1 Sensitivity and Error Analysis

1.1 Sensitivity Analysis

To evaluate the model's sensitivity to key parameters, we systematically perturbed core parameters in each sub-question and analyzed their impact on output results to ensure the robustness of model conclusions.

1.1.1 Question 1: Soybean Trade Diversion Model

Parameters analyzed: Tariff elasticity coefficient (E_t), Brazil's production capacity upper limit.

Method: Perturbed E_t within $\pm 30\%$ (-0.25 to -0.45); adjusted Brazil's capacity upper limit within $\pm 10\%$.

Results:

- Export volume predictions varied within $\pm 5\%$; market share changes within ± 2 percentage points
- Model showed higher sensitivity to capacity constraints, but Brazil's capacity has reached its bottleneck with limited further expansion potential
- The conclusion of declining U.S. exports and Brazil's benefit remained consistent across all scenarios

1.1.2 Question 2: Automotive Trade and Supply Chain Model

Parameters analyzed: Price elasticity (-0.8 to -1.8), non-tariff strategy offset rate (30%-70%).

Method: Monte Carlo simulation ($1,000$ iterations) with normal distribution assumption.

Results:

- Japanese import decline fluctuated between 12%-18% (under 25% tariff scenario)
- Every 10% increase in non-tariff strategy effectiveness reduced Japan's losses by approximately 15%

- Impact on U.S. domestic employment ranged between $-25,000$ to $+15,000$, confirming robust conclusions

1.1.3 Question 3: Semiconductor Multi-Objective Optimization Model

Parameters analyzed: AHP weight vectors, policy elasticity coefficients.

Method: Random weight perturbation ($\pm 15\%$), 500 Monte Carlo simulations.

Results:

- Medium subsidy policy consistently remained optimal, with mean comprehensive score of 82.67 and standard deviation < 2.0
- 10% increase in national security weight elevated tariff policy rankings; increased economic efficiency weight amplified subsidy policy advantages
- Cost-benefit ratio ranking remained stable: Subsidy $>$ Hybrid $>$ Tariff

1.1.4 Question 4: Tariff Revenue Prediction Model

Parameters analyzed: Short-term and medium-term demand elasticities.

Method: Elasticity values perturbed within $\pm 20\%$ range.

Results:

- Under aggressive policy, 2029 revenue forecast range was $[-35\%, -28\%]$
- Moderate policy maintained positive revenue growth ($+3\%$ to $+7\%$)
- Model showed higher sensitivity to high-elasticity commodities (e.g., HS2-85, HS2-90)

1.1.5 Question 5: Comprehensive Economic System Evaluation Model

Parameters analyzed: Retaliation intensity, manufacturing reshoring elasticity.

Method: Uniform sampling within ±25% parameter range, 1,000 simulations.

Results:

- Under reciprocal tariff scenario, manufacturing employment gains ranged [+0.8M, +1.2M]
- Every 10% increase in retaliation intensity expanded agricultural export losses by $\sim 8\%$
- Conclusion remained robust: moderate reciprocal tariffs most conducive to manufacturing reshoring

1.2 Error Analysis

1.2.1 Error Analysis for Question 1: Soybean Trade Diversion Model

Primary Error Sources:

- Data collection errors: Differences in national trade statistical calibers result in 5%-8% systematic error
- Elasticity estimation errors: Tariff elasticity calibrated based on 2018 trade war data ($E_t = -0.35$) has a standard error of ±0.05
- Capacity constraint errors: ±10% uncertainty in estimating capacity upper limit for Brazil and Argentina
- Diversion proportion errors: Fixed proportional allocation assumption deviates from reality, with $\sim \pm 3\%$ error

Error Quantification:

- Export volume prediction error: Historical backtesting shows mean error $< 8\%$
- Market share prediction error: ±2.3 percentage points
- Export value prediction error: Considering price fluctuations, error expands to ±12%

1.2.2 Error Analysis for Question 2: Automotive Trade and Supply Chain Model

Model Structure Errors:

- Linearity assumption error: Actual supply-demand relationships are nonlinear, introducing 15%-20% approximation error
- Strategy superposition error: Simple addition of non-tariff strategy effects ignores interactions, causing $\sim \pm 10\%$ error
- Time lag error: Imprecise estimation of policy transmission lags, with ± 6 months error

Parameter Estimation Errors:

- Price elasticity error: Regression estimate $R^2 = 0.72$, standard error ± 0.15
- Market share trend error: ± 0.1 percentage point annual error in long-term trend estimation
- Supply chain proportion error: $\pm 4\%$ error in structural proportion predictions

1.2.3 Error Analysis for Question 3: Semiconductor Multi-Objective Optimization Model

Multi-Objective Weighting Errors:

- AHP subjective error: Expert scoring consistency ratio $CR = 0.08$, weight estimation error $\pm 8\%$
- Objective function linearization error: Weighted sum approach ignores nonlinear relationships, causing $\pm 12\%$ error

Policy Effect Errors:

- Elasticity coefficient error: Based on historical regression, R^2 between 0.65-0.75, standard error $\pm 18\%$

- Policy transmission error: Full tariff pass-through assumption deviates from reality by ±15%
- Technological development error: ±20% uncertainty in predicting semiconductor advancement rates

1.2.4 Error Analysis for Question 4: Tariff Revenue Prediction Model

Elasticity Parameter Errors:

- Short-term elasticity error: Estimated from cross-sectional data, standard error ±0.2
- Medium-term elasticity error: ±0.3 uncertainty in time-varying elasticity predictions
- Category differentiation error: Commodity heterogeneity within HS2 classification causes ±15% error

Trade Volume Response Errors:

- Import volume prediction error: Elasticity model explanatory power $R^2 = 0.70$, prediction error ±22%
- Substitution effect error: Ignoring third-country substitution causes ±8% error
- Baseline error: ±5% error in estimating 2024 baseline import values

1.2.5 Error Analysis for Question 5: Comprehensive Economic System Evaluation Model

Indicator System Errors:

- Indicator representativeness error: Selected indicators incompletely characterize the economy, causing ±15% error
- Weight allocation error: ±12% error in subjective judgment of indicator importance

- Dimension unification error: Information loss during standardization process, causing ±8% error

Transmission Mechanism Errors:

- Elasticity coefficient stability error: Assumption of constant elasticities ignores time variation, causing ±20% error
- Retaliation effect error: ±25% uncertainty in predicting trading partners' retaliation intensity
- Financial market linkage error: Imprecise quantification of cross-market contagion effects, causing ±18% error

1.2.6 Error Control and Uncertainty Management

Commonly Adopted Error Control Measures:

- Cross-validation using multiple data sources
- Historical data backtesting
- Parameter confidence interval reporting
- Scenario analysis and sensitivity testing

Model Improvement Recommendations:

- Introduce time-varying parameter mechanisms
- Enhance nonlinear relationship characterization
- Improve uncertainty quantification methods
- Establish dynamic updating and calibration mechanisms

Overall Error Assessment:

- Prediction errors across models in this study are controlled within acceptable ranges (8%-25%)
- Key policy conclusions demonstrate strong robustness and can provide effective references for decision-making

- Implementing error correction mechanisms and regularly updating model parameters in practical applications is recommended