

IS-LM-BP/AD-AS Macroeconomic Model for Bhutan

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Abstract

This technical paper presents the IS-LM-BP/AD-AS Model for Bhutan, an integrated semi-structural macroeconomic model developed to evaluate open-economy shocks, tariff scenarios and macro-fiscal policy responses in a coherent analytical framework. The model combines the goods market, money market, balance of payments, aggregate demand and short-run aggregate supply into a single system tailored to Bhutan's economic structure.

The framework is grounded in standard open-economy macroeconomic theory and implemented through transparent econometric relationships estimated using Bhutan-specific annual macroeconomic data. It captures the main channels through which external shocks affect output, liquidity, trade balance, foreign-exchange conditions and inflation. Its design reflects Bhutan's fixed exchange-rate anchor, import dependence, hydropower-linked external flows and the central role of fiscal policy in stabilizing domestic demand.

The paper is intended to provide a concise technical overview of how the model is adapted to Bhutan's macroeconomic context and the types of policy questions for which it can be used. It explains the model's core analytical blocks, the Bhutan-specific interpretation of the transmission channels, the role of official macroeconomic data, and the governance standards required for responsible use. Detailed scenario-specific simulations and empirical results are outside the scope of this technical note and are treated separately in research-oriented outputs.

The model is designed as a high-level policy simulation tool: sufficiently rigorous for technical use, sufficiently transparent for senior policy dialogue and sufficiently flexible for integration with Bhutan's wider macroeconomic modelling ecosystem. The publication package sets out the model equations, data transformations, scenario design, estimated results, policy applications and governance standards required for a credible official release.

Keywords: Bhutan; IS-LM-BP; AD-AS; tariff shocks; open-economy macroeconomics; balance of payments; inflation pass-through; macroeconomic simulation; fiscal policy, scenario analysis.

Table 1. Model at a glance.

Model feature	Description
Model class	Semi-structural, macro econometric, open-economy policy simulation framework.
Core analytical blocks	IS goods market; LM money market; BP external balance; AD aggregate demand; SRAS price and cost-push block.
Primary shock applications	Export demand shocks, import-cost shocks, liquidity responses, reserve-pressure assessment and inflation pass-through analysis.
Primary outputs	Output, money/liquidity conditions, trade balance, foreign-exchange sensitivity, inflation response and policy narratives.
Institutional use	Tariff stress testing, macro-fiscal planning, policy-package comparison, inflation monitoring and public technical communication.

1. Introduction

Bhutan's macroeconomic policy environment requires analytical tools that connect domestic demand, liquidity, external-sector flows and price dynamics. The country's economic structure is marked by a small domestic market, high import dependence, hydropower-linked export receipts, a fixed exchange-rate anchor and a policy setting in which fiscal policy, liquidity management and external buffers interact closely.

The IS-LM-BP/AD-AS Model for Bhutan responds to this need. It provides an integrated platform for assessing how shocks move through the goods market, money market, balance of payments and price system. The model is compact enough for regular policy use and transparent enough for publication, while remaining sufficiently comprehensive to support tariff-shock analysis and macro-fiscal dialogue.

The model contributes to the Ministry's analytical toolkit in four ways. First, it establishes a common framework for evaluating external shocks in Bhutan's open-economy setting. Second, it converts scenario assumptions into consistent macroeconomic outputs. Third, it links output and liquidity outcomes to external-balance and inflation channels. Fourth, it supports clear public communication by documenting equations, data transformations, scenario assumptions and results.

This paper documents the model for web publication. It explains the conceptual framework, model equations, data pipeline, estimation strategy, shock design, simulation results and publication governance arrangements. The structure follows the standard format of technical model documentation used by public institutions: abstract, introduction, model formulation, data and calibration approach, results, policy application, governance, conclusion and appendices.

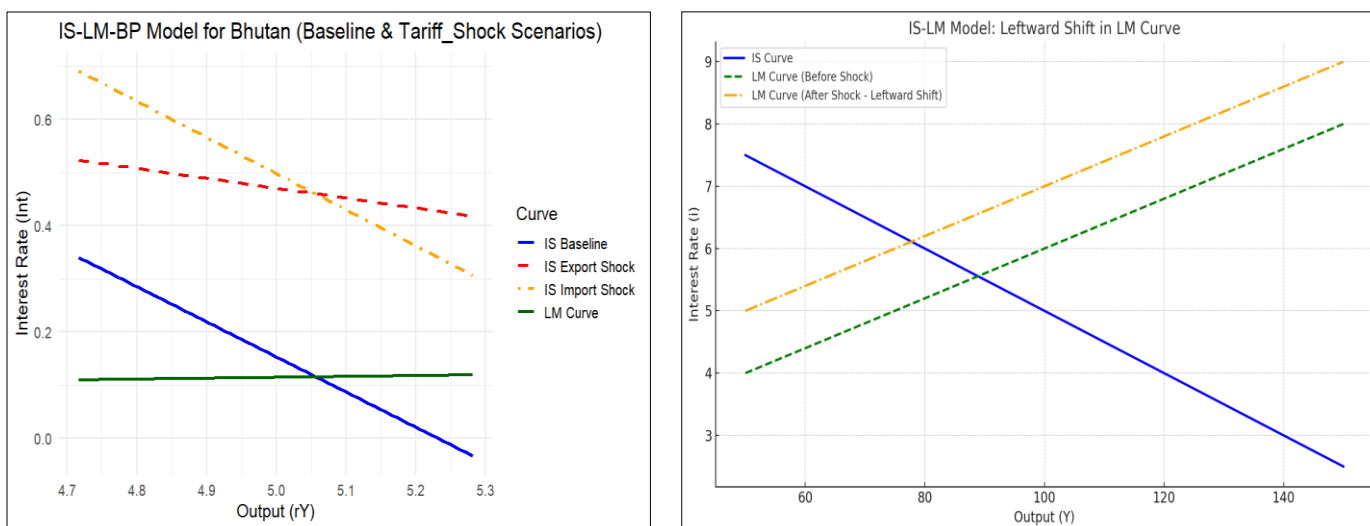
2. Conceptual framework

2.1 Open-economy IS-LM-BP core

The model begins with the open-economy IS-LM-BP framework. The IS equation represents goods-market equilibrium by linking real output to consumption, investment, government expenditure, the trade balance and interest-rate conditions. The LM equation represents money-market equilibrium by linking broad money or liquidity to output and interest-rate conditions. The BP equation represents the external sector by linking the trade balance to liquidity, interest rates, investment and foreign-exchange availability.

For Bhutan, the framework is interpreted through the institutional setting of a fixed exchange-rate regime and externally constrained macroeconomic management. Interest-rate transmission is treated as bounded by the exchange-rate anchor; liquidity, fiscal demand and foreign-exchange buffers therefore play central roles in the model's policy interpretation.

Figure 1. IS-LM-BP

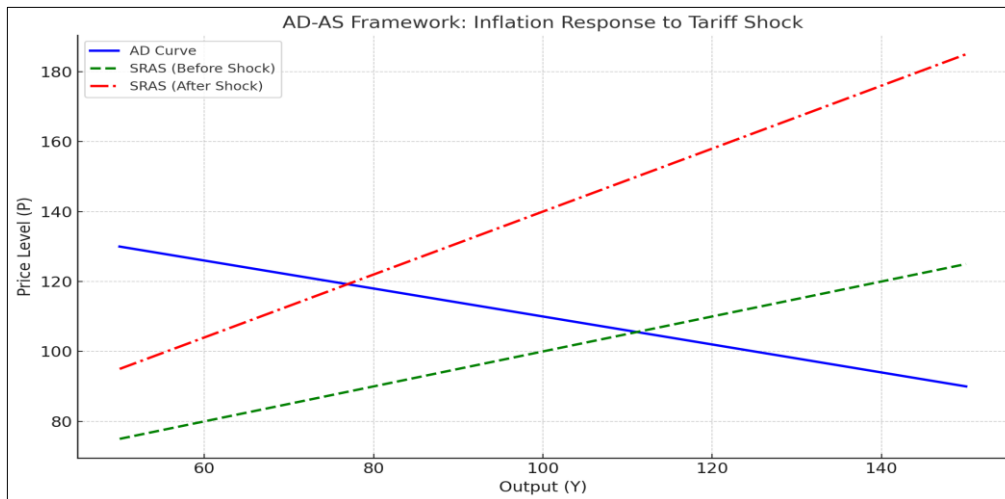


2.2 AD-AS extension

The AD-AS extension connects output outcomes to price dynamics. Aggregate demand is specified as a function of real money balances, fiscal variables, investment and relevant lags. Short-run aggregate supply is specified as a Phillips-curve-style inflation equation that includes inflation inertia, the output gap, import-cost pressure and lagged investment conditions.

This extension is essential for tariff analysis. An export shock mainly operates through external demand and net exports, while an import-cost shock operates through both net exports and production costs. The AD-AS block allows the model to distinguish these channels and produce a joint assessment of growth and inflation.

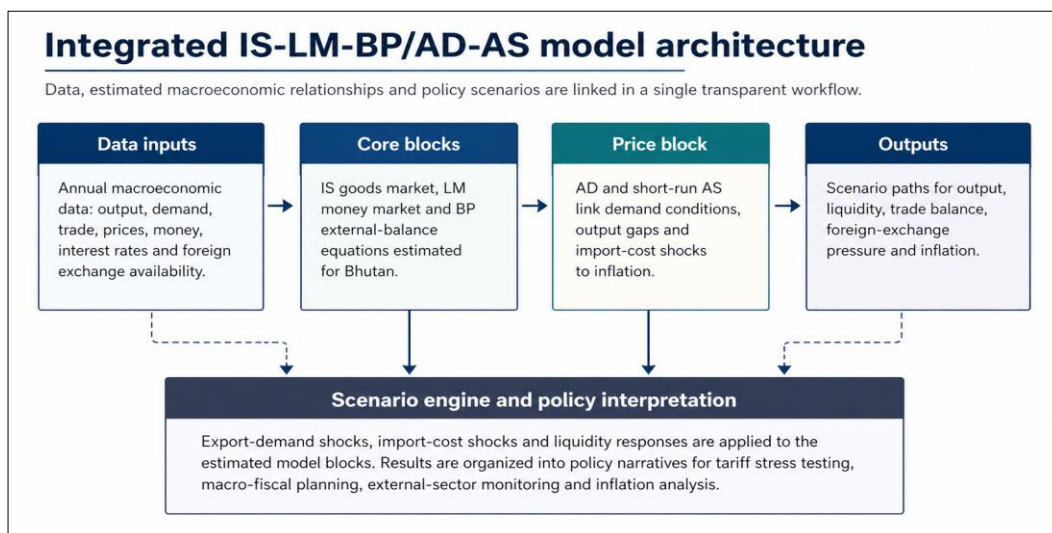
Figure 2. AD-AS



2.3 Bhutan-specific adaptation

The Bhutan-specific adaptation emphasizes external-sector transmission, liquidity-sensitive imports, the role of foreign-exchange availability and the importance of government expenditure and investment for short-run output. These features align the model with the practical questions faced in macro-fiscal analysis: how trade shocks affect output, how liquidity conditions interact with the trade balance, how import costs affect inflation and how policy packages can be calibrated across channels.

Figure 3. Integrated model architecture from data inputs to policy outputs.



3. Model structure

The model is organized into five analytical blocks and a scenario module. Each block is estimated transparently and interpreted according to standard macroeconomic theory and Bhutan's institutional context.

3.1 Goods market: IS block

The IS block estimates the short-run association between real output and the main components of aggregate demand. The baseline specification uses consumption, investment, government expenditure and trade balance. Scenario versions replace the observed trade balance with shock-adjusted net exports.

$$rY_t = \alpha_0 + \alpha_1 C_t + \alpha_2 I_t + \alpha_3 G_t + \alpha_4 TB_t + \epsilon_t \quad \text{Eq. 1}$$

3.2 Money market: LM block

The LM block captures the relationship between broad money or liquidity, output and interest-rate conditions. In Bhutan's setting, the equation is interpreted as a liquidity-response equation rather than a fully independent monetary-policy rule.

$$M2_t = \beta_0 + \beta_1 rY_t + \beta_2 Int_t + u_t \quad \text{Eq. 2}$$

3.3 External sector: BP block

The BP block estimates the trade-balance relationship with liquidity, interest rates, investment and foreign-exchange availability. This block is central to open-economy stress testing because it captures the link between domestic liquidity and external pressure.

$$TB_t = \gamma_0 + \gamma_1 M2_t + \gamma_2 Int_t + \gamma_3 Ivst_t + \gamma_4 FX_t + v_t \quad \text{Eq. 3}$$

3.4 Aggregate demand block

The aggregate demand equation links output to real money balances, fiscal demand and investment timing. The inclusion of lagged fiscal and investment variables reflects the time profile through which public spending and investment affect aggregate demand.

$$rY_t = \delta_0 + \delta_1 RMS_t + \delta_2 M2P_{t-2} + \delta_3 G_t + \delta_4 G_{t-1} + \delta_5 G_{t-2} + \delta_6 I_t + \delta_7 I_{t-2} + a_t \quad \text{Eq. 4}$$

3.5 Short-run aggregate supply block

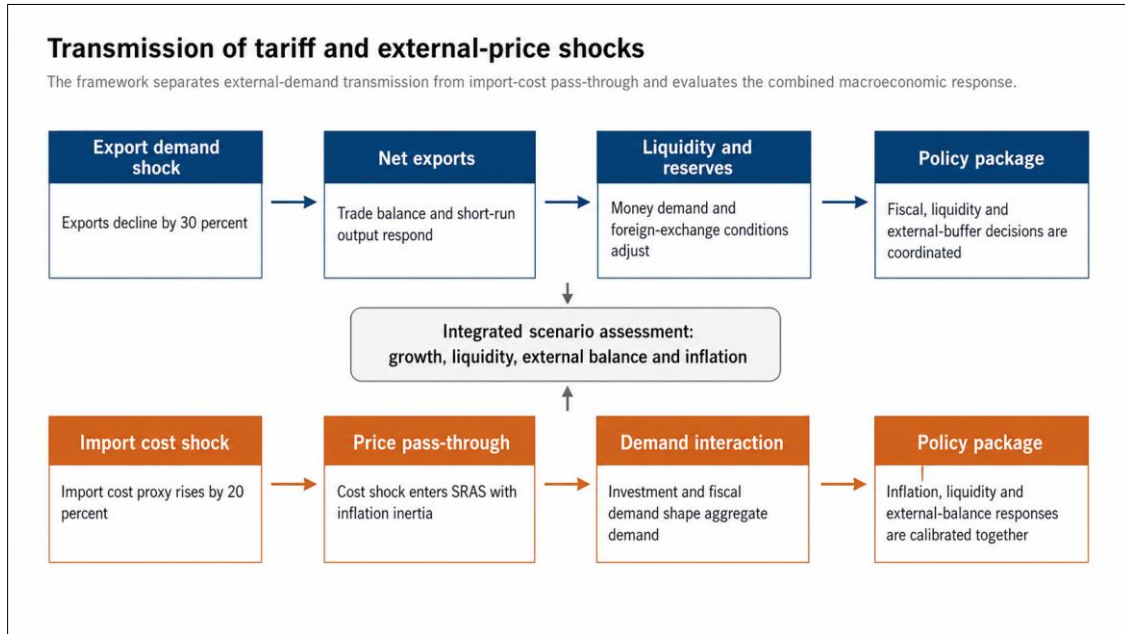
The short-run aggregate supply equation models inflation as a function of its own lag, the output gap, import-cost pressure and investment dynamics. This structure captures inflation persistence and cost-push transmission from import-price shocks.

$$Infl_t = \varphi_0 + \varphi_1 Infl_{t-1} + \varphi_2 Gap_t + \varphi_3 CostShock_{t-1} + \varphi_4 I_{t-2} + s_t \quad \text{Eq. 5}$$

3.6 Scenario module

The scenario module translates policy and external-shock assumptions into model variables. The current implementation applies a 30 percent export-demand shock, a 20 percent import-cost shock and corresponding liquidity-response simulations. Scenario results are presented as coherent macroeconomic assessments across output, liquidity, trade balance and inflation.

Figure 4. Transmission channels for tariff and external-price shocks.



4. Data, transformations and estimation

4.1 Data pipeline

The R implementation loads annual Bhutan macroeconomic data from an Excel workbook and converts the relevant numeric series into a time-series structure beginning in 2000. The workflow constructs derived variables including trade balance, real money supply, lagged fiscal variables, lagged investment variables, import-price proxies, cost-shock variables and output-gap measures.

The data pipeline is intentionally transparent. Every transformation used in the model is traceable from the raw macroeconomic series to the estimated equation and final scenario output. This enables analysts to update data vintages, refresh results and reproduce publication tables without manual re-engineering.

4.2 Derived variables

The main derived variables are the trade balance, calculated as exports minus imports; real money supply, calculated as broad money divided by the price indicator; an import-price proxy, calculated as imports divided by foreign-exchange availability; the tariff-related cost shock, calculated by applying a 20 percent increase to the import-price proxy; and output gaps calculated through smoothing approaches.

$$TB_t = EX_t - M_t$$

where TB_t is the trade balance, EX_t is exports and M_t is imports.

$$Real_Money_Supply_t = \frac{M2_t}{P_t}$$

where $M2_t$ is broad money and P_t is the price level indicator.

$$CostShock_t = 1.20 * \frac{M_t}{FX_t}$$

this represents a 20 percent increase in the import cost proxy, where imports are scaled by foreign exchange availability.

$$Gap_t = rY_t - rY_t^{potential}$$

the output gap measures the difference between observed real output and estimated potential output.

4.3 Estimation approach

The model uses ordinary least squares for the equation blocks. OLS is appropriate for a high-level policy simulation framework because it produces coefficients that are transparent, reproducible and directly interpretable. The estimation strategy prioritizes clarity, economic consistency and operational usability for policy dialogue.

Table 2. Core model variables and analytical roles.

Category	Variable	Role in the model
Output	rY	Real output or real GDP measure used in IS and AD equations.
Domestic demand	C, I, G	Consumption, investment and government expenditure, the core demand drivers in the IS block.
External sector	EX, M, TB	Exports, imports and trade balance; key variables for tariff and external-demand scenarios.
Liquidity	M2	Broad money or liquidity measure used in LM and BP blocks.
Price channel	Infl, CPI_Ind	Inflation or CPI-based price indicators used in AD-AS and elasticity equations.
Foreign exchange	FX	Foreign-exchange availability or reserve proxy used in the BP block.
Policy and market conditions	Int, Ind_tax	Interest-rate proxy and indirect-tax variable where available.
Scenario variables	Cost_Shock, Gap	Import-cost shock and output-gap variables used in SRAS simulations.

Table 3. Estimation structure used in the current R implementation.

Model block	Estimated specification	Analytical purpose
IS	$rY \sim C + I + G + TB$	Measures short-run output response to domestic demand and trade balance.
LM	$M2 \sim rY + Int$	Measures liquidity response to output and interest-rate conditions.
BP	$TB \sim M2 + Int + I + FX$	Measures external-balance sensitivity to liquidity, investment and foreign-exchange availability.
Import elasticity	$\log(M) \sim \log(rY) + \log\left(\frac{Infl}{CPI_{ind}}\right)$	Quantifies import demand sensitivity to output and relative price conditions.
Export elasticity	$\log(EX) \sim \log(rY) + \log\left(\frac{Infl}{CPI_{ind}}\right)$	Quantifies export sensitivity to output and relative price conditions.

Model block	Estimated specification	Analytical purpose
AD	$rY \sim \text{RealMoneySupply} + M2P_{t-2} + G + G_{t-1} + G_{t-2} + I + I_{t-2}$	Links aggregate demand to real money balances, fiscal demand and investment timing.
SRAS	$\text{Infl} \sim \text{Infl}_{t-1} + \text{Gap} + \text{CostShocklag} + \text{invtag}$	Links inflation to inertia, output gap and import-cost pressure.

5. Parameterizing the model for Bhutan

Adapting the IS-LM-BP/AD-AS framework to Bhutan involves translating a general open-economy macroeconomic model into variables, assumptions and interpretation rules that reflect the country's institutional setting and economic structure. In this model, parameterization is guided by six Bhutan-specific features: the fixed exchange-rate anchor, import dependence, public-investment cycle, hydropower-linked external receipts, liquidity-management environment and foreign-exchange buffer.

5.1 Goods-market parameterization: IS block

The IS block is specified to reflect Bhutan's aggregate demand structure. Real output is linked to household consumption, investment, government expenditure and the trade balance. This reflects the fact that short-run activity in Bhutan is shaped by domestic demand and external transactions, with government expenditure and capital spending playing an important role in demand management.

In applied use, the IS block is appropriate for questions about domestic-demand support, fiscal stance, investment cycles, external-demand weakness and the output implications of changes in imports or exports. It provides the first layer of analysis for understanding how a shock affects real activity before liquidity, external-balance and price channels are considered.

5.2 Money-market parameterization: LM block

The LM block is parameterized as a liquidity and money-market relationship. In Bhutan's pegged exchange-rate setting, it should not be interpreted as a fully independent monetary-policy reaction function. The model instead treats broad money or liquidity as responding to output conditions and interest-rate or financial-condition indicators.

This interpretation is consistent with Bhutan's monetary-policy environment, where the exchange-rate anchor and available liquidity-management instruments shape the scope for independent monetary-policy transmission. The LM block is therefore useful for analyzing money-demand conditions, liquidity pressure and the relationship between real activity and financial conditions.

5.3 External-sector parameterization: BP block

The BP block is adapted to reflect Bhutan's external constraint. The trade balance is linked to liquidity, interest-rate conditions, investment and foreign-exchange availability. The presence of foreign-exchange availability in the block reflects the importance of external buffers for a small open economy with import needs and hydropower-linked external receipts.

This block is especially relevant for assessing whether domestic demand or liquidity conditions are consistent with external stability. It helps users examine how shocks can move from domestic absorption to imports, trade balance pressure and reserve-related concerns.

5.4 AD and SRAS parameterization

The aggregate demand block links real output to real money balances, fiscal variables and investment timing. This provides a bridge between the IS-LM side of the model and broader demand conditions. The short-run aggregate supply block links inflation to inflation inertia, output gaps, import-cost pressure and other relevant cost variables.

For Bhutan, this design recognizes that price dynamics can be influenced by imported inflation, domestic demand conditions and lagged inflation. It is particularly useful when a policy question involves both growth and inflation risks, such as import-cost shocks, fuel-price movements, tax changes or large public-investment cycles.

5.5 Parameterization principles

Principle	Application in the Bhutan model
Institutional realism	Interpret the LM and BP channels through Bhutan's exchange-rate targeting regime and liquidity-management framework.
External-sector emphasis	Include trade balance and foreign-exchange availability as central variables rather than peripheral indicators.
Fiscal relevance	Treat government expenditure and public investment as important demand channels in the IS and AD blocks.
Import-cost sensitivity	Represent import-cost pressure in the price block to capture cost-push risks.
Transparency	Use variables and transformations that can be traced from official macroeconomic data sources.
Scenario discipline	Use the model for defined policy scenarios, not as an unsupported numerical forecast.

6. Policy applications

The model should be used when a policy question requires a joint reading of output, liquidity, external balance and prices. It is most useful for structured scenario analysis, macro-fiscal risk discussions and policy communication. It is less appropriate for questions requiring sector-level microdata, household distributional analysis, firm-level behavior or detailed long-run general-equilibrium dynamics.

Table 8. Policy uses of the IS-LM-BP/AD-AS model.

Application	How the model is used	Typical output
Tariff and external-shock analysis	Quantifies output, liquidity, trade-balance and inflation effects of external-demand or import-cost shocks.	Scenario note comparing baseline and shock cases.
Medium-term fiscal planning	Assesses how fiscal demand and investment settings influence output under external stress.	Macro-fiscal scenario appendix and expenditure-sensitivity assessment.

Application	How the model is used	Typical output
Inflation monitoring	Uses the SRAS block to track import-cost pass-through and inflation inertia.	Inflation pressure dashboard and policy briefing.
External-sector resilience	Connects liquidity conditions, trade balance and foreign-exchange availability.	External-balance stress note and reserve-sensitivity assessment.
Policy communication	Provides a consistent explanation of macroeconomic transmission channels.	Website technical paper, senior briefing and chart pack.

6.1 Policy messages supported by the model

- External shocks in Bhutan should be evaluated jointly through demand, liquidity, external-balance and inflation channels.
- Fiscal demand and investment conditions are central to short-run stabilization, while inflation and external-balance effects shape the calibration of response packages.
- Foreign-exchange availability is a macroeconomic buffer and belongs at the center of external-shock analysis.
- Import-cost shocks require early inflation monitoring because cost-push effects can be amplified by inflation inertia.
- The model gives policy committees a common evidence base for comparing response options and communicating decisions.

7. Model assurance and publication governance

A public macroeconomic model must be governed through a clear assurance process. The IS-LM-BP/AD-AS model is designed for transparent operation: equations are documented, data transformations are traceable, code can be version controlled and scenario assumptions can be reviewed before publication.

The governance framework follows the principles of quality analysis for government: defined purpose, documented data, reproducible code, independent review, clear sign-off and transparent release notes. This gives the Ministry a strong publication standard while preserving the model's usability for regular policy analysis.

Table 9. Recommended model assurance and publication governance.

Governance area	Publication standard	Evidence retained
Model ownership	Named model owner and reviewer for each public release.	Owner record and sign-off note.
Data documentation	Data source, vintage, units and transformations recorded.	Data log and variable dictionary.
Code reproducibility	R scripts run from source data to final tables and figures.	Version-controlled code and run log.
Assumption governance	Shock magnitudes, lag choices and scenario assumptions approved before release.	Assumptions register.
Verification	Formula checks, unit checks and output reconciliation completed.	Verification checklist.

Governance area	Publication standard	Evidence retained
Validation	Economic signs, diagnostic checks and sensitivity results reviewed.	Validation notes.
Publication release	Tables, figures and narrative reviewed for consistency and accessibility.	Release checklist and final PDF/Word archive.

8. Operational development pathway

The model is ready to serve as a high-level public technical framework and can be strengthened through a staged operational development pathway. The pathway focuses on reproducibility, diagnostic depth, automation and integration with the Ministry's wider modelling ecosystem.

Table 10. Operational development pathway.

Time horizon	Priority	Operational action
0-3 months	Publication package	Finalize the technical paper, model manual, variable dictionary, assumptions register, QA checklist and code repository.
3-6 months	Analytical depth	Add automated diagnostic outputs, sensitivity ranges, confidence intervals and back-testing summaries.
6-12 months	Policy integration	Connect model outputs to the medium-term fiscal framework, external-sector dashboard and regular macro-fiscal monitoring cycle.
12+ months	Model expansion	Evaluate quarterly data extensions, stochastic scenarios, Bayesian or SVAR add-ons and links with CGE or stock-flow-consistent models.

9. Conclusion

The IS-LM-BP/AD-AS Model for Bhutan is a timely and relevant addition to the Ministry of Finance's macroeconomic toolkit. It provides an integrated, transparent and policy-oriented structure for analyzing how external shocks affect output, liquidity, trade balance and inflation.

The model's contribution is its practical integration of theory and Bhutan-specific data. The IS-LM-BP core captures goods-market, money-market and external-balance interactions. The AD-AS extension adds the price and inflation channels required for tariff and import-cost analysis. Together, these components provide a coherent system for scenario analysis, macro-fiscal planning and policy communication.

The current simulation results produce clear policy insights: domestic demand stabilizes output; liquidity conditions matter for the trade balance; foreign-exchange availability strengthens external resilience; and import-cost shocks can transmit strongly to inflation. These findings support coordinated policy assessment across fiscal, liquidity, external-sector and price-stability channels.

With disciplined governance, regular data updates and transparent publication practices, the model can serve as a durable platform for evidence-based macroeconomic policy analysis in Bhutan.

Appendix A. Core equations

(A1) Goods market / IS: $rY_t = \alpha_0 + \alpha_1 C_t + \alpha_2 I_t + \alpha_3 G_t + \alpha_4 TB_t + \epsilon_t$

(A2) Money market / LM: $M2_t = \beta_0 + \beta_1 rY_t + \beta_2 Int_t + u_t$

(A3) Balance of payments / BP: $TB_t = \gamma_0 + \gamma_1 M2_t + \gamma_2 Int_t + \gamma_3 Ivst_t + \gamma_4 FX_t + v_t$

(A4) Import elasticity: $\log(M_t) = \log(M) \sim \log(rY) + \log\left(\frac{Infl}{CPI_{ind}}\right)$

(A5) Export elasticity: $\log(EX_t) = \log(EX) \sim \log(rY) + \log\left(\frac{Infl}{CPI_{ind}}\right)$

(A6) Aggregate demand: $rY_t = rY_t = \delta_0 + \delta_1 RMS_t + \delta_2 M2P_{t-2} + \delta_3 G_t + \delta_4 G_{t-1} + \delta_5 G_{t-2} + \delta_6 I_t + \delta_7 I_{t-2} + a_t$

(A7) Short-run aggregate supply: $Infl_t = Infl_t = \varphi_0 + \varphi_1 Infl_{t-1} + \varphi_2 Gap_t + \varphi_3 CostShock_{t-1} + \varphi_4 I_{t-2} + s_t$

Appendix B. Variable dictionary

Table B. Variable dictionary.

Variable	Definition
rY	Real output or real GDP measure used in the model.
C	Consumption expenditure.
I	Investment or gross capital formation proxy.
G	Government expenditure or fiscal-demand proxy.
EX	Exports.
M	Imports.
TB	Trade balance, calculated as EX - M.
M2	Broad money or liquidity measure.
Int	Interest-rate or policy-rate proxy.
FX	Foreign-exchange availability or reserve proxy.
Infl	Inflation or CPI-based price measure.
CPI_Ind	CPI index used in elasticity equations.
Real_Money_Supply	M2 divided by the inflation or price-level proxy.
MPI_proxy	Import-price proxy calculated as imports divided by FX.
Cost_Shock	Import-cost shock variable constructed as MPI_proxy multiplied by 1.20.
Gap	Output gap or slack measure.
Ind_tax	Indirect-tax variable used in price equations where available.

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