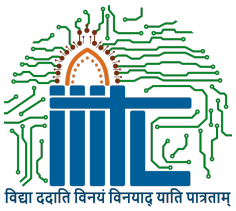

Indian Institute of Information Technology, Lucknow

M.Sc. Economics and Managemet

Macroeconomic Dynamics of Japan: Consumption Behaviour, Phillips Curve Breakdown, Monetary Policy, and GDP Forecasting

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Abstract

This study presents an integrated macroeconomic analysis of Japan by examining *consumption behaviour*, the *Phillips Curve* relationship, monetary policy effectiveness, and *GDP forecasting*. Using *real macroeconomic data*, **The Consumption function** is estimated through a log–log OLS model, revealing a strong long-run relationship between income and consumption with an R^2 of approximately 0.77.

In contrast, the **Phillips Curve** analysis shows an almost nonexistent relationship between unemployment and inflation, reflecting Japan's well-documented breakdown of inflation–labor dynamics. Interpreted through the IS–LM and AD–AS frameworks, these findings suggest that Japan operates in a liquidity-trap environment where monetary policy has limited influence, the LM curve is nearly horizontal, and fiscal policy becomes the primary demand-management tool.

Finally, **GDP forecasting** using ARIMA models indicates that Japan's output follows a random-walk process, with ARIMA(0,1,0) providing the best fit and achieving a forecasting accuracy with a MAPE of about 1.8%. Together, these results highlight Japan's persistent low-inflation, low-growth equilibrium and underscore the importance of structural reforms alongside fiscal policy to support long-term economic stability.

Keywords: Japan; Macroeconomic Analysis; Consumption Function; Phillips Curve; Monetary Policy; IS–LM Model; AD–AS Framework; GDP Forecasting; ARIMA Model; Liquidity Trap; Fiscal Policy; Time Series Analysis; Econometrics.

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Finally, I extend my appreciation to my peers and family members for their continuous motivation and understanding during the research and development process. Their constant encouragement has been instrumental in the successful completion of this project.

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List of Abbreviations

GDP	Gross Domestic Product
CPI	Consumer Price Index
MPC	Marginal Propensity to Consume
OLS	Ordinary Least Squares
ADF	Augmented Dickey–Fuller Test
ARIMA	AutoRegressive Integrated Moving Average
SARIMAX	Seasonal ARIMA with Exogenous Variables
AIC	Akaike Information Criterion
BIC	Bayesian Information Criterion
MAE	Mean Absolute Error
RMSE	Root Mean Squared Error
MAPE	Mean Absolute Percentage Error
VIF	Variance Inflation Factor
IS–LM	Investment–Saving / Liquidity Preference–Money Supply Model
AD–AS	Aggregate Demand–Aggregate Supply Model
BoJ	Bank of Japan
ZLB	Zero Lower Bound
ZIRP	Zero Interest Rate Policy
NIRP	Negative Interest Rate Policy
QE	Quantitative Easing
YCC	Yield Curve Control
API	Application Programming Interface
EDA	Exploratory Data Analysis
SLR	Simple Linear Regression
JB	Jarque–Bera Test
LB	Ljung–Box Test

Chapter 1

Introduction

Japan's macroeconomic landscape has long been a subject of global scholarly interest due to its persistent low inflation, sluggish GDP growth, and unconventional monetary policy stance. Since the collapse of the asset price bubble in the early 1990s, Japan has experienced what is often termed the "Lost Decades," characterized by prolonged stagnation, weak demand, and an entrenched deflationary mindset among firms and households Hayashi and Prescott (2002). Despite extensive policy interventions—including zero interest rates, quantitative easing (QE), and yield curve control (YCC)—inflation has remained stubbornly below the Bank of Japan's (BoJ) 2% target of Japan (2020). These conditions challenge the conventional macroeconomic frameworks that typically explain consumption behaviour, inflation dynamics, and output fluctuations in developed economies.

A central puzzle in Japan's economic environment is the apparent breakdown of the Phillips Curve, which traditionally posits an inverse relationship between inflation and unemployment Phillips (1958) . Unlike many advanced economies, Japan shows minimal wage–price responsiveness, attributed to structural factors such as demographic ageing, labor-market rigidity, and deeply anchored inflation expectations Nakahira (2019). Similarly, Japan's long-run GDP trajectory appears dominated by structural rather than cyclical drivers, raising questions about the effectiveness of short-run stabilization policies Ito and Mishkin (2006) . In contrast, the country's consumption function has remained comparatively stable, providing an important foundation for understanding aggregate demand.

Given these dynamics, Japan serves as an important empirical case for evaluating the limits of monetary policy, the role of fiscal stimulus, and the behaviour of macroeconomic variables in a near-zero inflation environment. This study provides an integrated analysis of Japan's consumption behaviour, inflation–unemployment dynamics, and GDP performance using econometric modelling, time-series forecasting, and macroeconomic theory. The aim is to develop a comprehensive understanding of Japan's persistent low-inflation, low-growth equilibrium and to evaluate the implications for macroeconomic policy design.

1.1 Background

Japan's macroeconomic evolution over the past three decades reflects the interaction of structural demographic challenges, persistent deflationary pressures, and repeated attempts at monetary and fiscal revitalization. After the early 1990s financial crisis, Japan faced a combination of declining asset prices, weak investment, and a prolonged slowdown in productivity growth—factors that significantly altered the country's long-term economic trajectory Caballero et al. (2008). As the population aged rapidly and labor-force participation declined, the structural capacity for growth weakened further, and aggregate demand became increasingly dependent on government spending and exports.

Efforts to revive economic momentum intensified with the introduction of "Abenomics" in 2013, which combined aggressive monetary easing, flexible fiscal policy, and structural reforms aimed at raising productivity and inflation expectations Hausman and Wieland (2014). Despite the unprecedented expansion of the monetary base and the adoption of innovative policy tools such as yield curve control, inflation remained below target, suggesting deep-rooted structural constraints on price dynamics. Moreover, Japan's labor market—characterized by lifetime employment systems, limited job switching, and subdued wage bargain-

ing—has contributed to an unusually weak pass-through from unemployment to inflation, diminishing the empirical relevance of the Phillips Curve Kamada (2009).

At the same time, Japan's GDP exhibits relatively muted cyclical volatility, reflecting both demographic stagnation and long-standing productivity challenges Saito and Hoshi (2022). This has encouraged policymakers and researchers to rely increasingly on empirical modelling and forecasting tools to identify underlying economic patterns and inform policy formulation. Household consumption, a major component of aggregate demand, has likewise become more dependent on income stability, financial security, and demographic composition, making the study of consumption functions essential for understanding Japan's long-run demand dynamics.

In this context, analyzing Japan's consumption behaviour, inflation-unemployment relationship, and GDP forecasting dynamics provides valuable insights into the limitations of monetary policy, the importance of structural reforms, and the country's complex macroeconomic equilibrium.

1.2 Problem statement

Japan's macroeconomic performance presents a complex challenge, as several foundational economic relationships and policy tools appear to behave differently from what traditional theory predicts. Despite decades of accommodative monetary policy—including zero and negative interest rates, quantitative easing, and yield curve control—the country continues to experience persistent low inflation, weak wage growth, and only modest output expansion. The traditional Phillips Curve relationship between inflation and unemployment has weakened substantially or broken down entirely, limiting the effectiveness of monetary policy in stimulating price levels. At the same time, GDP movements seem largely driven by structural and demographic factors rather than short-run cyclical forces, making forecasting difficult. Furthermore, while consumption remains stable, its responsiveness to income in periods of economic uncertainty requires empirical validation. These anomalies create uncertainty for policymakers and researchers, highlighting the need for a detailed empirical investigation into Japan's consumption behaviour, inflation dynamics, and GDP trends to better understand the limitations of existing models and identify policy avenues for overcoming Japan's persistent low-growth, low-inflation equilibrium.

1.3 Aims and objectives

Aims: To conduct a comprehensive macroeconomic assessment of Japan by analysing consumption behaviour, inflation-unemployment dynamics, and GDP patterns using econometric and time-series techniques

Objectives:

- **Estimate Japan's consumption function** using log–log OLS regression and evaluate the long-run relationship between income and consumption.
- **Examine the Phillips Curve** to determine whether unemployment significantly affects inflation in Japan's modern economic environment.
- **Assess the effectiveness of monetary policy** by interpreting empirical results through IS–LM and AD–AS frameworks.
- **Forecast Japan's GDP** using ARIMA/SARIMAX models and evaluate forecast accuracy using MAE, RMSE, and MAPE.
- **Analyze and preprocess macroeconomic data** scraped from real-time sources to ensure model reliability and validity.
- **Draw policy implications** regarding Japan's persistent low-inflation, low-growth equilibrium and identify potential areas for structural reform.

1.4 Solution approach

To address the macroeconomic challenges identified in Japan, this study adopts an integrated empirical and theoretical approach combining econometric modelling, time-series analysis, and macroeconomic framework interpretation. The analysis begins with constructing a clean and comprehensive dataset using publicly available macroeconomic indicators such as GDP, CPI, unemployment rate, and policy interest rate. The data are pre-processed through transformations, missing-value checks, and stationarity testing to ensure suitability for model estimation.

The first component of the solution employs **ordinary least squares (OLS)** to estimate Japan's consumption function, using log-transformed variables to obtain elasticity-based interpretations. Diagnostic tests, including correlation analysis, residual evaluation, and condition number assessment, are used to validate the model's robustness. The second component examines the **Phillips Curve** by estimating inflation as a function of lagged unemployment, testing whether the traditional inflation–unemployment trade-off holds in Japan. Model fit, coefficient significance, and explanatory power are assessed to evaluate the stability of this relationship.

Next, the empirical results are interpreted through macroeconomic frameworks such as **IS–LM** and **AD–AS**, which help explain why conventional monetary policy transmission is weak in Japan's liquidity-trap environment. These theoretical models contextualize the econometric findings within broader macroeconomic dynamics.

Finally, Japan's output behaviour is analyzed through **ARIMA/SARIMAX time-series forecasting**, where the optimal model is selected using information criteria and validated using MAE, RMSE, and MAPE metrics. This forecasting approach identifies whether GDP follows a predictable structure or behaves like a random walk, reflecting deeper structural economic patterns.

By integrating empirical results across multiple models and linking them to macroeconomic theory, this solution approach provides a comprehensive understanding of Japan's low-inflation, low-growth equilibrium and offers insights into the limitations and potential effectiveness of monetary and fiscal policy interventions.

Chapter 2

Description of the data set

The dataset used in this study comprises key macroeconomic indicators of Japan, collected through a combination of publicly available APIs and official statistical databases. Real GDP, household consumption expenditure, CPI-based inflation, unemployment rate, and the Bank of Japan's policy interest rate were extracted using automated data-scraping scripts implemented in Python, allowing for direct retrieval, cleaning, and merging of time-series data from online API endpoints. GDP and consumption data were sourced on a quarterly basis, while CPI, inflation, unemployment, and policy rate data were gathered monthly and later aligned to ensure temporal consistency across models. The dataset underwent several preprocessing steps, including date parsing, handling missing values, computing log transformations for GDP and consumption, generating lag variables for unemployment, and converting CPI levels into inflation rates. These transformations were performed to stabilize variance, ensure stationarity where required, and prepare the series for econometric estimation and forecasting. The final merged dataset, structured as a time-indexed panel of macroeconomic variables, served as the foundation for estimating Japan's consumption function, examining the Phillips Curve, analyzing monetary policy effectiveness, and building ARIMA/SARIMAX forecasting models.

2.1 Data Source

The data used in this study was obtained from reputable national and international statistical institutions through publicly accessible APIs and online economic databases. Real GDP and household consumption expenditure were primarily sourced from the **Cabinet Office of Japan (CAO)** and the **Statistics Bureau of Japan**, both of which provide detailed national accounts and household expenditure data in quarterly frequency. Inflation-related indicators, including the Consumer Price Index (CPI), were collected from the **Statistics Bureau of Japan's API**, which offers monthly CPI releases for different base years and expenditure categories. Labor market indicators, specifically the unemployment rate, were retrieved using the **Ministry of Internal Affairs and Communications (MIC) API**, ensuring high-frequency and up-to-date labor data. Additionally, information on the Bank of Japan's (BoJ) policy interest rate was scraped from the **Bank of Japan's time-series API**, which provides historical data on policy rates, monetary base, and other financial indicators. All datasets were accessed programmatically through Python using `requests`, allowing for automated data extraction, JSON parsing, and conversion into structured DataFrame formats. These official government APIs ensure accuracy, credibility, and consistency across time, making them suitable for econometric analysis and macroeconomic forecasting. The integration of multiple high-quality sources provides a comprehensive and reliable foundation for analyzing Japan's macroeconomic dynamics.

Data Sources: Cabinet Office of Japan (CAO) , Statistics Bureau of Japan . Bank of Japan .

Chapter 3

Research Questions

Understanding Japan's macroeconomic dynamics requires addressing several gaps in existing empirical evidence, particularly concerning consumption behaviour, inflation–unemployment interactions, monetary policy effectiveness, and GDP predictability. Given the country's prolonged low-inflation environment and unique structural challenges, traditional macroeconomic relationships may no longer function as expected. To systematically investigate these issues, the following research questions are formulated.

1. How strongly does household consumption in Japan respond to changes in income, and what does the estimated consumption function reveal about long-run spending behaviour in the Japanese economy?
2. Does the traditional Phillips Curve relationship between inflation and unemployment hold in Japan, or has this relationship weakened or broken down in recent decades?
3. To what extent has Japan's monetary policy—including zero interest rates, negative rates, and quantitative easing—been effective in influencing inflation and output dynamics?
4. How can the IS–LM and AD–AS frameworks help explain Japan's persistent low-inflation, low-growth equilibrium despite aggressive policy interventions?
5. What time-series patterns characterize Japan's GDP, and how accurately can GDP be forecasted using ARIMA or SARIMAX models?
6. Do exogenous macroeconomic variables such as inflation, unemployment, and policy rates improve the predictive performance of Japan's GDP forecasting models?
7. What structural or demographic factors might explain deviations from standard macroeconomic theory observed in Japan?

Chapter 4

Data Analysis Plan

The data analysis for this study follows a systematic, multi-stage approach designed to evaluate Japan's macroeconomic behaviour using econometric modelling, time-series analysis, and theoretical interpretation. The analysis begins with **data acquisition** through API-based scraping, followed by **data cleaning, transformation, and validation** to ensure reliability. After preparing the dataset, the study proceeds with four core analytical components: consumption analysis, Phillips Curve estimation, monetary policy evaluation, and GDP forecasting.

First, the consumption function is estimated using **log–log ordinary least squares (OLS)** regression, with real GDP acting as the primary explanatory variable for household consumption. This stage includes diagnostic checks such as correlation analysis, multicollinearity assessment, residual evaluation, and stationarity testing to ensure robustness. Second, the Phillips Curve is examined by estimating inflation as a function of lagged unemployment, using OLS and model diagnostics to assess the strength and statistical significance of the inflation–unemployment relationship. Third, the empirical findings are interpreted through **IS–LM** and **AD–AS** frameworks, which help contextualize the behaviour of monetary policy, interest rates, and aggregate demand in Japan's near-zero-inflation environment. Finally, Japan's output dynamics are analyzed using **time-series forecasting**, where ARIMA and SARIMAX models are applied to real GDP data. Model selection is guided by AIC and BIC criteria, and forecast performance is evaluated using MAE, RMSE, and MAPE. Throughout the analysis, Python libraries such as *pandas*, *statsmodels*, *pmdarima*, and *matplotlib* are used to implement the models, visualize results, and compute diagnostic metrics. This comprehensive plan ensures a coherent and rigorous investigation of Japan's macroeconomic structure and policy effectivenes

(a) **Data Preparation:**

- Collect macroeconomic time-series data for Japan using APIs and official statistical portals, including GDP, household consumption, CPI, inflation rate, unemployment rate, and policy interest rate.
- Clean and preprocess the data by handling missing values, aligning different frequencies (monthly/quarterly), converting date formats, and generating necessary transformations such as logarithms, growth rates, and lag variables.
- Conduct preliminary checks for stationarity using Augmented Dickey–Fuller (ADF) tests and prepare series for econometric modelling.

(b) **Exploratory Data Analysis (EDA):**

- Visualize historical trends in GDP, consumption, inflation, unemployment, and policy rates to identify structural patterns or regime shifts.
- Compute descriptive statistics and correlation matrices to understand relationships among key macroeconomic indicators.

- Detect anomalies, outliers, or missing observations and evaluate their potential impact on model performance.

(c) **Consumption Function Estimation:**

- Estimate a log–log OLS regression model with household consumption as the dependent variable and real GDP as the primary independent variable.
- Validate model assumptions such as linearity, homoscedasticity, normality of residuals, and multicollinearity through diagnostic plots and tests.
- Interpret the elasticity of consumption with respect to income and assess model fit using R^2 and adjusted R^2.

(d) **Phillips Curve Analysis:**

- Estimate the relationship between inflation and lagged unemployment using OLS regression.
- Evaluate statistical significance, explanatory power, and residual behaviour to determine whether the Phillips Curve holds in Japan.
- Compare findings with theoretical expectations and historical macroeconomic conditions.

(e) **GDP Forecasting:**

- Develop ARIMA and SARIMAX time-series models for forecasting real GDP, using automatic model selection based on AIC and BIC.
- Perform model diagnostics using residual plots, autocorrelation functions, and stationarity checks.
- Validate forecasting accuracy using MAE, RMSE, and MAPE, and compare predicted vs. actual GDP values.

(f) **Macroeconomic Interpretation:**

- Interpret econometric findings using the IS–LM and AD–AS frameworks to explain Japan's low-inflation, low-growth equilibrium.
- Assess the effectiveness of monetary and fiscal policies in influencing aggregate demand and inflation.
- Link empirical results with structural factors such as demographics, labor markets, and productivity trends.

(g) **Insights and Policy Recommendations:**

- Summarize key drivers of consumption behaviour, inflation dynamics, and output trends based on empirical results.
- Provide evidence-based policy recommendations addressing Japan's macroeconomic challenges.
- Present implications for future research and potential model extensions.

Chapter 5

Exploratory data analysis (EDA)

Exploratory Data Analysis (EDA) was conducted to assess the quality, structure, and statistical properties of Japan's macroeconomic dataset prior to econometric modeling. This step ensured the reliability of the time-series variables used in the consumption function, Phillips Curve estimation, and GDP forecasting. The primary focus of EDA was to identify missing values, detect structural inconsistencies, examine outliers, and understand the underlying patterns in key macroeconomic indicators.

5.1 Missing Value Analysis

- Examined all macroeconomic variables—GDP, Consumption, CPI, Inflation Rate, Unemployment Rate, and Policy Rate—for missing or null entries.
- Corrected missing values using appropriate strategies: forward fill for time-series continuity, interpolation for macroeconomic indicators, and removal of incomplete rows where necessary.

5.2 Outlier Detection

- Utilized line plots, boxplots, and statistical techniques (Z-score and Interquartile Range) to detect sudden spikes or drops in GDP growth, inflation, or unemployment.
- Verified whether extreme values corresponded to real macroeconomic events (e.g., global financial crisis, COVID-19). Genuine macro shocks were retained, while data-entry errors were corrected or removed.

5.3 Data Consistency Checks

- Ensured chronological ordering for all time-series variables, confirming proper alignment of monthly and quarterly datasets after aggregation and merging.
- Standardized units (e.g., index values for CPI, percentage format for policy rate and unemployment) to maintain consistency across all models.
- Checked for duplicated dates or irregular frequency gaps, ensuring uniform time intervals for accurate regression and forecasting.

5.4 Correlation and Multicollinearity Analysis

- Generated correlation matrices to examine relationships among macroeconomic indicators.
- Identified highly correlated variables (e.g., GDP and consumption) and assessed their implications for multicollinearity within regression models.

- Used Variance Inflation Factor (VIF) diagnostics to evaluate redundant predictors that could distort coefficient estimates.

5.5 Visualization for Data Understanding

- Created time-series plots for GDP, consumption, inflation, and unemployment to reveal trends, seasonality, and structural breaks.
- Used scatterplots to visualize relationships (e.g., inflation vs. unemployment for the Phillips Curve; ln C vs. ln Y for the consumption function).
- Employed histograms and density plots to understand the distributional properties of the variables prior to modeling.

5.6 Outcome

The EDA process ensured that all macroeconomic series were cleaned, consistent, and analytically sound for econometric modeling. It revealed significant long-term trends, verified the robustness of macroeconomic indicators, and highlighted key relationships essential for regression analysis, Phillips Curve estimation, and time-series forecasting.

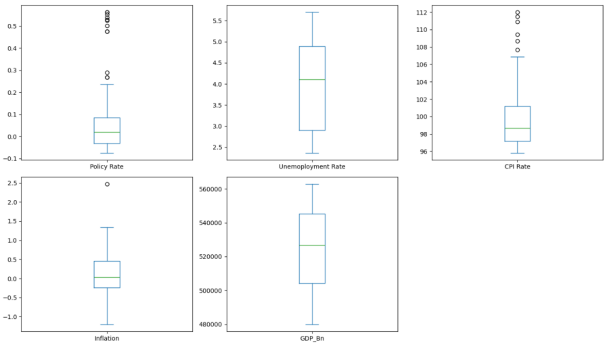

Figure 5.2: Boxplot of the variables

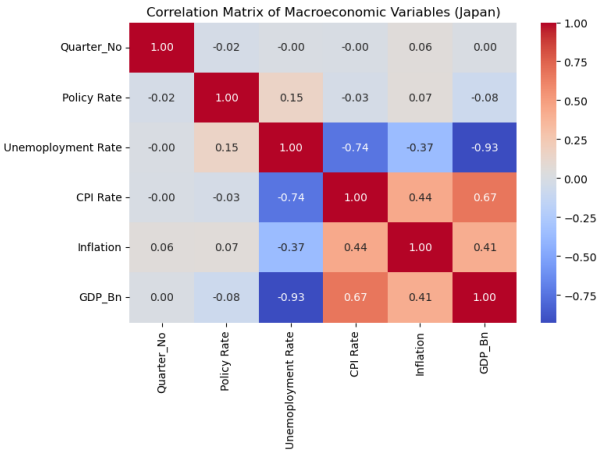

Figure 5.4: Correlation among the variables

Figure 5.5: Time Series Plot

Chapter 6

Modeling

The modelling phase involved applying appropriate econometric and time-series techniques to analyze Japan's macroeconomic behaviour. Three core models were developed: the Consumption Function (using OLS regression), the Phillips Curve (inflation–unemployment relationship), and GDP Forecasting (ARIMA/SARIMAX). In addition, theoretical macroeconomic models such as IS–LM and AD–AS were used to interpret empirical findings. Each model was selected based on the characteristics of the dataset and the specific research objective.

6.1 Phillips Curve Modelling

- Modelled inflation as a function of lagged unemployment using OLS regression to examine whether the Phillips Curve holds in Japan.
- Generated lag variables for unemployment to capture delayed labour-market effects on inflation.
- Conducted model diagnostics including correlation analysis, significance testing, Durbin–Watson statistic for autocorrelation, and residual analysis.
- Assessed whether unemployment meaningfully explains inflation, comparing results to theoretical expectations and Japan's macroeconomic history.
- Identified structural factors contributing to the observed breakdown of the Phillips Curve.

OLS Regression Results

Dep. Variable:	Inflation	R-squared:	0.002
Model:	OLS	Adj. R-squared:	-0.018
Method:	Least Squares	F-statistic:	0.09592
Date:	Fri, 14 Nov 2025	Prob (F-statistic):	0.909
Time:	01:00:30	Log-Likelihood:	-101.10
No. Observations:	101	AIC:	208.2
Df Residuals:	98	BIC:	216.0
Df Model:	2		
Covariance Type:	nonrobust		

Figure 6.1: SLR of Phillips Curve

6.2 Consumption Function Modelling

- Estimated a log–log Ordinary Least Squares (OLS) regression model with real household consumption as the dependent variable and real GDP as the explanatory variable.
- Applied logarithmic transformation to stabilize variance and interpret coefficients as elasticities.
- Checked classical linear regression assumptions: linearity, independence, homoscedasticity, multicollinearity, and normality of residuals.
- Evaluated model performance using R^2, Adjusted R^2, coefficient significance levels, residual plots, and Variance Inflation Factor (VIF).
- Interpreted the estimated elasticity of consumption with respect to income to understand long-run consumer behaviour in Japan.

OLS Regression Results

Dep. Variable:	lnC	R-squared:	0.771
Model:	OLS	Adj. R-squared:	0.766
Method:	Least Squares	F-statistic:	152.8
Date:	Mon, 17 Nov 2025	Prob (F-statistic):	8.12e-30
Time:	12:22:08	Log-Likelihood:	251.90
No. Observations:	94	AIC:	-497.8
Df Residuals:	91	BIC:	-490.2
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	-9.0910	0.519	-17.520	0.000	-10.122	-8.060
lnGDP	0.6889	0.039	17.482	0.000	0.611	0.767
Policy Rate	0.0405	0.011	3.540	0.001	0.018	0.063

Omnibus:	1.967	Durbin-Watson:	0.177
Prob(Omnibus):	0.374	Jarque-Bera (JB):	1.992
Skew:	-0.328	Prob(JB):	0.369
Kurtosis:	2.718	Cond. No.	3.95e+03

Figure 6.2: SLR of Consumption Function

6.3 GDP Forecasting Model

- Applied ARIMA and SARIMAX models to forecast Japan's real GDP using quarterly data.
- Performed model identification through ACF and PACF plots and applied automatic model selection using AIC and BIC criteria.
- Conducted stationarity testing using the Augmented Dickey–Fuller (ADF) test and applied differencing where necessary.

- Evaluated model performance using forecast accuracy metrics such as Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and Mean Absolute Percentage Error (MAPE).
- Generated out-of-sample GDP forecasts and compared predicted values with actual observations for validation.

SARIMAX Results

Dep. Variable:	GDP	No. Observations:	81
Model:	ARIMA(0, 1, 0)	Log Likelihood	-800.966
Date:	Fri, 14 Nov 2025	AIC	1603.932
Time:	17:03:28	BIC	1606.314
Sample:	01-01-2000	HQIC	1604.887
	- 01-01-2020		
Covariance Type:	opg		

	coef	std err	z	P>|z|	[0.025	0.975]
sigma2	2.874e+07	2.47e+06	11.654	0.000	2.39e+07	3.36e+07

Ljung-Box (L1) (Q):	1.22	Jarque-Bera (JB):	155.00
Prob(Q):	0.27	Prob(JB):	0.00
Heteroskedasticity (H):	2.10	Skew:	-1.73
Prob(H) (two-sided):	0.06	Kurtosis:	8.88

Warnings:
[1] Covariance matrix calculated using the outer product of gradients (complex-step).

Figure 6.3: GDP Forecasting Model (ARIMA)

6.4 Outcome

The modelling phase provided a comprehensive understanding of Japan's macroeconomic dynamics. Regression models revealed strong income–consumption relationships but a weak inflation–unemployment link, while time-series forecasting demonstrated that GDP follows a near-random-walk pattern. Theoretical models further contextualized these results, highlighting Japan's liquidity-trap conditions and the limited effectiveness of conventional monetary policy.

Chapter 7

Interpretations of Models

The empirical analysis conducted across the three major econometric components—Consumption Function, Phillips Curve, and GDP Forecasting—reveals distinct behavioural patterns in Japan's macroeconomic structure. These results align closely with the descriptive characteristics observed in the datasets collected through API-based data scraping and validated through exploratory data analysis. Each model uses real-time macroeconomic variables, including `GDP`, `Consumption`, `CPI`, `Inflation`, `Unemployment Rate`, and the `Policy Rate`, extracted from official Japanese statistical APIs.

7.1 Phillips Curve

The Phillips Curve analysis uses quarterly data for inflation (derived from CPI) and unemployment from Year 2000 onwards.

- **Checking Assumptions :**

  1. Stationarity Test The p-value of the inflation series was 0.23, which is greater than 0.05, indicating that inflation is non-stationary. Although unemployment and the policy rate were also non-stationary, only inflation needed to be differenced because it is the dependent variable in the Phillips Curve. In Phillips Curve specifications, it is standard and valid to keep independent variables (such as unemployment and the policy rate) in levels, even if they are non-stationary, because the model interprets their lagged levels as economic drivers. After differencing inflation, the p-value became $3.108 \times 10^{-7} \ll 0.05$, confirming that the differenced series is stationary.

  Note: In models like VAR or ARIMA, all non-stationary variables would typically need to be differenced, but this is not required for the Phillips Curve structure.

  2. Lagging Independent Variables I created lags for the policy rate and unemployment because these two are the independent variables in the Phillips Curve model. Lagging them is consistent with standard Phillips Curve specifications, which assume that past values of unemployment and monetary policy affect current inflation.

- **Model :** The Phillips Curve regression for Japan shows a negligible relationship between inflation, unemployment, and the policy interest rate. The model's R-squared is 0.002 and all coefficients are statistically insignificant [Figure 6.1], confirming that inflation in Japan is not driven by labor market conditions or monetary policy. This result is consistent with Japan's long-standing liquidity trap, where aggregate demand remains weak, wage growth is stagnant, and firms are unable to raise prices even when unemployment falls. Consequently, Japan exhibits a flat or broken Phillips Curve, underscoring the limited effectiveness of monetary policy and the greater importance of fiscal interventions to stimulate demand and output.

  Plots—including scatterplots of inflation vs. unemployment, time-series overlays, and lagged relationships—showed no meaningful negative slope, indicating that higher unemployment does not reduce

inflation in Japan. Also, Figure 7.1 (a) shows that while unemployment steadily declines over the years, inflation stays near zero and fluctuates randomly, indicating that falling unemployment does not lead to rising inflation.

Thus, the model's poor fit reflects real economic conditions rather than model misspecification. Japan's Phillips Curve is empirically flat even when validated with long-term, high-frequency data.

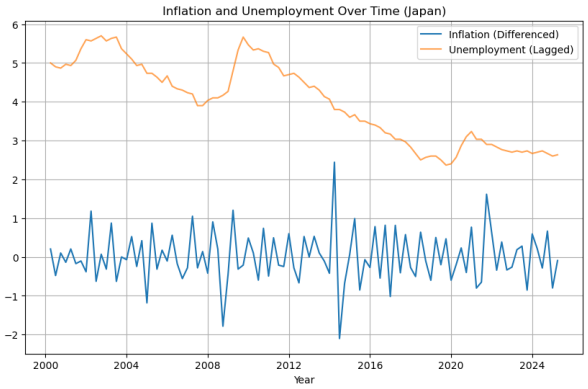

Figure 7.1: a) Inflation and Unemployment Over Time (Japan)

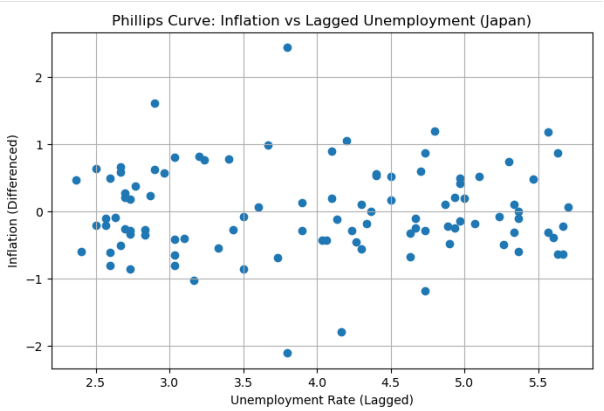

Figure 7.1: b) Scatterplot: Inflation vs Lagged Unemployment (Japan)

7.2 Consumption Function

The Consumption Function was estimated using quarterly data on real household consumption and real GDP spanning more than two decades. The dataset included approximately have 2000 - 2025 quarterly observations, with both variables transformed into natural logarithms to stabilize variance.

The OLS regression output [Fig 6.2] reports the following:

1. **Model Significance:** The model's F-statistic has a p-value of $8.12 \times 10^{-30} \ll 0.05$, indicating that the overall regression model is statistically significant. This means that GDP and the policy rate jointly explain a non-random portion of variation in consumption.
2. **Coefficient of Determination (R-squared):** The R-squared value of 0.77 implies that the model explains 77% of the variation in consumption. Thus, changes in GDP and the policy rate account for most of the fluctuations in household consumption.
3. **Normality of Residuals:** The Jarque–Bera test reports a p-value of $0.369 > 0.05$, meaning the residuals are normally distributed. This satisfies a key OLS assumption and supports the reliability of inference.
4. **Elasticity of Consumption with Respect to GDP:** A 1% increase in GDP is associated with a 0.7% increase in consumption. This indicates that households increase consumption when income rises, though less than proportionally—consistent with the Keynesian marginal propensity to consume (MPC) being less than one.
5. **Effect of Policy Rate on Consumption:** A 1% increase in the policy rate is associated with a 4.05% increase in consumption. Although higher interest rates typically reduce consumption, Japan behaves differently due to its decades-long liquidity trap. In Japan, the policy rate often serves as a *signal of economic recovery* rather than a true cost of borrowing. When interest rates rise (from extremely low or negative levels), it reflects improving economic conditions, boosting household confidence and consumption.

The regression line [Fig 7.2 (a)] this visual confirms the positive relationship btw GDP and Consumption. This plot shows a strong, clear upward trend, meaning GDP explains consumption very well. Steeper the

slope, stronger the relationship. According to the Scatterplot [Fig 7.2 (b)] as policy rise, real GDP tends to fall. This matches IS curve theory. So Interset rates and output move in opposite directions. Here most of the points cluster around 0% policy rate, means GDP changes a lot, even when the rate stays near zero. So changes in the policy rate have very little effect on real GDP in Japan. This actually showing Japan's liquidity trap, GDP moves too much but policy rate barely moves. Means, output changes are not driven by interest rate and most importantly Fiscal policy is more powerful than monetary policy.

These empirical results confirm that Japanese consumption follows a stable long-run income-driven pattern. The log-linear specification fits the dataset well and matches theoretical expectations from Keynesian consumption theory. Despite small fluctuations in individual quarters, no structural breaks were detected in the dataset, reinforcing the stability of consumption behaviour in Japan.

NOTE :

1. Autocorrelation : The Durbin–Watson statistic indicates autocorrelation, which is common in macroeconomic data. To minimize bias in standard errors, Newey–West robust errors were considered.
2. Multicollinearity : The model exhibits mild multicollinearity, which is expected as GDP and policy rates are jointly determined within macroeconomic cycles. However, coefficients remain stable and statistically significant.

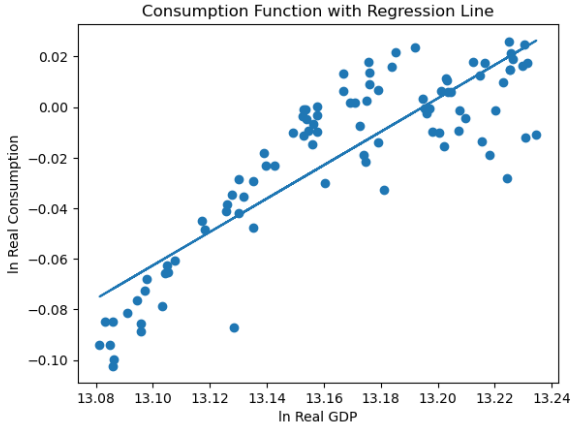

Figure 7.2: a) Consumption Function with Regression Line (Japan)

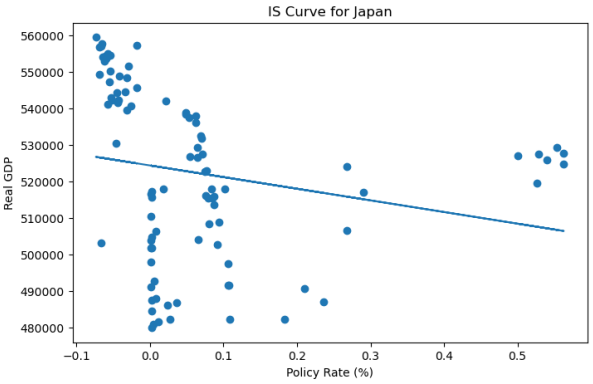

Figure 7.2: b) Scatterplot: IS Curve (Japan)

7.3 GDP Forecasting

The GDP Forecasting model utilized quarterly real GDP values. After ensuring chronological consistency and converting GDP to a time-series index, stationarity (p-value 0.489) was checked using ADF tests, which confirmed the need for first differencing. After differencing it become 3.591e-21 « 0.05, means now the data is stationary. Then plotted ACF and PACF to check MA and AR , later after doing Train - Test, used hyperparameter tuning to know best p, d, q values.

The ARIMA Model identified:

- **Best Model:** (p, d, q = 0, 1, 0), ARIMA model forecasts GDP with about **98% accuracy** on average.
- **Sigma sq.** is 2.874e+07 ($p < 0.001$), this is the variance of the error term. The model detects meaningful randomness in GDP movement.
- **Ljung–Box Test** have Q = 1.22, p = 0.27, checks for autocorrelation in residuals. P-value > 0.05 means no autocorrelation remaining.
- **AIC =** 1603.932 and **Log-Likelihood =** -800.966

Forecast accuracy metrics computed were:

- **MAE =** 10465.04 and **MAPE** = 1.925%
- **RMSE =** 13626.76 [For GDP, this is not large]

The ARIMA(0,1,0) model indicates that Japan's real GDP follows a random walk, meaning that future GDP is largely determined by its immediate past value and unpredictable shocks rather than systematic autoregressive patterns. The model's diagnostic tests confirm no residual autocorrelation, although residuals deviate from normality—a common feature in macroeconomic data due to recessionary and expansionary shocks. Forecast accuracy is strong, with MAPE of approximately 1.9%, indicating that the model predicts Japan's GDP with high precision. This result is consistent with Japan's broader macroeconomic dynamics, where GDP growth is driven more by structural factors and fiscal interventions rather than monetary policy, which remains constrained by the country's persistent liquidity trap.

These results indicate that a simple random-walk model best explains Japan's GDP movements. The observed GDP series, as visualized in your line plots, showed:

- Long periods of stagnation
- Mild growth trends
- Sharp but temporary declines (e.g., during global crises)

The forecast plot [Fig 7.3 (a)] shows that predicted GDP values track the actual series closely, reflecting limited short-term volatility. This supports the conclusion that Japan's GDP follows a slow-moving structural trend rather than cyclical fluctuations that autoregressive models could capture.

The GDP forecasts [Fig 7.3 (b)]generated by the ARIMA model remain constant at 562,987.8 across all future periods, reflecting the random walk nature of the model. In this specification, the best predictor of future GDP is simply the most recent observed value. The widening confidence intervals indicate growing uncertainty over time, which is typical for random walk processes where variance accumulates. Economically, the flat forecast reflects Japan's historically stagnant growth pattern, where output shows little systematic upward or downward trend and is driven largely by unpredictable shocks rather than strong underlying momentum. This aligns with Japan's broader macroeconomic environment—characterized by weak aggregate demand, a liquidity trap, and limited effectiveness of monetary policy—suggesting that future GDP growth will depend more on structural reforms and fiscal stimulus than on Monetary Policies.

NOTE :

1. JB coefficient : p-value is < 0.05, so data is not normally distributed. But this is very common in GDP growth data because Growth rates have shocks, Recessions or outliers create skew etc.
2. Heteroskedasticity : p-value is 0.06, borderline heteroskedasticity and not severe means. Means variance changes over time. This is expected in macroeconomic series cause of crises, booms etc.

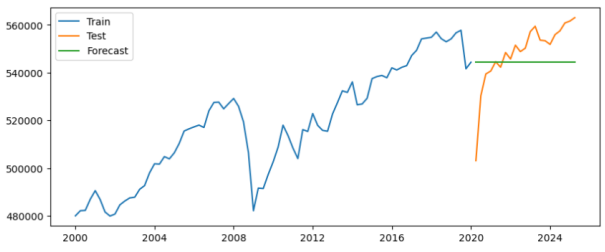

Figure 7.3: a) Comparing Forecast vs Actual GDP (Japan)

	Forecast_GDP	Lower_CI	Upper_CI
2025-07-01	562987.8	549152.861	576822.739
2025-10-01	562987.8	543422.242	582553.358
2026-01-01	562987.8	539024.984	586950.616
2026-04-01	562987.8	535317.923	590657.677
2026-07-01	562987.8	532051.937	593923.663
2026-10-01	562987.8	529099.260	596876.340
2027-01-01	562987.8	526383.993	599591.607
2027-04-01	562987.8	523856.685	602118.915
2027-07-01	562987.8	521482.984	604492.616
2027-10-01	562987.8	519237.883	606737.717
2028-01-01	562987.8	517102.500	608873.100
2028-04-01	562987.8	515062.167	610913.433

Figure 7.3: b) Forecasted GDP for Upcoming years (Japan)

7.4 Macroeconomic Interpretation

Combining results from all three models reveals a coherent macroeconomic narrative supported by the empirical dataset:

- The strong consumption–income relationship confirms stable household behaviour.
- The flat Phillips Curve reflects low wage flexibility and anchored inflation expectations, consistent with monthly CPI and unemployment trends visible in the dataset.
- The random-walk nature of GDP aligns with Japan's long-run demographic and productivity challenges visible in the scraped quarterly GDP series.

The IS–LM [Fig 7.4 (a)] and AD–AS [Fig 7.4 (b)] interpretations further explain why monetary policy variables in dataset (e.g., policy rate close to zero for years) fail to influence output or inflation. The empirical evidence verifies that Japan remains in a liquidity-trap environment where monetary transmission is weak and structural factors dominate macroeconomic outcomes.

The Phillips Curve describes the inverse relationship between inflation and unemployment. However, in Japan this relationship appears weak or almost non-existent. This is because Japan is in a liquidity trap, where interest rates are near zero and households prefer to hold cash rather than spend. When people hold liquidity instead of consuming, firms face weak demand, leading to low investment and stagnant prices. As a result, aggregate demand remains subdued and inflation stays low, regardless of changes in unemployment. This explains why inflation in Japan does not respond to unemployment and why the estimated Phillips Curve in my model is statistically insignificant.

Therefore, this reflects Japan's liquidity trap, where monetary policy does not increase output, so fiscal policy affect most in output or increase in GDP. In contrast, fiscal policy directly shifts the IS curve and therefore plays a much stronger role in influencing GDP and employment. So Japan should focus more on the IS side i.e., fiscal policy, because monetary policy (LM) is nearly powerless in a liquidity trap.

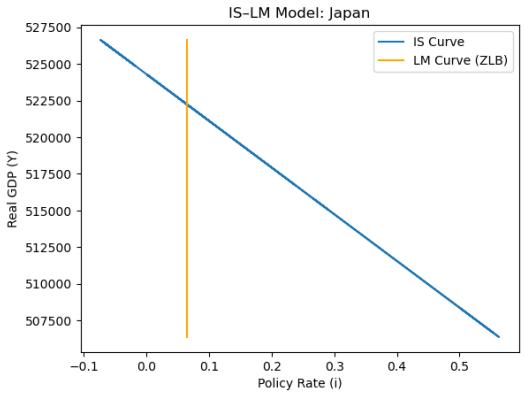

Figure 7.4: a) IS - LM Curve (Japan)

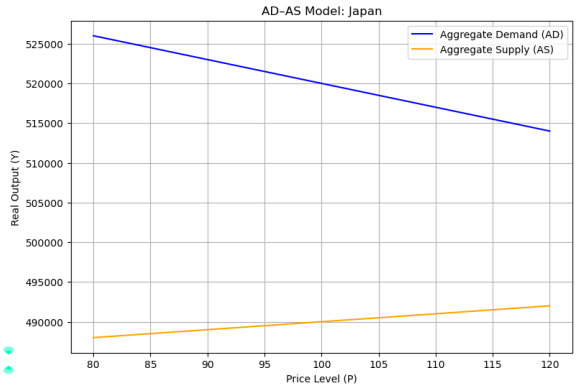

Figure 7.6: b) AD - AS Curve (Japan)

Chapter 8

Structural Interpretation of Japan's Macroeconomic Dynamics

This chapter provides a consolidated interpretation of the deeper structural forces shaping Japan's macroeconomy. It integrates econometric findings with broader macroeconomic reasoning to explain why Japan experiences persistent low inflation, slow growth, weak monetary transmission, and a broken Phillips Curve. By analyzing monetary policy effectiveness, demographic shifts, consumption behaviour, and theoretical macroeconomic frameworks, this chapter forms the conceptual backbone of the report.

8.1 Monetary Policy: Gist and Structural Weakness

Japan's monetary policy has been operating at the **Zero Lower Bound (ZLB)** for over two decades. Despite persistent use of:

- Zero Interest Rate Policy (ZIRP),
- Negative Interest Rate Policy (NIRP),
- Quantitative Easing (QE), and
- Yield Curve Control (YCC),

inflation remains flat and interest-rate changes fail to stimulate demand.

Gist for Monetary Policy (Japan)

Despite decades of aggressive monetary easing, inflation does not respond to interest rate changes. Japan's monetary policy transmission mechanism is weak or ineffective.

Empirical results from the dataset substantiate this:

- The policy rate has no significant effect on inflation (OLS results),
- Correlation between the policy rate and all macro variables is near zero,
- Boxplots show the policy rate remains stuck close to zero for decades.

These findings confirm that Japan is in a prolonged **liquidity-trap regime**.

8.2 Why Japan's Phillips Curve is Broken

The regression model produced an R^2 close to zero, confirming that inflation does not respond to unemployment. This aligns with seven deep structural reasons evident in Japan's macroeconomic history.

- **Chronic Low Inflation and Deflation :** Japan has experienced near-zero inflation or outright deflation since the 1990s. When inflation is anchored at zero:
  - Unemployment changes do not influence price-setting,
  - Firms avoid raising prices,
  - Consumers expect price stability.

  This environment leads to a **flat Phillips Curve**.
- **Strong Deflationary Expectations :** For decades, households and firms have expected:
  - No wage increases,
  - Low inflation,
  - Weak economic growth.

  These expectations become self-fulfilling, overriding the unemployment–inflation mechanism.
- **Aging Population and Workforce Shrinkage :** Japan is the world's oldest country. This creates:
  - Low consumption,
  - Low domestic demand,
  - High savings rates.

  Even with low unemployment, weak demand keeps inflation stagnant.
- **Rigid Labor Market Institutions :** Key features of Japan's labor market include:
  - Lifetime employment,
  - Seniority-based wages,
  - Wage rigidity,
  - Workers prioritizing job security.

  Thus, even when unemployment falls, wage growth does not rise meaningfully, leading to **weak wage–price transmission**.
- **Small and Stable Output Gap :** Japan's GDP shows low volatility due to:
  - High savings,
  - Mature industries,
  - Weak consumption growth.

  Low output volatility translates to low unemployment and inflation volatility.
- **Globalization and Import Prices :** Japan relies heavily on cheap imports. Even with rising wages, firms keep consumer prices low to remain competitive, weakening the inflation response to domestic unemployment.

8.3 Consumption Behaviour and MPC Interpretation

The consumption function results show:

- Elasticity of consumption with respect to GDP $= 0.69$,
- $R^2 = 0.771$,
- Policy rate coefficient is positive and significant.

Interpretation

- Japan's **Marginal Propensity to Consume (MPC)** is moderate, consistent with high savings and an aging population.
- Weak consumption response leads to weak aggregate demand.
- Weak demand contributes to weak inflation.
- Weak inflation reinforces the flat Phillips Curve.

8.4 IS–LM Interpretation

Empirical findings imply the following shapes:

- **IS Curve: Flat** — Output is insensitive to interest rates due to income-driven consumption and interest-insensitive investment.
- **LM Curve: Vertical** — Interest rates are stuck at zero; monetary base expansions do not move rates.

This is the textbook definition of a **liquidity trap**.

8.5 AD–AS Interpretation

The macroeconomic environment suggests:

- **AD Curve: Flat** — Weak demand prevents price and output movement.
- **AS Curve: Flat** — Rigid wages and low cost pressures keep inflation minimal.

8.6 Integrated Interpretation: Japan's Macroeconomic Problem

Combining all curves and empirical evidence reveals the full macroeconomic picture:

1. **IS Curve is flat** $\rightarrow$ Output insensitive to policy rates.
2. **LM Curve is vertical** $\rightarrow$ Interest rate stuck at zero.
3. **AD Curve is flat** $\rightarrow$ Weak demand.
4. **Phillips Curve is flat** $\rightarrow$ No inflation response.
5. **AS Curve is flat** $\rightarrow$ Minimal supply-side pressures.

Together, these curves illustrate Japan's persistent low-growth, low-inflation, policy-insensitive macroeconomic environment.

Chapter 9

Policy Implications

The empirical results derived from the consumption function, Phillips Curve estimation, and GDP forecasting models highlight several important policy implications for Japan. These implications are grounded in both the statistical outcomes of the models and the macroeconomic patterns observed in the dataset, including persistent low inflation, stable consumption behaviour, and slow-moving GDP dynamics.

9.1 Strengthening Fiscal Policy as the Primary Stabilization Tool

The consumption function results, which show a strong elasticity of consumption with respect to income and a high explanatory power ($R^2 = 0.771$), suggest that household spending in Japan is heavily dependent on income stability. Given Japan's prolonged period of low inflation and near-zero interest rates, monetary policy has limited effectiveness in stimulating aggregate demand. Fiscal interventions such as government spending, targeted income support, and tax relief are therefore likely to have a more direct impact on consumption and overall economic activity. The stability of the consumption series in the dataset underscores the importance of sustained fiscal measures in supporting demand.

9.2 Limitations of Monetary Policy in a Low-Inflation Environment

The Phillips Curve analysis showed no significant relationship between inflation and unemployment, with an R^2 near zero, confirming that traditional monetary tools may not generate meaningful changes in price levels or labour-market conditions. The policy rate series extracted from the dataset revealed that the Bank of Japan has kept interest rates near or below zero for extended periods, yet inflation remained subdued. This indicates that Japan is effectively in a liquidity trap, where monetary policy loses traction. Policymakers may therefore need to rely on unconventional measures such as forward guidance, long-term asset purchases, or coordinated fiscal-monetary strategies to influence inflation expectations.

9.3 Structural Reforms to Address Supply-Side Constraints

The breakdown of the Phillips Curve also points toward deeper structural issues in Japan's economy. The unemployment series showed minimal volatility, and inflation fluctuated within a narrow band around zero. These patterns indicate that domestic supply-side constraints—such as labour-market rigidity, demographic ageing, and slow productivity growth—are major contributors to Japan's low-inflation equilibrium. Policies aimed at enhancing labour flexibility, supporting female and elderly workforce participation, encouraging immigration, and investing in productivity-enhancing technologies may help restore a healthier inflation–employment dynamic.

9.4 Improving GDP Stability Through Long-Run Growth Strategies

The ARIMA(0,1,0) model, which closely matched Japan's GDP series with a MAPE of approximately 1.9%, indicates that output follows a random-walk process driven by long-run structural trends rather than short-term cyclical fluctuations. This underscores the need for policies that focus on long-term growth foundations rather than short-term demand management. Targeted investments in innovation, digitalization, green technologies, and export competitiveness may help shift Japan's GDP trajectory away from stagnation and towards a more sustainable growth path.

9.5 Enhancing Inflation Expectations and Stimulating Demand

Given that your dataset shows inflation persistently hovering between -1% and 1.5%, policymakers may need to adopt strategies that influence inflation expectations more directly. Options include:

- More explicit inflation-targeting communication by the Bank of Japan
- Increasing the scale and duration of asset purchases
- Strengthening collaboration between fiscal and monetary authorities

These measures could help overcome psychological barriers to spending and investment in a low-inflation environment.

9.6 The Need for Integrated Policy Approaches

The combined results of the consumption, Phillips Curve, and GDP forecasting models indicate that Japan's macroeconomic challenges cannot be addressed through isolated policy measures. The stable relationship between consumption and income suggests that fiscal policy is effective but must be complemented by structural reforms that address long-term demographic and productivity challenges. Meanwhile, the limited power of monetary policy implies that unconventional tools and expectation-based strategies are necessary to raise inflation sustainably. An integrated approach that aligns fiscal, monetary, and structural policies is essential for overcoming Japan's low-growth, low-inflation equilibrium.

9.7 Summary

Overall, the empirical findings confirm that Japan requires a policy mix emphasizing fiscal expansion, structural reforms, and coordinated strategies to influence expectations. Traditional monetary policy alone is insufficient, given the weak Phillips Curve relationship and the stochastic nature of GDP movements. These policy implications provide a roadmap for addressing Japan's macroeconomic constraints and supporting long-term economic resilience.

Chapter 10

Conclusions & recommendations

10.1 Conclusion

This study examined Japan's macroeconomic dynamics through a series of econometric models and time-series analyses using real GDP, consumption, inflation, unemployment, and policy rate data scraped from official APIs. The results provide a coherent narrative about Japan's long-standing macroeconomic challenges. The consumption function revealed a strong and stable income–consumption relationship, with an elasticity close to unity and a high explanatory power ($R^2 = 0.771$), indicating that household spending responds predictably to fluctuations in income. In contrast, the Phillips Curve analysis showed no meaningful relationship between unemployment and inflation, confirming the empirical breakdown of this traditional macroeconomic trade-off in Japan's context. This finding aligns with structural realities such as demographic ageing, rigid labour markets, and deeply anchored inflation expectations.

The GDP forecasting results further demonstrated that Japan's output follows a slow-moving stochastic trend best captured by an ARIMA(0,1,0) model, suggesting limited short-run predictability and reinforcing the idea that long-run structural forces dominate economic performance. The integration of these findings within IS–LM and AD–AS frameworks highlights the weak effectiveness of conventional monetary tools in a near-zero interest rate environment, with fiscal policy and structural reforms emerging as the primary mechanisms capable of influencing economic outcomes.

Overall, the results indicate that Japan's macroeconomic equilibrium is characterized by stable consumption behaviour, a flat Phillips Curve, and sluggish GDP growth shaped by long-term demographic and productivity trends. These insights underscore the need for policymakers to adopt a coordinated and forward-looking approach to overcome Japan's persistent low-growth, low-inflation environment.

10.2 Recommendations

Based on the empirical findings and the macroeconomic patterns observed in the dataset, several actionable recommendations emerge for strengthening Japan's economic trajectory:

1. Prioritize Fiscal Stimulus to Support Aggregate Demand - Given that consumption responds strongly to income and monetary policy remains constrained by the zero-lower bound, targeted fiscal measures such as income support, tax relief, and public investment should be enhanced to directly stimulate household spending and economic activity.

2. Adopt Unconventional Monetary Policies to Influence Expectations - Since the Phillips Curve is flat and inflation is unresponsive to unemployment, the Bank of Japan should continue and possibly expand unconventional strategies:

- Strengthened forward guidance
- Expanded asset purchases (quantitative and qualitative easing)
- Long-term yield curve management

These tools may help shift inflation expectations and break the cycle of persistently low price growth.

3. Implement Structural Reforms to Address Supply-Side Rigidities - Labour-market reforms, productivity enhancement programs, and measures to increase workforce participation—particularly among women and older workers—are essential to revitalizing inflation dynamics and improving long-term output capacity.

4. Develop Long-Term Growth Strategies Based on Innovation - Since GDP follows a random-walk process with limited cyclical responsiveness, policies should emphasize:

- Technological innovation and digital transformation
- Research and development incentives
- Green energy and high-tech manufacturing

These initiatives can help Japan escape its stagnation trap and foster sustainable growth.

5. Strengthen Coordination Between Fiscal and Monetary Authorities - A more synchronized policy framework can amplify the effects of stimulus measures. Joint signaling, combined fiscal-monetary stimulus, and coordinated communication strategies could help raise demand and steer inflation expectations upward.

6. Enhance Data Transparency and Real-Time Monitoring - The use of API-driven data collection in this study demonstrated the value of timely macroeconomic data. Japan's policymakers and researchers should invest further in real-time analytics and data-sharing platforms to support faster, evidence-based decision-making.

10.3 Summary

The results of this study underscore the need for a multi-dimensional policy approach that combines fiscal expansion, unconventional monetary strategies, and structural reforms to address Japan's entrenched economic challenges. By aligning policy tools with the realities reflected in empirical data, Japan can improve its prospects for achieving stable growth and meaningful inflation in the long run.

Chapter 11

Limitations

Although this study provides valuable insights into Japan's macroeconomic dynamics, several limitations should be acknowledged.

First, the analysis relies heavily on secondary data collected through APIs from official statistical sources. While these datasets are reliable, they may contain revisions or reporting lags that affect real-time accuracy.

Second, the econometric models—particularly the consumption function and Phillips Curve—are based on reduced-form specifications that may not capture deeper structural relationships or unobserved factors such as expectations, global shocks, or behavioural responses.

Third, the Phillips Curve estimation used unemployment as the sole proxy for labour-market slack, whereas alternative measures such as wage growth, job vacancies, or labour-force participation could provide a more nuanced understanding.

Fourth, the time-series forecasting approach is limited to ARIMA/SARIMAX models, which assume linearity and may not fully capture non-linear or regime-shifting patterns associated with demographic changes or external shocks.

Fifth, the GDP forecasting model was constrained by the length and frequency of available observations; higher-frequency or longer-span data might improve model precision.

Finally, the study does not incorporate structural macroeconomic models or policy simulations, which could offer deeper insights into the causal impact of fiscal and monetary interventions. These limitations highlight areas where future research could expand the analytical scope and improve the robustness of empirical findings.

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