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Potential Output in the Kyrgyz Republic

Nasir Rao, Anvar Muratkhanov, and Nihal Haider

SIP/2025/081

IMF Selected Issues Papers are prepared by IMF staff as background documentation for periodic consultations with member countries. It is based on the information available at the time it was completed on May 7, 2025. This paper is also published separately as IMF Country Report No 25/119.

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Potential Output in the Kyrgyz Republic, Kyrgyz Republic

Prepared by Nasir Rao, Anvar Muratkhanov, and Nihal Haider

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ABSTRACT: This paper revisits the potential output of the Kyrgyz Republic considering recent structural shifts and external shocks, including the pandemic and the regional conflict. Utilizing a suite of methodologies – production function, state-space models, and statistical filters – it estimates potential output growth at 5.3 percent, up from around 4.4 percent prior to the pandemic. This increase is primarily driven by capital accumulation and labor force expansion. However, total factor productivity remains below historical averages. The persistently positive output gap points to overheating risks, underscoring the need for counter-cyclical policies and structural reforms.

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Potential Output in the Kyrgyz Republic

Kyrgyz Republic

Prepared by Nasir Rao, Anvar Muratkhanov, and Nihal Haider[1]

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INTERNATIONAL MONETARY FUND

KYRGYZ REPUBLIC

SELECTED ISSUES

May 7, 2025

Approved By
Middle East and Central Asia Department

Prepared By Nasir Rao, Anvar Muratkhanov, and Nihal Haider.

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POTENTIAL OUTPUT IN THE KYRGYZ REPUBLIC[1]

This study reassesses potential output in the Kyrgyz Republic in light of recent structural changes and external shocks, including the pandemic and the regional conflict. Using a combination of production function analysis, state-space models, and univariate filters, the paper provides a comprehensive estimate of the country's evolving productive capacity. The findings indicate a notable rise in potential output growth to 5.3 percent, largely driven by capital accumulation and labor force expansion. However, total factor productivity remains below historical averages. The positive output gap since 2021, which reflects strong post-pandemic growth, including due to the spillovers from the regional conflict, points to possible risks of overheating and rising inflationary pressures. Addressing these challenges will require structural reforms to enhance investment, improve labor market efficiency, and foster productivity gains to support higher and sustainable economic growth.

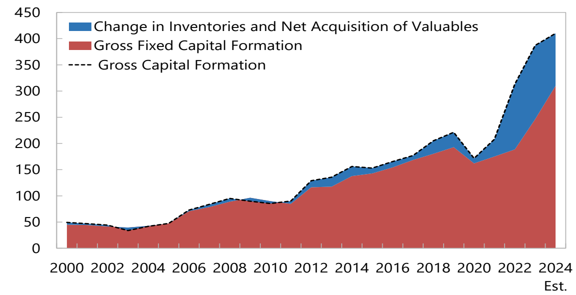
A. Introduction

1. **Estimating potential output is essential for effective policymaking.** It defines the economy's maximum sustainable level of production without triggering inflation, which serves as a benchmark for assessing whether the economy operates above or below capacity. An output gap, which is a difference between actual and potential GDP, allows policymakers to understand how far an economy is operating from this level and guide policy decisions. A positive output gap (where actual GDP exceeds potential GDP) indicates the overuse of the factors of production, or overheating, often leading to inflationary pressures, necessitating policy tightening to prevent an unsustainable build-up of macro imbalances. Conversely, a negative output gap signals underutilization of capital and labor, offering room for policy easing without causing inflation.

2. **Major economic shocks and structural changes can alter productive capacity and hence the potential output.** In the Kyrgyz Republic, the pandemic and Russia's war in Ukraine changed labor markets, investment patterns, and trade dynamics, contributing to an unexpectedly high GDP growth of 9 percent annually from 2022-2024, and leading to a surge in gross capital formation (Figure 1). This robust growth outpaced the CCA average of 6.1 percent during the same period (Figure 2). While part of this growth surge is likely to be transitory, driven by external demand shifts and trade rerouting, it could also reflect economy's structural transformation over the years. The shift from agriculture to mining and services, a shrinking (but still significant) informal sector, technological advances, demographic patterns, climate change, and new trade patterns have reshaped labor markets and capital allocation, influencing growth potential in the Kyrgyz Republic.

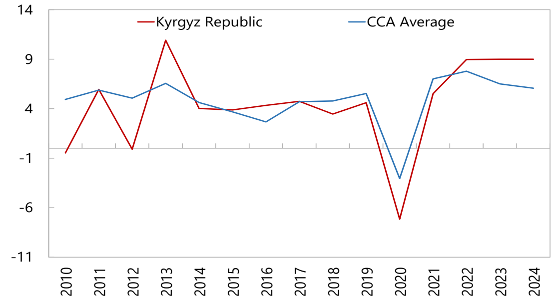
[1] Prepared by Nasir Rao, Anvar Muratkhanov, and Nihal Haider (all MCD).

Figure 1. Gross Capital Formation
(in constant2018 prices, KGS billion)



Source: NSC and IMF staff calculations.

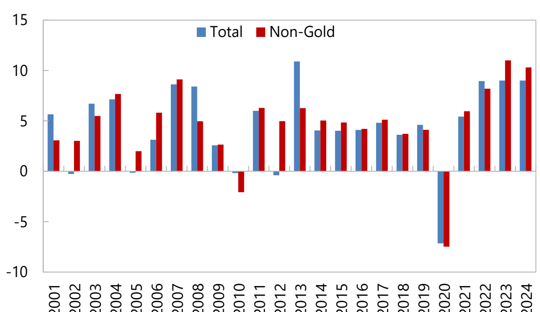
Figure 2. GDP Growth – Regional Comparison
(in percent)



Source: NSC and World Economic Outlook.

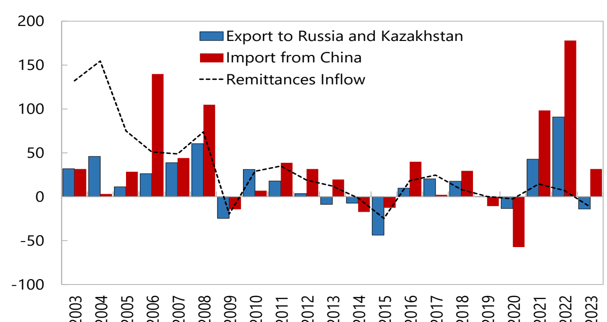
3. Reflecting these changes, the Kyrgyz Republic's growth trajectory has undergone notable shifts in the last two decades. From 2001 to 2013, the economy grew by over 5 percent on average annually, driven by remittance-fueled consumption, gold production, and strong external demand (Figure 3). Post-2014, external headwinds from slower growth in Russia and Kazakhstan reduced remittances and external demand, exposing structural vulnerabilities (Figure 4). The 2015 accession to the EAEU and Kazakhstan's WTO membership further altered regional trade, diminishing Kyrgyz Republic's re-export role.

Figure 3. GDP Growth
(in percent)



Source: NSC and IMF staff calculations.

Figure 4. Regional Trade and Remittances
(percent change)



Source: NBK and IMF staff calculations.

B. Methodology and Results

4. This paper uses three different methods to estimate potential output and capture both structural and cyclical dynamics. These include the production function method for a supply-side perspective, the multivariate Kalman filter for dynamic adjustments, and univariate techniques such as the Hodrick-Prescott (HP) filter and Beveridge-Nelson decomposition to identify underlying trends. The analysis uses quarterly data from 2000 onward since the earlier post-independence years were fraught with economic volatility and less reliable data. This comprehensive approach ensures a robust assessment of the Kyrgyz Republic's evolving potential output.

Production Function

5. The production function approach follows the methodology proposed by Denis *et al.* (2006) to estimate potential output. It is based on a Cobb-Douglas production function. Capital input is represented by the capital stock, calculated using the perpetual inventory method with the initial stock based on 1999 data from the World Bank's "*The Changing Wealth of Nations 2021*". Depreciation rates, averaging 3.6 percent, were sourced from the Penn World Table Database. Capital stock series was converted to real values using 2018 as the base year, applying gross capital formation data and adjusting investment series for seasonality. Labor input combines calculated employment levels and average hours worked. Elasticities of capital and labor inputs were estimated using a Vector Error Correction Model (VECM).

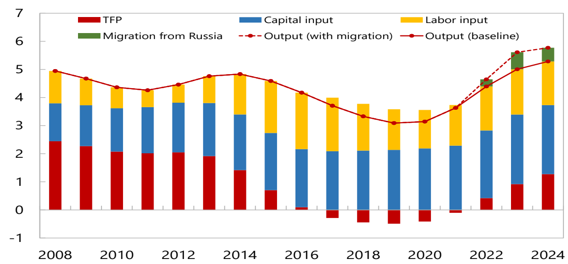
6. Total Factor Productivity (TFP) is calculated as a residual, reflecting both productivity dynamics and shocks to output. Adjustments were made to isolate these shocks before applying the HP filter to smooth the TFP series. While Denis *et al.* (2006) used unsmoothed capital stock for EU countries, this paper applies the HP filter to the Kyrgyz Republic's capital stock to address fluctuations driven by volatile inventories. This approach ensures that long-term trends in TFP and capital stock align with potential output growth, providing a clearer representation of productivity's contribution to economic performance.

7. The results suggest that Kyrgyz Republic's potential output growth has risen to 5.3 percent in recent years, with non-gold potential output reaching 5.6 percent. This growth is primarily driven by capital stock accumulation and labor. TFP has turned positive in 2022, but remains below historical averages observed prior to 2015 (Figure 5). Non-gold potential output growth of 5.6 percent indicates that the contribution of the gold sector is negative, reflecting plateauing gold production in recent years (Figure 6).

8. A notable driver of recent growth dynamics is the influx of Russian migrants since 2022. In the absence of a reliable estimate of the number of migrants, for the purposes of this exercise the paper assumes that 70,000 have settled permanently in the Kyrgyz Republic[2]. This results in an upward revision of potential output growth to 5.8 percent with non-gold potential output growth reaching 6.1 percent. This increase reflects both the direct expansion of the labor force and the boost in capital stock. It may also explain part of the TFP gain as reportedly many migrants are young and skilled IT professionals with above average productivity.

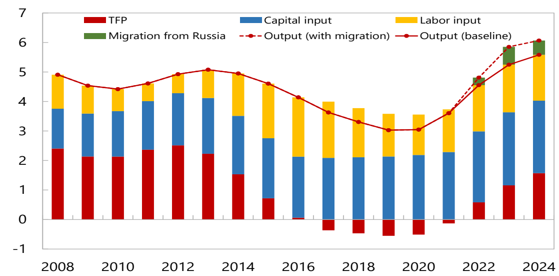
[2] There is no exact data available on the number of people who remained in the Kyrgyz Republic. Our estimate is based on figures from the Department of Population Registration of the Kyrgyz Republic, which states that between January and October 2022, 170 thousand Russian citizens made official registration in the Kyrgyz Republic. We are assuming that 60 percent of them eventually left, while the remaining 40 percent stayed.

Figure 5. Potential Output (Total)
(percent)



Source: IMF staff calculations.

Figure 6. Potential Output (Non-Gold)
(percent)



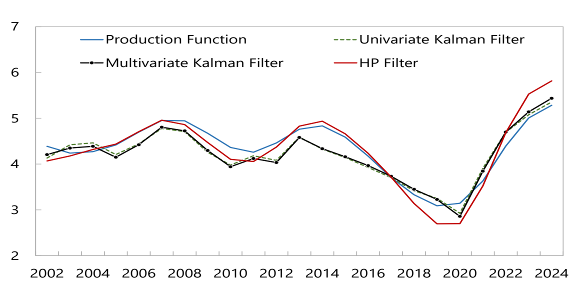
Source: IMF staff calculations.

State Space Models and Univariate Filters

9. State-space models, which rely on multivariate and univariate Kalman filters, and HP filter reinforce the findings of the production function approach. These models yield potential output growth estimates ranging between 5.3 and 5.8 percent, and non-gold potential output growth reaching 6.4 percent (Figure 7A and 7B). The univariate Kalman and HP filters effectively isolate long-term output trends, which provide valuable insights for the Kyrgyz economy given its exposure to external shocks. In contrast, the multivariate Kalman filter adds depth by incorporating macroeconomic relationships like the Phillips curve and Okun's law, capturing the interplay between output, inflation, and unemployment. Together, these models complement the production function, providing dynamic, data-driven insights that reflect both structural shifts and cyclical fluctuations in the economy. The consistency of these results underscores the robustness of potential output estimates, indicating that underlying growth trends are well-captured.

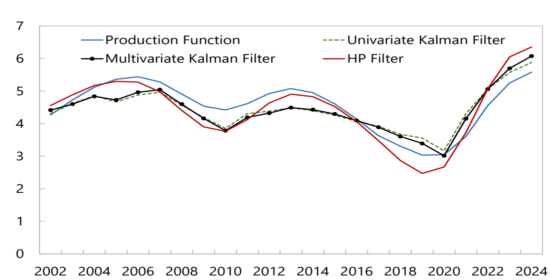
10. The results of the Beveridge-Nelson decomposition also align with other models, adding to robustness. AR and ARMA models show stable potential output growth of 4.4 percent during 2001–2014, a decline to 3.5 percent in 2015–2021 due to subdued growth and the pandemic, and a strong rebound to 5.3 percent in 2022–2024.

Figure 7a. Potential Output (Total)
(in percent)



Source: IMF staff calculations.

Figure 7b. Potential Output (Non-Gold)
(percent)



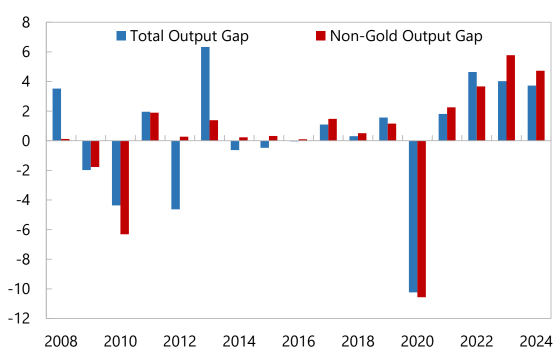
Source: IMF staff calculations.

Output Gap Dynamics

11. The output gap in the Kyrgyz Republic has turned persistently positive in the recent years, especially for non-gold GDP. This trend reflects strong post-pandemic recovery, supported by capital inflows and labor migration from Russia. Figure 8 shows that after some fluctuations, the output gap increased significantly after 2020, indicating that growth has outpaced its potential. This growth boost is more pronounced for non-gold output, highlighting the declining share of gold production and the growing importance of domestic demand and other sectors, such as construction and trade. While TFP remains below early 2010s levels, its upward trend signals gradual efficiency gains alongside growth driven by capital and labor. However, a consistently high positive output gap may suggest overheating of the economy, which could pose risks of inflation, asset price distortions, and macroeconomic imbalances if not carefully managed.

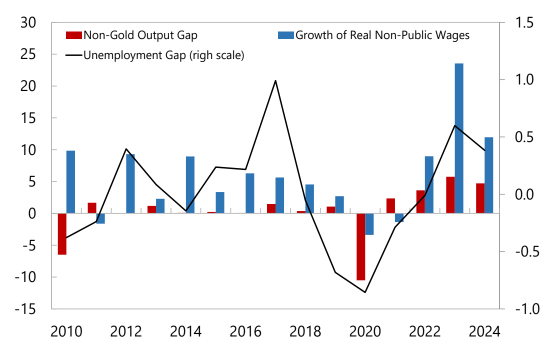
12. The tightening of the labor market might also be a reflection of rising output gaps. Declining unemployment rates and rising real wages indicate strong labor demand relative to supply (Figure 9). This mismatch can fuel wage-driven inflation, as firms compete for a limited pool of workers, pushing up labor costs that are often passed on to consumers through higher prices. The inflow of skilled Russian migrants, while expanding the labor force, has had mixed effects. Those working remotely for foreign companies have limited impact on local labor markets, while others have added to labor supply but not fully eased pressures due to skill mismatches and increased demand for services driven by higher migrant consumption. The correlation between the output gap and labor market indicators, such as real wage growth and the unemployment gap, highlights the cyclical nature of these dynamics.[3]

Figure 8. Output Gap Dynamics
(in percent)



Source: IMF staff calculations.

Figure 9. Output Gap vs Labor Indicators
(in percent)



Source: NSC and IMF calculations

[3] Unemployment gap is calculated as difference between non-accelerating inflation rate of unemployment (NAIRU) and actual unemployment.

C. Conclusion and Policy Recommendations

13. The Kyrgyz Republic's recent economic performance was marked by a strong post-pandemic recovery and external spillovers from the regional conflict. The surge in real GDP growth in 2022-2024 was driven by capital stock accumulation and labor input, but TFP remains below historical averages. The potential output growth rate is estimated to have increased to 5.3 percent since the pandemic from about 4.4 percent before, but it is well below the current pace of growth. Temporary external tailwinds may mask underlying economic fragilities, necessitating prudent macroeconomic policies and deeper and broader structural reforms to improve long-term growth potential and strengthen resilience.

14. This persistently positive output gap highlights the risk of economic overheating. If continued, this could lead to build-up of inflationary pressures, labor shortages and macroeconomic imbalances. To mitigate these risks, policymakers should adopt counter-cyclical fiscal and monetary policies and advance reforms that attract investment, improve labor markets and strengthen productivity. Some of the key reform areas include fostering a business-friendly environment, improving access to finance, strengthening of property rights and the rule of law, and enhancing education and skills development.

Annex I. Model Specifications

Production Function

1. The production function used in the paper is expressed as:

$$Y_t = TFP_t * K_t^{\alpha} * L_t^{1-\alpha}$$

where Y_t denotes real GDP; TFP_t denotes Total Factor Productivity; K_t and L_t denote capital and labor inputs respectively; α and $1-\alpha$ represents output elasticities of capital and labor respectively.

The paper follows a structured approach to estimate potential output growth, comprising three key steps: (1) calculating the equilibrium levels of capital and labor inputs, (2) estimating the output elasticities of capital and labor, and (3) deriving the dynamics of TFP linked to potential output growth.

Estimation of Capital and Labor Inputs:

2. The paper employs capital stock as the measure of capital input, calculated using the perpetual inventory method.

$$K_t = K_{t-1} * (1 - \delta_{t-1}) + I_t$$

where K_t denotes capital stock at constant prices at period t; I_t denotes flow of investments at constant prices at period t; δ denotes capital depreciation rate; K_{t-1} denotes capital stock at constant prices at period t-1.

The paper employes composite labor input indicator with the following structure[1]:

$$L_t = LF_t * (1 - U_t) * AHW_t$$

Which is transformed to the following form:

$$\overline{L}_t = \overline{LF}_t * (1 - U_t^{NAIRU}) * \overline{AHW}_t$$

where $\overline{L}_t$ is the potential labor input; $\overline{LF}_t$ is the trend of labor force (in millions of persons); U_t^{NAIRU} represents the non-accelerating rate of inflation; $\overline{AHW}_t$ is the trend of average hours worked series.

3. Non-accelerating rate of inflation of the level of 4.4 percent[2], trends of labor force and average hours worked were estimated applying the HP filter to the actual series. To mitigate the

[1] The quarterly data for the period Q1 2010 to Q4 2023 on all the components was obtained from the ILOSTAT database. To extend the historical series back to the year 2000, the constructed labor input indicator was extrapolated for the period Q1 2000 to Q4 2009 using the dynamics of the official employment series provided by the National Statistical Committee. To remove the seasonal factors, the composite indicator was seasonally adjusted.

[2] The Kalman filter analysis for the unemployment rate yields comparable results.

endpoint bias, before implying the filter the original series were first extended with four-year forecasts generated by ARIMA models, covering the period up to 2027.

Estimation of the Output Elasticities of Labor and Capital:

4. Due to the presence of cointegration between real GDP, labor and capital, the paper utilized the Vector Error-Correction Model (VECM) to estimate the output elasticities of capital and labor inputs.[3] The use of VECM also helps to mitigate some aspects of endogeneity and serial-correlation inherent to the time-series data. At the same time the VECM will allow to obtain the values of long-run relationships between the interest variables.

The specification of the model is following:

Long-Term equation:

$$\ln(Y_{t-1}) = \beta_1 \ln(K_{t-1}) + \beta_2 \ln(L_{t-1}) + \beta_0$$

Matrix of short-term equations:

$$\Delta \ln(Y_t) = \alpha_0 + \lambda_1 \epsilon_{t-1} + \sum_{n=1}^{N} \alpha_{1,n} \Delta \ln(K_{t-n}) + \sum_{n=1}^{N} \alpha_{2,n} \Delta \ln(L_{t-n}) + \sum_{n=1}^{N} \alpha_{3,n} \Delta \ln(Y_{t-n}) + \sum_{i=1}^{I} \alpha_{4,i}\, \text{shock}_i + u_{1,t}$$

$$\Delta \ln(K_t) = \gamma_0 + \lambda_2 \epsilon_{t-1} + \sum_{n=1}^{N} \gamma_{1,n} \Delta \ln(K_{t-n}) + \sum_{n=1}^{N} \gamma_{2,n} \Delta \ln(L_{t-n}) + \sum_{n=1}^{N} \gamma_{3,n} \Delta \ln(Y_{t-n}) + \sum_{i=1}^{I} \gamma_{4,i}\, \text{shock}_i + u_{2,t}$$

$$\Delta \ln(L_t) = \phi_0 + \lambda_3 \epsilon_{t-1} + \sum_{n=1}^{N} \phi_{1,n} \Delta \ln(K_{t-n}) + \sum_{n=1}^{N} \phi_{2,n} \Delta \ln(L_{t-n}) + \sum_{n=1}^{N} \phi_{3,n} \Delta \ln(Y_{t-n}) + \sum_{i=1}^{I} \phi_{4,i}\, \text{shock}_i + u_{3,t}$$

Where β_1 and β_2 denotes long-term coefficients reflecting the elasticity of output with respect to capital and labor; β_0 denotes constant term, Y_t denotes real GDP in constant 2018 prices (in million KGS); K_t denotes calculated unsmoothed capital stock/investments in constant 2018 prices; L_t denotes composite indicator of labor input; ε_{t-1} denotes the error correction term, which reflects deviations from the long-run equilibrium; λ_i denotes adjustment coefficients indicating the speed of return to equilibrium; $shock_i$ denotes the series of dummy variables to capture the effect of significant internal and external shocks like political instability in 2010 and onset of the Covid-19 in 2020; u_t – denotes short-term disturbances. The sample size of estimation is quarterly data from Q1 2001 to Q4 2023.

5. Given that capital stock represents the long-term productive capacity of an economy, while investment reflects short-term fluctuations in productive capacity, two models are estimated to evaluate the output elasticity of capital input: one using capital stock and the other using investment flows. This dual-model approach ensures a comprehensive analysis of capital's contribution to

[3] The presence of cointegration among the variables of interest was evaluated using the Johansen Cointegration test. Prior to conducting the test, the variables were examined for the presence of a unit root to confirm their non-stationary nature, ensuring the appropriateness of the cointegration analysis.

output by capturing both long-term and short-term dynamics. Additionally, it serves as a robustness check to validate the consistency of results across two specifications.

Table 1. Kyrgyz Republic: Results for Long-Term Equation

	Original coefficients		**Normalized coefficients**	
	(1)	(2)	(1)	(2)
Capital stock	0.281** (0.110)		0.311** (0.123)	
Investments		0.293* (0.046)		0.294* (0.046)
Labor input	0.624** (0.274)	0.703* (0.226)	0.689** (0.303)	0.706* (0.227)

Standard errors are shown in parentheses.
Significance levels: *p<0.01; **p<0.05; *** p<0.1; ^ insignificant with p>0.1

6. The original coefficients were normalized to ensure their sum equaled one, aligning with the theoretical assumption of constant returns to scale in the Cobb-Douglas production function. Notably, the specification using investments inherently satisfied this assumption, as the original coefficients naturally summed to one. The resulting estimates closely align with those of Kudabaeva (2010), who reported an output elasticity of capital at 0.26 and labor at 0.74, further validating the robustness of the analysis.

Total Factor Productivity:

7. After calculating all the observable components of the production function, the dynamics of total factor productivity can be derived as the residual using the following equation:

$$\Delta TFP_t = \left(\Delta Y_t - (0.3 * \Delta K_t + 0.7 * \Delta L_t)\right)$$

After adjusting TFP for the shocks that may distort true productivity trends, the refined TFP series was smoothed using the HP filter and, along with other computed components, was integrated into the following equation to derive the annual potential output growth series:

$$\Delta \bar{Y}_t = (\Delta \overline{TFP}_t + 0.3 * \Delta \bar{K}_t + 0.7 * \Delta \bar{L}_t)$$

Multivariate Kalman Filter

8. The paper employs the Multivariate Filter methodology developed by Blagrave *et al.* (2015), which incorporates equations utilizing three key observable indicators: real GDP growth, inflation, and the unemployment rate. This approach models potential output as a latent variable, estimating it alongside the output gap by leveraging the relationships between the variables. The Kalman filter is employed to estimate unobservable variables, while parameter values and the variances of shock terms in the equations are determined using Bayesian estimation techniques.

The model estimation is based on annual data for GDP growth, inflation[4], and the unemployment rate from 2000 to 2023. To address the endpoint problem, the sample size was extended to 2026 by including estimates for 2024 and projections for 2025–2026.
The model has the following structure:

Output Equations:

$$y = Y - \bar{Y}$$
$$\bar{Y}_t = \bar{Y}_{t-1} + G_t + \varepsilon_t^{\bar{Y}}$$
$$G_t = \theta G^{SS} + (1-\theta)G_{t-1} + \varepsilon_t^{G}$$
$$y_t = \phi y_{t-1} + \varepsilon_t^{y}$$

where y denotes output gap, Y is real GDP in log terms, $\bar{Y}$ is potential real GDP, G_t is potential output growth, $\varepsilon_t^{\bar{Y}}$ – potential output shock term, G^{SS}- potential output steady-state path, ε_t^{G} – potential output growth shock term, and ε_t^{y} – output gap shock.

Philips Curve Equation:

$$\pi_t = \lambda\pi_{t+1} + (1-\lambda)\pi_{t-1} + \beta y_t + \varepsilon_t^{\pi}$$

Where π_t denotes inflation, and ε_t^{π} inflation shock.

Unemployment Equations:

$$u_t = \bar{U}_t - U_t$$
$$\bar{U}_t = (\tau_4\bar{U}^{SS} + (1-\tau_4)\bar{U}_{t-1}) + g\bar{U}_t + \varepsilon_t^{\bar{U}}$$
$$g\bar{U}_t = (1-\tau_3)g\bar{U}_{t-1} + \varepsilon_t^{g\bar{U}}$$

Where u_t- gap between actual unemployment and its equilibrium process, $\bar{U}_t$ denotes Non-Accelerating Level of Inflation, U_t- actual unemployment, $\bar{U}^{SS}$ is steady state inflation rate, $g\bar{U}_t$ is variation in the NAIRU (to allow persistent deviations of the NAIRU from its steady-state value), $\varepsilon_t^{\bar{U}}$ – NAIRU shock term, $\varepsilon_t^{g\bar{U}}$ is shock term of the variation in the NAIRU.

Okun's Law Equation:

$$u_t = \tau_2 u_{t-1} + \tau_1 y_t + \varepsilon_t^{u}$$

Where ε_t^{u} denotes unemployment gap shock term.

Beveridge-Nelson Decomposition

[4] To account for the impact of global food and energy prices, the model incorporates core inflation instead of headline inflation.

9. The Beveridge-Nelson (BN) decomposition separates permanent and transitory components in economic time series. Developed in the 1980s, it is widely used to analyze economic growth dynamics and estimate output gaps, including those caused by the COVID-19 pandemic in the Euro Area. In potential output analysis, BN decomposition identifies long-term trends versus short-term fluctuations, helping policymakers distinguish structural shifts from temporary shocks. Applied within an ARIMA model, it effectively isolates economic disturbances. The approach involves the following equations:

ARIMA Model Specification:

$$Y_t=\phi(B)\ \theta(B)\ -1\epsilon_t$$

where Y_t is the time series, $\phi(B)$ is the autoregressive (AR) polynomial, $\theta(B)$ is the moving average (MA) polynomial and the ϵ_t is a white noise error term.

Permanent and Transitory Components:

$$Y_t=Y_t^P+Y_t^T$$

where Y_t^P is the permanent component, representing the long-term trend, and Y_t^T is the transitory component, representing short-term fluctuations.

Estimation of Permanent Component:

The permanent component is often estimated through the long-run forecast derived from the ARIMA model:

$$YtP=limh\to\infty\ E[Yt+h|Yt]$$

This equation indicates that the permanent component is the expected value of the future values of the series, given the current value, as the forecast horizon approaches infinity.

Estimation of Transitory Component:

The transitory component can then be calculated as:

$$Y_t^T=Y_t-Y_t^P$$

Hodrick–Prescott Filter

10. The Hodrick–Prescott filter is applied to quarterly data spanning from 2000Q1 to 2024Q3, incorporating estimates and projections for 2024Q4 to 2027Q4 to address the end-point problem. The smoothing parameter (lambda) is set to 1600

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