Country Projections Model (CPM)

Outline

- Introduction
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- Forecasting process
  - Model overview
- Model equations
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  - External variables
  - CPI and interest rates
  - Exchange rates and UIP
- Model forecast outputs

Introduction

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Country-specific Projections Model

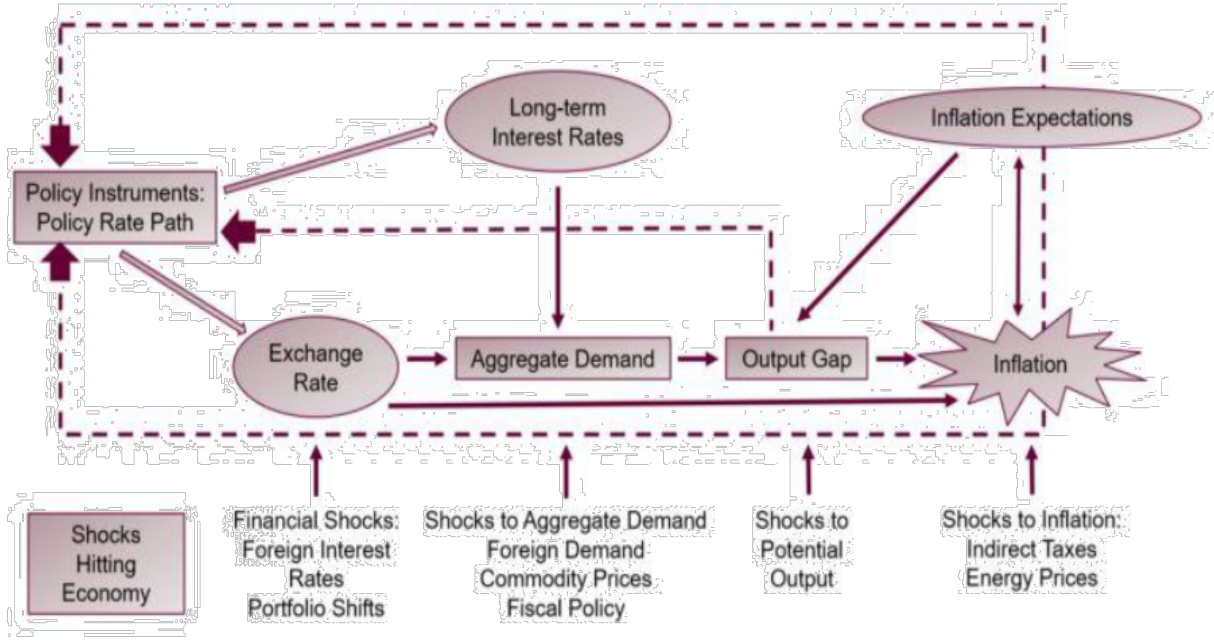
- Rooted in a Quarterly Projections Model framework (IMF), with some important extensions:

❖GDP demand-side decomposition.

- **Bottom-up** and **top-down** forecasts.
- Facilitates narratives.

❖ Functional for both economies with **quarterly** and **annual** frequency data.

- Timely data decompositions not mandatory – prior assumptions can be introduced.



Overview of CPM's structure

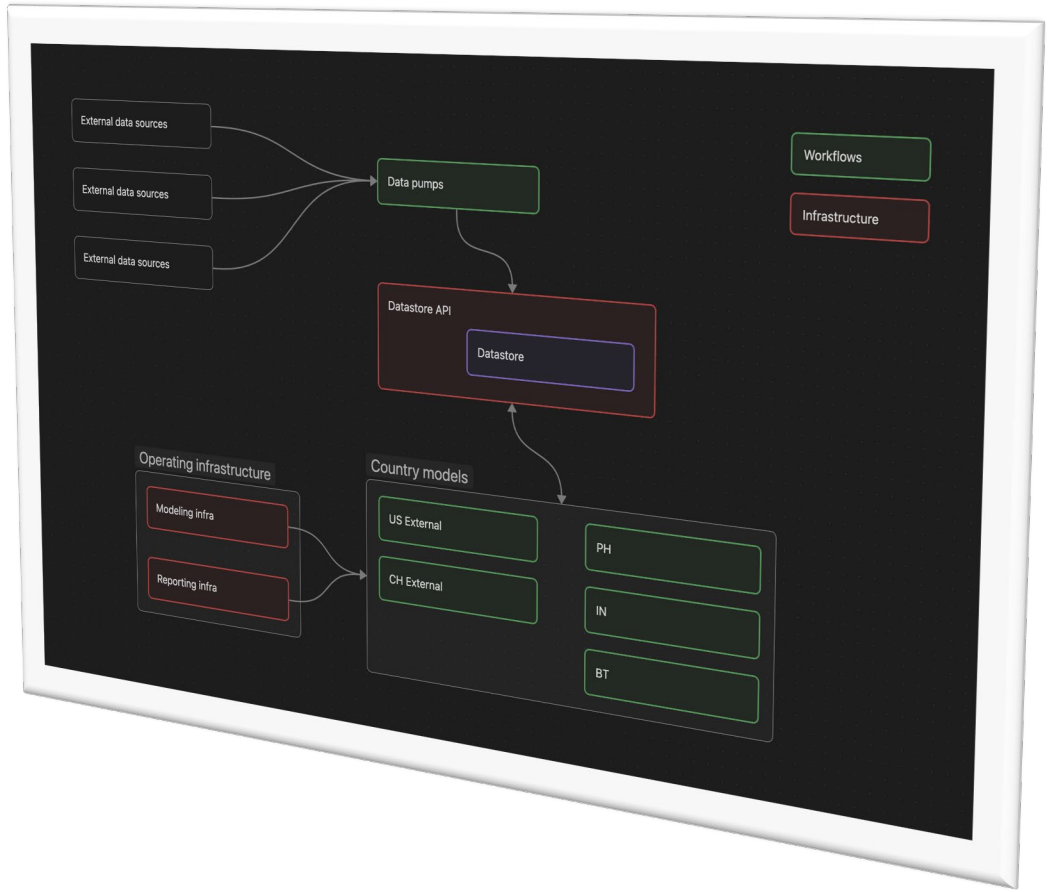
- A template structure for all economies.
  - Trend-gap model with New Keynesian features.
  - Country-specific parameters and data.

Country model
- IS curve
- Phillips curve
- UIP
- policy rule

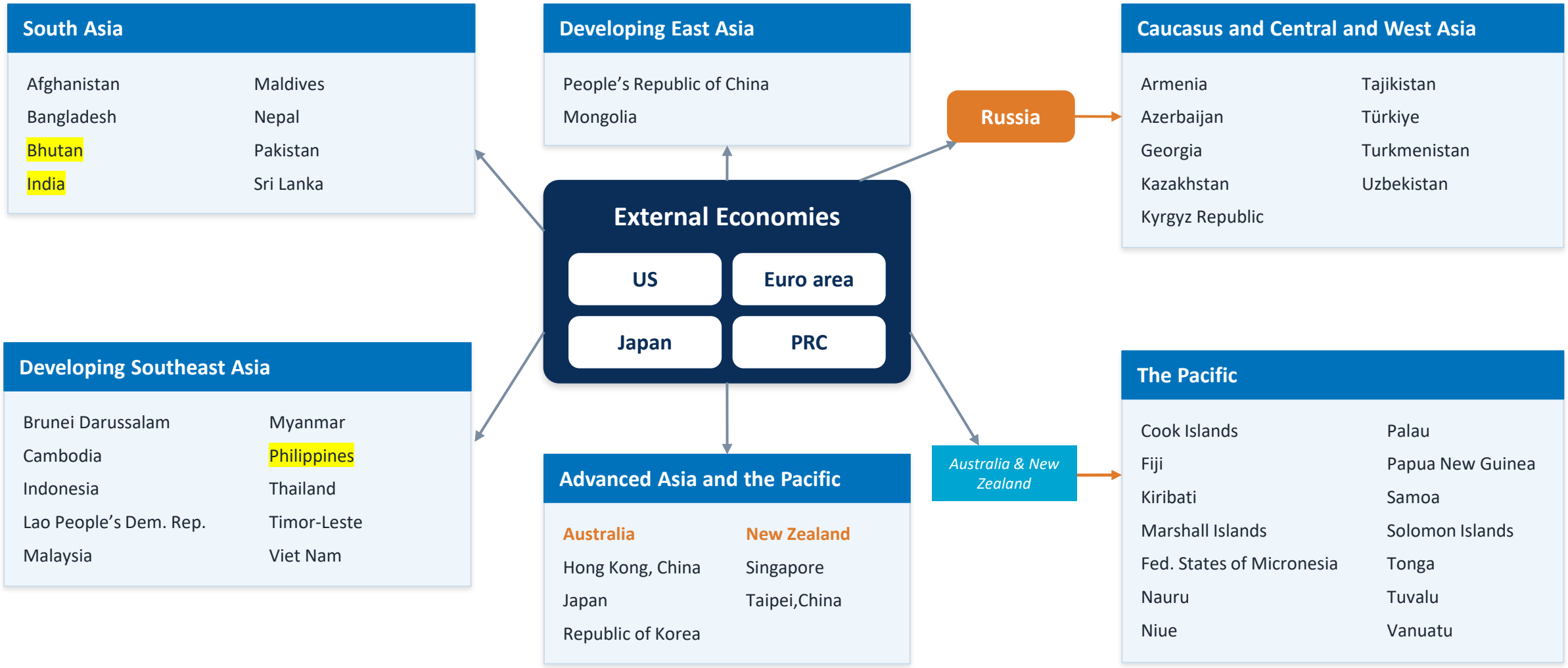
- Two-tier modeling:

  (1) external environment; (2) focus countries.

- Model is coded in Python.
  - ➢ Easy deployment.



Economy Groupings and Linkages



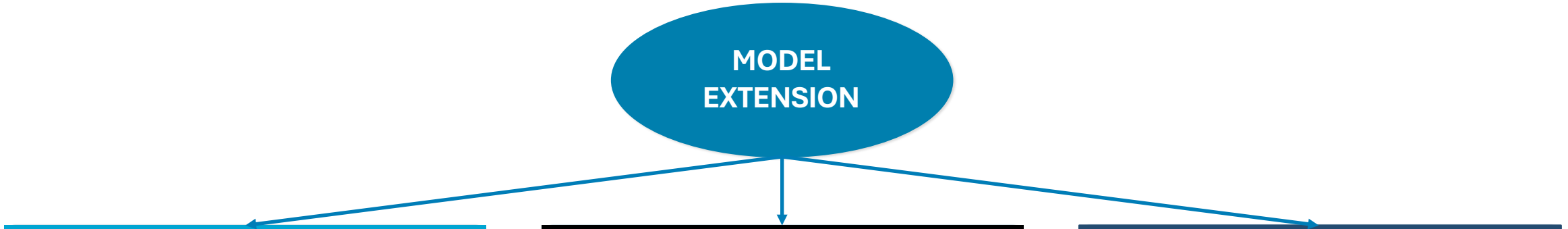
Note: PRC = People's Republic of China; US = United States. Pilot economies

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Model Development Plan

Three parallel enhancements will deepen the model and strengthen its data foundation.

SCOPE EXPANSION | **Additional DMCs and corresponding external economies**



Inflation decomposition

Separate headline inflation into key components and underlying drivers.

Global commodity prices

Integrate global energy prices

Data infrastructure

Move from individual CSV files to a structured, scalable database.

System Requirements





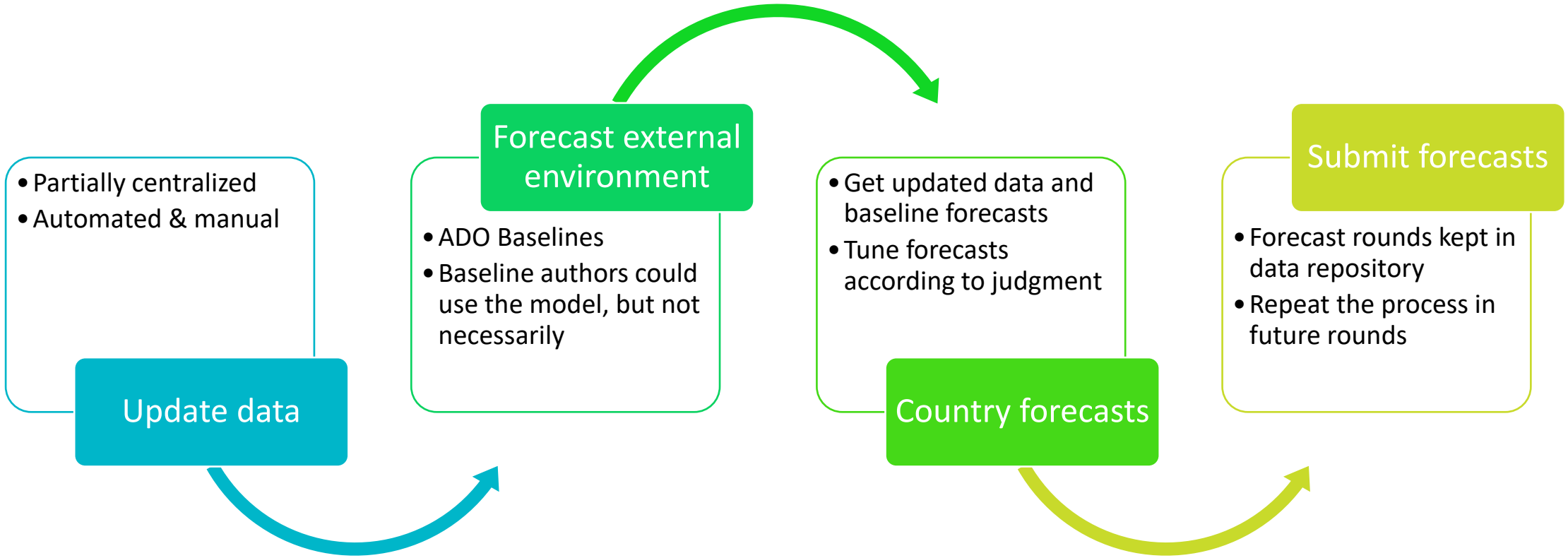
- Python 3.12 or later
- IDE such as Microsoft Visual Studio Code
- The tool does not require Python expertise from the user.

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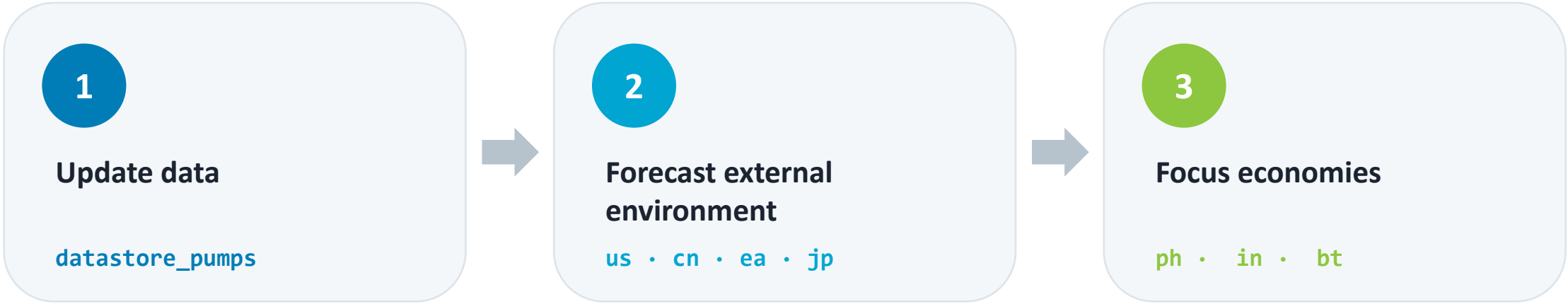
Forecasting process

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Typical Forecasting Process

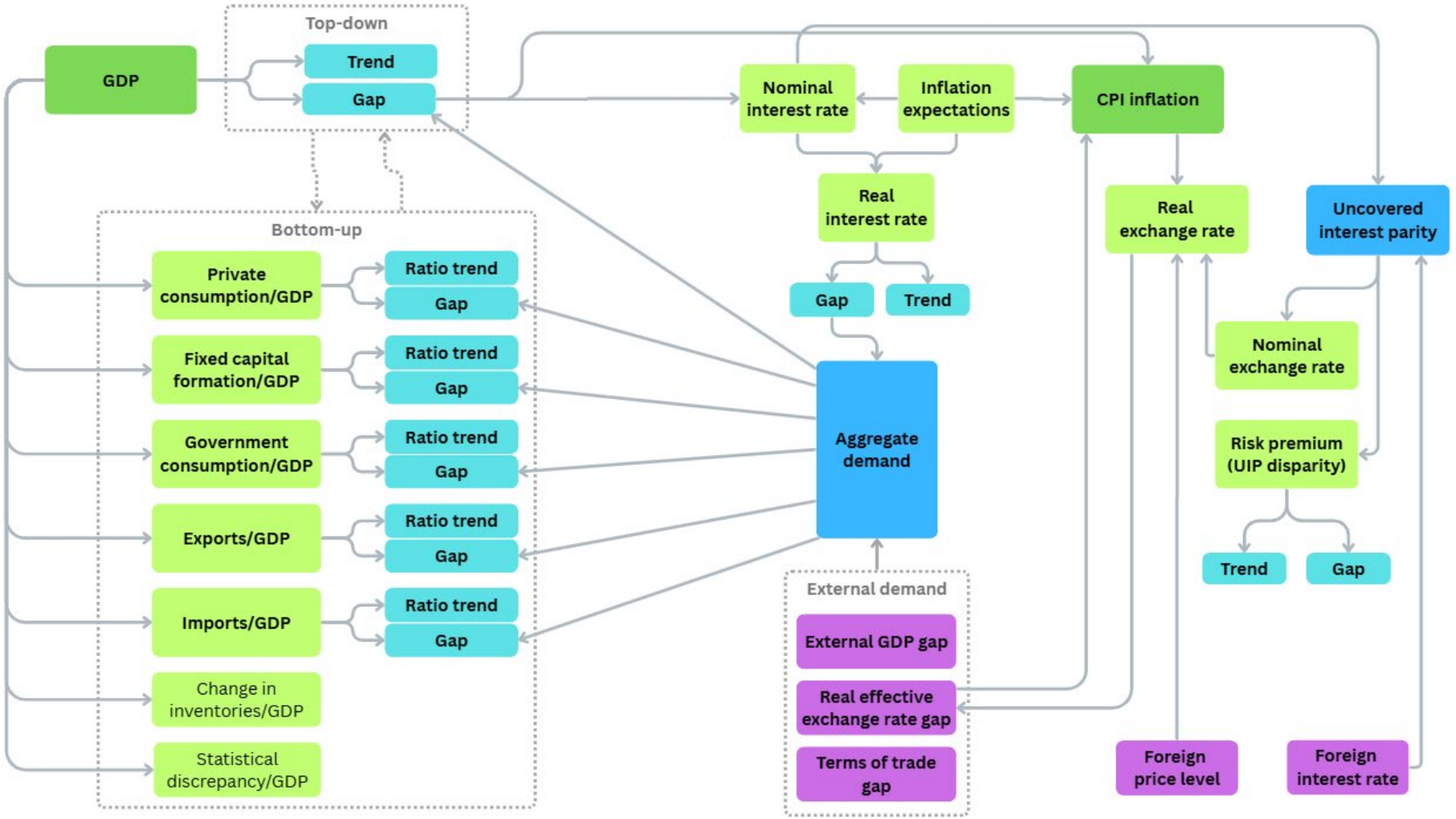


Model Forecast Sequencing



bt = Bhutan, cn = People's Republic of China, ea= euro area, in = India, jp = Japan, ph = Philippines us = United States.

Model Overview



Model Equations

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Mathematical conventions

- $\tilde{x}$ denotes gaps (proportional deviations from trend)
- $\overline{x}$ denotes trends
- $\Delta \log x$ denotes log growth rates (Q/Q)
- $\Delta^4 \log x$ denotes year-over-year log growth rates
- $\star$ denotes external variables (ending in “w”)
- eff denotes effective external variables (ending in "wx")
- x denotes external variables excluding US (ending in "x")
- ste denotes short-term expectations
- ss denotes steady-state values
- ann superscript denotes annual moving averages (4-quarter sums)
- $\left[\frac{x}{y}\right]_t$ denotes ratios
- $\varepsilon_{x,t}$ denotes structural shocks to trends
- c_0, c_1 denote autoregressive parameters

Trend-Gap decompositions

- Most key variables undergo a trend-gap multiplicative decomposition:

$$x_t = \overline{x}_t \times \tilde{x}_t \Longrightarrow \ln x_t = \ln \overline{x}_t + \ln \tilde{x}_t$$

Where:

- $\overline{x}_t$ is the trend component
- $\tilde{x}_t$is the gap component (proportional deviation from trend)
- When $\tilde{x}_t = 1$, the variable equals its trend
- When $\tilde{x}_t > 1$, the variable is above trend
- When $\tilde{x}_t < 1$, the variable is below trend

*Some variables have an additive decomposition

ADB

Top-down GDP identity

Aggregate GDP

- Main GDP Identity

$$gdp_t = \overline{gdp}_t \times \widetilde{gdp}_t$$

- Aggregate GDP Gap

$$\begin{aligned}\log \widetilde{gdp}_t = {} & c_0 \log \widetilde{gdp}_{t-1} - c_1 \tilde{r}\imath_t + c_2 \log \widetilde{re}_t^{eff} \\ & + c_3 \log \widetilde{tot}_t + c_4 \log \widetilde{gdp}^{\star \text{eff}}{}_t \\ & + \varepsilon_{gdp,t}^{\text{ann}} + \varepsilon_{gdp,t} + \varepsilon_{gdp,t}^{\text{bu}}\end{aligned}$$

- The aggregate GDP gap equation captures how real output deviates from its trend level based on key macroeconomic conditions. It responds to real interest rate gaps ($\tilde{r\imath}_t$), effective external competitiveness ($\widetilde{re}_t^{eff}$), terms of trade ($\widetilde{tot}_t$), and external demand conditions ($\widetilde{gdp}^{\star \text{eff}}{}_t$).

Top-down GDP identity

Aggregate GDP

- Real GDP Trend Growth

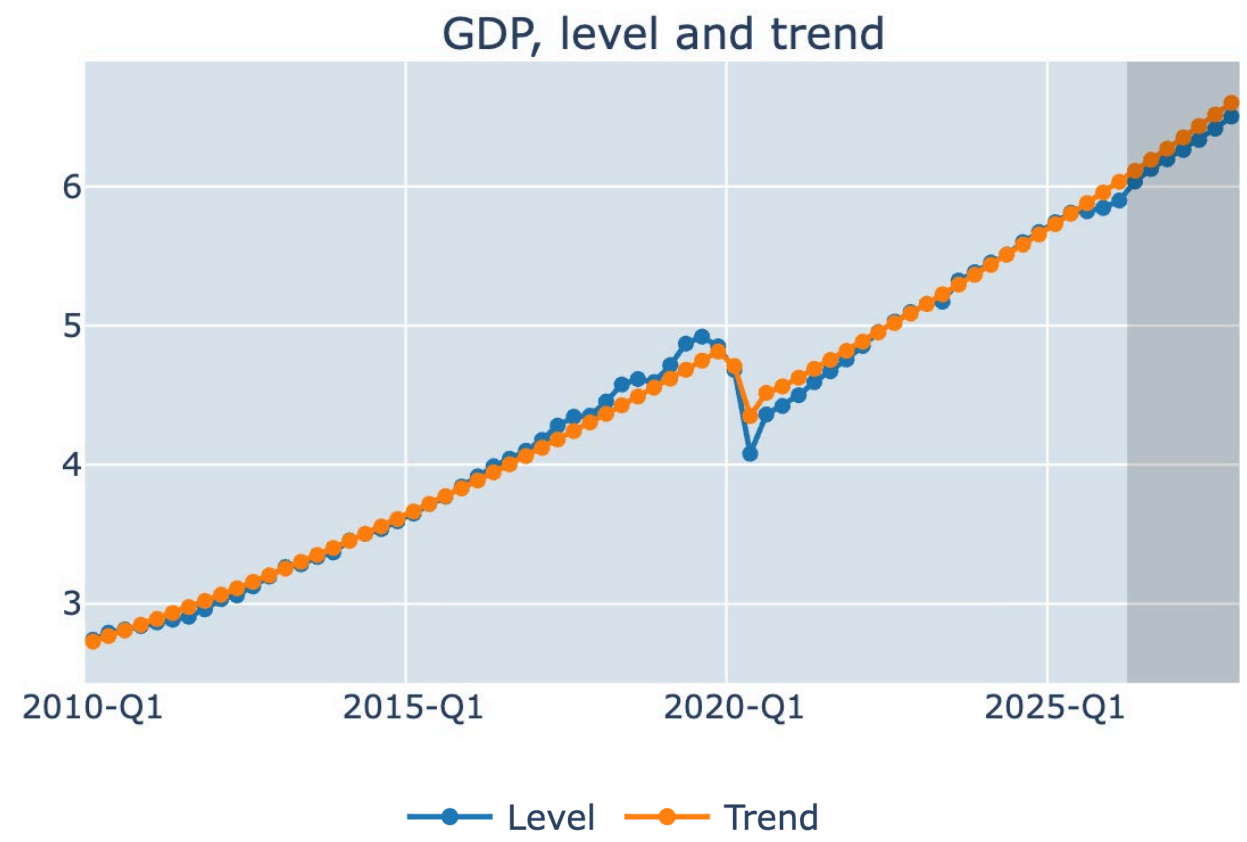
$$4\,\Delta \log \overline{gdp}_t - \varepsilon_{\overline{gdp},t} = c_0 \left(4\,\Delta \log \overline{gdp}_{t-1} - \varepsilon_{\overline{gdp},t-1}\right) + (1 - c_0)\,4\,\Delta \log \overline{gdp}^{ss} + \varepsilon_{\Delta \log \overline{gdp},t}$$

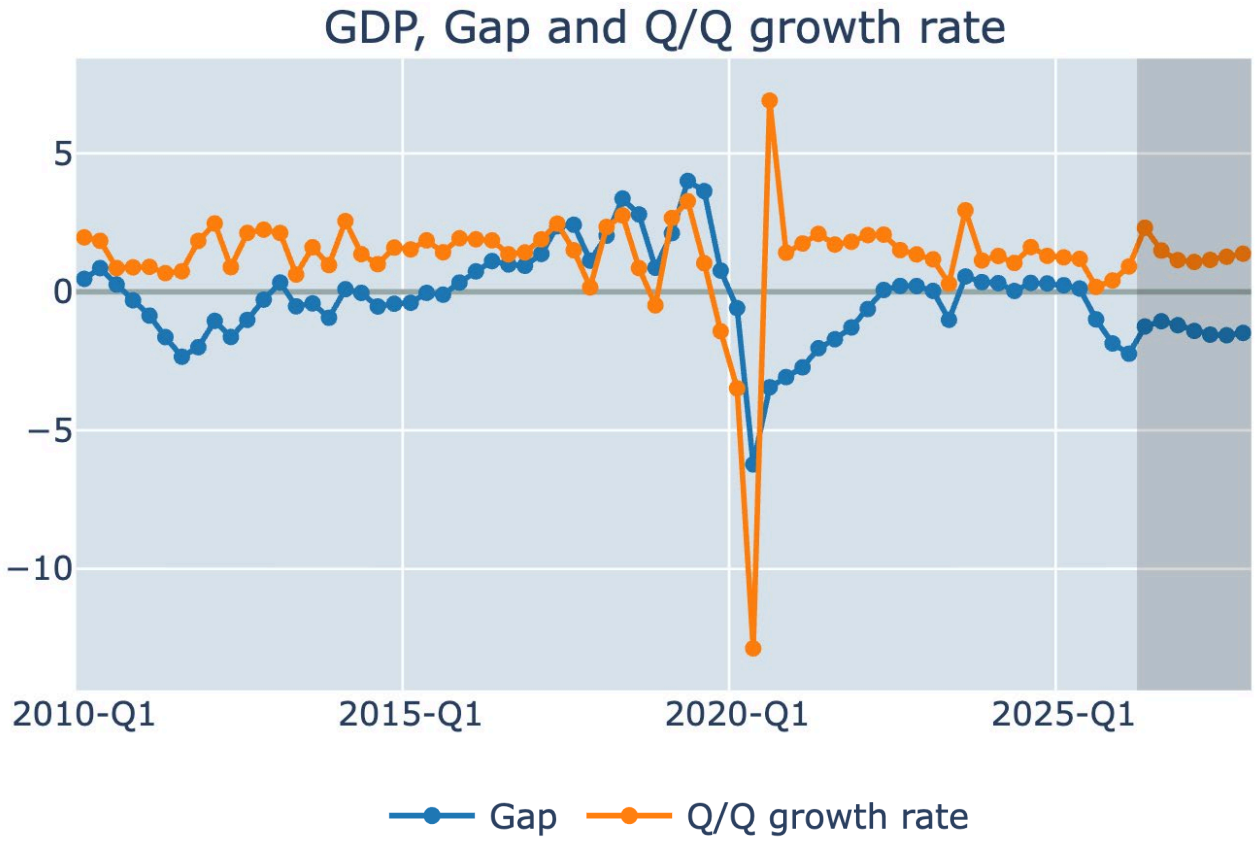
  - The real GDP trend growth equation captures the long-run behavior of real GDP, modeled as an autoregressive ($\overline{gdp}_{t-1}$), mean-reverting process ($\Delta \log \overline{gdp}^{ss}$).

Top-down GDP identity

Aggregate GDP

Philippines: Aggregate GDP estimates





Top-down GDP identity

Aggregate GDP

- Annual GDP moving average

$$gdp_t^{\text{ann}} = \sum_{j=0}^{3} gdp_{t-j}$$

- The annual moving average provides a model-based interpolation mechanism that allows incorporation of annual data observations.
- In Q4, these match exactly the annual figures, enabling the Kalman filter to handle mixed-frequency data and perform quarterly interpolation of annual observations (such as those of Bhutan).

ADB

Bottom-up GDP identity

GDP Components

- GDP Component Trend-Gap identity

For each component: $\mathrm{J} \in \{cpr, cgg, fcf, xgs, mgs\}$

$$\mathrm{J}_t = \bar{\mathrm{J}}_t \times \tilde{\mathrm{J}}_t$$

- Applies to private consumption (cpr), government consumption (cpr), fixed capital formation (fcf), and exports (xgs) and imports (mgs) of goods and services.

ADB

Bottom-up GDP identity

GDP Components

- Private Consumption Gap

$$\log \widetilde{cpr}_t = c_{p,0} \log \widetilde{cpr}_{t-1} - c_{p,1} \tilde{ri}_t + c_{p,2} \log \widetilde{re}_t^{eff} + c_{p,3} \log \widetilde{tot}_t + \varepsilon_{cpr,t}^{ann} + \varepsilon_{cpr,t} + \left[\frac{cpr}{gdp}\right]^{ss} \varepsilon_{gdp,t}^{td}$$

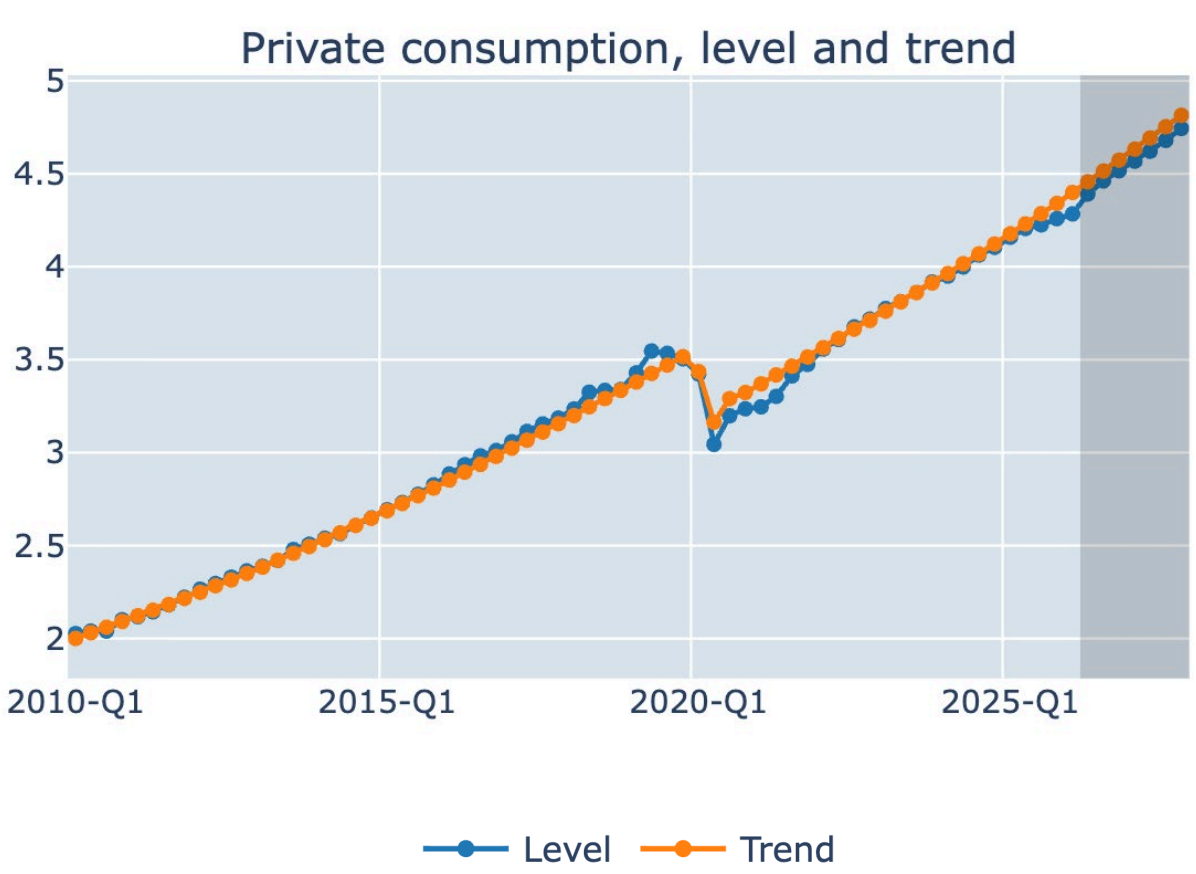
- Private consumption gaps reflect household spending decisions relative to trend, influenced by borrowing costs ($\tilde{ri}_t$), external competitiveness ($\widetilde{re}_t^{eff}$), and terms of trade effects ($\widetilde{tot}_t$).

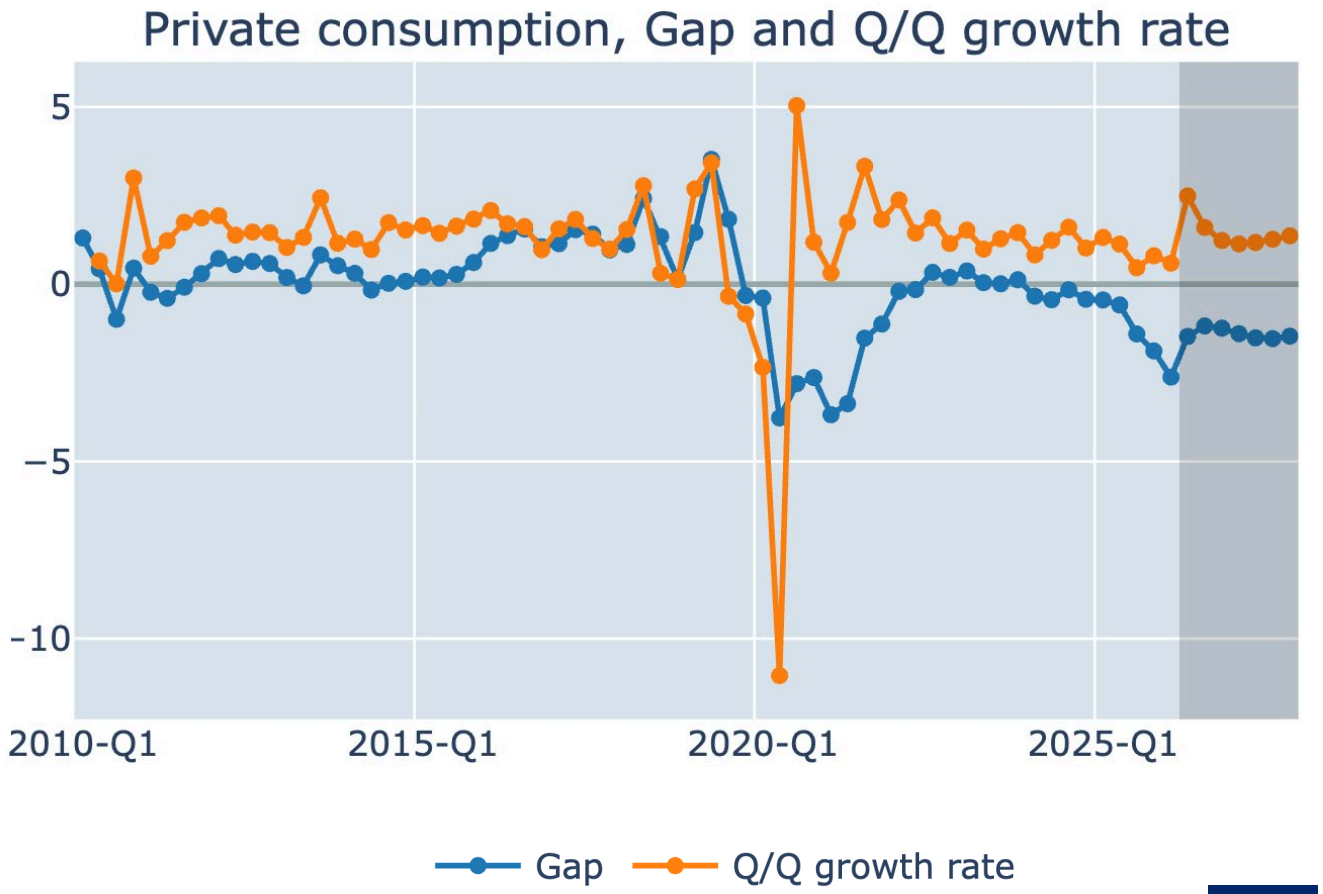
ADB

Bottom-up GDP identity

GDP Components

Philippines: Private Consumption Estimates





Bottom-up GDP identity

GDP Components

- Government Consumption Gap

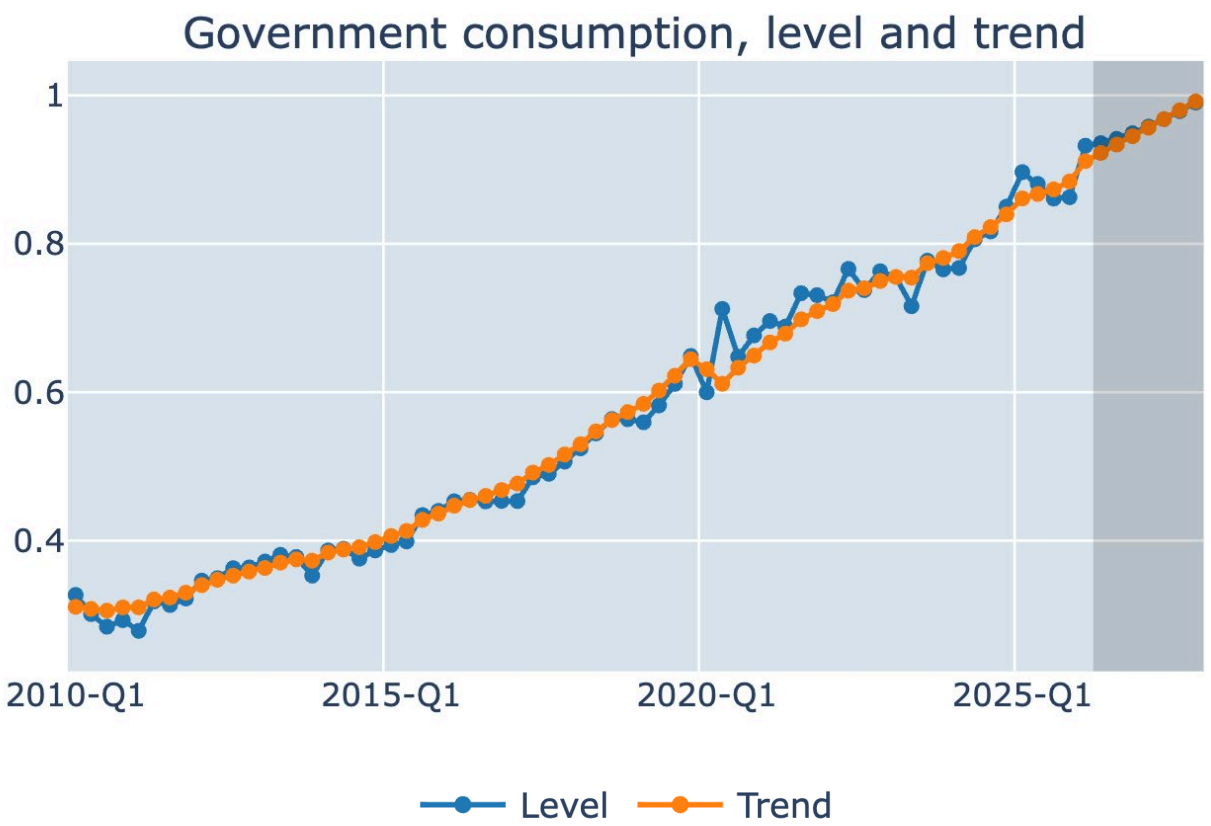
$$\log \widetilde{cgg}_t = c_{g,0} \log \widetilde{cgg}_{t-1} - c_{g,1} \tilde{r}\mathrm{i}_t + c_{g,2} \log \widetilde{re^{\mathrm{eff}}}_t + c_{g,3} \log \widetilde{tot}_t + \varepsilon^{\mathrm{ann}}_{cgg,t} + \varepsilon_{cgg,t} + \left[\frac{cgg}{gdp}\right]^{\mathrm{ss}} \varepsilon^{\mathrm{td}}_{gdp,t}$$

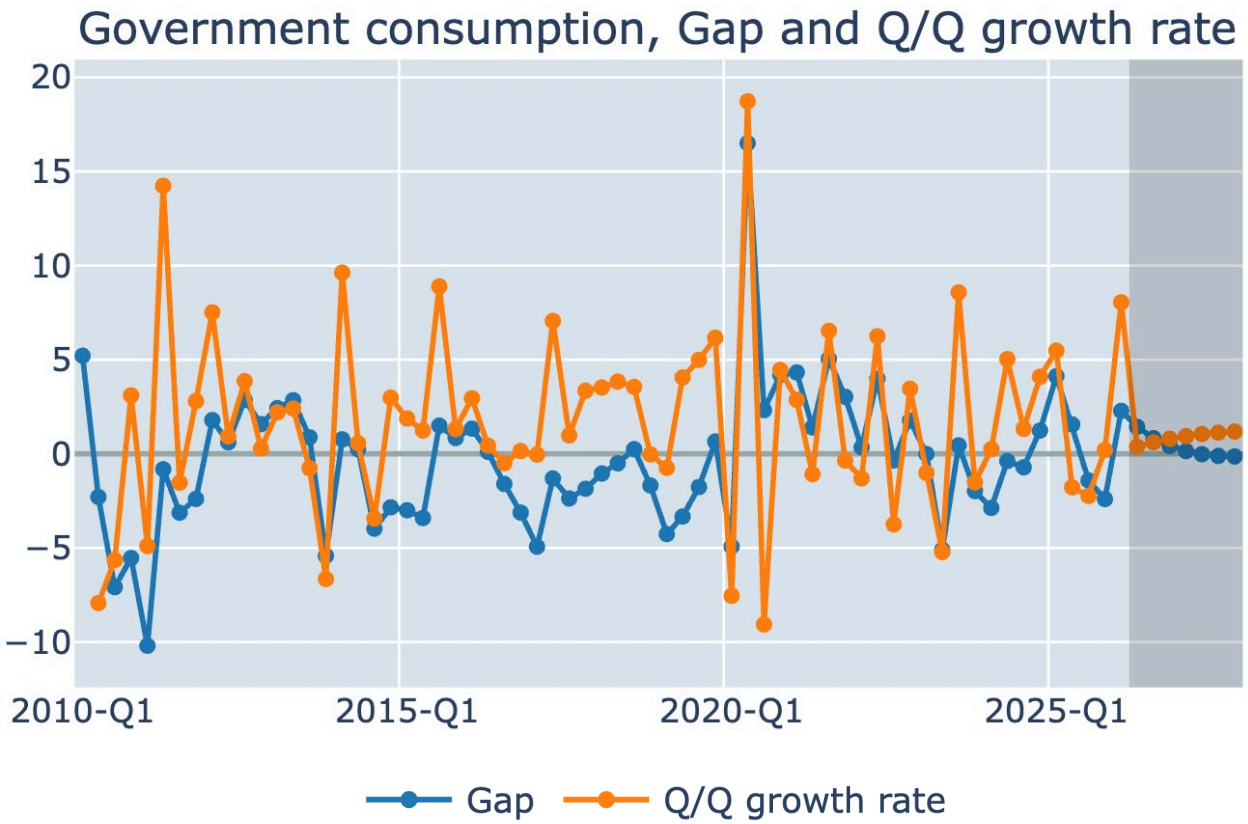
- Government consumption gaps capture discretionary fiscal policy effects and automatic stabilizers that cause public spending to deviate from its trend path. It is also influenced by borrowing costs ($\widetilde{ri}_t$), external competitiveness ($\widetilde{re}_t^{eff}$), and terms of trade effects ($\widetilde{tot}_t$).

Bottom-up GDP identity

GDP Components

Philippines: Government Consumption Estimates





Bottom-up GDP identity

GDP Components

- Fixed Capital Formation Gap

$$\log \widetilde{fcf}_t = c_{f,0} \log \widetilde{fcf}_{t-1} - c_{f,1} \tilde{r}\mathrm{i}_t + c_{f,2} \log \widetilde{re}_t^{eff} + c_{f,3} \log \widetilde{tot}_t + \varepsilon_{fcf,t}^{\mathrm{ann}} + \varepsilon_{fcf,t} + \left[\frac{fcf}{gdp}\right]^{\mathrm{ss}} \varepsilon_{gdp,t}^{\mathrm{td}}$$

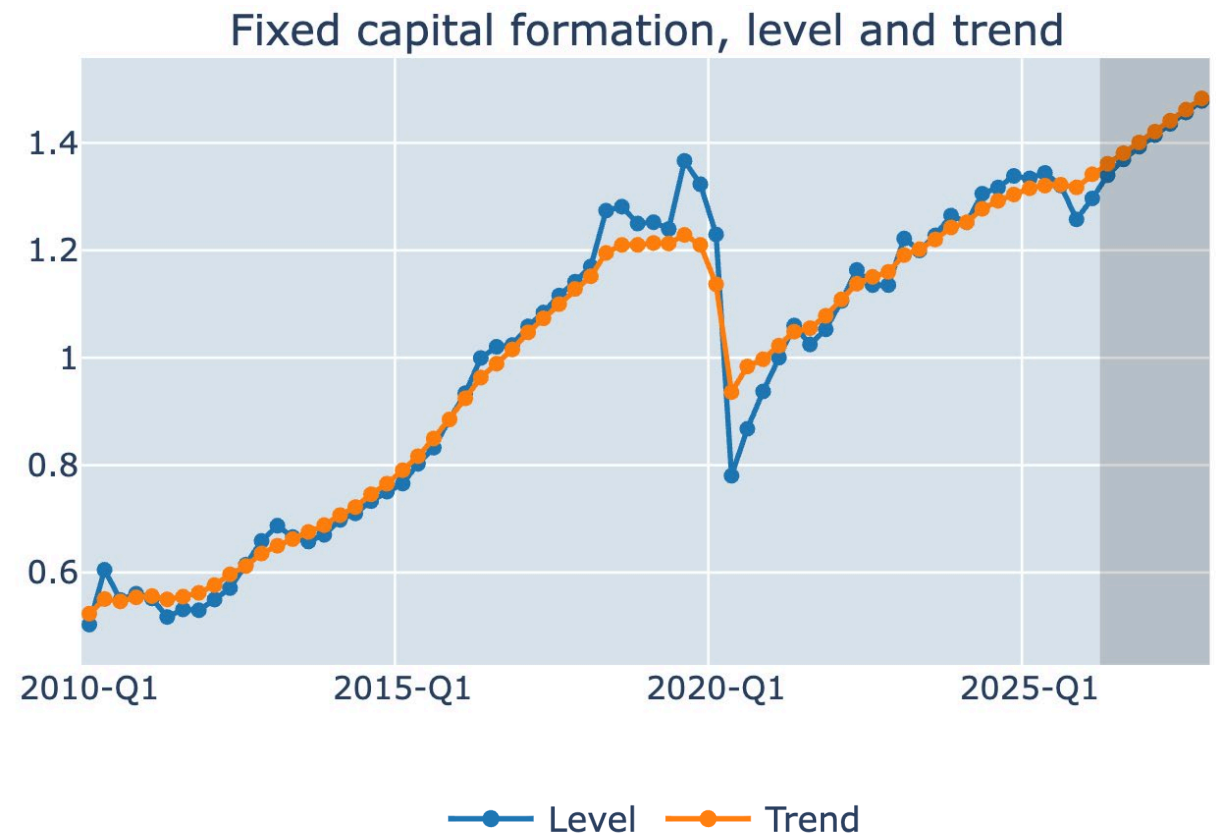
- Investment gaps reflect business investment decisions driven by financing conditions ($\tilde{r}\mathrm{i}_t$), competitiveness effects ($\widetilde{re}_t^{eff}$), and terms of trade impacts on capital goods prices ($\widetilde{tot}_t$).

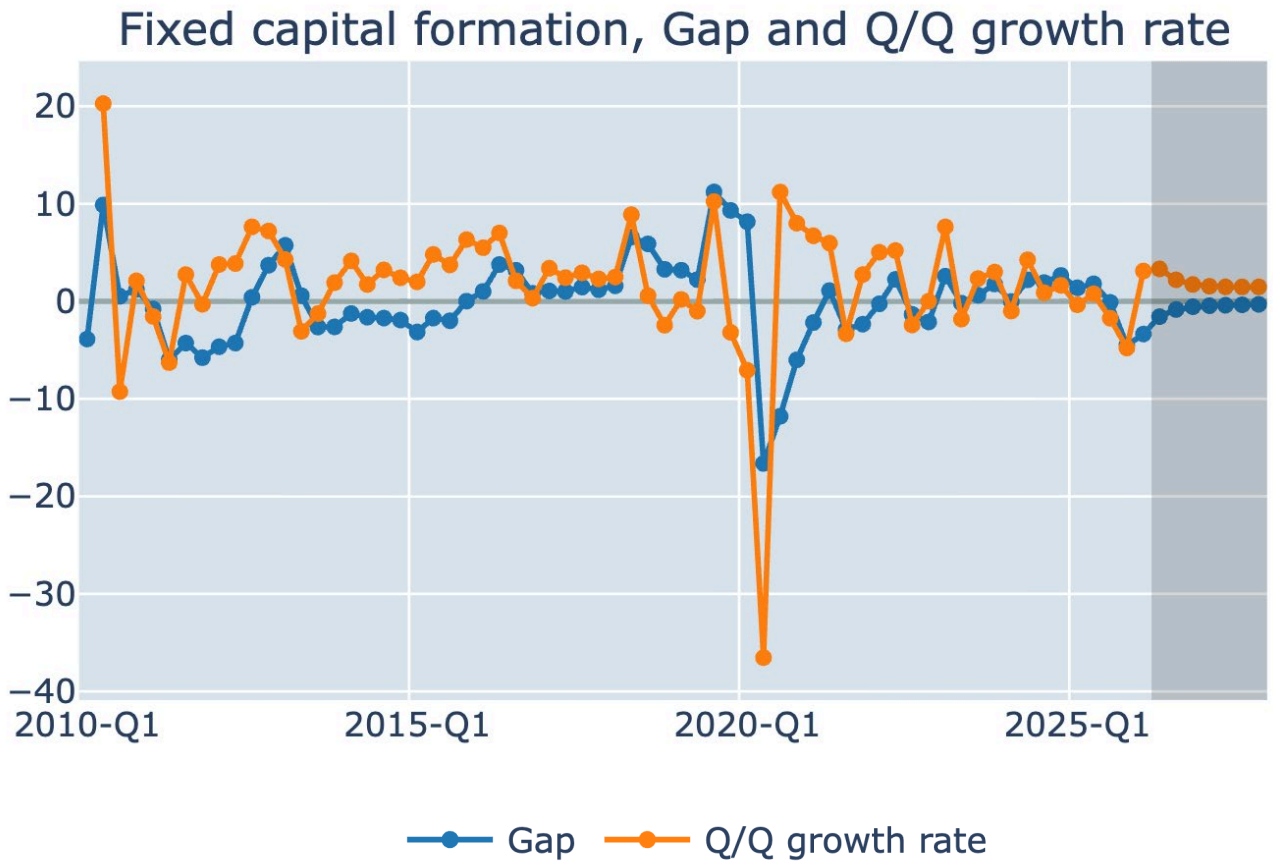
ADB

Bottom-up GDP identity

GDP Components

Philippines: Fixed Capital Formation Estimates





Bottom-up GDP identity

GDP Components

- Goods and Services Export Gap

$$\log \widetilde{xgs}_t = c_{x,0} \log \widetilde{xgs}_{t-1} + c_{x,2} \log \widetilde{reff}_t + c_{x,3} \log \widetilde{tot}_t + \varepsilon^{\text{ann}}_{xgs,t} + \varepsilon_{xgs,t} + \left[\frac{xgs}{gdp}\right]^{\text{ss}} \varepsilon^{\text{td}}_{gdp,t}$$

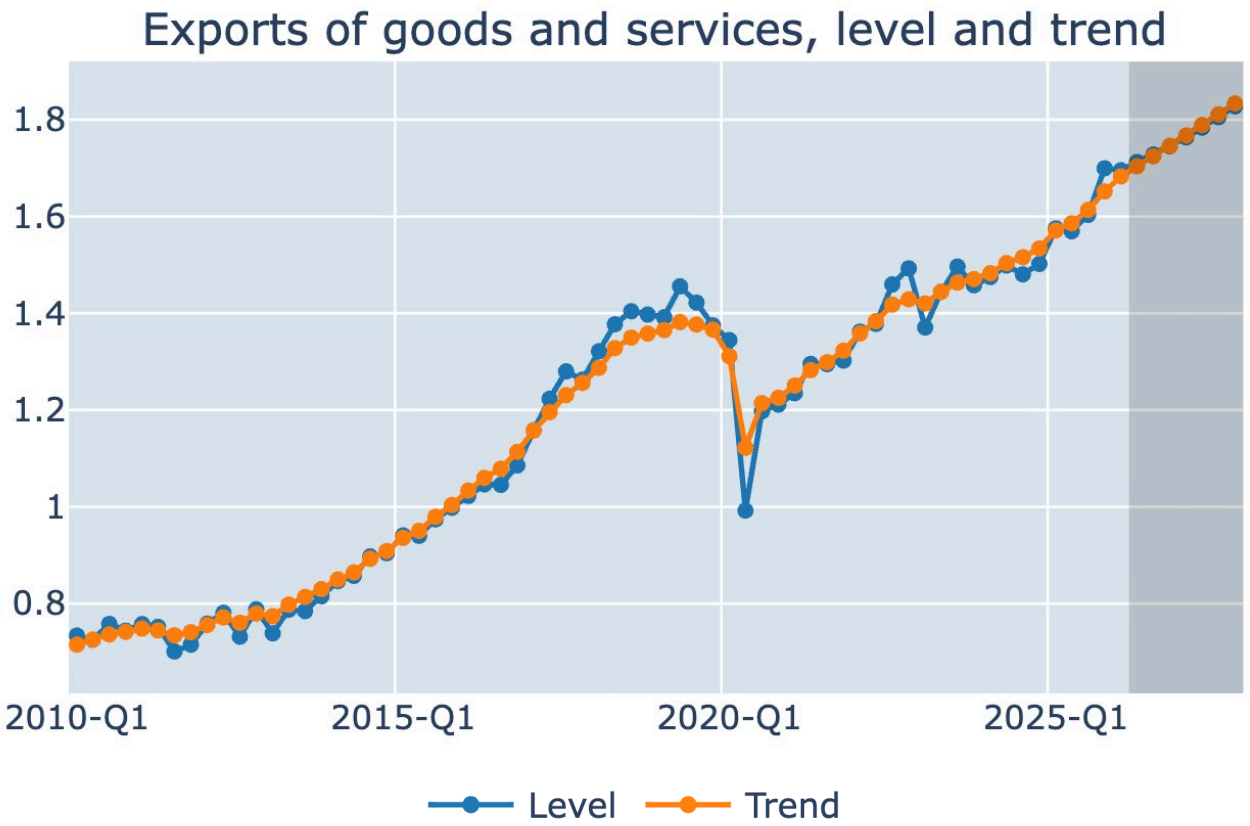
- Export gaps capture the competitiveness ($\widetilde{re}_t^{eff}$) and external demand effects on trade performance ($\widetilde{tot}_t$), with no direct interest rate sensitivity reflecting institutional export financing.

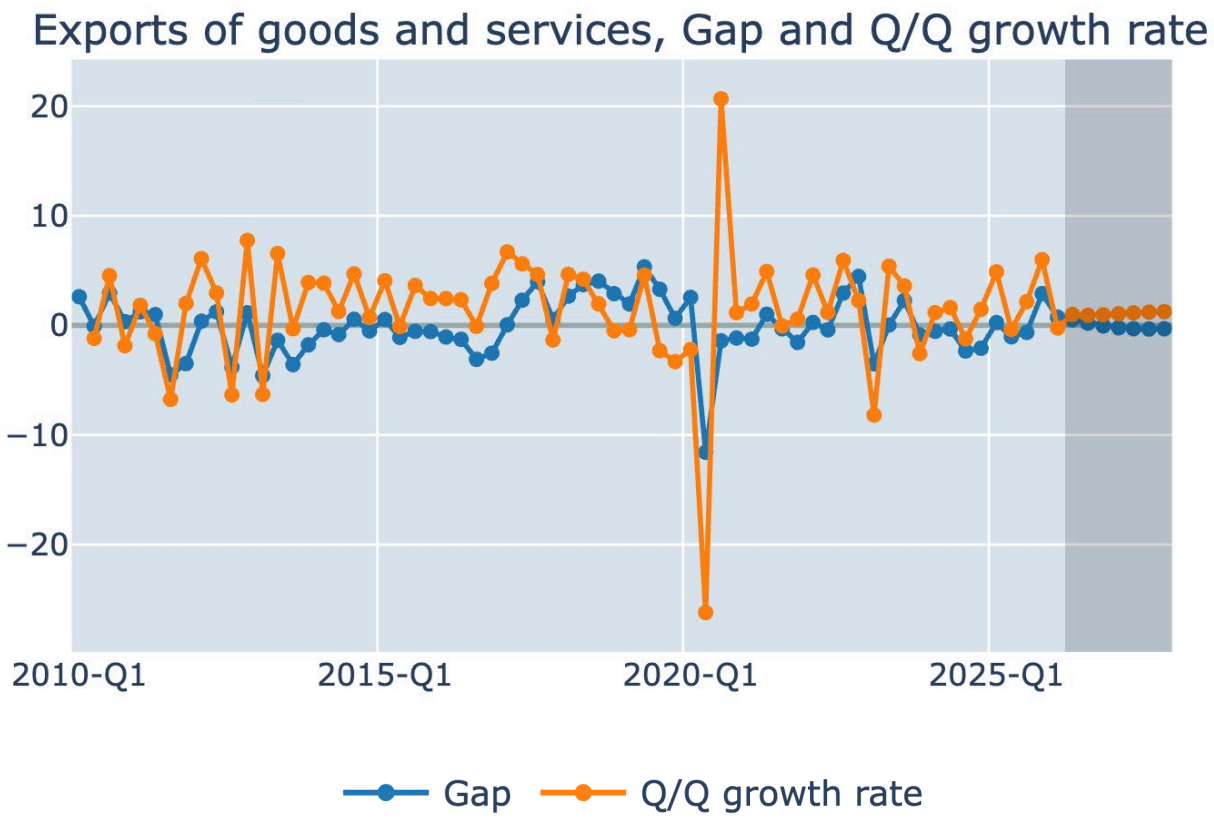
ADB

Bottom-up GDP identity

GDP Components

Philippines: Exports of goods and services estimates





Bottom-up GDP identity

GDP Components

- Goods and Services Import Gap

$$\log \widetilde{mgs}_t = c_{m,0} \log \widetilde{mgs}_{t-1} + c_{m,2} \log \widetilde{re^{\text{eff}}}_t + \varepsilon^{\text{ann}}_{mgs,t} + \varepsilon_{mgs,t} - \left[\frac{mgs}{gdp}\right]^{\text{ss}} \varepsilon^{\text{td}}_{gdp,t}$$

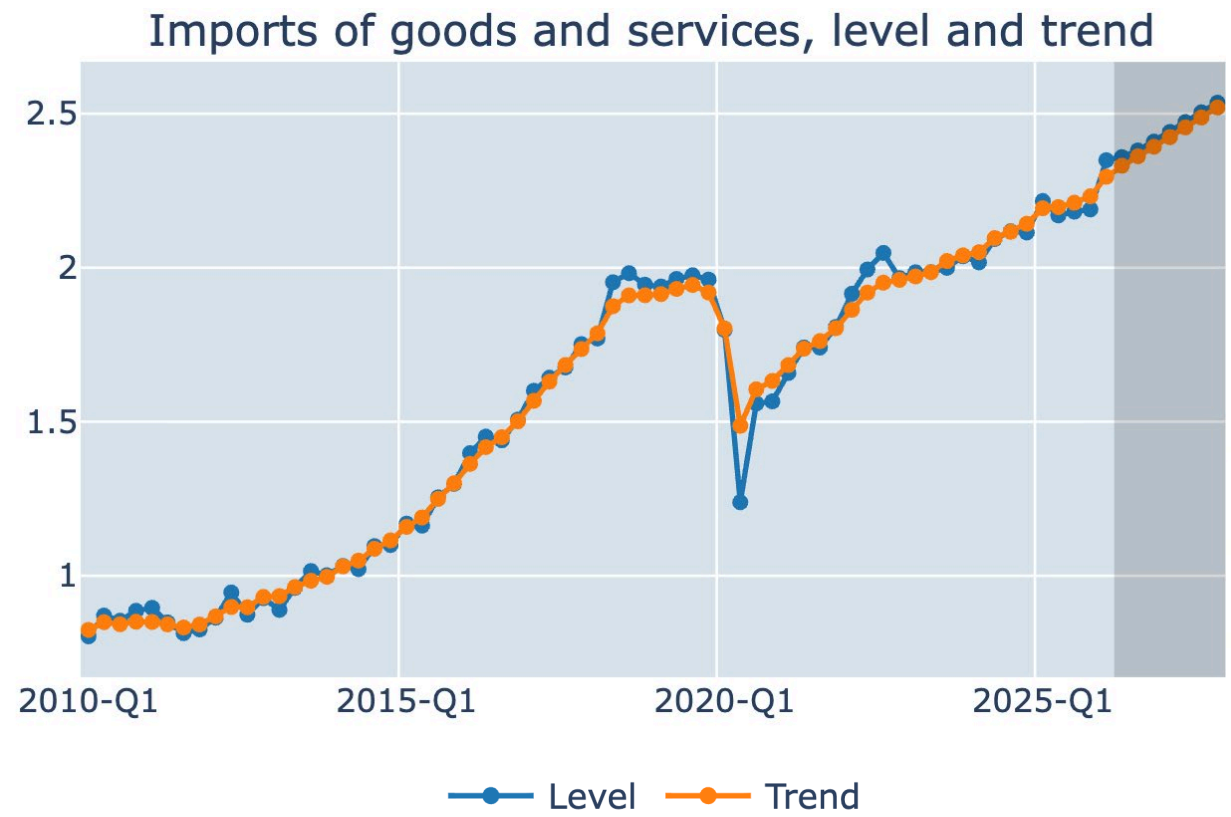
- Import gaps respond to domestic competitiveness conditions ($\widetilde{re}_t^{eff}$), reflecting how external price competitiveness affects import demand relative to trend.

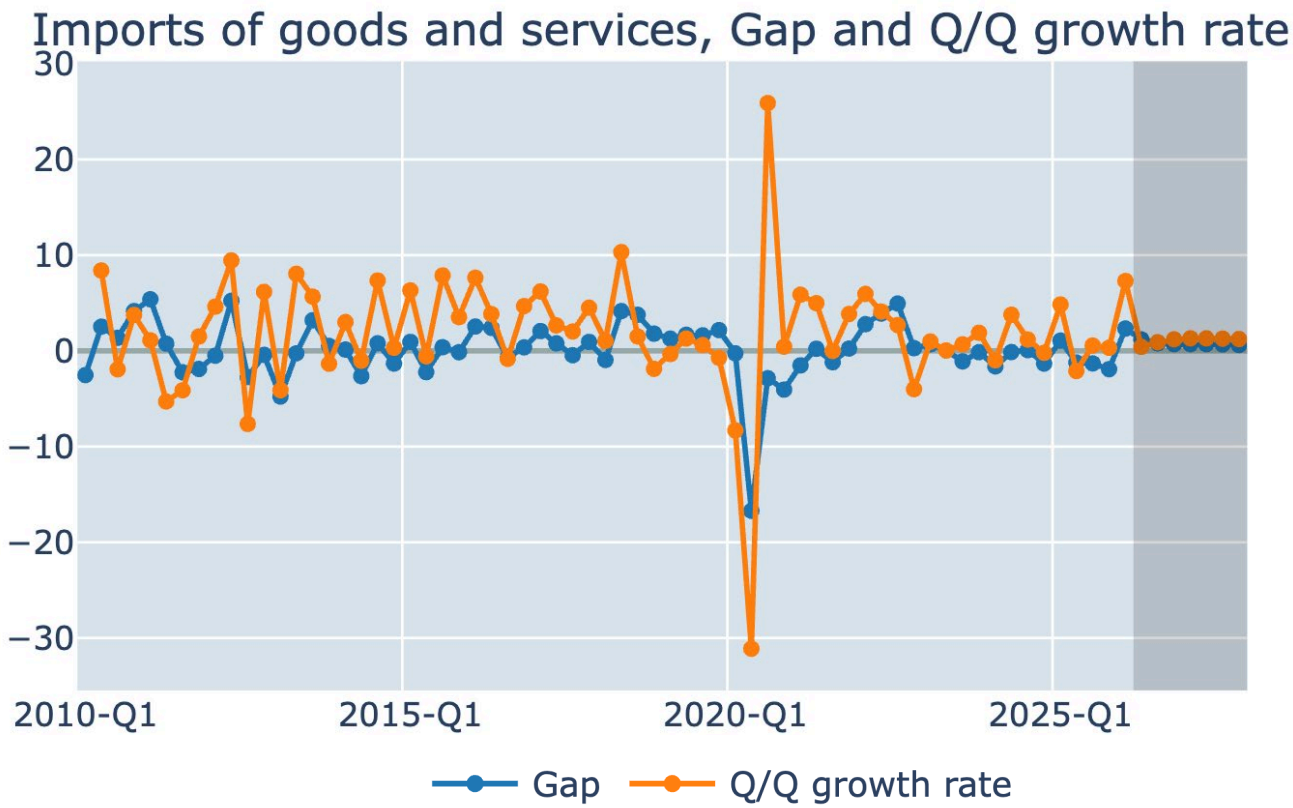
ADB

Bottom-up GDP identity

GDP Components

Philippines: Imports of goods and services estimates





Bottom-up GDP identity

GDP Components

- Change in Business Inventories to GDP

$$\left[\frac{cbi}{gdp}\right]_t = c_{\mathrm{b},0}\left[\frac{cbi}{gdp}\right]_{t-1} + \left(1 - c_{\mathrm{b},0}\right)\overline{\left[\frac{cbi}{gdp}\right]_t} + \varepsilon_{\left[\frac{cbi}{gdp}\right],t}$$

- Inventory accumulation follows a mean-reverting process around its trend ($\overline{\left[\frac{cbi}{gdp}\right]_t}$), capturing the cyclical nature of business inventory management.

Bottom-up GDP identity

GDP Components

- Statistical Discrepancy to GDP

$$\left[\frac{sdx}{gdp}\right]_t = c_{s,0}\left[\frac{sdx}{gdp}\right]_{t-1} + \varepsilon_{\left[\frac{sdx}{gdp}\right],t}$$

- The statistical discrepancy captures measurement errors and unobserved components in GDP accounting, modeled as a persistent but mean-reverting process ($\mu = 0$).

Bottom-up GDP identity

GDP Components

- Component trend definitions

For each component: $\mathrm{J} \in \{cpr, cgg, fcf, xgs, mgs\}$

$$\bar{\mathrm{J}}_t = \overline{\left[\frac{\mathrm{J}}{gdp}\right]}_t \times \overline{gdp}_t$$

- GDP component trends are modeled as functions of trend share of GDP ($\overline{\left[\frac{\mathrm{J}}{gdp}\right]}_t$) and aggregate GDP trend ($\overline{gdp}_t$)

Bottom-up GDP identity

GDP Components

- Component share trend

For each component: $\mathrm{J} \in \{cpr, cgg, fcf, xgs\}$

$$\log\left[\frac{\mathrm{J}}{gdp}\right]_t = c_{\mathrm{J},0} \log\left[\frac{\mathrm{J}}{gdp}\right]_{t-1} + \left(1 - c_{\mathrm{J},0}\right) \log\left[\frac{\mathrm{J}}{gdp}\right]^{\mathrm{ss}} + \varepsilon_{\left[\frac{\mathrm{J}}{gdp}\right],t}$$

- Modeled as an autoregressive mean-reverting process ($\left[\frac{\mathrm{J}}{gdp}\right]^{\mathrm{ss}}$).
- Note: imports are determined residually.

Bottom-up GDP identity

GDP Components

- Component annual moving trend

$$\mathrm{J}_t^{\mathrm{ann}} = \sum_{k=0}^{3} \mathrm{J}_{t-k}$$

- Annual moving average enables mixed-frequency estimation by exactly matching annual data in Q4 periods.

ADB

Bottom-up GDP identity

GDP Components

- Bottom-up trend identity

$$1 = \overline{\left[\frac{cpr}{gdp}\right]}_t + \overline{\left[\frac{cgg}{gdp}\right]}_t + \overline{\left[\frac{fcf}{gdp}\right]}_t + \overline{\left[\frac{cbi}{gdp}\right]}^{ss} + \overline{\left[\frac{xgs}{gdp}\right]}_t - \overline{\left[\frac{mgs}{gdp}\right]}_t$$

- Ensures the trend components sum to 1 and residually determines the import-to-GDP share
- **Note on CBI and SDX trends:** The change in business inventories ratio $\overline{\left[\frac{cbi}{gdp}\right]}^{ss}$ has a **constant trend** set at the steady-state parameter level (no time variation). The statistical discrepancy ratio trend is **fixed at zero always:**

$$\overline{\left[\frac{sdx}{gdp}\right]}_t = 0$$

Bottom-up GDP identity

GDP Components

- Bottom-up level identity:

$$gdp_t^{\text{ident}} = cpr_t + cgg_t + fcf_t + xgs_t - mgs_t + \left[\frac{cbi}{gdp}\right]_t \times gdp_t + \left[\frac{sdx}{gdp}\right]_t \times gdp_t$$

- Obtained by combining the component trend and gap equations

Top-down and Bottom-up GDP reconciliation

- The two GDP quantities are reconciled through:

$$gdp_t^{\text{ident}} = gdp_t \times gdp_t^{\text{resid}}$$

  - Where gdp_t^{resid} is a residual term that is exogenized (takes as a given) and set to 1 when the model is solved. The actual discrepancy between the two quantities is absorbed by either the top-down shocks ($\varepsilon_{gdp,t}^{\text{td}}$) or bottom-up shock ($\varepsilon_{gdp,t}^{\text{bu}}$). These shocks adjust their respective GDP gap equations to reconcile the two quantities.
  - The choice of either a top-down or bottom-up adjustment is left to the discretion of the user.

ADB

External variables

- Terms of trade trend-gap identity

$$tot_t = \overline{tot}_t \times \widetilde{tot}_t$$

- Terms of trade trend

$$\log \overline{tot}_t = \log \overline{tot}_{t-1} + \varepsilon_{\overline{tot},t}$$

- Terms of trade gap

$$\log \widetilde{tot}_t = c_{t,0} \log \widetilde{tot}_{t-1} + \varepsilon_{tot,t}$$

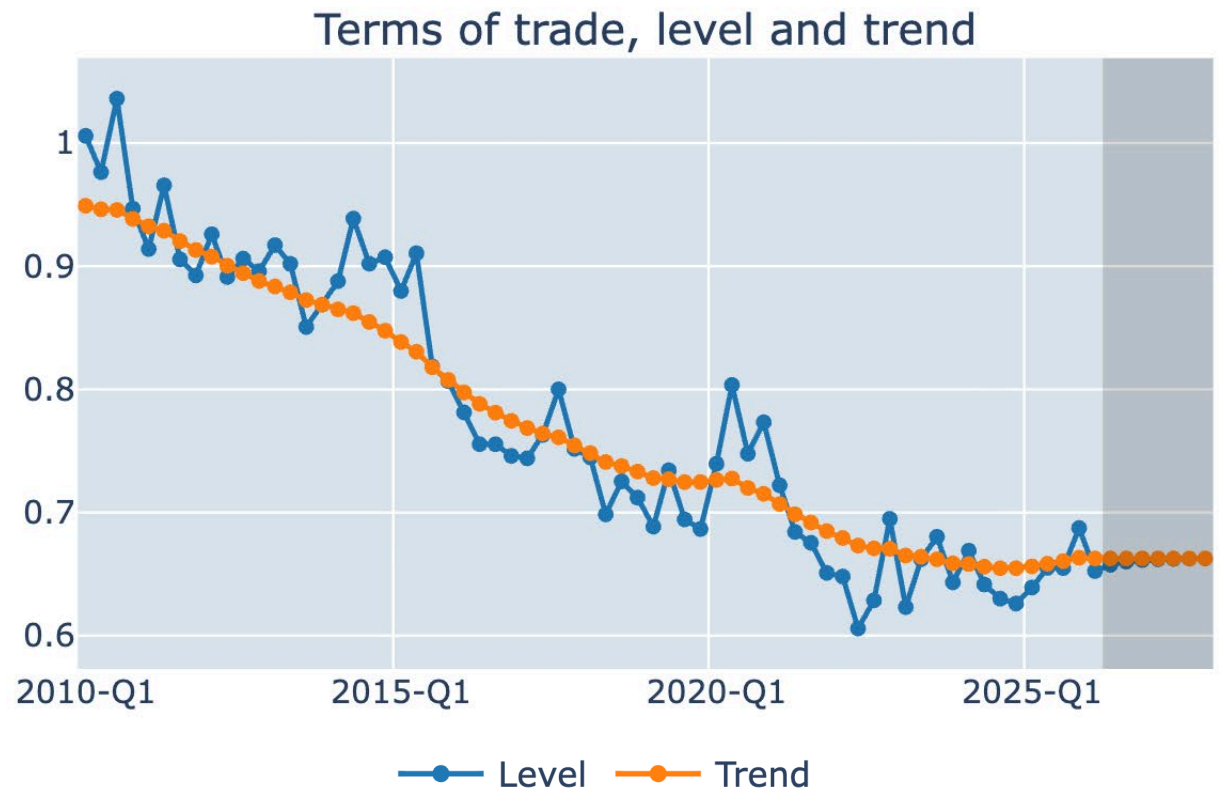
- Annual moving average terms of trade

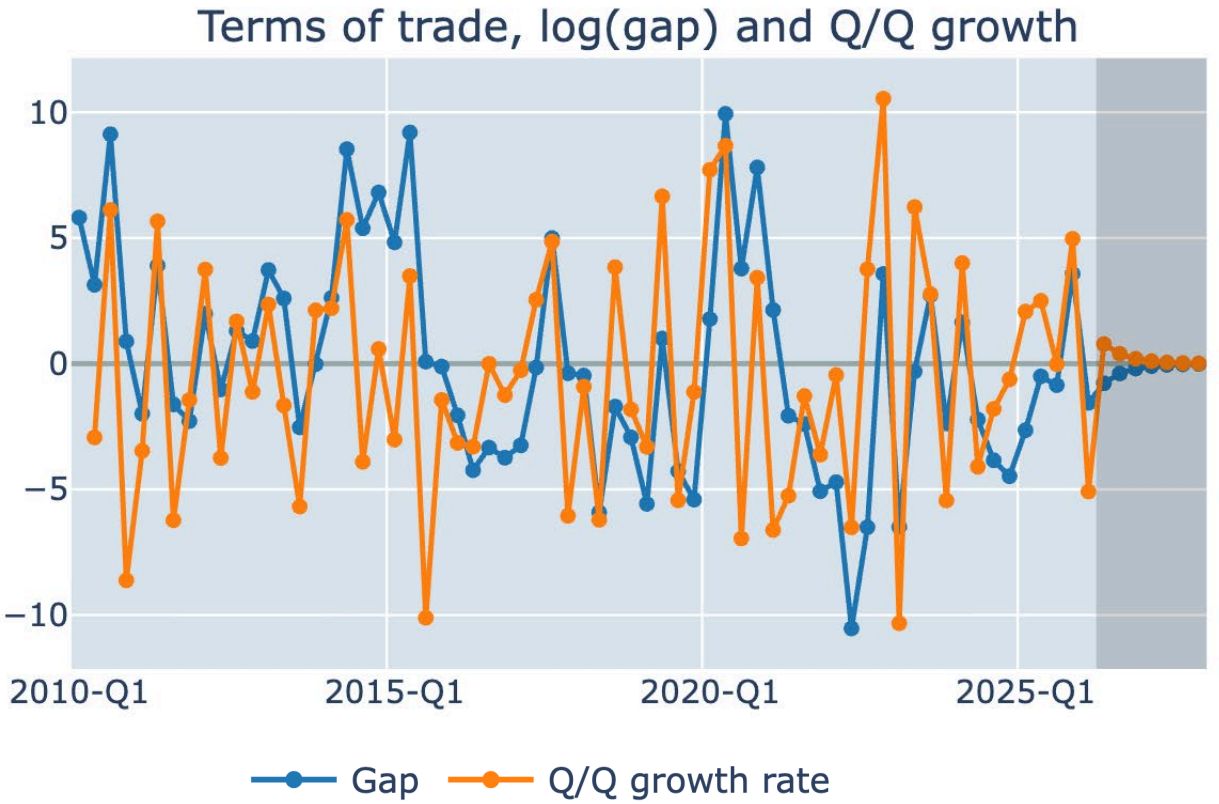
$$tot_t^{\text{ann}} = \sum_{j=0}^{3} tot_{t-j}$$

ADB

External variables

Philippines: Terms of trade estimates





External variables

- External real GDP gap

$$\log \widetilde{gdp^{\star x}}_t = c_0 \log \widetilde{gdp^{\star x}}_{t-1} + \varepsilon_{gdp^{\star x},t} + \tau_{gdp^{\star x},t}$$

  - This represents economic slack in external economies excluding the US, capturing foreign demand conditions that affect domestic exports and competitiveness

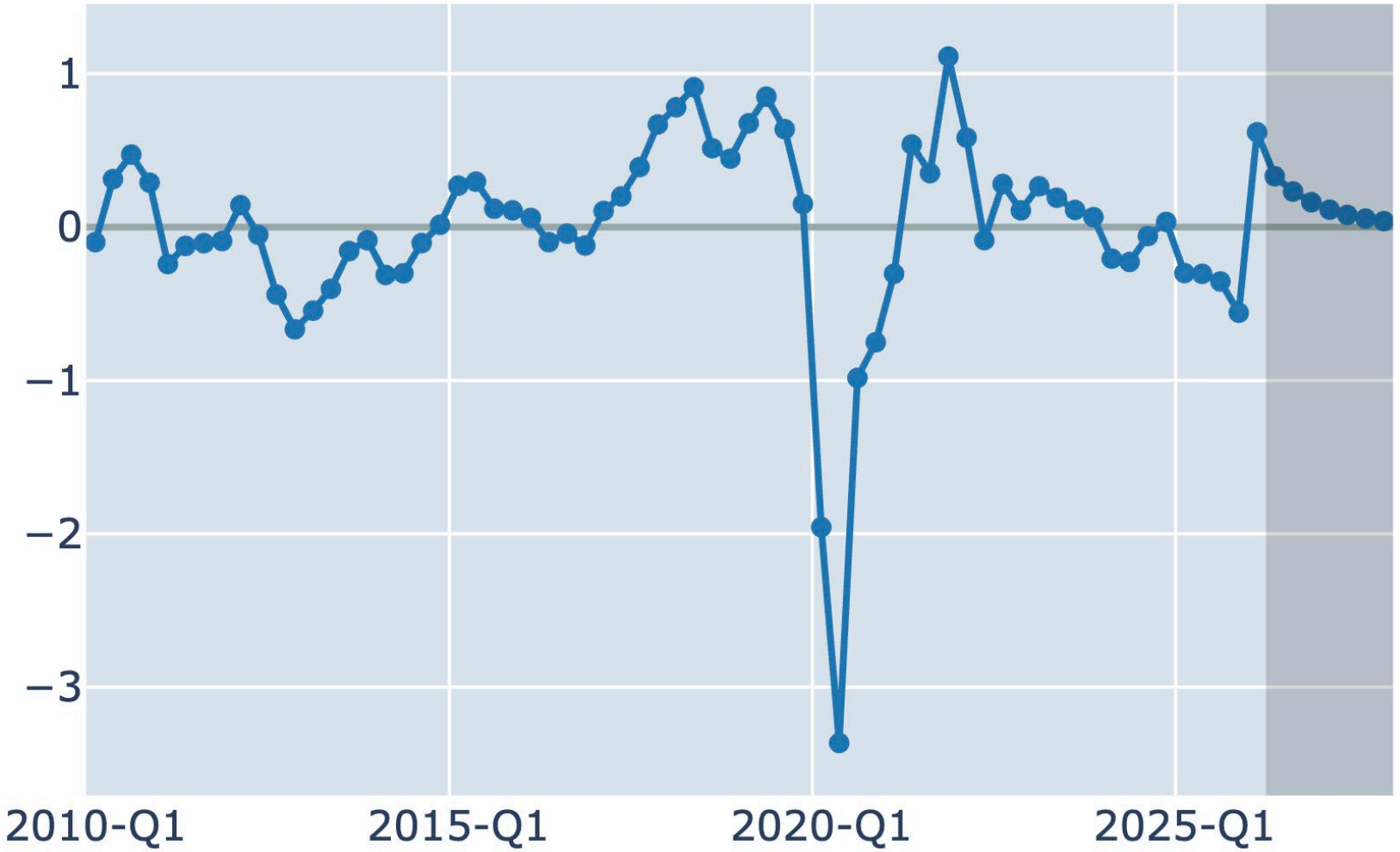
- Effective external real GDP gap

$$\log \widetilde{gdp^{\star \text{eff}}}_t = \omega_{\text{us}} \log \widetilde{gdp^{\star}}_t + (1 - \omega_{\text{us}}) \log \widetilde{gdp^{\star x}}_t$$

- A trade-weighted combination of US ($\widetilde{gdp^{\star}}$) and non-US ($\widetilde{gdp^{\star x}}$)external GDP gaps, providing a comprehensive measure of foreign demand conditions relevant for domestic economic activity.

External variables

Philippines: Effective external GDP gap



External variables

- External real exchange rate gap

$$\log \widetilde{re}^{x}{}_{t} = c_0 \log \widetilde{re}^{x}{}_{t-1} + \varepsilon_{re^x,t} + \tau_{re^x,t}$$

  - Captures deviations of external real exchange rates from equilibrium levels, representing competitiveness conditions in foreign markets excluding the US.

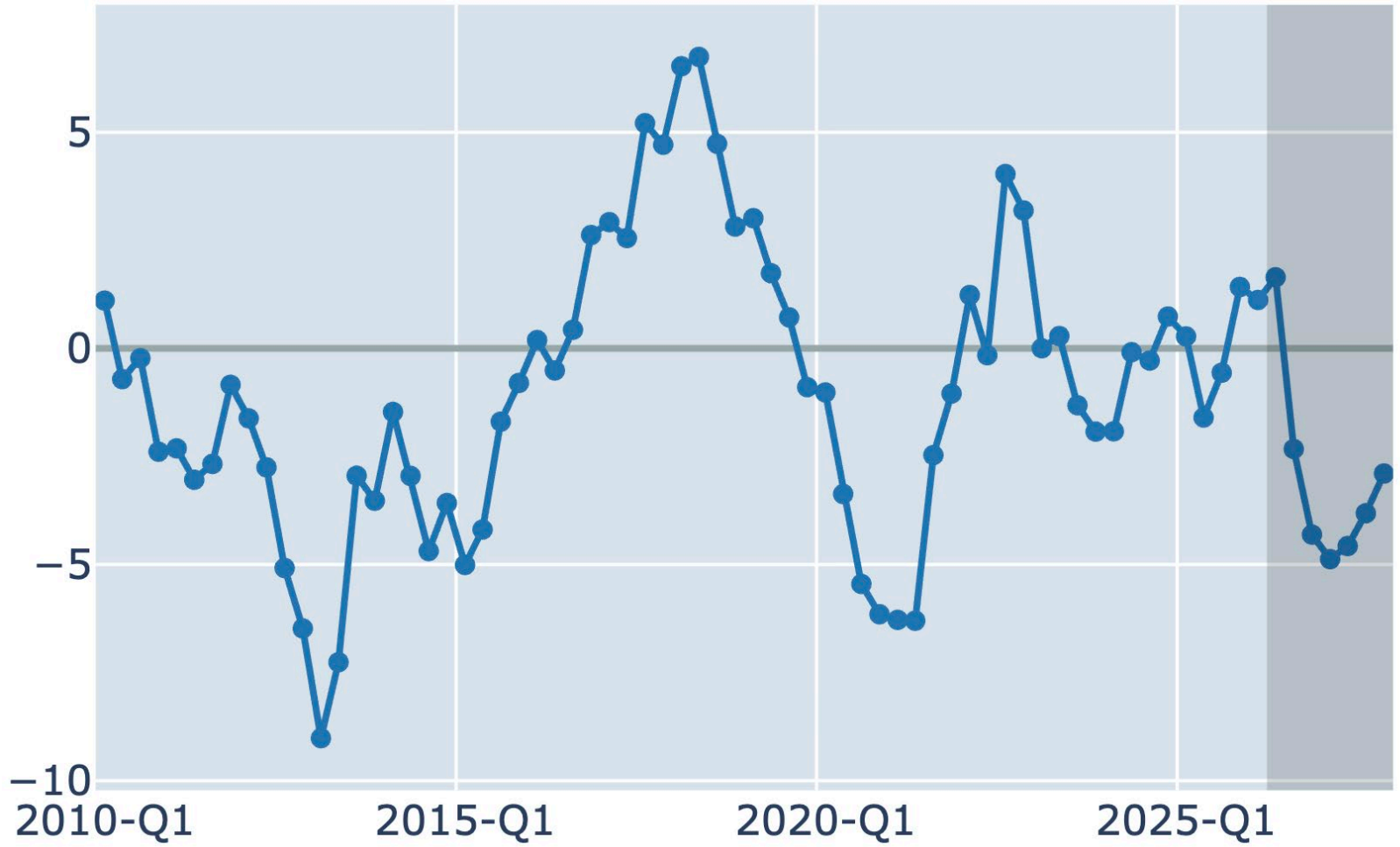
- Effective external real exchange rate gap

$$\log \widetilde{re}^{\text{eff}}{}_{t} = \log \widetilde{re}_t - (1 - \omega_{\text{us}}) \log \widetilde{re}^{x}{}_{t}$$

  - A competitiveness measure that combines domestic real exchange rate effects ($\widetilde{re}_t$) with external real exchange rate conditions ($\widetilde{re}^{x}{}_{t}$), weighted by trade importance.

External variables

Philippines: Effective external real exchange rate gap



CPI and interest rates

- Philips Curve

$$4\,\Delta \log cpi_t = c_0 \cdot 4\,\Delta \log cpi_{t-1} + (1 - c_0) \cdot 4\,\Delta \log cpi_t^{\text{ste}}$$

- $$+c_1 \log \widetilde{gdp}_t + c_2 \log \widetilde{re}^{\text{eff}}_t$$
$$+\varepsilon^{ann}_{cpi,t} + \varepsilon_{\Delta \log cpi,t} + \varepsilon^{\text{short}}_{\Delta \log cpi,t} + \tau_{\Delta \log cpi,t}$$

  - Links inflation to economic slack ($\widetilde{gdp}_t$) and competitiveness effects ($\widetilde{re}^{\text{eff}}$), with expectations formed as a weighted average of forward-looking (cpi_t^{ste}) and backward-looking (cpi_{t-1}) components.

  - Where the short-lived shock and tune components

$$\varepsilon^{\text{short}}_{\Delta \log cpi,t} = \varepsilon^{\text{aux}}_{\text{short},t} - c_x\, \varepsilon^{\text{aux}}_{\text{short},t-1}$$
$$\tau_{\Delta \log cpi,t} = \tau^{\text{aux}}_t - (c_x - 0.1)\, \tau^{\text{aux}}_{t-1}$$

CPI and interest rates

- CPI Inflation trend

$$4\,\Delta \log \overline{cpi}_t = c_0 \cdot 4\,\Delta \log \overline{cpi}_{t-1} + (1 - c_0) \cdot 4\,\Delta \log \overline{cpi}^{ss} + \varepsilon_{\Delta \log \overline{cpi},t}$$

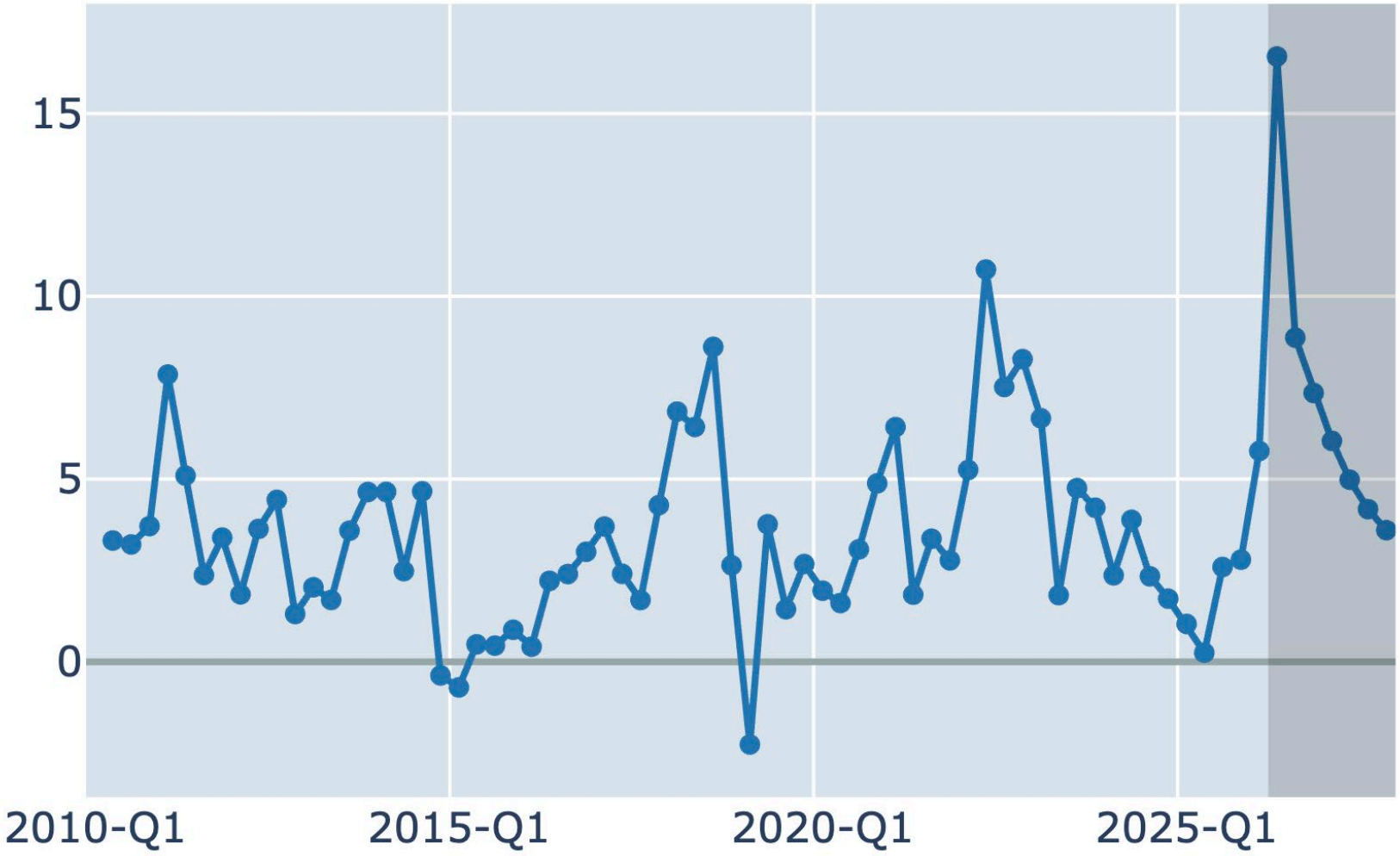
- CPI short-term expectations

$$4\,\Delta \log cpi_t^{ste} = c_1 \cdot 4\,\Delta \log cpi_{t+1} + (1 - c_1) \cdot 4\,\Delta \log \overline{cpi}_t$$

- Inflation expectations combine forward-looking rational expectations (cpi_{t+1}) with adaptive elements based on the underlying inflation trend ($\overline{cpi}_t$).

CPI and interest rates

Philippines: CPI, Q/Q annualized



CPI and interest rates

- Real Interest Rate

$$r1_t = i_t - 4\,\Delta \log cpi1_{t+1}^{\text{ste}}$$

- Fisher equation linking nominal rates (i_t), real rates and expected inflation ($cpi1_{t+1}^{\text{ste}}$)

- Real Interest Rate Trend-Gap identity (additive)

$$r1_t = \overline{r1}_t + \tilde{r1}_t$$

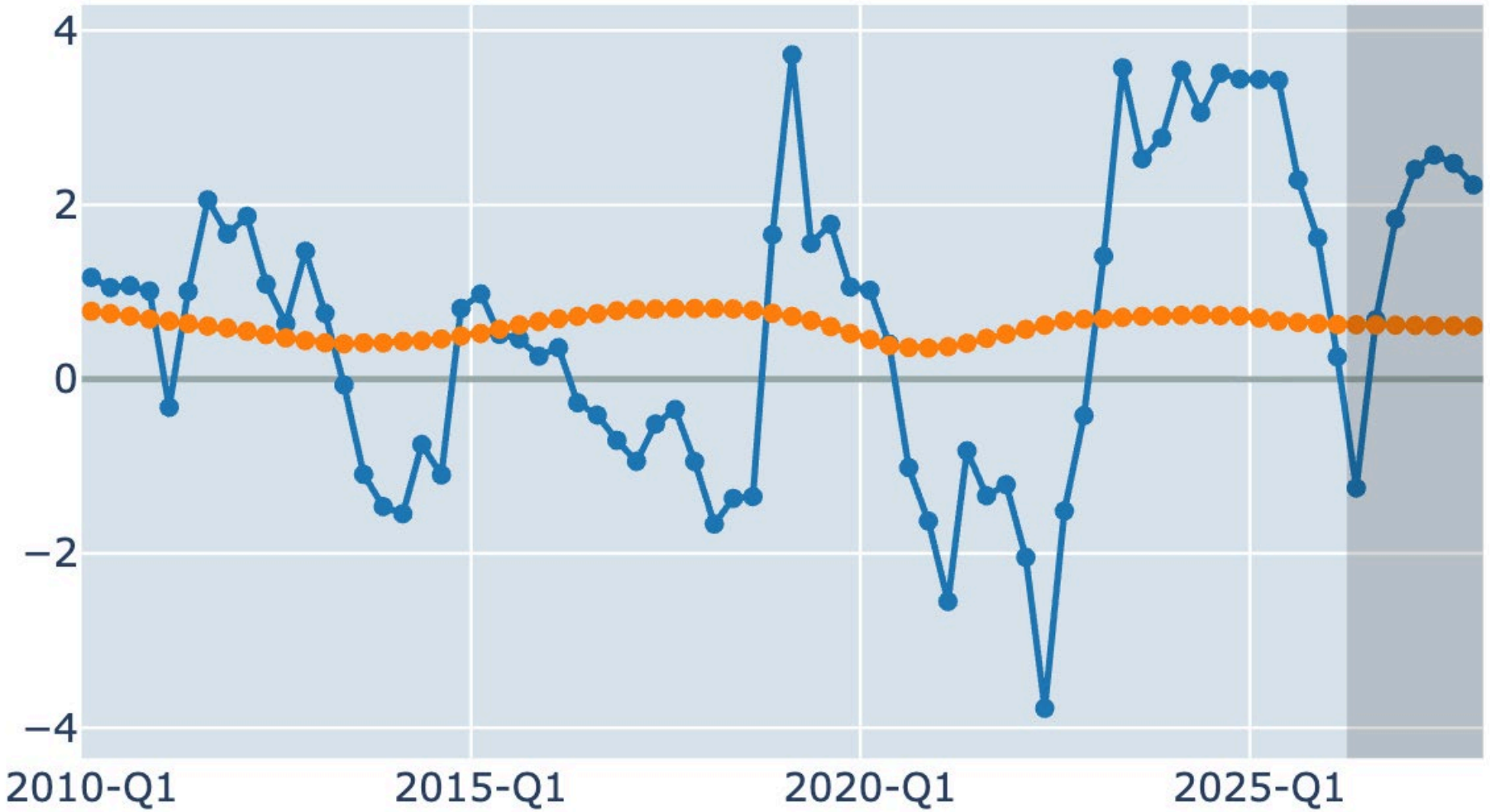
- Real Interest Rate Trend

$$\overline{r1}_t = c_0\,\overline{r1}_{t-1} + (1 - c_0)\,\overline{r1}^{\text{ss}} + \varepsilon_{\overline{r1},t}$$

ADB

CPI and interest rates

Philippines: Real interest rate and trend



CPI and interest rates

- Nominal interest rate

$$i_t = c_0\, i_{t-1} + (1 - c_0)\,(\bar{\imath}_t + mpr_t) + \varepsilon_{1,t}^{ann} + \varepsilon_{i,t} + \tau_{i,t}$$

  - The policy rate adjusts gradually toward a target level that incorporates the trend rate ($\bar{\imath}_t$) plus a monetary policy reaction component (mpr_t), allowing for policy inertia.

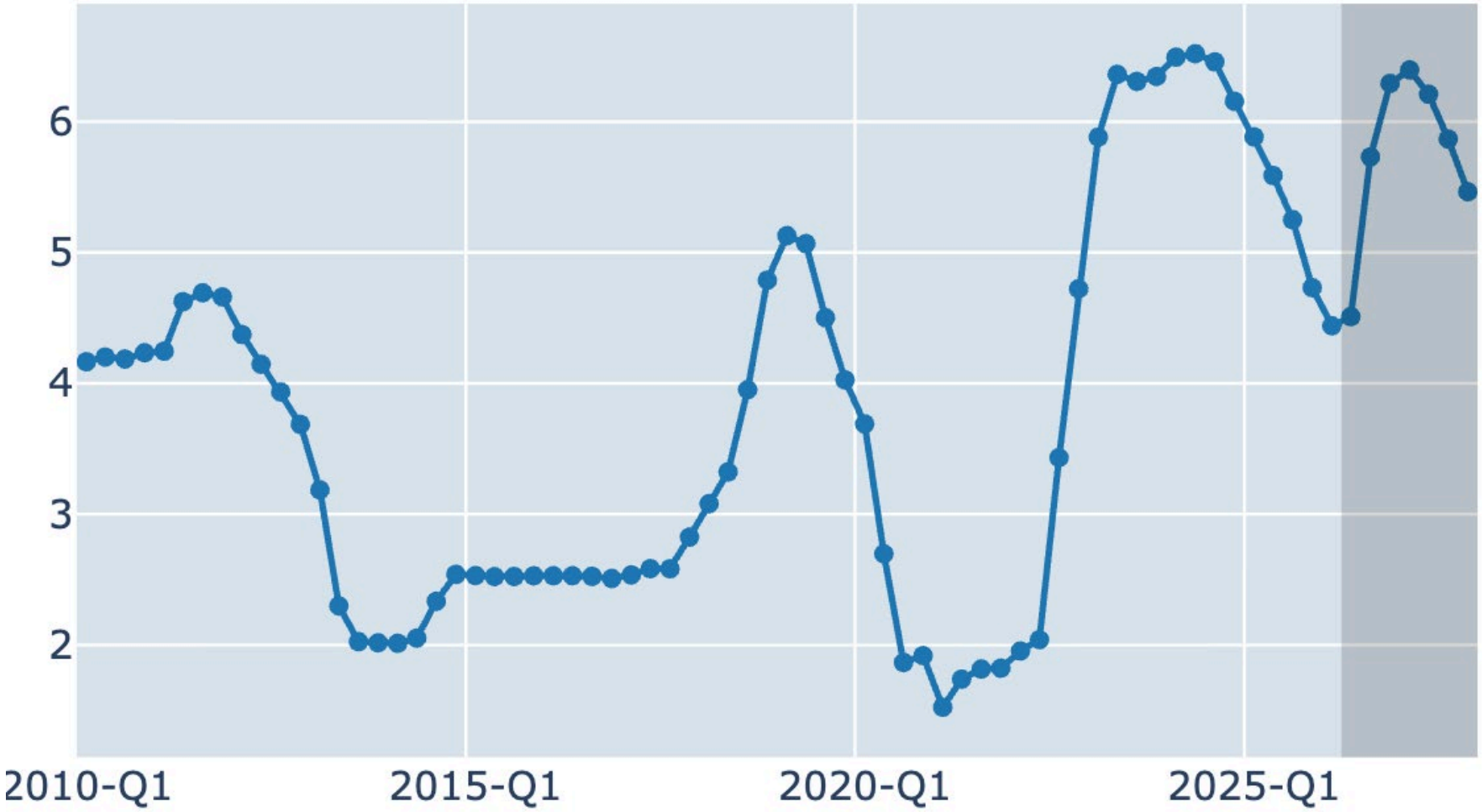
- Nominal interest rate trend

$$\bar{i}_t = \overline{r\imath}_t + 4\,\Delta \log \overline{cpi}_t$$

ADB

CPI and interest rates

Philippines: Nominal interest rate



CPI and interest rates

- Monetary Policy Reaction Term

$$mpr_t = c_1 \left(\Delta^4 \log cpi_{t+3} - 4\,\Delta \log \overline{cpi}_t \right) + c_2 \log \widetilde{gdp}_t + c_3 \log \widetilde{re}_t$$

  - Systematic component of monetary policy that responds to deviations of expected inflation from target ($\Delta \log cpi_{t+3} - 4\,\Delta \log \overline{cpi}_t$), output gaps ($\widetilde{gdp}$), and exchange rate competitiveness effects ($\widetilde{re}_t$).

ADB

Exchange rates and Uncovered Interest Parity

- Real Exchange Rate Definition

$$re_t = \frac{cpi_t^{\star} \times e_t}{cpi_t}$$

  - Where $cpi_t^{\star}$ is the foreign price level and e_t is the nominal exchange rate.

- Real Exchange Rate Trend-Gap Identity

$$re_t = \overline{re}_t \times \widetilde{re}_t$$

ADB

Exchange rates and Uncovered Interest Parity

- Real Exchange Rate Trend

$$
\begin{aligned}
4\,\Delta \log \overline{re}_t = {} & c_0 \cdot 4\,\Delta \log \overline{re}_{t-1} \\
& + (1 - c_0) \cdot 4\,\Delta \log \overline{re}^{ss} \\
& + c_1 \cdot 4\,\log \widetilde{re}_{t+1} \\
& + \varepsilon_{\Delta \log \overline{re},t}
\end{aligned}
$$

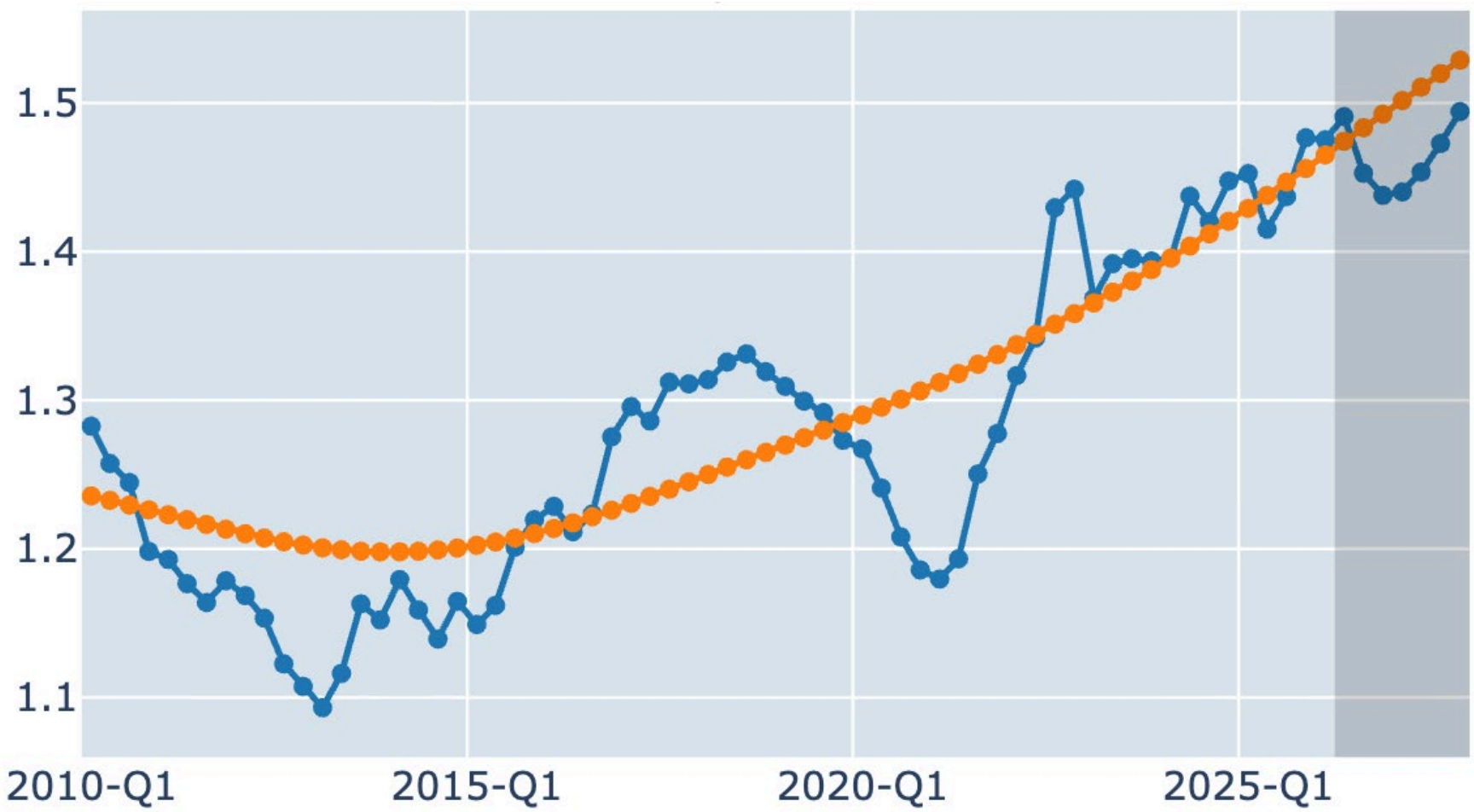
  - Modeled as an autoregressive ($\overline{re}_{t-1}$) mean-reverting process ($\overline{re}^{ss}$) that includes a forward-looking component ($\widetilde{re}_{t+1}$).

- Nominal Exchange Rate Trend Growth

$$\Delta \log \overline{e}_t = \Delta \log \overline{re}_t - \Delta \log \overline{cpi}_t^{\star} + \Delta \log \overline{cpi}_t$$

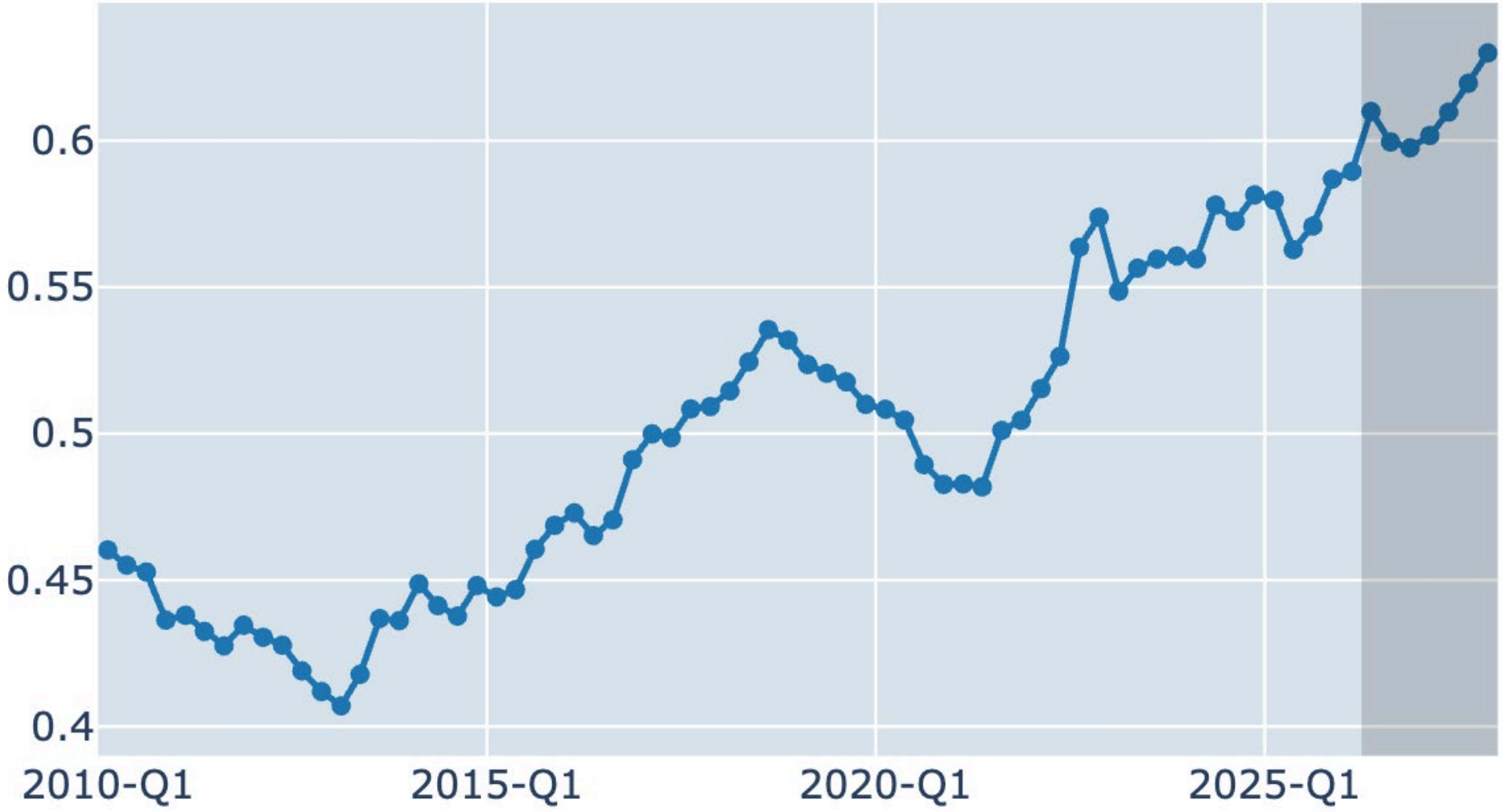
Exchange rates and Uncovered Interest Parity

Philippines: Real Exchange Rate and Trend



Exchange rates and Uncovered Interest Parity

Philippines: Nominal Exchange Rate (USD/100)



Exchange rates and Uncovered Interest Parity

- UIP condition

$$i_t - i_t^\star = 4\,(\log e_t^{\text{ste}} - \log e_t) + disp_t$$
$$+\varepsilon_{e,t} + \tau_{e,t}$$

  - Links domestic (i_t) and foreign ($i_t^\star$) interest rates through expected exchange rate changes ($\log e_t^{\text{ste}} - \log e_t$) and a risk premium ($disp_t$), allowing for deviations from perfect capital mobility.

- Nominal Exchange Rate Short-term Expectations

$$\log e_t^{\text{ste}} = c_1\ \log e_{t+1} + (1 - c_1)\ \log e_{t-1}$$
$$+(1 - c_1)\ \cdot \frac{1}{2} \cdot\ 4\,\Delta \log \overline{e}_t$$

  - Exchange rate expectations combine forward-looking market expectations (e_{t-1}) with adaptive elements based on recent exchange rate trends (e_{t-1} and $\overline{e}_t$)

ADB

Exchange rates and Uncovered Interest Parity

- UIP Disparity Trend-Gap identity

$$disp_t = \overline{disp}_t + \widetilde{disp}_t$$

- UIP Disparity Gap

$$\widetilde{disp}_t = c_0 \, \widetilde{disp}_{t-1} + \varepsilon_{disp,t} + c_1 \, \tau_{e,t}$$

  - Captures persistent deviations from uncovered interest parity, representing risk premia and market sentiment effects that cause exchange rates to deviate from fundamental values.

ADB

Exchange rates and Uncovered Interest Parity

- UIP Trend Relationship

$$\overline{ri}_t - \overline{ri}_t^{\star} = 4\,\Delta \log \overline{re}_{t+1} + \overline{disp}_t$$

  - Note: The UIP disparity trend $\overline{disp}_t$ is **not modeled separately.** It is determined residually from the UIP trend relationship above to ensure consistency between real interest rate trends ($\overline{ri}_t - \overline{ri}_t^{\star}$) and expected real exchange rate changes ($\overline{re}_{t+1}$). It adjusts endogenously to satisfy the long-run uncovered interest parity condition.

Forecast outputs

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Model Forecast Outputs

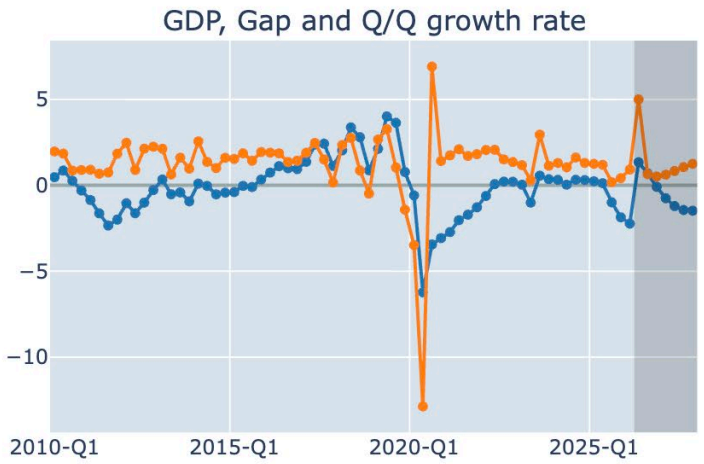
1. Forecast outputs are presented in quarterly and annual terms
2. These include:
   - Real GDP ratios of GDP components
   - Gaps in real GDP components
   - Real GDP components annualised Q/Q growth
   - Annual sum of real GDP components Y/Y growth
   - Supporting variables
   - External environment variables

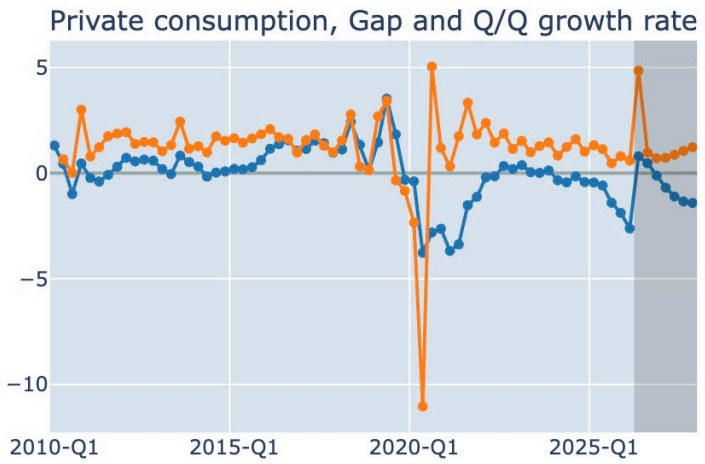
Real GDP ratios of GDP components

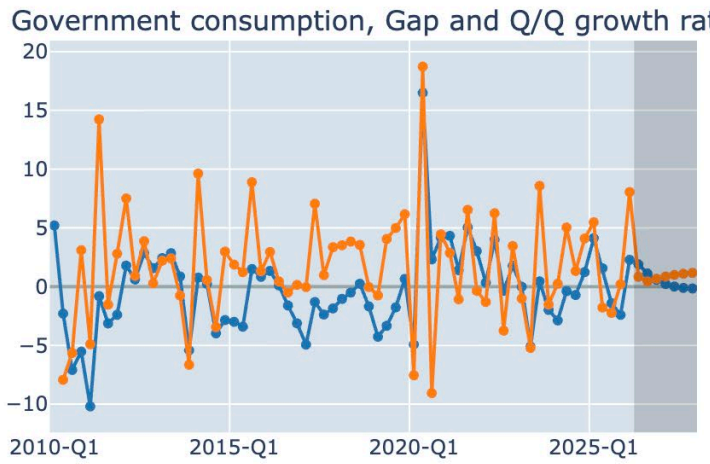


Gaps in real GDP components

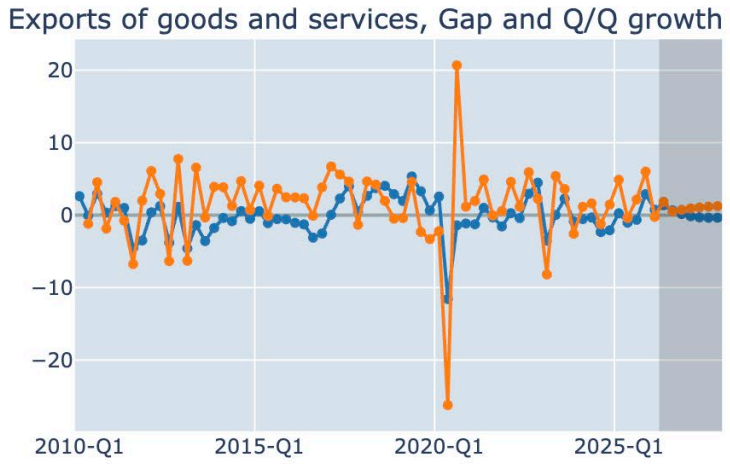
The Philippines: Gaps in real GDP components and Q/Q growth rates

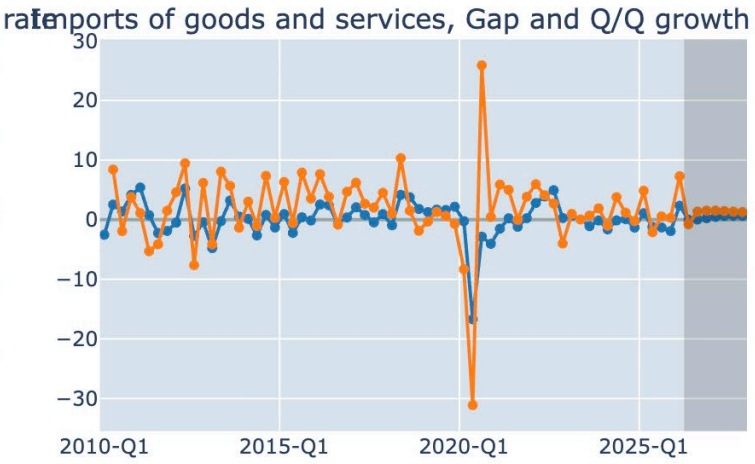








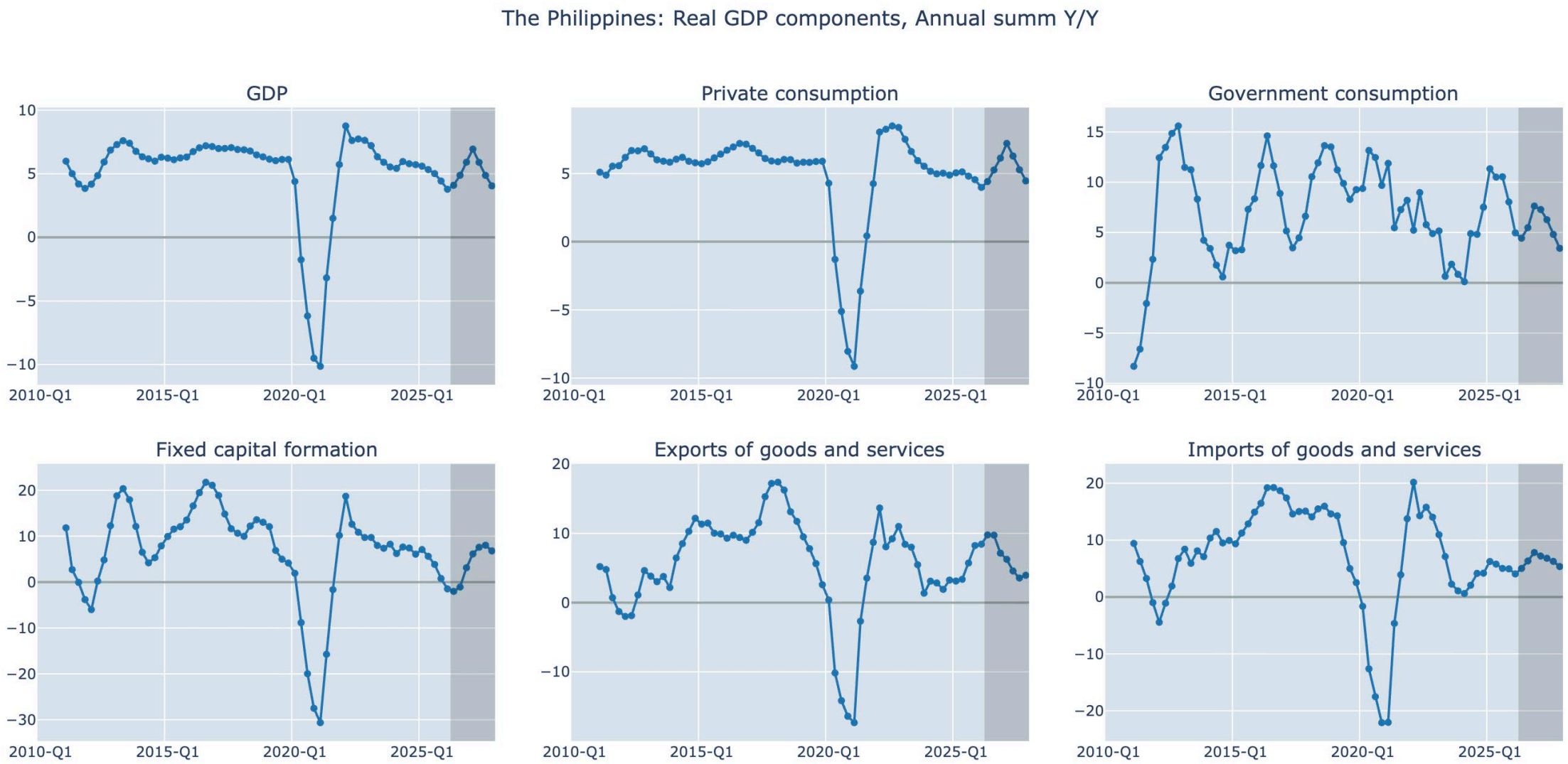




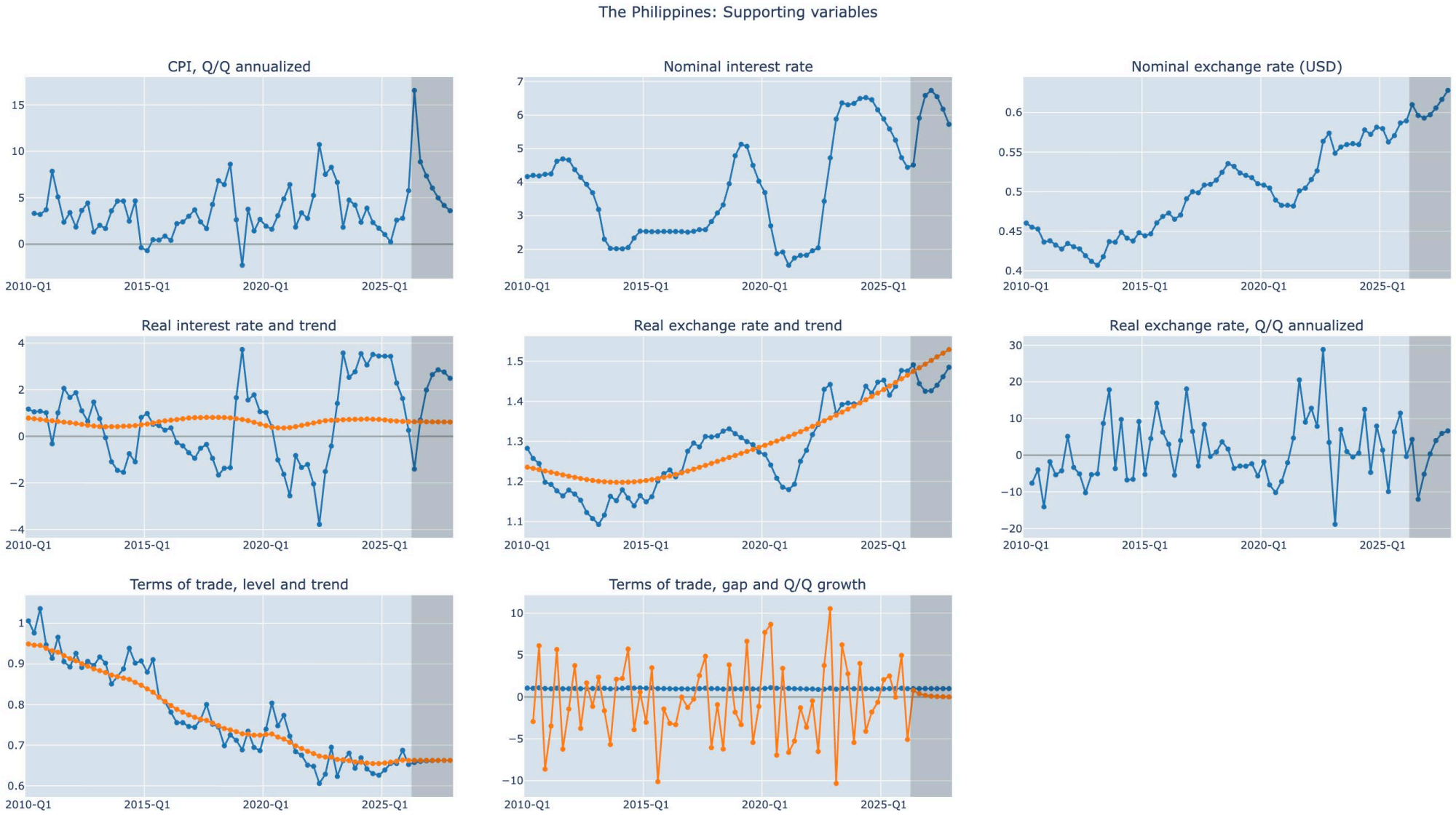
Real GDP components annualised Q/Q growth



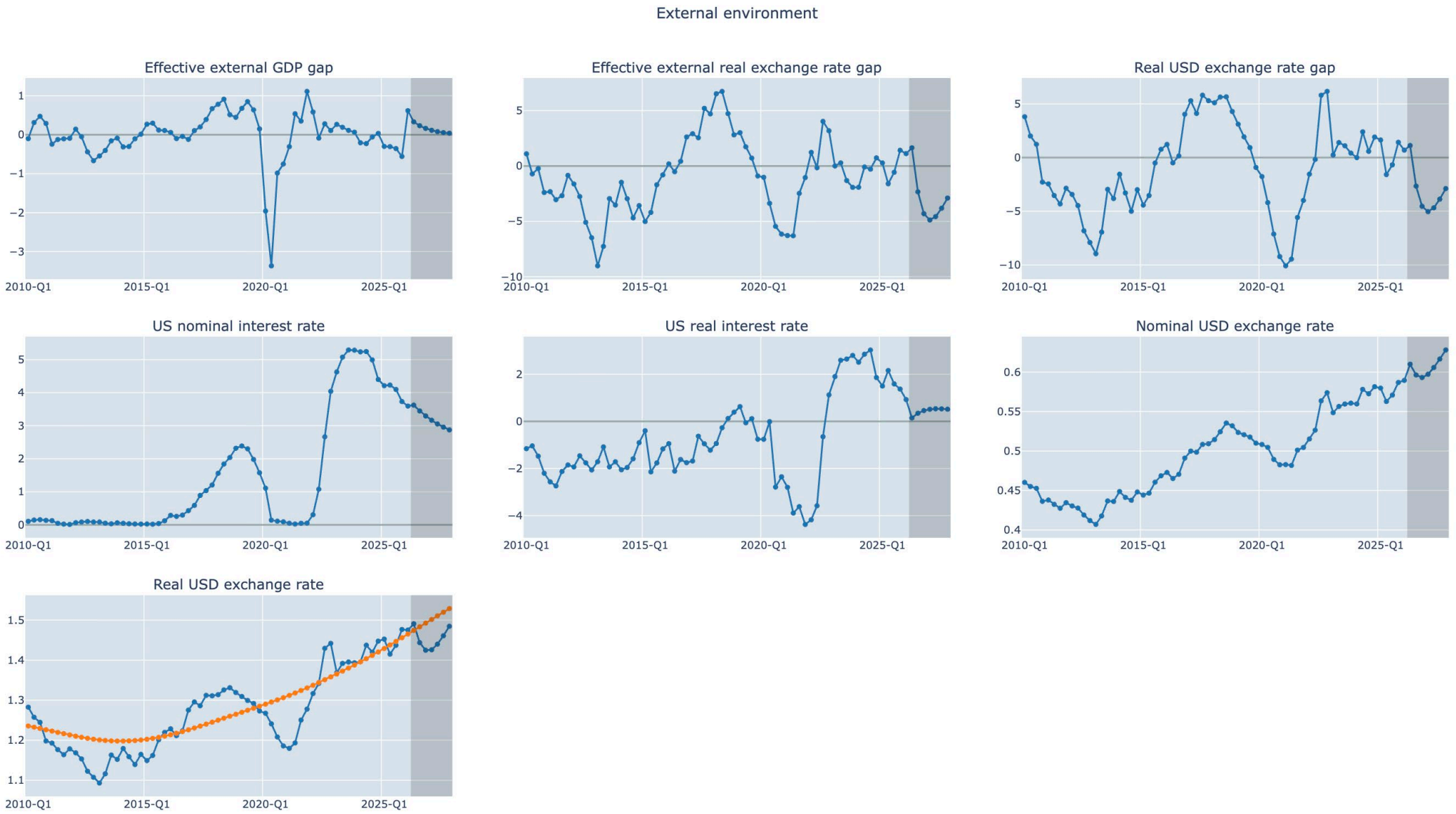
Annual sum of real GDP components Y/Y growth



Supporting variables



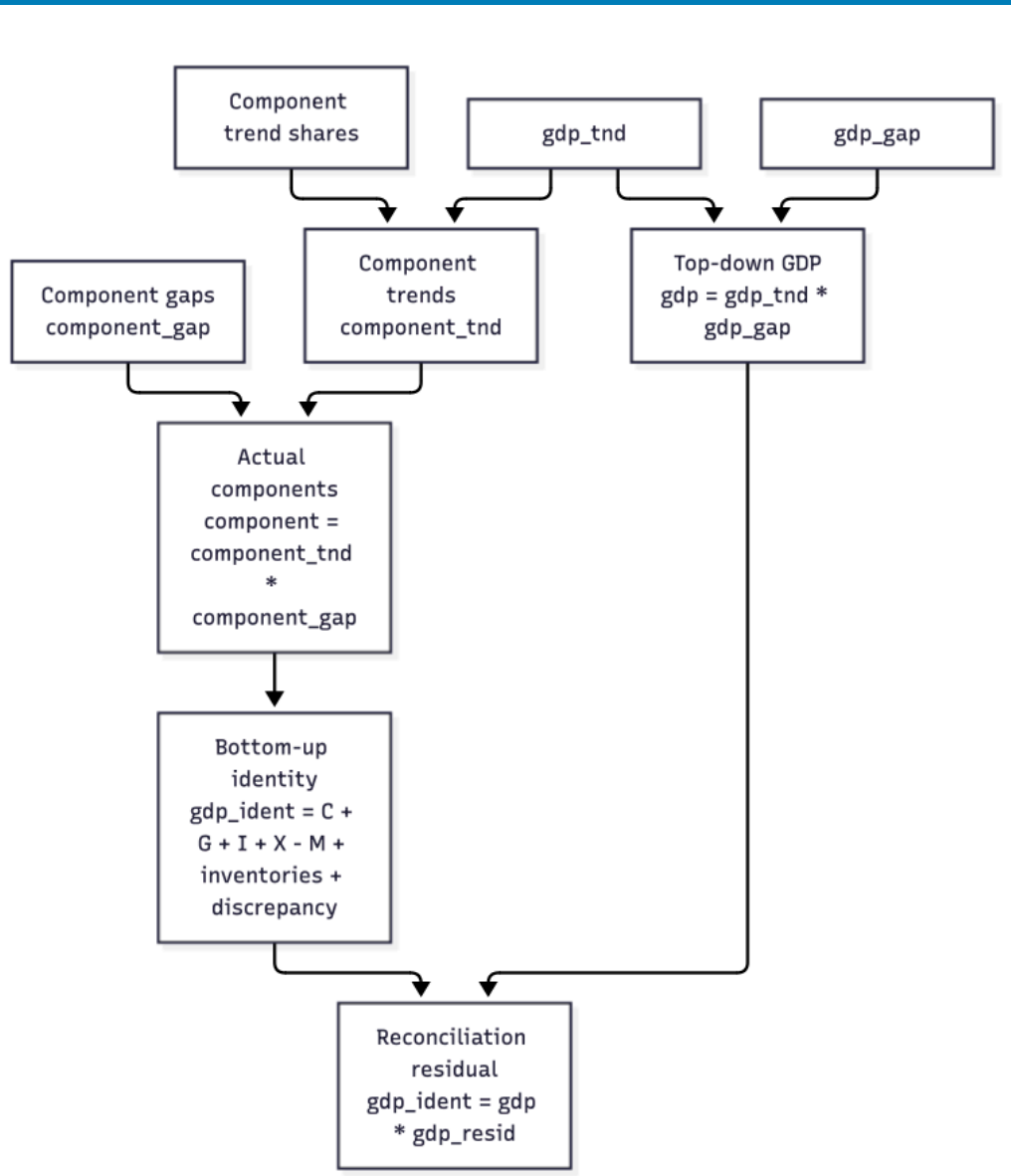
External environment charts



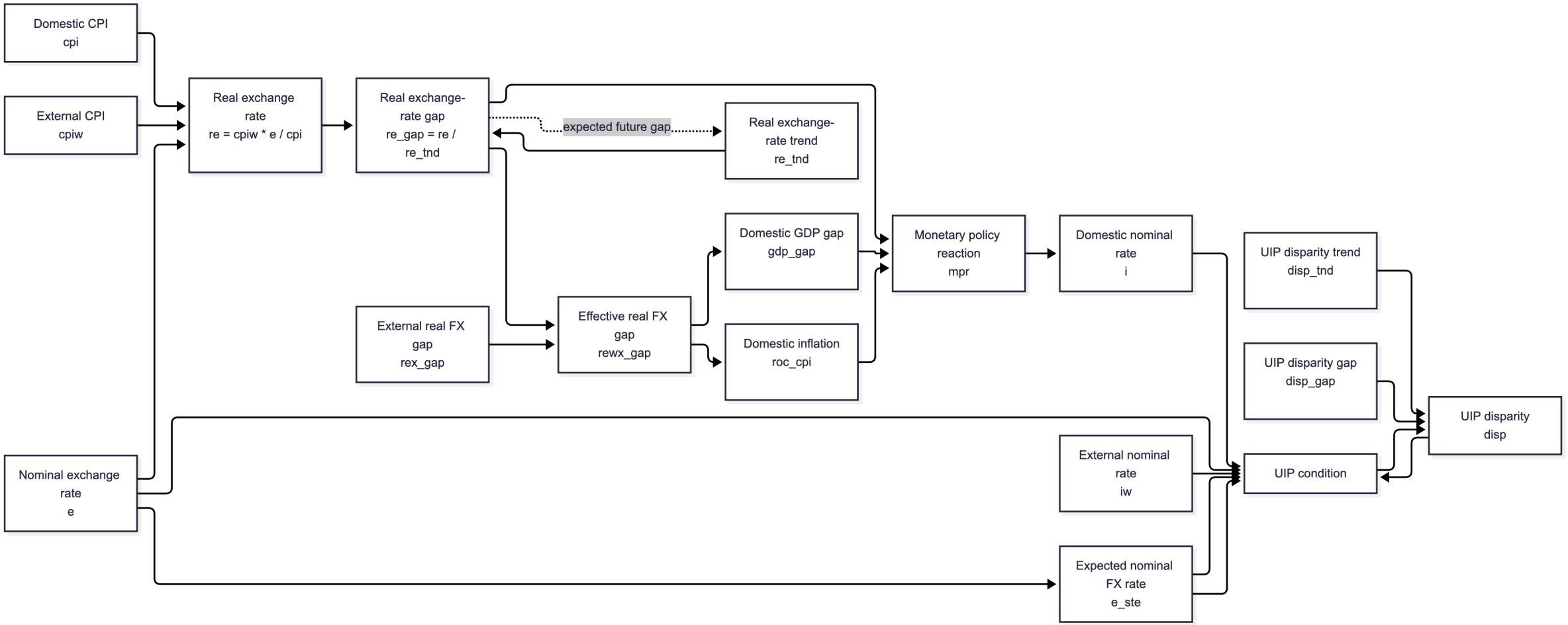
Appendix

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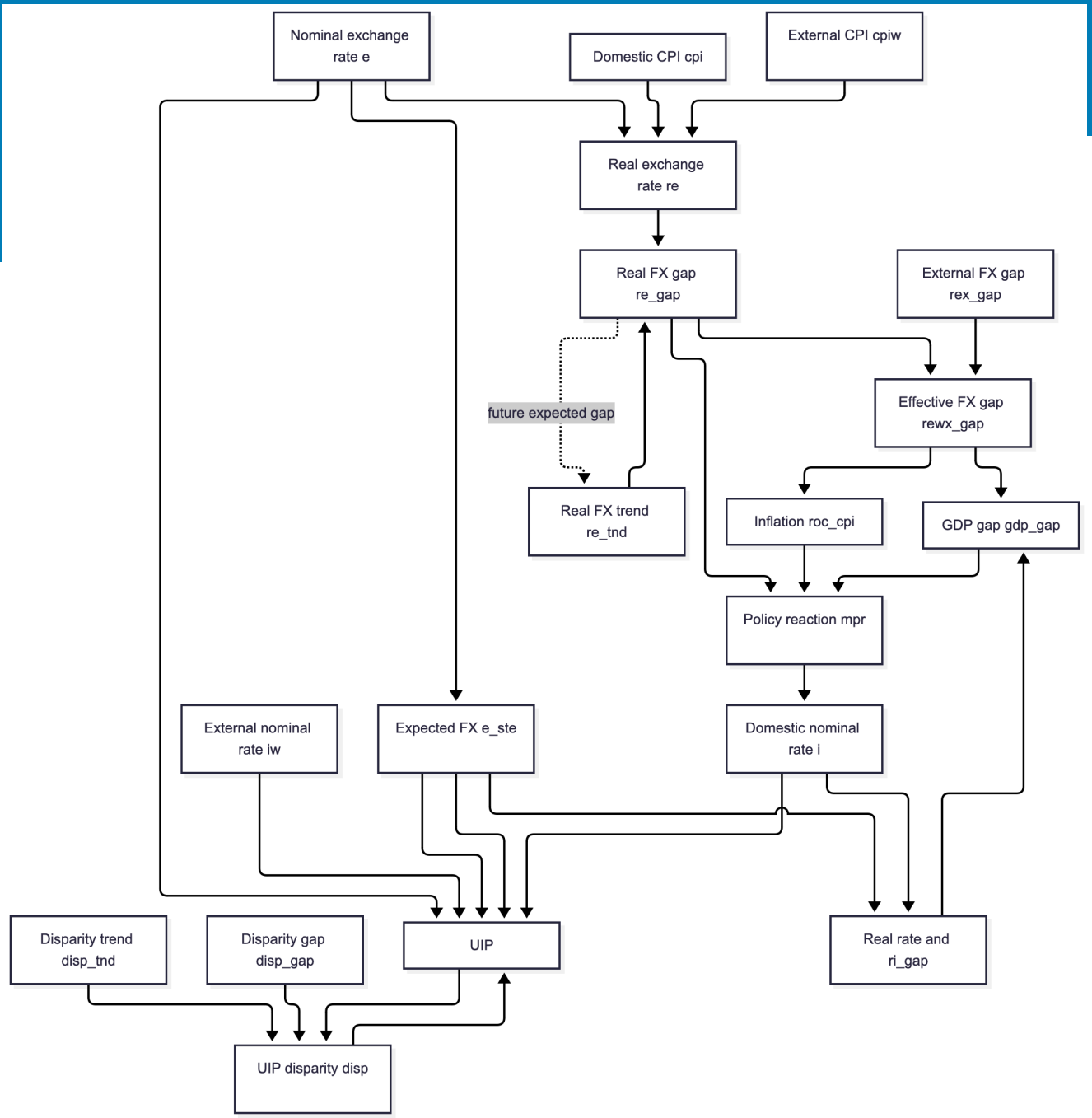
GDP and outputs



CPI and interest rates



Exchange rates and UIP



Bhutan data and models

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Bhutan data handling

- National accounts data are available in the following frequencies:
  - **Annual:** expenditure components (consumption, government, investment, exports, imports, inventories) and terms of trade
  - **Quarterly:** real GDP, seasonally adjusted
  - **Monthly (Converted to quarterly):** CPI (seasonally adjusted), BTN/USD exchange rate, and interest rate (using average of bank lending and deposit rates)
- To address the different frequencies, annual data enter as rolling sums where each annual total is placed in Q4, with Q1 to Q3 left blank.
- The Kalman filter then fills the gaps by inferring the quarterly path such that the four quarters add up to the annual total, guided by quarterly GDP and the model's dynamics.

Bhutan exchange rate

- For Bhutan, there is no difference for the interest rate and exchange rate model equations, only the calibrated parameter estimates differ.
- Where it differs is in the forecast where it takes the nominal exchange rate forecast from India's forecasts as a given because of the currency peg.
  - This is why running the India model is a prerequisite to running the Bhutan model.
- UIP is then closed with a risk premium wedge, while the interest rate still follows Bhutan's own policy rule.
- With no policy or market rate available, the interest rate is the average of bank lending and deposit rates.