GDP Cycle and RBC Analysis of Japan and South Africa (1994 - 2024)

Authors:
Maximilian Stein
Arthur Briens

Advisor:
Prof. Lise Patureau (LEDa)

Academic year:
2024-2025

Abstract: This paper investigates the analysis of business cycles and GDP growth patterns of Japan and South Africa from 1994 to 2024 and provides a Real Business Cycle Analysis for Japan. It offers a comparative analysis of two structurally distinct economies through both historical narrative and BC modeling. Japan, characterized by deflationary stagnation and advanced economic integration, is compared with South Africa, whose post-apartheid trajectory has been shaped by structural reforms, commodity dependence, and persistent inequality. The analysis utilizes quarterly GDP data decomposed into trend and cyclical components, revealing Japan's stable but smothened cycle and South Africa's volatile and asymmetric fluctuations. Key findings include the strong correlation in business cycle movement ($\rho = 0.75$), suggesting synchronized responses to global shocks despite divergent structural profiles. A calibrated RBC model for Japan illustrates standard propagation dynamics of technology shocks and validates theoretical expectations, especially in investment and labor responses. While Japan's cycle reflects mature market adjustments with low volatility, South Africa remains vulnerable to both global demand shifts and internal policy constraints. The paper underscores the importance of structural resilience and adaptive policy in shaping business cycle behavior across advanced and emerging economies.

Key-words: RBC Analysis, GDP Trend Analysis, Japan, South Africa

1. Introduction

The study of real business cycles and GDP growth in Japan and South Africa presents a compelling comparison of two economies with distinct structural characteristics and growth trajectories. Japan, the world's fourth-largest economy by nominal GDP, has shown signs of stronger growth in 2025, with real GDP rising and wage growth accelerating. The Japanese economy grew at an annualized rate of 2.2 percent in the fourth quarter of 2024, supported by a recovery in private consumption and steady wage growth. However, elevated inflation and a tight labor market pose challenges to sustained economic expansion. The government's support to households and corporate profits has contributed to a virtuous cycle of wages and inflation, which is expected to continue strengthening the economy. In contrast, South Africa's economic outlook is weakly positive, with GDP growth projected at 1.6 percent in 2025. The country's growth is driven by faster exports, private consumption, and a rebound in fixed investment. Domestic demand is aided by a recovery in purchasing power as wage growth outpaces inflation, and the Central Bank's monetary policy loosening cycle is expected to support economic activity. However, South Africa faces structural constraints, including infrastructure bottlenecks and low productivity, which hinder stronger growth. The presentation of the 2025 budget and the implementation of long-delayed reforms are crucial factors that could accelerate growth and job creation. This analysis aims to compare these two economies, gaining precious insight into the effect of international integration on real business cycles and GDP growth.

2. Economic Historic Background (1994-2024): Japan and South Africa

In this section, we look at the recent economic history of Japan and South Africa, to gain clear insight into what could possibly explain the trends and variations in the data and graphs.

2.1. Japan

The biggest factor in Japan's economy and economic policy has been the same for the last 30 years: deflation. After the second world war, and a new found momentum and openness to trade, Japan became an economic powerhouse and greatly profited from glovalization. In the 80s, an economic bubble had been forming, with stringent tariffs and a large trade surplus, lots of cash was available. For a few years, speculation rose and a bubble started to form. The climax of this bubble was a crash and deflationary spiral in 1989, leading to the "lost decade", as the bubble took a long time to collapse [10]. Japan's central bank used quantitative easing to try and slow down deflation, without much success. The Japanese government attempted a "structural reform" in 1998 to restart the economy, but without success [5]. In 2000, the financial crisis hit Japan like most of the developed world, adding more problems to the Japanese economy. 2006 marked the end of the zero-rate policy. Shortly after, in 2008, Japan; like most of the West, was hit very harshly by the financial crash. The country has always had a strong banking sector, and with their low interest rates, international banks had been taking gambles on the stock market by using Yens (cheap money). After a slow recovery, the Japanese still had to deal with the deflationary spiral. Shinzo Abe, who became prime minister for a second time in 2012, started his "Abenomics", which essentially revolved around aggressive government spending in infrastructure and a devaluation of the yen [9]. Hoping it would boost the consumption and kickstart the economy again, the policy peaked in 2015 as the central bank doubled the money supply. With a national debt skyrocketting (going above 200 per cent of GDP) and the deflationary spiral showing particular resistance when faced with quantitative easing, Japan had many serious challenges to face coming into the 2020s. In 2020, just like the entire world, covid hit Japan. Following a 7.1 per cent shrinkage in the last quarter of 2019, the economy had no time to recover properly before being hit a second serious blow [6].

2.2. South Africa

The South African economy has experienced profound structural transformations, policy shifts, and cyclical fluctuations since the advent of democracy in 1994. While Japan's economic narrative over the past three decades has been defined by persistent deflation, South Africa's economic story has been characterized by the complex transition from apartheid isolation to global integration, punctuated by commodity cycles, political transitions, governance challenges, and persistent structural inequalities.

Transition and Early Growth (1994-2000)

The new democratic government that came to power in 1994 inherited an economy burdened by international isolation, significant structural distortions, and extreme inequality. In navigating this complex transition, the government achieved impressive gains in stabilizing the economy and establishing foundations for broader-based growth [7]. The economic reforms introduced were deliberate and measured, resulting in an average growth rate of 2.9% per annum between 1994 and 2000, significantly outperforming the 1.4% average during the final years of apartheid from 1980 to 1993. The Growth, Employment and Redistribution (GEAR) strategy adopted in 1996 prioritized fiscal discipline, market liberalization, and macroeconomic stability [3]. Nevertheless, the volatility of this transition period was evident. The East Asian financial crisis around 1998 affected South Africa more severely than many other economies, as the country was simultaneously adjusting to global reintegration, including managing new capital flows and exchange rate pressures [3].

Commodities Boom and Economic Expansion (2001-2007)

The early 2000s marked South Africa's strongest sustained economic performance of the post-apartheid era. The economy expanded at an impressive average rate of 4.3% per annum between 2001 and 2007, coinciding with and benefiting significantly from the global commodities boom [1] & [3]. Industrial efficiency improved through greater exposure to global competition, and the economy became more diversified and less vulnerable to commodity price swings. However, beneath the surface of this strong performance, structural challenges persisted, including infrastructure constraints, skills shortages, and continuing inequality [7].

Global Financial Crisis and Its Aftermath (2008-2012)

The global financial crisis of 2008-2009 brought South Africa's strongest growth period to an abrupt end. Economic growth decelerated sharply to an average of 2.2% between 2008 and 2012, with a 1.5% contraction in 2009 marking South Africa's first recession in 17 years. Despite this challenging environment, fixed investment continued to grow at 3.4% annually, supported by infrastructure development for the 2010 FIFA World Cup and ongoing public investment programs [3].

The Zuma (2009 - 2018) and Ramaphosa Years (2018 - 2021)

The governing period of president Jacob Zuma was characterized by widespread allegations of corruption and state capture, with political uncertainty reflected in twelve cabinet reshuffles that severely damaged business and consumer confidence [8]. The economy became trapped in a low-growth equilibrium, with annual expansion rates consistently below population growth, resulting in declining per capita income. With President Ramamosa taking office in February 2018, his administration brought renewed hope for economic reform and governance improvements. His administration commenced efforts to address corruption, restore institutional capacity, and implement structural reforms to revitalize economic growth. However, these nascent reform efforts faced an unprecedented challenge with the onset of the COVID-19 pandemic in early 2020.

2.2.1 Post Pandemic Years (2021 - 2024)

The post-pandemic recovery has been uneven and constrained by both new and persistent challenges. The economy rebounded by approximately 4.9% in 2021, reflecting a partial recovery from the deep contraction of 2020. However, this recovery momentum proved short-lived as structural constraints reasserted themselves. Chronic electricity shortages intensified during 2022-2023, with unprecedented levels planned power outages severely affecting the economic activity across all sectors.

3. Business Cycle Analysis

In this section, Figure 1 examines the evolution of real GDP and the cyclical components of economic activity in Japan and South Africa over the period 1994 to 2024. By decomposing the logarithm of real GDP into trend and cyclical components, we gain insight short-term business cycle fluctuations. We utilize quarterly GDP per capita data from the OECD Data Explorer for both Japan and South Africa, covering the period from the first quarter of 1994 (1994-Q1) to the third quarter of 2024 (2024-Q3) [4]. The data are reported in US dollars, seasonally and calendar adjusted, and follow the output approach to GDP measurement. These series serve as the foundation for our trend-cycle decomposition, business cycle analysis, and cross-country comparisons throughout the analysis.
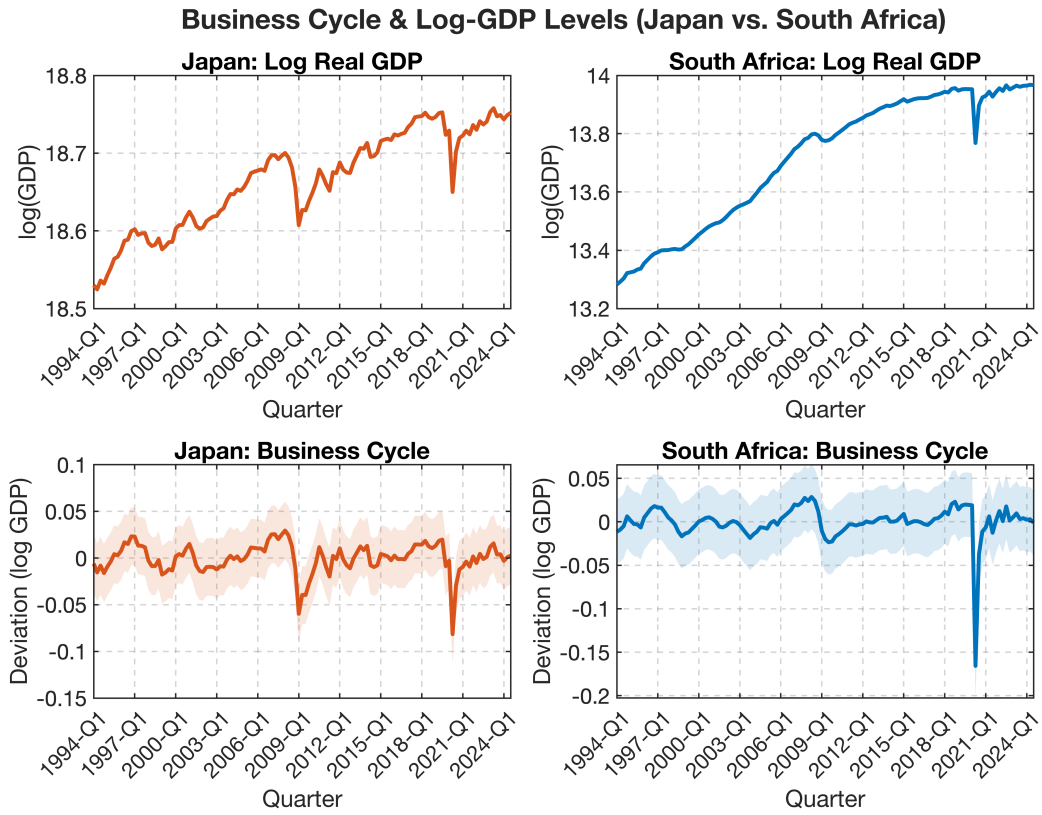
3.1. General Analysis

Figure 1: Log real GDP and business cycle components for Japan and South Africa from 1994 to 2024.

3.1.1 Japan – Log Real GDP and Business Cycle

The upper-left panel depicts the logarithm of real GDP in Japan over time. Japan's economy is strongly linked to the global economy and value chains. While it has a robust domestic market, it capitalized on the opportunities available during its post-war development. This enabled the country to build a strong capacity for growth but also left it highly vulnerable to international shocks. As Figures 1 and 2 illustrate, the Japanese economy has been significantly impacted by global disruptions such as the dot-com bubble and the 2008 financial crisis. This reflects the characteristics of an economy that is highly integrated into global value chains.

We also observe that monetary and fiscal policy appear to have had minimal long-term impact on Japan's GDP. There is a slight uptick in 2015, but it does not represent a substantial or sustained change. The series shows a steady upward trajectory, indicative of long-term economic growth, albeit with some notable fluctuations. The sharp dip around 2008 - 2009 coincides with the global financial crisis, which significantly impacted Japan's economy. Another clear drop is visible in 2020, aligning with the COVID-19 pandemic's onset. Despite these

downturns, the overall trend is positive, suggesting gradual recovery and resilience in the Japanese economy. The lower-left panel isolates the cyclical component of Japan's log real GDP by removing the long-term trend. This HP-filtered series highlights deviations from potential output, capturing recessions and expansions. The graph reveals pronounced contractions during the global financial crisis and the COVID-19 pandemic, with smaller cycles of expansion and contraction in between. The shaded area indicates uncertainty or confidence bands around the cyclical component, showing relatively mild fluctuations outside of crisis periods. Overall, Japan's business cycles are moderate and tightly clustered around zero, characteristic of a mature, stable economy.

3.1.2 South Africa - Log Real GDP and Business Cycle

The upper-right panel presents the log of real GDP for South Africa. The growth trajectory is also upward but slightly more volatile compared to Japan. From 1994 through the late 2000s, South Africa experienced robust growth. However, growth appears to decelerate post-2010. A particularly steep contraction occurs in 2020, reflective of the pandemic's disproportionate effect on emerging markets. Notably, the recovery post-2020 is slower and less stable than Japan's, suggesting structural challenges within South Africa's economy. The lower-right panel shows the business cycle component for South Africa. In contrast to Japan, the cyclical fluctuations are larger. The economy exhibits greater volatility, with deviations frequently exceeding ± 0.05 in log GDP. The 2020 downturn is especially severe, followed by an uneven recovery. Additionally, cyclical variations appear to be more frequent, suggesting susceptibility to both domestic and global shocks. This volatility underscores South Africa's exposure to commodity prices, political instability, and global capital flows.
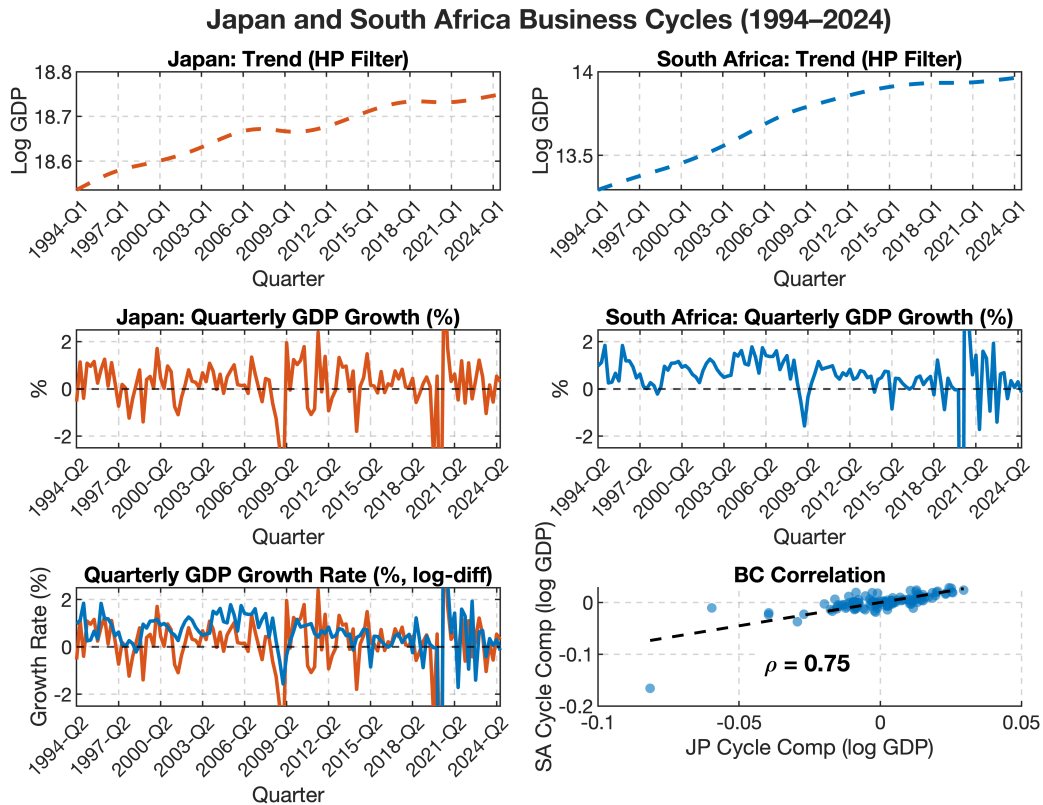
3.2. Trend and Correlation Analysis

Figure 2: HP-filtered GDP trends, quarterly GDP growth rates, and business cycle correlation between Japan and South Africa (1994–2024).

3.2.1 Japan

The upper-left panel presents the trend component of Japan's real GDP extracted using the Hodrick–Prescott filter. The trajectory is characterized by steady but modest growth across the three-decade span. While the trend appears largely linear post-2000, minor slowdowns are visible around global crises such as the 2008 financial meltdown and the COVID-19 pandemic. The graph indicates a relatively stable long-run growth path, consistent with Japan's mature economic profile and low volatility in structural output. This the centre-right panel captures Japan's quarter-over-quarter real GDP growth rates. Growth fluctuates within a fairly narrow range, typically oscillating between -2% and +2%. Despite brief volatility spikes during crises, the series quickly returns to a stable rhythm. The relatively muted amplitude of fluctuations highlights Japan's macroeconomic stability and strong institutional framework, including automatic stabilizers and monetary policy credibility.

3.2.2 South Africa

The upper-right panel trend in South Africa's GDP displays more curvature compared to Japan. It shows strong upward momentum until around 2008, after which the slope flattens, reflecting structural stagnation and declining growth potential in the post-crisis period. Unlike Japan, where trend output remains stable, South Africa's trend becomes more smoothed after 2010, possibly due to domestic constraints and declining productivity growth. This illustrates the long-run development challenges faced by emerging economies. In contrast, South Africa's growth rates are significantly more volatile (centre-right). The series features sharp contractions, especially during the 2008 financial crisis and the 2020 COVID-19 shock, where quarterly GDP growth plummeted below -10%. This volatility reflects South Africa's vulnerability to external shocks, commodity price swings, and internal political-economic dynamics. Furthermore, growth performance post-2015 is noticeably more erratic, highlighting rising structural weaknesses and macroeconomic imbalances.

3.2.3 Comparison and Correlation

The lower-left panel overlays the quarterly GDP growth rates of both countries to highlight comparative business cycle movements. While both economies experience contractions during global crises, the magnitude and persistence of South Africa's downturns are significantly greater. Periods of synchronized movement do occur - particularly during global downturns - but Japan's smoother pattern stands in contrast to South Africa's high-frequency, high-volatility fluctuations. This side-by-side dynamic emphasizes the difference in shock absorption capacity and economic resilience. The lower-right panel quantifies the correlation between Japan's and South Africa's cyclical movements of GDP. The positive correlation (= 0.75) suggests a relatively high degree of co-movement in their business cycles despite differing economic structures. This could reflect increasing global economic integration, common exposure to global demand and capital markets, or synchronized responses to major international events. However, the dispersion around the trend line also signals that co-movement is not perfect and that idiosyncratic factors still play a role.

4. RBC Business Analysis Example - Japan

This section presents a Real Business Cycle (RBC) analysis for Japan, utilizing dynare as a calibrated dynamic stochastic model to investigate the behavior of key macroeconomic variables over time. We sourced macroeconomic indicators - namely GDP, consumption, investment, and hours worked - for Japan from the World Bank's World Development Indicators database [2]. The dataset covers the period from the first quarter of 1994 (1994-Q1) to the third quarter of 2024 (2024-Q3) and provides annualised, calendar-adjusted values in constant prices. These variables were used to calibrate and simulate the RBC model to examine Japan's macroeconomic dynamics in response to technology shocks over the selected time horizon.

4.1. Analysis of Descriptive Values

Table 1 - Eigenvalue Analysis: The eigenvalue analysis reveals that three eigenvalues exceed one in modulus, corresponding to the model's three forward-looking (jump) variables: the Lagrange multiplier, consumption, and investment. This satisfies the Blanchard-Kahn conditions, which ensure saddle-path stability in rational expectations models. Although two eigenvalues are exceptionally large (7.315×10^{15} and 1.631×10^{18}), these likely stem from numerical scaling rather than economic instability. The verified rank condition confirms the existence of a unique and stable equilibrium path.

Table 3 - Policy and transition functions: The policy functiosn indicate that a one-unit TFP shock raises output by 1.75%, investment by 2.43%, and labor by 1.29%, highlighting the procyclical response of these variables. Lagged capital contributes significantly to persistence: higher capital today boosts future output and consumption, while reducing labor supply through wealth effects. The model's strong investment response reflects the central role of capital accumulation in business cycle propagation.

Table 4 - Correlation Matrix: The correlation matrix shows output is almost perfectly correlated with investment (0.9995) and labor (0.9940), indicating synchronized fluctuations across production and factor inputs. Its lower correlation with consumption (0.5952) reflects the latter's smoother path. The strong comovement between investment and labor underscores their responsiveness to TFP shocks.

Table 5 - Autocorrelation: Autocorrelation coefficients confirm high persistence in consumption (0.9055 at lag 1), consistent with intertemporal optimization. Output, investment, and labor also exhibit moderate persistence (0.71), suggesting that TFP shocks have long-lasting but decaying effects-characteristics well aligned with empirical features of Japanese business cycles.

4.2. Analysis of an Exogenous TFP Shock

The impulse response functions in Figure 3 illustrate the dynamic adjustment of key macroeconomic aggregates—output ($\hat{y}$), consumption ($\hat{c}$), investment ($\hat{i}$), and hours worked ($\hat{H}$)—to a one-time positive exogenous technology shock (ea). These responses, expressed as percentage deviations from the steady state over a 30-period horizon, encapsulate the propagation mechanisms embedded within the RBC framework under HP-filtered data.

Output ($\hat{y}$) exhibits an immediate and substantial increase, peaking at approximately 1.3% in the first period, followed by a smooth and monotonic decline toward the steady state. This dynamic is consistent with a standard RBC setting featuring an AR(1) technology process, where a persistent but temporary productivity shock drives an initial spike in production that gradually dissipates as the shock fades.

Consumption ($\hat{c}$) responds more gradually, displaying a hump-shaped trajectory that peaks around period 20 at approximately 0.37%. This delayed and smoothed response reflects intertemporal optimization on the part of forward-looking households. In anticipation of higher future income, consumption increases gradually, aligning with the permanent income hypothesis. The shape and timing of this response highlight the model's built-in consumption smoothing behavior in response to anticipated productivity gains.

Investment ($\hat{i}$) demonstrates the most pronounced immediate reaction, surging by roughly 2.0% in period 1. This strong and front-loaded response reflects firms' incentives to rapidly accumulate capital in the face of higher productivity. As the shock's effect wanes, investment gradually declines, tracking the adjustment path of the capital stock. The magnitude of this response underscores the procyclical and highly volatile nature of investment in RBC models, where capital formation is central to transmitting shocks to the real economy.

Hours worked ($\hat{H}$) also increase contemporaneously with the shock, peaking just below 1.0%, before steadily

declining. The initial response captures the substitution effect, whereby a rise in the real wage makes labor supply temporarily more attractive. Over time, however, the wealth effect begins to dominate: as households accumulate capital and enjoy higher income, they gradually reduce labor supply in favor of leisure. This dynamic illustrates how labor supply decisions in RBC models are shaped by the trade-off between income and leisure in intertemporal utility maximization.

Overall, these responses reflect the canonical RBC transmission mechanism: a technology shock leads to immediate expansions in output, labor, and investment, while consumption adjusts more gradually. All variables converge back to their steady states within the 30-period horizon, in line with the stationarity implied by log-linearization around a balanced growth path. The size and shape of these impulse responses—particularly the pronounced reaction of investment and the delayed consumption peak - are broadly consistent with empirical observations from advanced economies such as Japan, where TFP shocks tend to be persistent yet moderate in scale.

5. Conclusion

This paper has explored the macroeconomic dynamics and business cycle characteristics of Japan and South Africa over a thirty-year period, combining historical narrative with empirical decomposition and theoretical modeling. Despite vastly different political economies, both countries reveal insightful patterns of cyclical co-movement shaped by globalization, structural policy, and external shocks. Japan's post-bubble target highlights the limitations of monetary intervention in breaking persistent deflationary trends. Its damped business cycle, steady long-run growth, and successful smoothing of consumption are signs of a stable, advanced economy. In contrast, South Africa's economy, while demonstrating resilience in the early post-apartheid period and during the commodity boom, remains prone to volatility due to structural bottlenecks, governance fragility, and global exposure. The RBC model applied to Japan shows theoretical alignment with empirical dynamics - especially in investment-led volatility and consumption smoothing - validating its relevance for advanced economies. The correlation analysis between both countries' business cycles suggests an increasing synchronization due to global integration, though magnitudes and durations differ significantly. This analyis underscores that while international economic forces drive convergence in business cycles, domestic structural features and institutional capacity fundamentally shape the resilience and trajectory of economic performance. As South Africa continues to implement long-overdue reforms and Japan adapts to demographic and fiscal pressures, both countries illustrate critical lessons in the interplay between policy, productivity, and macroeconomic stability.

References

[1] Bulent Badsha. South africa in one word: Commodities. *M&G Investments*, January 2024.

[2] World Bank. World development indicators: Gdp, consumption, investment, and hours worked (japan), 2025. Accessed: 2025-03-23.

[3] Department of Research and Information. South african economy: An overview of key trends since 1994. Technical report, Industrial Development Corporation, Pretoria, South Africa, December 2013.

[4] Organisation for Economic Co-operation and Development (OECD). Quarterly gdp per capita (expenditure approach, us dollars, seasonally adjusted), 2025. Accessed: 2025-03-27.

[5] Naruki Mori, Shigenori Shiratsuka, and Hiroo Taguchi. Policy responses to the post-bubble adjustments in japan: A tentative review. *Monetary and Economic Studies*, 19(S-1):53–102, 2001.

[6] Martin Mühleisen and Hamid Faruqee. Japan: Population aging and the fiscal challenge. *Finance & Development*, 38(1), March 2001.

[7] Michael Nowak. The first ten years after apartheid: An overview of the south african economy. In Michael Nowak and Luca Antonio Ricci, editors, *Post-Apartheid South Africa: the First Ten Years*. International Monetary Fund, Washington, D.C., 2006.

[8] Palesa Shipalana. The good, the bad and the ugly: An economic review of zuma's presidency. *South African Institute of International Affairs*, December 2017.

[9] Wikipedia contributors. Abenomics - wikipedia, the free encyclopedia, 2025. [Online; accessed 10-April-2025].

[10] Wikipedia contributors. Japanese asset price bubble - wikipedia, the free encyclopedia, 2025. [Online; accessed 10-April-2025].

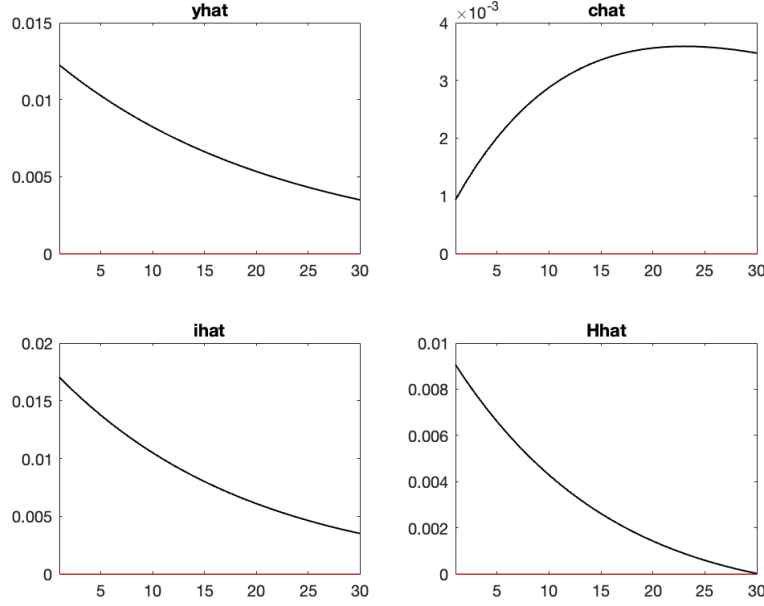# A. Appendix - Real Business Cycle Analysis: Japan

Figure 3: RBC Component Analysis of Japan Data from OECD (1994–2024) - Output ($yhat$), consumption ($chat$), investment ($ihat$), and hours worked ($Hhat$).

Table 1: Eigenvalues of the System

Modulus	Real Part	Imaginary Part
0.9500	0.9500	0
0.9689	0.9689	0
1.0120	1.0120	0
7.315×10^{15}	7.315×10^{15}	0
1.631×10^{18}	-1.631×10^{18}	0

Table 2: Model Summary

Description	Count
Number of Variables	9
Number of Shocks	1
State Variables	2
Static Variables	5

Table 3: Policy and Transition Function Coefficients

	$\hat{y}$	$\hat{c}$	$\hat{i}$	$\hat{H}$
$\hat{A}_{t-1}$	1.6629	0.1264	2.3125	1.2292
$\hat{k}_{t-1}$	0.1608	0.7194	-0.0753	-0.4468
ea_t	1.7505	0.1331	2.4342	1.2939

Table 4: Correlation Matrix (HP-filtered)

	$\hat{y}$	$\hat{c}$	$\hat{i}$	$\hat{H}$
$\hat{y}$	1.0000	0.5952	0.9995	0.9940
$\hat{c}$	0.5952	1.0000	0.5702	0.5041
$\hat{i}$	0.9995	0.5702	1.0000	0.9969
$\hat{H}$	0.9940	0.5041	0.9969	1.0000

Table 5: Autocorrelations (HP-filtered)

Order	1	2	3	4	5
$\hat{y}$	0.7147	0.4734	0.2737	0.1125	-0.0139
$\hat{c}$	0.9055	0.7766	0.6280	0.4713	0.3159
$\hat{i}$	0.7129	0.4705	0.2703	0.1090	-0.0171
$\hat{H}$	0.7103	0.4665	0.2657	0.1043	-0.0214