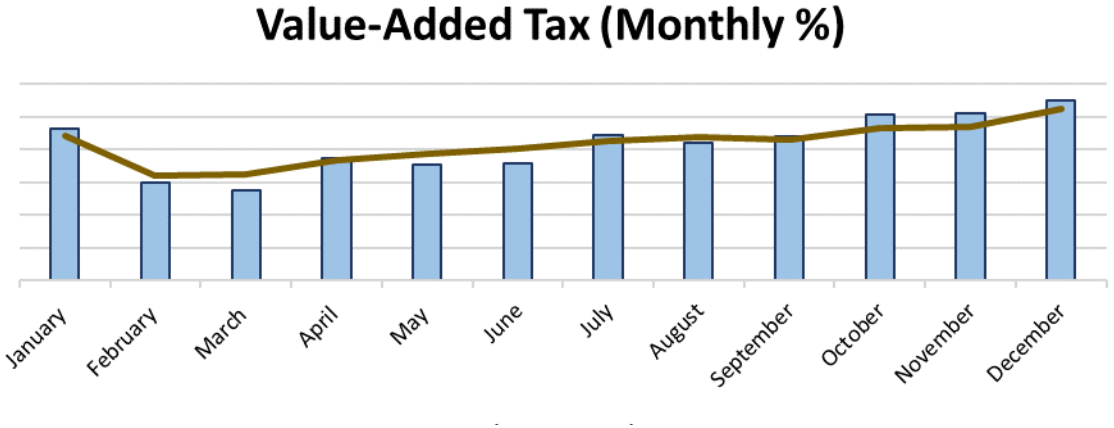
Monthly Cumulative Revenue Increase Rates

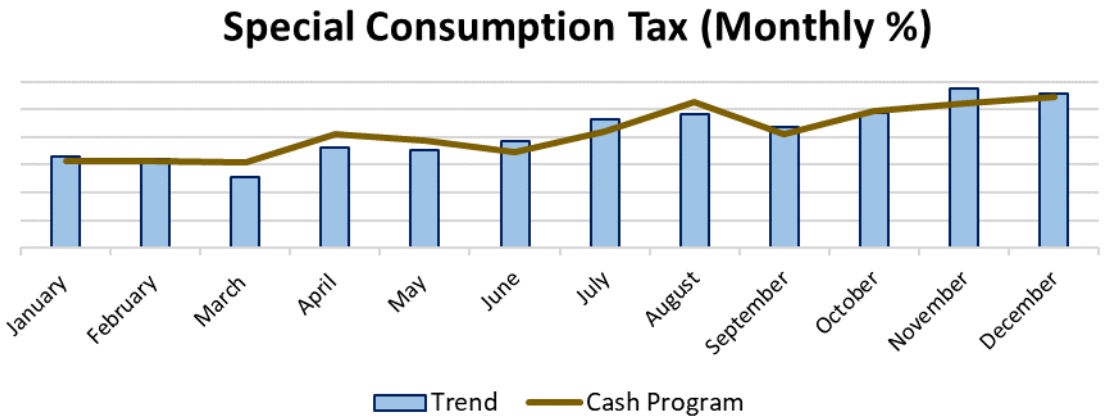


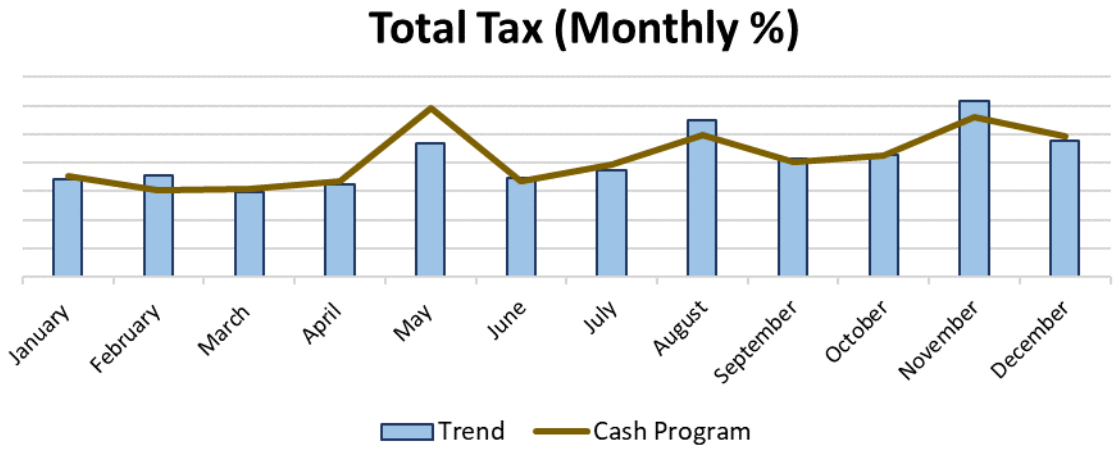
Tax Revenue Analysis

- For accurate overall tax forecasts, the analysis of specific tax revenues is important.





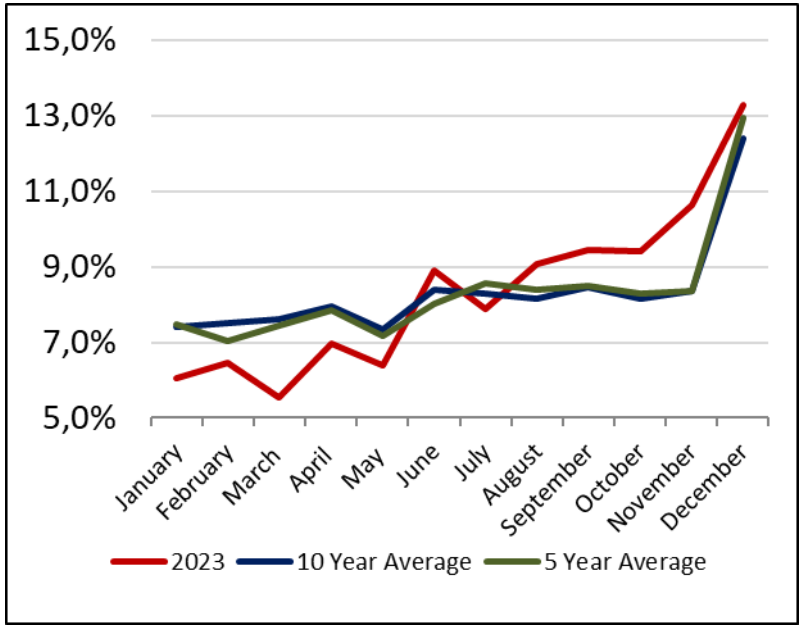




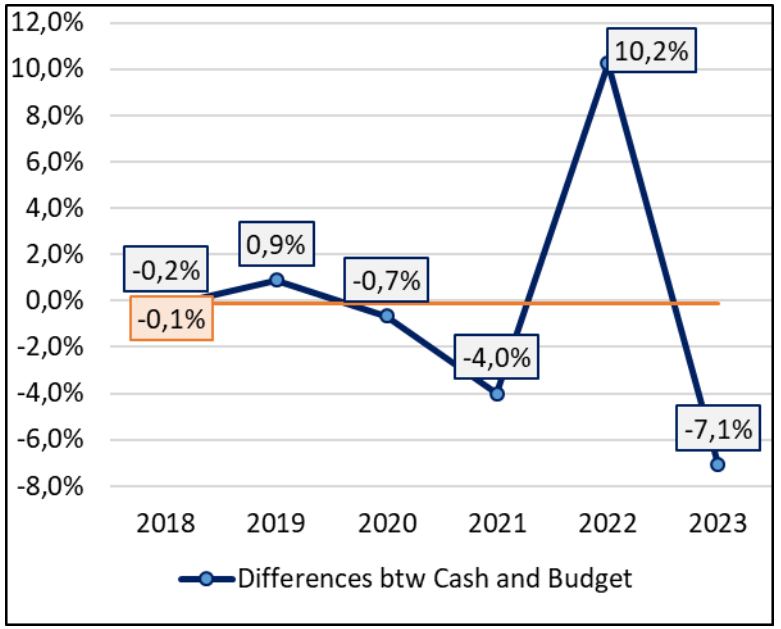
Expenditure Trend Analysis

- The annual cash-based expenditure programme, developed in line with the medium-term programme, **is analysed on the basis of the realisation trends of previous years.**
- In this context, examples of trend analysis of expenditures are presented below;

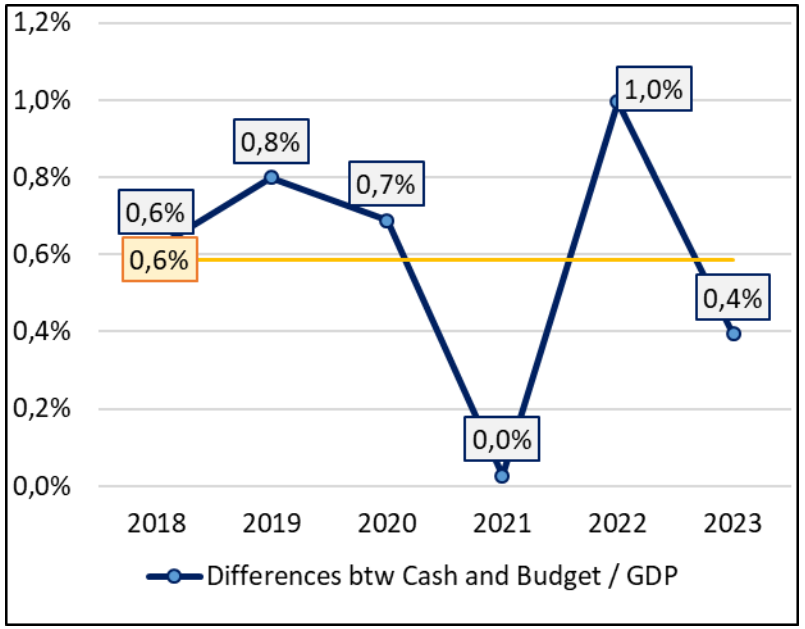
Percentage Distribution of Monthly Expenditures



Difference btw Growth Rates by Years (%)

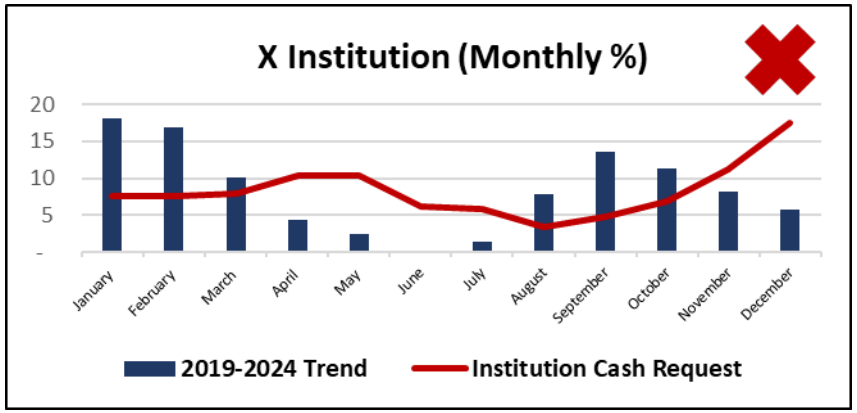


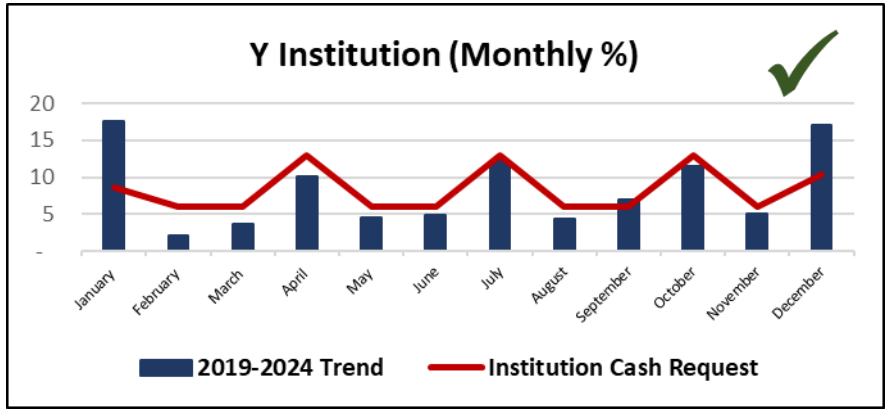
Difference btw Nominal Cash Budget to GDP (%)

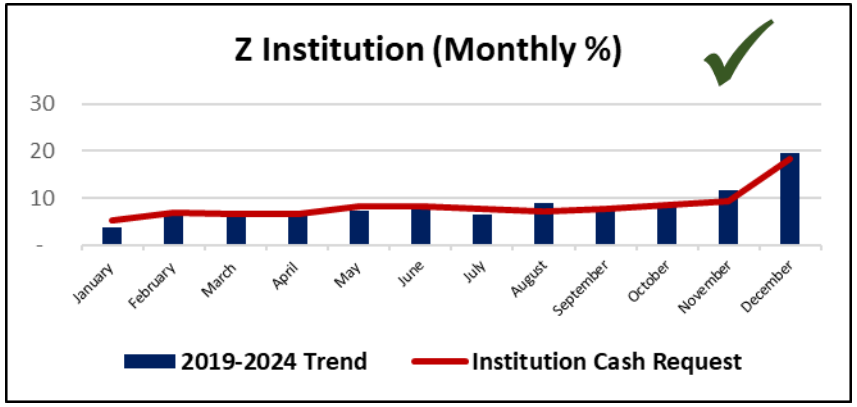


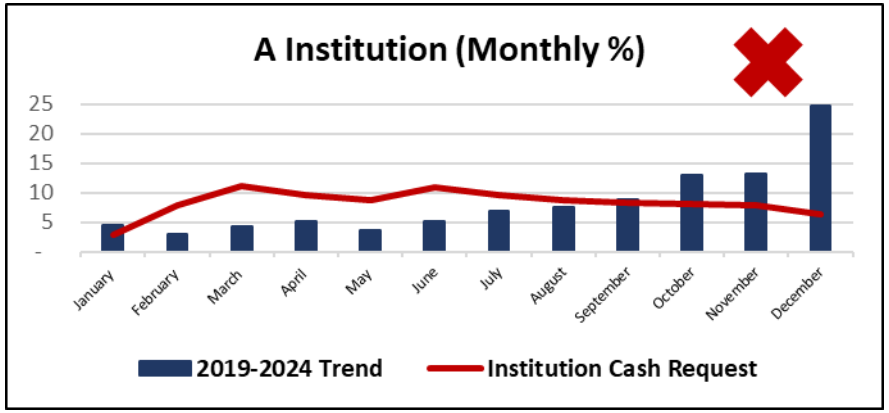
Institutions' Cash Request Trend Analysis

- In order to develop a bottom-up forecast, it is necessary to analyse the reliability of the cash demands made by institutions, taking into account the trends observed in the previous year.









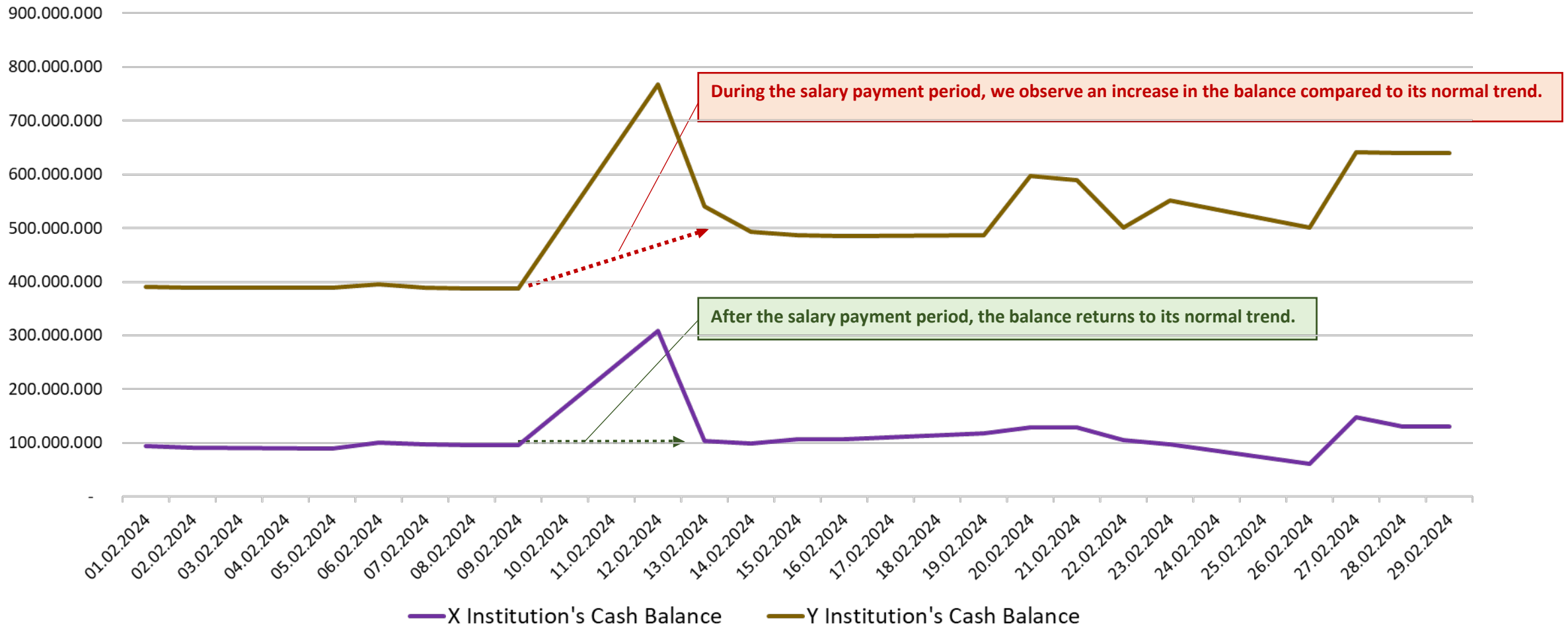
Compatibility of Cash Requests with Budget Allocation

Examples of Unrealistic Cash Requests			(million ₺)
Institution Name	**Monthly Cash Request (A)**	**Monthly Average Budget Allocation (B)**	**Percentage Deviation (A-B/B)**
A INSTITUTION	187	126	**48%**
S INSTITUTION	89	41	**117%**
N INSTITUTION	213	162	**31%**
M INSTITUTION	97	38	**155%**

Examples of Realistic Cash Requests			(million ₺)
Institution Name	**Monthly Cash Request (A)**	**Monthly Average Budget Allocation (B)**	**Percentage Deviation (A-B/B)**
C INSTITUTION	94	87	**8%**
E INSTITUTION	123	118	**4%**
F INSTITUTION	321	302	**6%**
I INSTITUTION	56	52	**8%**

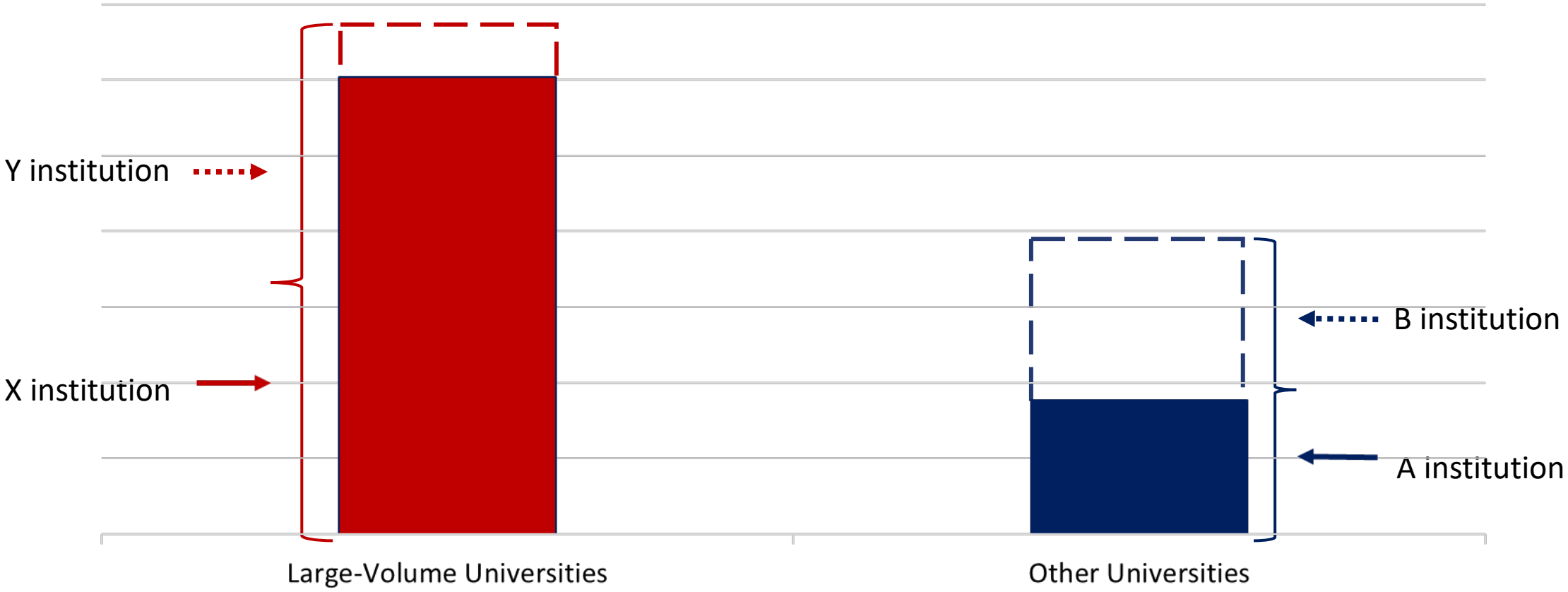
In formulating the cash programme for institutions, due consideration is given to the relevant institutions' budgetary allocations.

The Lenght of Elapsed Time in Spending the Requested Cash



Cross-Verification Between Institutions

- The **average monthly cash demands** of universities (such as those with hospitals) with relatively higher number of staff **are compared** with those of universities (such as those without hospitals) with relatively limited number of staff.



Performance Evaluation of Public Institutions

- The **demand performance of administrations is measured and regularly monitored** in order to improve the cash demands of administrations so that the treasury cash program can be carried out more effectively.

INSTITUTION NAME	Requested Amount	Realized Payments	Demand/Realization Ratio
Institution A	x	x	100%
…	x	x	…
Institution K	x	x	90%
Institution L	x	x	89%
…	x	x	…
Institution P	x	x	50%
Institution R	x	x	49%
…	x	x	…
Institution Z	x	x	0%

Administrations are divided into groups according to their **demand performance**. Demand performances are taken into account when transferring cash to administrations.

Preparation of the Cash Program (Based on Institutions' Cash Request and Analysis)

Several issues are taken into consideration in the cash program of public institutions.

These considerations are;

- **Monthly average budget allocation of public institutions** are monitored to ensure budget and cash alignment,
- **The balance amounts of the institutions** are controlled according to whether there is a need for treasury aid or not,
- Size of public institutions' **arrears amounts**,
- **Request performance of public institutions** is calculated by taking demand-realization ratios into account,
- **Institutional grades** created in line with demand performances are applied as a coefficient in the cash program.

Preparation of the Cash Program (Based on Institutions' Cash Request and Analysis)

- Treasury cash transfer requests of public institutions within the scope of the Treasury Single Account are submitted through the TSA-IS as of June 1, 2024.
- By integrating institutions into TSA-IS, TSA-IS increased the effectiveness of the cash program.

Cash Program Criterias (Example)

DRAFT CASH PROGRAM						FINAL CASH PROGRAM			
Institution Name	Cash Request of Inst.	Analysis*	Institutions Budget + Arrears	Institution's Score	Cash Prog.	Institution's Balance	Revised Request of Inst.	Cash Prog. (Final)	Request Coverage Rate
X Institution	100	X	95	B	85	X	95	**90**	**95%**
Y Institution	200	X	150	C	150	X	190	**150**	**79%**
…			X			X	X	X	**X%**
…			X			X	X	X	**X%**
…			X			X	X	X	**X%**
…			X			X	X	X	**X%**

*It covers trend analysis, budget allocation, cross verificiation, analysis of expenditure duration and performance evaluations for public institutions.

Enhancing the Quality of Data

- Improving the Cash Request Information Systems
- Cash Request Granularity
- Accounting Codes Revision

Improving the Efficiency of Cash Request System

- Increasing the efficiency of institutions' cash requests improves cash programming and forecasting. enables more accurate liquidity management. and reduces operational costs

	Previous	*Current*	*Performance Rating*	*Target*
Frequency of Cash Request Submission by Instituttuons	Weekly	Daily	▲	**Establishing Effective Cash Request System**
Cash Request Submission Horizon	Next Three Months	Next Three Months	▶	
Cash Request Granularity	3 Breakdowns	7 Breakdowns	▲	
Electronic Submission of Cash Requests	IT System. Excel. Email	IT System	▲	

Cash Request Granularity

- In order to ensure the sound execution of the Treasury cash program, the **Cash Request System (CRS) was detailed to meet the needs of the current cash program**

Institution Example	Type of Cash Requests	Type of New Cash Requests
Ministry Of Family and Social Services	- Personnel Expenditures - SSI Government Contributions - Other Expenditures	- Personnel Expenditures - SSI Government Contributions - General Health Insurance - Social and Economic Support Services - Maternity Aid - Disabled Care Service - …
Ministry Of National Education	- Personnel Expenditures - SSI Government Contributions - Other Expenditures	- Personnel Expenditures - SSI Government Contributions - Student Scholarships and Loans - Coursebook Payments - University Expenditures - School Tools and Equipment - …

Cash-Based Accounting Codes Revision

- To **determine the cash needs of public institutions** and to facilitate payments by the Ministry, accounts with **accounting code 325** are used
- To improve the accuracy of Treasury cash forecasts and enhance monitoring of payments to public institutions, **accounting code 325 has been detailed.**

Accounting Codes Example	Elaborated New Accounting Codes Example
Personnel expenditures **325.1.12** →	**325.1.12.1** Additional work provisions **325.1.12.2** Contracted staff payments **325.1.12.3** Intern students payments
Service Procurement **325.02.11** →	**325.02.11.1** Laboratory service procurements **325.02.11.2** Dining hall service procurements **325.02.11.3** Services for Disabled Individuals

The Way Forward

Artificial Intelligence (AI) Based Cash Flow Forecasting Project

Artificial Intelligence (AI) Based Cash Flow Forecasting Project

- Objective is to analyze historical cash and budget data to improve future cash flow forecasting using **AI-based time-series analysis**.
- The project will contribute to the consistent forecasting of cash deficits/surpluses, reduce liquidity risk thereby enhance the effectiveness of cash management practices.
- The project continues with internal resources while collaborating with private tech companies for Proof of Concept (PoC) studies.
- The first phase involves forecasting tax revenues, major local expenditures and personnel expenditures.

Artificial Intelligence (AI) Based Cash Flow Forecasting Project

- The project is planned to be developed in three phases.
  - The **first phase** involves creating forecasting models.
  - The **second phase** focuses on establishing and adapting to the Machine Learning Operations (MLOps) platform that plays a crucial role in model retraining and the continuous improvement of machine learning models.
  - The **third phase** is essential for enabling interactive communication with the model.

Phase-1: Forecasting Models

- Revenue Forecast
- Expenditure Forecast

Phase-2: MLOps Platform

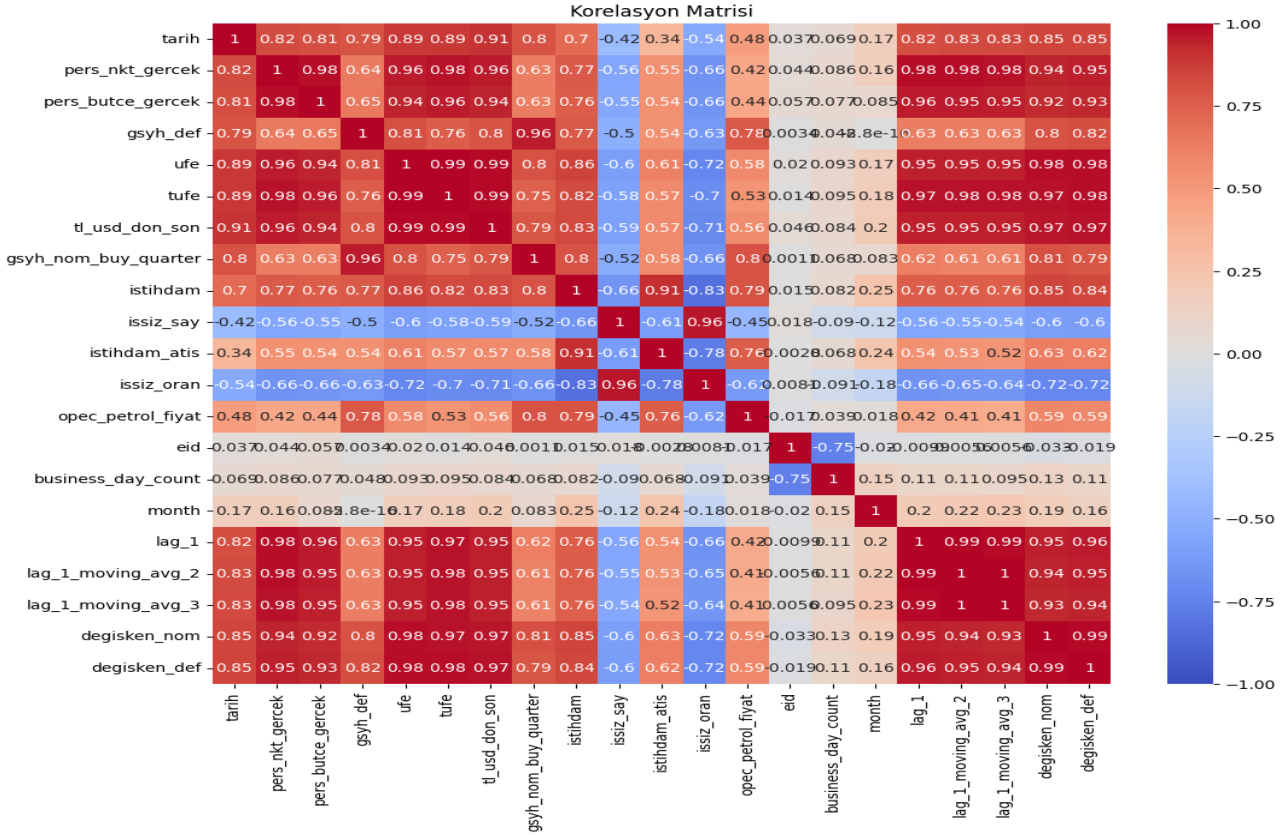
- Continuous Integration
- Continuous Delivery
- Continuous Training
- Continuous Monitoring
- Migration of forecast models to the MLOps platform

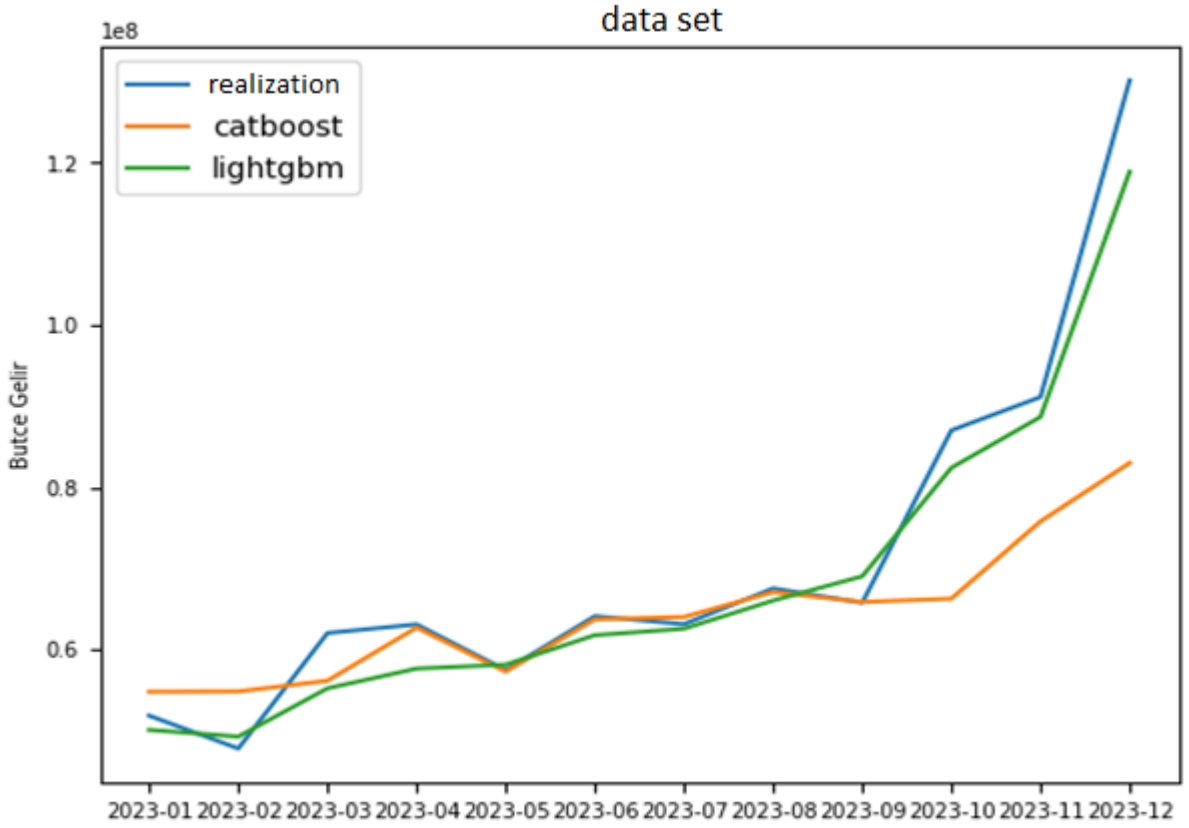
Phase-3: GenAI Based Chatbot

- Should work 'On-Prem.'
- Could predict the effects of major shock scenarios
- Medium to long term development
- Requires detailed analysis

Artificial Intelligence (AI) Based Cash Flow Forecasting Project

- So far, we have utilized several machine learning algorithms and statistical models such as CatBoost, LightGBM, ARIMAX, SARIMAX, Regression, and Prophet.
- The heatmap shows the correlation coefficients between independent variables, helping us understand their interdependencies.
- Among these, **the most promising result**s were achieved with the CatBoost and **LightGBM algorithms**.



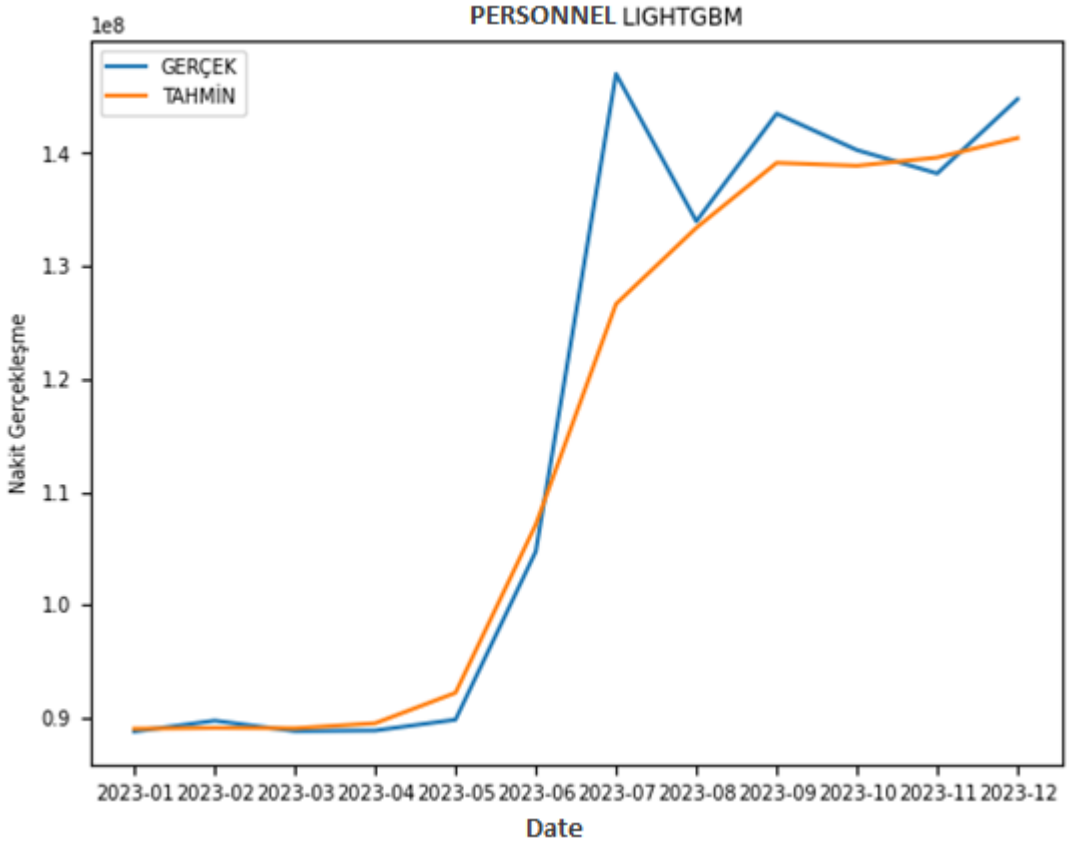


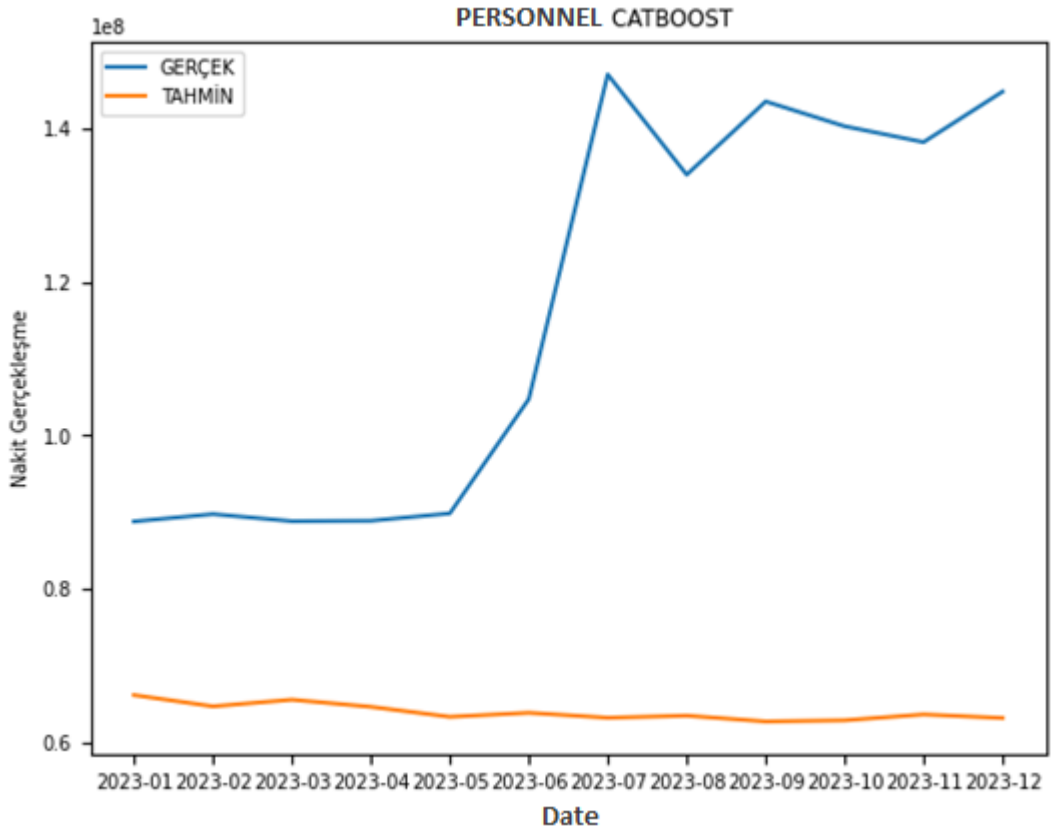
Machine Learning Models (LightGBM and CatBoost)

- **CatBoost Model:**
  - Developed by Yandex.
  - Performs well with categorical data (e.g., names, regions).
  - Reduces preprocessing and handles missing data.
  - Used for tasks like classification, regression, and **trend predictions in finance**.

- **LightGBM Model:**
  - Developed by Microsoft.
  - Handles large datasets efficiently with a fast, leaf-wise tree-building method.
  - Performs well with high-dimensional data while staying accurate.
  - **Ideal for forecasting** and ranking tasks, especially when speed and scalability matter.

Results for Personnel Related Cash Flows

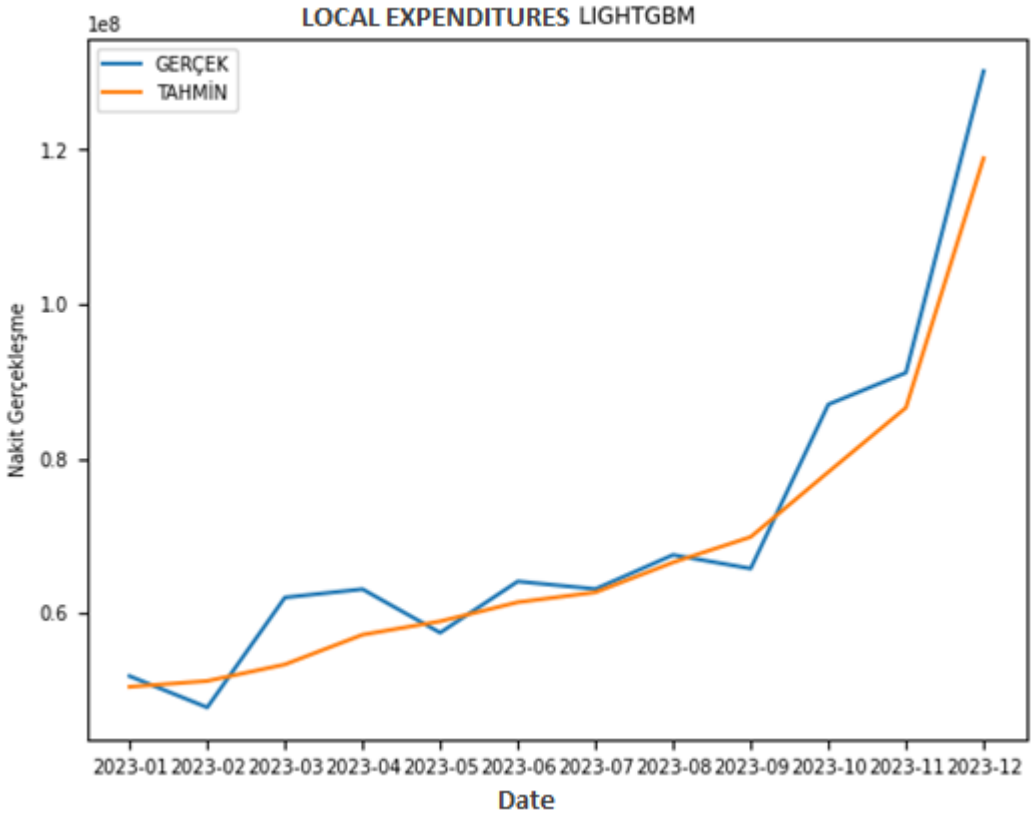


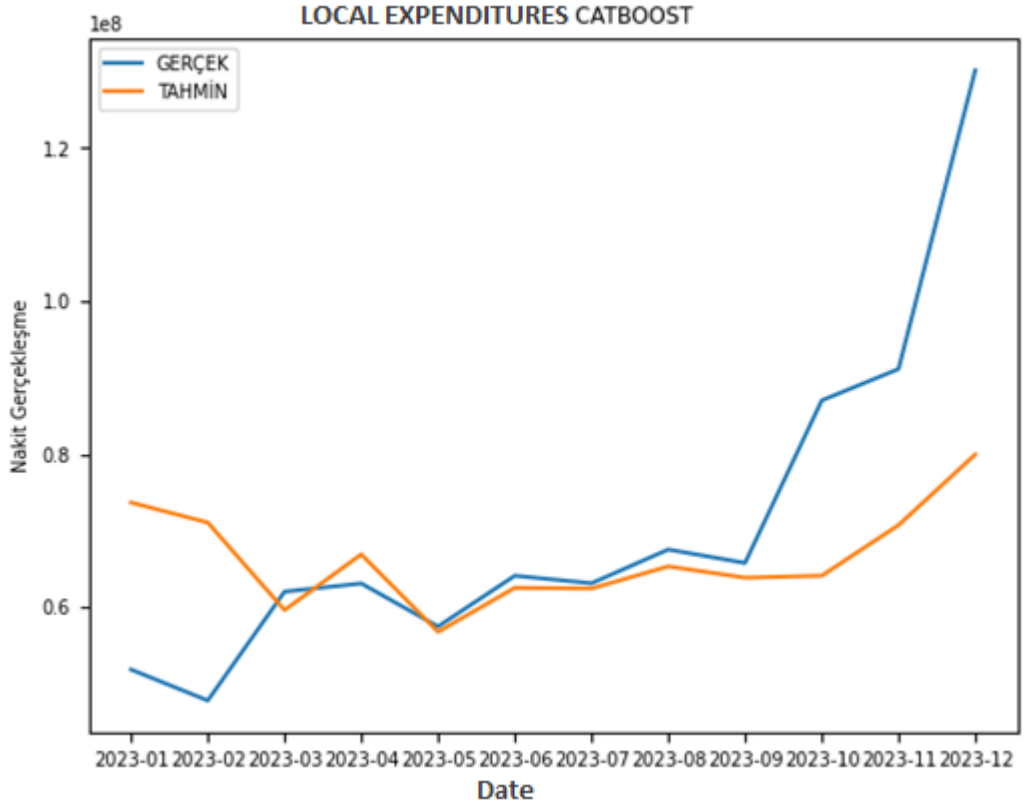


- **LightGBM** model shows promising results for forecasting monthly personnel-related cash flows, with predictions closely tracking actual values.
- The model handles seasonal variations reasonably well, though there are minor discrepancies during mid-year

- **CatBoost** model, in its current form, is insufficient for forecasting personnel-related cash flows.
- The flat-line forecast indicates a need for better model tuning to capture seasonal spikes like the one seen in July.

Results for Local Expenditures Related Cash Flows





- **LightGBM** performs better in terms of stability and alignment with actual cash flows,
- **CatBoost** seems more volatile and misses key trends mid-year.
- Both models, however, need improvement to address the sharp increase in cash flows towards the end of the year, indicating the presence of seasonal cash surges (december surge) that neither model fully captures.

Artificial Intelligence (AI) Based Cash Flow Forecasting Project

- We envisage that the completion of the cash forecasting phase of the project will also pave the way for addressing other issues related to cash management.
- We are currently in the initial stages and anticipate that it will take about two years to complete these phases.

Ideal Cash Reserve and Cash Buffer Levels

- Determine the **ideal cash reserve**.
- Establish the **cash buffer** level to mitigate liquidity risk.
- Ensure **adequate liquidity** throughout the year.

Portfolio Management

- Determine **optimal composition** of TL foreign currency, and gold.
- Evaluate **income and expense flows** alongside projected **domestic and external debt servicing** figures.
- Enhance **effective reserve management** aligned with the Treasury's strategic objectives.

Remuneration

- Provide **investment recommendations**.
- Identify **suitable alternative investment** instruments.
- Enhance management of the Treasury's **cash reserves.**

REPUBLIC OF TÜRKİYE
MINISTRY OF TREASURY AND FINANCE

Thank You For Your Attention

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