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RESEARCH PAPER

THE IMPACT OF "RECIPROCAL TARIFFS" ON DEVELOPING COUNTRIES: A DYNAMIC ANALYSIS

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HINH T. DINH & CUONG LE VAN

This paper develops a continuous-time optimal control model to analyze the economic effects of the U.S. administration's newly imposed "reciprocal tariffs," which are determined by bilateral trade deficits. The model focuses on a small, open developing economy integrated into global value chains and facing limited policy space. We demonstrate how reciprocal tariffs, endogenously linked to the trade balance, affect production, consumption, capital accumulation, and overall welfare. We derive the full dynamic system, characterize its steady state, and explore the implications of domestic policy responses. The paper concludes with detailed policy recommendations for developing countries navigating this new trade environment, highlighting the roles of import substitution, export diversification, and regional cooperation in mitigating vulnerability to reciprocal tariffs.

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1. INTRODUCTION

On April 2, 2025, President Donald Trump initiated one of the most significant shifts in U.S. trade policy in nearly a century by imposing a baseline 10% tariff on all imports, along with additional country-specific tariffs ranging from 10% to 50% for countries designated as having "non-reciprocal trading practices" with the United States. The formula used to calculate these reciprocal tariffs, shown in Annex 1, is based solely on the U.S. bilateral trade deficit with the country in question and is independent of existing tariff structures. Nevertheless, the implementation of these tariffs or a modified version negotiated subsequently is likely to have far-reaching global effects, particularly on developing countries that depend heavily on exports for growth and poverty reduction.

This paper presents an optimal control model to analyze the impact of reciprocal tariffs on the economic performance of developing countries. It assumes that the United States will apply this mechanism on a continuous basis rather than as a one-time adjustment to monitor and respond to bilateral trade imbalances. Under this scheme, the larger a country's trade surplus with the United States, the higher the U.S. tariff imposed on that country's exports. The model captures the intertemporal trade-offs faced by a small, open economy with limited policy space and deep integration into global value chains. We show how tariff shocks affect the capital stock and trade balance, shaping the optimal trajectories of consumption and capital accumulation.

2. MODEL SETUP

2.1 Economic Environment

We consider a small open economy that produces a single good using capital K and labor L according to a Cobb-Douglas production function. The economy trades with the rest of the world and is integrated into global value chains.

2.2 Production Function

The economy's production function is given by:

$$Y(t) = A(t)K(t)^\alpha L(t)^{1-\alpha}$$

where:

- $Y(t)$ is output at time t
- $A(t)$ is total factor productivity
- $K(t)$ is the capital stock
- $L(t)$ is labor input
- α is the capital share in production, with $0 < \alpha < 1$

For simplicity, we normalize the labor supply to 1, so $L(t) = 1$ for all t . This gives us:
 $Y(t) = A(t)K(t)^\alpha$

2.3 Tariff Effects on Productivity

We assume that total factor productivity is not affected by foreign tariffs:

$$A(t) = \bar{A}(t)$$

where:

- $\bar{A}$ is the baseline productivity level in the absence of tariffs
- τ is the foreign tariff rate (reciprocal tariffs) imposed on the country's exports
 $\tau(t) = b \cdot NX(t)$ where $NX(t)$ is the trade balance and $b > 0$
- $NX(t) = \epsilon_1 Y_e^{\mu_1} (1 - \tau) - \epsilon_2 Y^{\mu_2} (1 - \tau^*)$ where Y_e is foreign economy output (a proxy of foreign demand); Y is the domestic economy output; τ is the foreign tariff rate imposed on the country's exports; τ^* is the domestic tariff rate on imports; μ_1 and μ_2 are the elasticities of exports and imports, respectively with $0 \leq \mu_1$ and $0 \leq \mu_2$; $\epsilon_1 > 0, \epsilon_2 > 0$

2.4 National Income Identity

The national income identity for our open economy is:

$$Y(t) = C(t) + I(t) + NX(t)$$

where:

- $C(t)$ is consumption
- $I(t)$ is investment
- $NX(t)$ is net exports (the trade balance)

2.5 Trade Balance

$$NX(t) = \epsilon_1 Y_e^{\mu_1} (1 - \tau(t)) - \epsilon_2 Y(t)^{\mu_2} (1 - \tau^*)$$

$$\text{Substituting the production function: } NX(t) = \epsilon_1 Y_e^{\mu_1} (1 - \tau(t)) - \epsilon_2 (\bar{A}K(t)^\alpha)^{\mu_2} (1 - \tau^*)$$

Since

$$\tau(t) = bNX(t)$$

$$\text{Substituting this into the trade balance equation: } NX(t) = \epsilon_1 Y_e^{\mu_1} (1 - bNX(t)) - \epsilon_2 \bar{A}^{\mu_2} K(t)^{\alpha\mu_2} (1 - \tau^*)$$

$$NX(t) = \epsilon_1 Y_e^{\mu_1} - \epsilon_1 Y_e^{\mu_1} bNX(t) - \epsilon_2 \bar{A}^{\mu_2} K(t)^{\alpha\mu_2} (1 - \tau^*)$$

$$NX(t)(1 + \epsilon_1 Y_e^{\mu_1} b) = \epsilon_1 Y_e^{\mu_1} - \epsilon_2 \bar{A}^{\mu_2} K(t)^{\alpha\mu_2} (1 - \tau^*)$$

$$\text{Therefore: } NX(t) = \frac{\epsilon_1 Y_e^{\mu_1} - \epsilon_2 \bar{A}^{\mu_2} K(t)^{\alpha\mu_2} (1 - \tau^*)}{1 + \epsilon_1 Y_e^{\mu_1} b}$$

Thus

$$\frac{\partial NX(t)}{\partial K} = \frac{-\epsilon_2 \bar{A}^{\mu_2} (1 - \tau^*) \alpha \mu_2 K^{\alpha\mu_2 - 1}}{1 + \epsilon_1 Y_e^{\mu_1} b} < 0$$

and

$$\frac{\partial^2 NX(t)}{\partial K^2} = \frac{-\epsilon_2 \bar{A}^{\mu_2} (1 - \tau^*) \alpha \mu_2 (\alpha \mu_2 - 1) K^{\alpha\mu_2 - 2}}{1 + \epsilon_1 Y_e^{\mu_1} b} > 0$$

2.6 Capital Accumulation

The law of motion for capital is:

$$\dot{K}(t) = Y(t) - C(t) - NX(t) - \delta K(t)$$

$$\text{Substituting our expressions: } \dot{K}(t) = \bar{A}K(t)^\alpha - C(t) - \frac{\epsilon_1 Y_e^{\mu_1} - \epsilon_2 \bar{A}^{\mu_2} K(t)^{\alpha \mu_2} (1 - \tau^*)}{1 + \epsilon_1 Y_e^{\mu_1} b} - \delta K(t)$$

2.7 Consumption and Welfare

The social planner seeks to maximize the present discounted value of utility:

$$\max_{C(t)} \int_0^\infty e^{-\rho t} \frac{C(t)^{1-\sigma} - 1}{1-\sigma} dt$$

subject to the capital accumulation constraint, where:

- ρt is the discount rate
- σ is the inverse of the intertemporal elasticity of substitution
- $\frac{C(t)^{1-\sigma} - 1}{1-\sigma}$ is the instantaneous utility function (CRRA utility)

3. THE COMPLETE MODEL

Combining all the elements, the social planner's problem is:

$$\max_{C(t)} \int_0^\infty e^{-\rho t} \frac{C(t)^{1-\sigma} - 1}{1-\sigma} dt$$

subject to:

$$\dot{K}(t) = Y(t) - C(t) - NX(t) - \delta K(t)$$

$$\dot{K}(t) = \bar{A}K(t)^\alpha - C(t) - \frac{\epsilon_1 Y_e^{\mu_1} - \epsilon_2 \bar{A}^{\mu_2} K(t)^{\alpha \mu_2} (1 - \tau^*)}{1 + \epsilon_1 Y_e^{\mu_1} b} - \delta K(t)$$

4. OPTIMAL CONTROL SOLUTION

4.1 The Hamiltonian

To solve this optimal control problem, we form the current-value Hamiltonian:

$$H(K, C, \lambda, t) = \frac{C(t)^{1-\sigma} - 1}{1-\sigma} + \lambda(t) \left[\bar{A}K(t)^\alpha - C(t) - \frac{\epsilon_1 Y_e^{\mu_1} - \epsilon_2 \bar{A}^{\mu_2} K(t)^{\alpha \mu_2} (1 - \tau^*)}{1 + \epsilon_1 Y_e^{\mu_1} b} - \delta K(t) \right]$$

where $\lambda(t)$ is the current-value costate variable representing the shadow price of capital and

$$NX(t) = \frac{\epsilon_1 Y_e^{\mu_1} - \epsilon_2 \bar{A}^{\mu_2} K(t)^{\alpha \mu_2} (1 - \tau^*)}{1 + \epsilon_1 Y_e^{\mu_1} b}$$

4.2 First-Order Conditions

The necessary conditions for an optimum are:

1. First-order condition with respect to the control variable (C):

$$\begin{aligned}\frac{\partial H}{\partial C} &= 0 \\ C(t)^{-\sigma}(t) - \lambda(t) &= 0 \\ \lambda(t) &= C(t)^{-\sigma}\end{aligned}$$

2. The costate equation:

$$\begin{aligned}\dot{\lambda}(t) &= \rho\lambda(t) - \frac{\partial H}{\partial K} \\ \frac{\partial H}{\partial K} &= \lambda(t) \left[\alpha \bar{A}K(t)^{\alpha-1} + \frac{\epsilon_2 \bar{A}^{\mu_2} \alpha \mu_2 K(t)^{\alpha\mu_2-1} (1-\tau^*)}{1 + \epsilon_1 Y_e^{\mu_1} b} - \delta \right]\end{aligned}$$

3. The state equation:

$$\begin{aligned}\dot{K}(t) &= \frac{\partial H}{\partial K} \\ \dot{K}(t) &= \bar{A}K(t)^{\alpha} - C(t) - \frac{\epsilon_1 Y_e^{\mu_1} - \epsilon_2 \bar{A}^{\mu_2} K(t)^{\alpha\mu_2} (1-\tau^*)}{1 + \epsilon_1 Y_e^{\mu_1} b} - \delta K(t)\end{aligned}$$

4. The transversality condition:

$$\begin{aligned}\lim_{t \rightarrow \infty} e^{-\rho t} \lambda(t) K(t) &= 0 \\ \text{Or because } \lambda(t) &= C(t)^{-\sigma}: \\ \lim_{t \rightarrow \infty} e^{-\rho t} C(t)^{-\sigma} K(t) &= 0\end{aligned}$$

4.3 Derivation of the Consumption Growth Rate

From the first-order condition, we have $C(t)^{-\sigma} = \lambda(t)$. Taking the logarithm of both sides:

$$\ln \lambda(t) = -\sigma \ln C(t)$$

Differentiating with respect to time:

$$\frac{\dot{\lambda}(t)}{\lambda(t)} = -\sigma \frac{\dot{C}(t)}{C(t)}$$

$$\text{From the costate equation: } \frac{\dot{\lambda}(t)}{\lambda(t)} = \rho - \left[\alpha \bar{A}K(t)^{\alpha-1} + \frac{\epsilon_2 \bar{A}^{\mu_2} \alpha \mu_2 K(t)^{\alpha\mu_2-1} (1-\tau^*)}{1 + \epsilon_1 Y_e^{\mu_1} b} - \delta \right]$$

Therefore, the consumption growth rate is: $\frac{\dot{C}(t)}{C(t)} =$

$$\frac{1}{\sigma} \left[\alpha \bar{A}K(t)^{\alpha-1} + \frac{\epsilon_2 \bar{A}^{\mu_2} \alpha \mu_2 K(t)^{\alpha\mu_2-1} (1-\tau^*)}{1 + \epsilon_1 Y_e^{\mu_1} b} - \delta - \rho \right]$$

4.4 Complete Dynamical System

The complete dynamical system describing the evolution of the economy is:

$$\begin{aligned}\frac{\dot{C}(t)}{C(t)} &= \frac{1}{\sigma} \left[\alpha \bar{A} K(t)^{\alpha-1} + \frac{\epsilon_2 \bar{A}^{\mu_2} \alpha \mu_2 K(t)^{\alpha \mu_2 - 1} (1 - \tau^*)}{1 + \epsilon_1 Y_e^{\mu_1} b} - \delta - \rho \right] \\ \dot{K}(t) &= \bar{A} K(t)^\alpha - C(t) - \frac{\epsilon_1 Y_e^{\mu_1} - \epsilon_2 \bar{A}^{\mu_2} K(t)^{\alpha \mu_2} (1 - \tau^*)}{1 + \epsilon_1 Y_e^{\mu_1} b} - \delta K(t) \\ NX(t) &= \frac{\epsilon_1 Y_e^{\mu_1} - \epsilon_2 \bar{A}^{\mu_2} K(t)^{\alpha \mu_2} (1 - \tau^*)}{1 + \epsilon_1 Y_e^{\mu_1} b} \\ \tau(t) &= b \cdot NX(t)\end{aligned}$$

5. STEADY STATE ANALYSIS

In the steady state, $\dot{K}(t) = \dot{C}(t) = 0$.

From the consumption growth equation: $\alpha \bar{A} K_{ss}^{\alpha-1} + \frac{\epsilon_2 \bar{A}^{\mu_2} \alpha \mu_2 K_{ss}^{\alpha \mu_2 - 1} (1 - \tau^*)}{1 + \epsilon_1 Y_e^{\mu_1} b} = \delta + \rho$

From the capital accumulation equation: $C_{ss} = \bar{A} K_{ss}^\alpha - \frac{\epsilon_1 Y_e^{\mu_1} - \epsilon_2 \bar{A}^{\mu_2} K_{ss}^{\alpha \mu_2} (1 - \tau^*)}{1 + \epsilon_1 Y_e^{\mu_1} b} - \delta K_{ss}$

The steady-state trade balance is: $NX_{ss} = \frac{\epsilon_1 Y_e^{\mu_1} - \epsilon_2 \bar{A}^{\mu_2} K_{ss}^{\alpha \mu_2} (1 - \tau^*)}{1 + \epsilon_1 Y_e^{\mu_1} b}$

Proposition 1: There exists a unique steady state (K_{ss}, C_{ss}) . It is a saddle point.

Proof: The LHS of the above consumption growth equation is a strictly decreasing function of K from Section 2.5 and the fact that $\alpha < 1$. It equals $+\infty$ when $K = 0$ and 0 when $K = +\infty$. Hence there exists a unique K_{ss} which is solution to the above consumption growth equation. The value NX_{ss} is obtained from Section 2.5. Finally, the above capital accumulation equation gives the value C_{ss} .

6. TRADE BALANCE SENSITIVITY AND IMPLICATIONS

The trade balance now depends on:

- Export sensitivity: $\epsilon_1 Y_e^{\mu_1}$ scaled by $(1 - \tau)$
- Import sensitivity: $\epsilon_2 Y^{\mu_2}$ scaled by $(1 - \tau^*)$
- Tariff feedback: Through the denominator $1 + \epsilon_1 Y_e^{\mu_1} b$

Policy Implications

- Domestic tariffs (τ^*) now directly affect the trade balance and optimal paths
- Foreign income (Y_e) has a more complex relationship with domestic optimal policy
- Elasticity parameters (μ_1, μ_2) determine the responsiveness of trade flows

7. IMPACT OF RECIPROCAL TARIFF SHOCKS

7.1 Effect on Steady-State Trade Balance

From the trade balance equilibrium condition:

$$NX_{ss} = \frac{\epsilon_1 Y_e^{\mu_1} - \epsilon_2 \bar{A}^{\mu_2} K_{ss}^{\alpha \mu_2} (1 - \tau^*)}{1 + \epsilon_1 Y_e^{\mu_1} b}$$

Taking the total differential with respect to b :

$$\frac{dNX_{ss}}{db} = \frac{\partial NX_{ss}}{\partial b} + \frac{\partial NX_{ss}}{\partial K_{ss}} \frac{dK_{ss}}{db}$$

The direct effect is:

$$\frac{\partial NX_{ss}}{\partial b} = - \frac{(\epsilon_1 Y_e^{\mu_1} - \epsilon_2 A^{\mu_2} K_{ss}^{\alpha \mu_2} (1 - \tau^*)) \epsilon_1 Y_e^{\mu_1}}{(1 + \epsilon_1 Y_e^{\mu_1} b)^2} < 0$$

Result: $\frac{dNX_{ss}}{db} < 0$

Economic interpretation: More aggressive U.S. reciprocal tariffs reduce the country's steady-state trade surplus through multiple channels:

1. Export reduction channel: Higher expected tariffs directly reduce export competitiveness
2. Import elasticity channel: The μ_2 parameter determines how responsive imports are to domestic income changes
3. Foreign income sensitivity: The μ_1 parameter affects how much foreign economic conditions matter

7.2 Effect on U.S. Tariffs Faced by Target Country

The steady-state U.S. tariffs are: $\tau_{ss} = b \cdot NX_{ss}$

Taking the derivative:

$$\frac{d\tau_{ss}}{db} = NX_{ss} + b \frac{dNX_{ss}}{db}$$

Since $\frac{dNX_{ss}}{db} < 0$, the sign of $\frac{d\tau_{ss}}{db}$ depends on the relative magnitudes:

If trade balance is highly elastic: $\left| b \frac{dNX_{ss}}{db} \right| > NX_{ss}$, then $\frac{d\tau_{ss}}{db} < 0$

If trade balance is inelastic: $\left| b \frac{dNX_{ss}}{db} \right| < NX_{ss}$, then $\frac{d\tau_{ss}}{db} > 0$

The elasticity parameters μ_1 and μ_2 crucially determine this outcome.

7.3 Effect on Steady-State Capital

Proposition 2: We have $\frac{\partial K_{ss}}{\partial b} < 0$. And hence $\frac{\partial Y_{ss}}{\partial b} < 0$ (Y_{ss} is the steady-state output).

Proof: From the steady-state analysis, the optimality condition for capital is:

$$\alpha \bar{A} K_{ss}^{\alpha-1} + \frac{\epsilon_2 \bar{A}^{\mu_2} \alpha \mu_2 K_{ss}^{\alpha \mu_2 - 1} (1 - \tau^*)}{1 + \epsilon_1 Y_e^{\mu_1} b} = \delta + \rho$$

Define the left-hand side of the optimality condition as function $F(K_{ss}, b)$:

$$F(K_{ss}, b) = \alpha \bar{A} K_{ss}^{\alpha-1} + \frac{\epsilon_2 \bar{A}^{\mu_2} \alpha \mu_2 K_{ss}^{\alpha \mu_2 - 1} (1 - \tau^*)}{1 + \epsilon_1 Y_e^{\mu_1} b}$$

In steady state: $F(K_{ss}, b) = \delta + \rho$

Take the partial derivatives of F with respect to K_{ss} and b :

$$\frac{\partial F}{\partial K_{ss}} = \alpha(\alpha - 1) \bar{A} K_{ss}^{\alpha-2} + \frac{\epsilon_2 \bar{A}^{\mu_2} \alpha \mu_2 (\alpha \mu_2 - 1) K_{ss}^{\alpha \mu_2 - 2} (1 - \tau^*)}{1 + \epsilon_1 Y_e^{\mu_1} b}$$

Since $\alpha < 1$ and $\mu_2 \leq 1$, we have $\alpha - 1 < 0$ and $\alpha \mu_2 - 1 \leq 0$, therefore:

$$\frac{\partial F}{\partial K_{ss}} < 0$$

Calculate $\partial F / \partial b$:

$$\frac{\partial F}{\partial b} = - \frac{\epsilon_2 \bar{A}^{\mu_2} \alpha \mu_2 K_{ss}^{\alpha \mu_2 - 1} (1 - \tau^*) \epsilon_1 Y_e^{\mu_1}}{(1 + \epsilon_1 Y_e^{\mu_1} b)^2}$$

Since all parameters are positive: $\partial F / \partial b < 0$

Apply the implicit function theorem to $F(K_{ss}, b) = \delta + \rho$:

$$\frac{\partial K_{ss}}{\partial b} = - \frac{\frac{\partial F}{\partial b}}{\frac{\partial F}{\partial K_{ss}}} = - \frac{\frac{\partial F}{\partial b}}{\frac{\partial F}{\partial K_{ss}}}$$

Since $\partial F / \partial b < 0$ and $\partial F / \partial K_{ss} < 0$:

$$\frac{\partial K_{ss}}{\partial b} = - \frac{(-)}{(-)} = - \frac{(+)}{(+)} < 0$$

Therefore: $\partial K_{ss} / \partial b < 0$ and consequently $\partial Y_{ss} / \partial b < 0$ since $Y_{ss} = \bar{A} K_{ss}^\alpha$.

Note that because the steady state capital equation depends only on b ,

$$\frac{dK_{ss}}{db} = \frac{\partial K_{ss}}{\partial b} < 0$$

- Higher reciprocal tariff sensitivity reduces capital accumulation

7.4 Effect of Country's Own Tariff Policy

The country can adjust its own tariffs τ^* in response to U.S. reciprocal policy.

The case when $\tau^* = 0$, as in the recently announced U.S.-Vietnam trade agreement is examined in Annex 2.

Proposition 3: Consider the above model with $\tau^* = 0$. Suppose that the country's import demand is complementary to its exports, such that the elasticity of import demand μ_2 becomes zero. Then, for small positive values of reciprocal tariff intensity $b > 0$, the steady-state welfare of the developing country is strictly higher than under $b = 0$. Moreover, the foreign country (e.g., the U.S.) also benefits from improved trade balance without severe welfare losses.

Proof: From the model, lifetime utility is:

$$W(b) = \int_0^\infty e^{-\rho t} \frac{C(t)^{1-\sigma} - 1}{1-\sigma} dt$$

At steady state, $C(t) = C_{ss}(b)$, so:

$$W(b) = \frac{C_{ss}(b)^{1-\sigma} - 1}{\rho(1-\sigma)}$$

Thus, welfare improves if $\frac{dC_{ss}}{db} > 0$.

From the steady-state capital accumulation condition with $\tau^* = 0$:

$$C_{ss}(b) = \bar{A}K_{ss}^\alpha - \frac{\epsilon_1 Y_e^{\mu_1} - \epsilon_2 \bar{A}^{\mu_2} K_{ss}^{\alpha\mu_2}}{1 + \epsilon_1 Y_e^{\mu_1} b} - \delta K_{ss}$$

We analyze how this changes as $\mu_2 \rightarrow 0$.

As $\mu_2 \rightarrow 0$,

$$\bar{A}^{\mu_2} \rightarrow 1, K_{ss}^{\alpha\mu_2} \rightarrow 1$$

So, the trade balance becomes:

$$NX_{ss}(b) = \frac{\epsilon_1 Y_e^{\mu_1} - \epsilon_2}{1 + \epsilon_1 Y_e^{\mu_1} b}$$

Hence,

$$C_{ss}(b) = \bar{A}K_{ss}^\alpha - \frac{\epsilon_1 Y_e^{\mu_1} - \epsilon_2}{1 + \epsilon_1 Y_e^{\mu_1} b} - \delta K_{ss}$$

Also, from the Euler condition,

$$\alpha \bar{A} K_{ss}^{\alpha-1} = \delta + \rho \Rightarrow K_{ss} = \left(\frac{\alpha \bar{A}}{\delta + \rho} \right)^{\frac{1}{1-\alpha}} \equiv \bar{K}$$

Thus, K_{ss} becomes constant in this limit.

$$\frac{dC_{ss}}{db} = \frac{(\epsilon_1 Y_e^{\mu_1} - \epsilon_2) \cdot \epsilon_1 Y_e^{\mu_1}}{(1 + \epsilon_1 Y_e^{\mu_1} b)^2}$$

This is positive if $\epsilon_1 Y_e^{\mu_1} > \epsilon_2$, i.e., the country has a trade surplus.

Although the model centers on the developing country, a symmetric argument applies to the trade partner (the U.S.):

- Trade imbalance is reduced.
- Disruption is minimized due to low b .
- U.S. retains access to complementary imports.

Under $\tau^* = 0, \mu_2 \rightarrow 0$, and a trade surplus, a small positive reciprocal tariff ($b > 0$) increases C_{ss} and thus improves welfare in the developing country. The foreign country (e.g., the U.S.) also benefits through improved trade balance and preserved import efficiency. Hence, reciprocal tariffs can be Pareto-improving.

Effect on Trade Balance:

$$\frac{dNX_{ss}}{d\tau^*} = \frac{\epsilon_2 \bar{A}^{\mu_2} K_{ss}^{\alpha\mu_2}}{1 + \epsilon_1 Y_e^{\mu_1} b} > 0$$

The country's own tariffs improve its trade balance through import substitution.

Effect on US Tariffs Faced:

$$\frac{d\tau_{ss}}{d\tau^*} = b \frac{dNX_{ss}}{d\tau^*} > 0$$

Critical insight: The country's own tariffs increase the US tariffs it faces through the reciprocal mechanism!

8. TRANSITION DYNAMICS AND PHASE DIAGRAM ANALYSIS

8.1 Linearization around Steady State

Define deviations: $k = K - K_{ss}$ and $c = C - C_{ss}$

The linearized system is:

$$\begin{bmatrix} \dot{k} \\ \dot{c} \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} k \\ c \end{bmatrix}$$

Jacobian elements:

$$\begin{aligned} a_{11} &= \alpha(\alpha - 1)\bar{A}K_{ss}^{\alpha-2} + \frac{\epsilon_2 \bar{A}^{\mu_2} \alpha \mu_2 (\alpha \mu_2 - 1) K_{ss}^{\alpha\mu_2-2} (1 - \tau^*)}{1 + \epsilon_1 Y_e^{\mu_1} b} - \delta < 0 \\ a_{12} &= -1 < 0 \\ a_{21} &= \frac{C_{ss}}{\sigma} \left[\alpha(\alpha - 1)\bar{A}K_{ss}^{\alpha-2} + \frac{\epsilon_2 \bar{A}^{\mu_2} \alpha \mu_2 (\alpha \mu_2 - 1) K_{ss}^{\alpha\mu_2-2} (1 - \tau^*)}{1 + \epsilon_1 Y_e^{\mu_1} b} \right] < 0 \\ a_{22} &= 0 \end{aligned}$$

8.2 Eigenvalues and Stability Analysis

The characteristic equation: $\lambda^2 - a_{11}\lambda - a_{21} = 0$

Eigenvalues:

$$\lambda_1 = \frac{a_{11} + \sqrt{a_{11}^2 + 4a_{21}}}{2} > 0 \text{ (unstable)}$$

$$\lambda_2 = \frac{a_{11} - \sqrt{a_{11}^2 + 4a_{21}}}{2} < 0 \text{ (stable)}$$

The steady state remains a saddle point with determinacy.

8.3 Phase Diagram

The stable manifold slope: $\frac{dc}{dk} = \frac{\lambda_2}{a_{12}} = -\lambda_2 > 0$

8.4 Transition Path Under Reciprocal Tariffs

Phase 1: Immediate Response ($t = 0$)

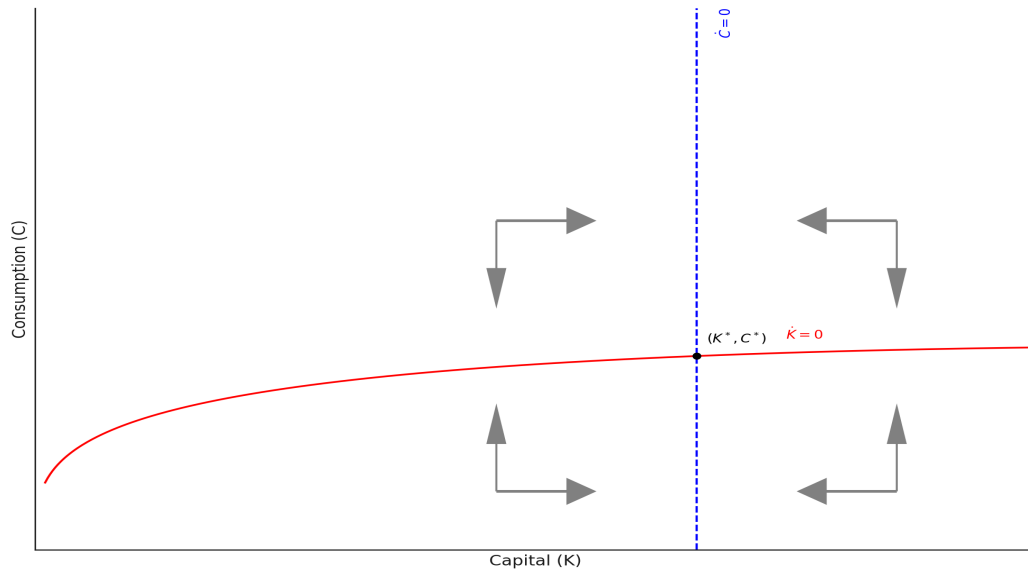
- Consumption jumps: Anticipating changes in both export and import dynamics
- Capital unchanged: Physical capital cannot adjust instantly
- Trade balance adjustment: Both export and import channels begin adjusting

Phase 2: Adjustment Process ($0 < t < \infty$)

1. Export channel evolution: $\epsilon_1 Y_e^{\mu_1} (1 - \tau(t))$ adjusts as tariffs change
2. Import channel evolution: $\epsilon_2 Y(t)^{\mu_2} (1 - \tau^*)$ responds to domestic growth
3. Dual rebalancing: Economy adjusts through both trade channels simultaneously
4. Capital accumulation: Responds to modified marginal product including import effects

Phase 3: New Steady State ($t \rightarrow \infty$)

- Balanced trade flows: Both export and import channels reach new equilibrium
- Modified capital stock: Potentially higher
- Policy-dependent outcomes: Final state depends critically on $\mu_1, \mu_2, \epsilon_1, \epsilon_2$

Figure 1. Phase Diagram in (K,C) Space**Legend:**

1. **$\dot{K} = 0$ locus** (red curve) - Shows where capital accumulation is zero. This curve is steeper than in standard models due to the additional import effect terms from the modified trade balance equation.
2. **$\dot{C} = 0$ locus** (broken blue line) - Shows where consumption growth is zero, now incorporating both export and import elasticity parameters (μ_1 and μ_2).
3. **Saddle point equilibrium** (black dot) - The intersection point (K^* , C^*) representing the long-run steady state.
4. **Direction arrows** - Show the motion in different regions of the phase space.

9. POLICY IMPLICATIONS

9.1 Optimal Response Strategy for Target Countries

In response to the continuously-adjusted reciprocal tariff mechanism, developing countries must adopt an informed and flexible strategy. First and foremost, they need to accept the new trade dynamics rather than resist them. Attempting to fight the adjustment path shown in the model, particularly the necessary short-term drop in consumption along the stable manifold, could prove counterproductive and destabilizing. Instead, countries should allow both their export and import sectors to adjust organically to the new realities imposed by the U.S. tariff structure.

A key opportunity lies in leveraging the import channel as a strategic policy lever. By carefully adjusting their own import tariffs, governments can improve the trade balance through substitution effects. However, such policies must be implemented with caution, as higher domestic tariffs may trigger even higher U.S. reciprocal tariffs under the new formula. The effectiveness of this approach

largely depends on the income elasticity of imports: when the elasticity is low, domestic tariffs are more potent in shifting trade balances without severely escalating U.S. retaliation.

Additionally, policymakers must develop a deep understanding of the trade elasticity parameters in the model. A high elasticity with respect to foreign income implies greater vulnerability to external economic fluctuations, while a high elasticity with respect to domestic income signals stronger influence through internal policy measures. In cases where both elasticities are low, the economy is more insulated from global trade pressures, which may open additional space for domestic reform and long-term planning.

9.2 Sectoral and Structural Policies

To adapt to the new trade environment and mitigate the risks of overexposure to U.S. markets, developing countries should prioritize export diversification. Reducing dependency on a single market diminishes the effective burden of reciprocal tariffs and enhances resilience. This calls for building trade relationships with alternative partners and focusing on sectors less sensitive to U.S. trade retaliation those characterized by lower trade elasticities.

At the same time, a cautious and strategic approach to import substitution is warranted. While higher domestic tariffs can shift demand toward local products and improve the trade balance, such measures may provoke retaliatory responses under the reciprocal framework. Therefore, governments should focus their efforts on sectors where imports are relatively unresponsive to income changes, allowing for gains without triggering a proportional rise in U.S. tariffs. Import substitution should be pursued not as a blanket policy, but in a selective manner that maintains export competitiveness and supports broader industrial policy goals.

An important and somewhat counterintuitive insight from the model is that reciprocal tariffs may actually promote capital accumulation. A reduction in the intensity of reciprocal tariffs (b) can lead to increased capital accumulation by enhancing incentives for export expansion, which in turn stimulates investment. This effect is likely to be reinforced if the country maintains low or zero import tariffs (Annex 2), as the resulting increase in imports particularly of capital goods would contribute to higher gross capital formation.

9.3 Timing and Sequencing

Timing and sequencing of policy actions are vital to navigating the transition effectively. In the immediate aftermath of the tariff shock, governments should focus on stabilizing expectations and minimizing social disruption. This includes clearly communicating the underlying economic logic of the adjustment path to stakeholders and preparing targeted social safety nets to cushion the consumption drop that may occur in the short term. Avoiding hasty or reactionary policies during this phase is crucial to prevent further economic volatility.

As the economy enters the medium-term adjustment phase, continuous monitoring of trade flows both exports and imports becomes necessary. Policy adjustments should be calibrated carefully to ensure that the economy stays on the stable adjustment path shown in the model. Structural policies may be needed to assist firms and sectors in transitioning from an export-led model toward one that

is more balanced or domestically oriented. This will require not only macroeconomic tools, but also sectoral planning, retraining programs, and infrastructure investments.

In the long run, the goal should be to build greater economic resilience. This entails reducing overall dependence on any single trading partner, especially a dominant one. Developing comparative advantages in sectors that are less exposed to tariff shocks and more stable in global demand will provide a foundation for sustainable growth. Flexibility in trade and industrial policy must also be preserved to allow adaptation to future shifts in the international trade environment, which is likely to remain uncertain.

9.4 Multilateral Considerations

Beyond unilateral measures, developing countries must think strategically about collective action. One approach is to collaborate with other countries similarly affected by the reciprocal tariff regime. By forming coalitions or regional trade arrangements, they can share the costs of adjustment and reduce their individual exposure. Joint responses may also help avoid the harmful spiral of protectionism, where countries raise tariffs in response to one another, resulting in widespread inefficiencies and economic fragmentation.

At the global level, although countries could, in theory, turn to multilateral institutions such as the World Trade Organization (WTO) to challenge the legality and fairness of the U.S. reciprocal tariff approach, the reality is that the WTO is largely defunct in its current form. Its dispute resolution mechanism has been paralyzed for years, and prospects for meaningful reform remain uncertain. It is increasingly likely that the organization will need to be restructured or replaced altogether before it can again serve as an effective arbiter of trade disputes. In the meantime, it is more pragmatic for countries to focus on alternative strategies. These may include forging regional alliances, deepening South-South trade cooperation, and engaging in targeted bilateral negotiations to reduce vulnerability to unilateral measures. Rather than relying on a moribund multilateral system, developing countries should treat multilateralism as a long-term aspiration while adopting more flexible and diversified trade strategies in the short to medium term.

9.5 Welfare Analysis and Political Economy

The welfare implications of the new trade regime are complex and will differ across sectors and social groups. Export-oriented industries are likely to experience immediate adjustment costs, including reduced market access and lower profitability. In contrast, industries that compete with imports are not affected and may even benefit from higher effective protection in some cases. This asymmetry calls for compensatory policies that can redistribute the gains from protected sectors to those bearing the brunt of adjustment. Social transfers, labor market programs, and targeted subsidies may all be part of the toolkit needed to ensure that the transition remains politically and socially sustainable.

Political support for adjustment policies is likely to be fragile in the short term, as the costs are immediate and concentrated, while the benefits are longer-term and diffuse. Thus, clear and transparent communication is essential to building trust and legitimacy. Policymakers must explain not only what is being done, but also why it is necessary and how it fits into a longer-term vision for

economic transformation. Compensation mechanisms should be framed not as concessions but as strategic investments in a smoother and more equitable transition.

Finally, the long-term success of any adjustment strategy depends on how it is carried out. Responses to economic pressure must avoid arbitrary impulses or opaque decision-making. Instead, they should be anchored in participatory processes that reflect societal values and priorities. Transparency, accountability, and dialogue will help maintain public support, reduce resistance, and improve the overall effectiveness of policy implementation. By embedding economic adjustment within a participatory framework, countries can ensure that the path they take is not only technically sound but also socially and politically resilient.

ANNEX 1

Formula Used by the Trump Administration in the Calculation of Reciprocal Tariffs¹

Let:

- τ_i : Current U.S. tariff on imports from country i
- $\Delta\tau_i$: Change in tariff needed to achieve trade balance
- $\varepsilon = 4$: Price elasticity of U.S. import demand
- $\varphi = 0.25$: Tariff pass-through to import prices
- m_i : U.S. imports from country i
- x_i : U.S. exports to country i

The bilateral trade balance condition is:

$$x_i = m_i(1 + \Delta\tau_i \cdot \varepsilon \cdot \varphi)$$

Solving for $\Delta\tau_i$:

$$\Delta\tau_i = \frac{x_i/m_i - 1}{\varepsilon \cdot \varphi}$$

This is the formula used in the calculation of reciprocal tariffs. The U.S. administration assumes that $\varepsilon \cdot \varphi = 1$. Notably, the formula is unrelated to actual tariff levels; instead, it is based solely on the U.S. bilateral trade deficit with the country in question. For example, in the case of Vietnam, U.S. imports were \$136.6 billion and U.S. exports were \$13.2 billion in 2024. This yields $\Delta\tau_i = -.9041$. The administration then halves this number for all countries. Consequently, Vietnam's reciprocal tariff was set at 46%. On July 2, 2025, President Trump announced a trade deal with Vietnam under which the tariff rate was reduced to 20% and 40% for transshipped goods.

¹https://ustr.gov/sites/default/files/files/Issue_Areas/Presidential%20Tariff%20Action/Reciprocal%20Tariff%20Calculations.pdf

ANNEX 2

Effects of a Decline in Reciprocal Tariff Intensity (b) with $\tau^* = 0$

Key Relationships

We have the following key relationships:

$$\text{Trade Balance: } NX(t) = \frac{\varepsilon_1 Y_e^{\mu_1} - \varepsilon_2 \bar{A}^{\mu_2} K(t)^{\alpha \mu_2} (1 - \tau^*)}{1 + \varepsilon_1 Y_e^{\mu_1} b}$$

$$\text{Reciprocal Tariff: } \tau(t) = b \cdot NX(t)$$

Assumption: $\tau^* = 0$ (no domestic import tariffs). Therefore, the trade balance simplifies to:

$$NX(t) = \frac{\varepsilon_1 Y_e^{\mu_1} - \varepsilon_2 \bar{A}^{\mu_2} K(t)^{\alpha \mu_2}}{1 + \varepsilon_1 Y_e^{\mu_1} b}$$

Effect of Decline in b on Trade Balance

$$\text{Taking the partial derivative of } \$NX\$ \text{ with respect to } b: \frac{\partial NX}{\partial b} = - \frac{(\varepsilon_1 Y_e^{\mu_1} - \varepsilon_2 \bar{A}^{\mu_2} K^{\alpha \mu_2}) \varepsilon_1 Y_e^{\mu_1}}{(1 + \varepsilon_1 Y_e^{\mu_1} b)^2}$$

- The sign of $\frac{\partial NX}{\partial b}$ depends on whether the country has a trade surplus or deficit:
If $\varepsilon_1 Y_e^{\mu_1} > \varepsilon_2 \bar{A}^{\mu_2} K^{\alpha \mu_2}$ (trade surplus): $\frac{\partial NX}{\partial b} < 0$
- If $\varepsilon_1 Y_e^{\mu_1} < \varepsilon_2 \bar{A}^{\mu_2} K^{\alpha \mu_2}$ (trade deficit): $\frac{\partial NX}{\partial b} > 0$

Therefore, a decline in b :

- Increases trade balance for countries with trade surplus
- Decreases trade balance for countries with trade deficit

Effect on Foreign Tariffs Faced

The foreign tariffs are: $\tau = b \cdot NX$

$$\frac{d\tau}{db} = NX + b \frac{\partial NX}{\partial b}$$

For a decline in b ($db < 0$) :

- Countries with trade surplus: Both NX increases and b decreases, so the net effect on τ depends on magnitudes
- Countries with trade deficit: NX decreases while b decreases, creating offsetting effects

Effect on Steady-State Capital

$$\text{From the steady-state optimality condition with } \tau^* = 0: \alpha \bar{A} K_{ss}^{\alpha-1} + \frac{\varepsilon_2 \bar{A}^{\mu_2} \alpha \mu_2 K_{ss}^{\alpha \mu_2 - 1}}{1 + \varepsilon_1 Y_e^{\mu_1} b} = \delta + \rho$$

Define the left-hand side of the optimality condition as function $F(K_{ss}, b)$:

$$F(K_{ss}, b) = \alpha \bar{A} K_{ss}^{\alpha-1} + \frac{\varepsilon_2 \bar{A}^{\mu_2} \alpha \mu_2 K_{ss}^{\alpha \mu_2 - 1}}{1 + \varepsilon_1 Y_e^{\mu_1} b}$$

In steady state: $F(K_{ss}, b) = \delta + \rho$

Take the partial derivatives of F with respect to K_{ss} and b :

$$\frac{\partial F}{\partial K_{ss}} = \alpha(\alpha - 1)\bar{A} K_{ss}^{\alpha-2} + \frac{\varepsilon_2 \bar{A}^{\mu_2} \alpha \mu_2 (\alpha \mu_2 - 1) K_{ss}^{\alpha \mu_2 - 2}}{1 + \varepsilon_1 Y_e^{\mu_1} b}$$

Since $\alpha < 1$ and $\mu_2 \leq 1$, we have $\alpha - 1 < 0$ and $\alpha \mu_2 - 1 \leq 0$, therefore:

$$\frac{\partial F}{\partial K_{ss}} < 0$$

$$\frac{\partial F}{\partial b} = -\frac{\varepsilon_2 \bar{A}^{\mu_2} \alpha \mu_2 K_{ss}^{\alpha \mu_2 - 1} \varepsilon_1 Y_e^{\mu_1}}{(1 + \varepsilon_1 Y_e^{\mu_1} b)^2} < 0$$

Applying the implicit function theorem to $F(K_s, b) = \delta + \rho$: $\frac{\partial K_{ss}}{\partial b} = -\frac{\partial F / \partial b}{\partial F / \partial K_{ss}} = -\frac{(-)}{(-)} = -\frac{(+)}{(+)} < 0$

Therefore: $\partial K_{ss} / \partial b < 0$, which means a decline in b leads to an increase in steady state capital stock.

Dynamic System Analysis

The complete dynamical system with $\tau^* = 0$ becomes:

$$\text{Consumption Growth: } \frac{\dot{C}(t)}{C(t)} = \frac{1}{\sigma} \left[\alpha \bar{A} K(t)^{\alpha-1} + \frac{\varepsilon_2 \bar{A}^{\mu_2} \alpha \mu_2 K(t)^{\alpha \mu_2 - 1}}{1 + \varepsilon_1 Y_e^{\mu_1} b} - \delta - \rho \right]$$

$$\text{Capital Accumulation: } \dot{K}(t) = \bar{A} K(t)^\alpha - C(t) - \frac{\varepsilon_1 Y_e^{\mu_1} - \varepsilon_2 \bar{A}^{\mu_2} K(t)^{\alpha \mu_2}}{1 + \varepsilon_1 Y_e^{\mu_1} b} - \delta K(t)$$

$$\text{Trade Balance: } NX(t) = \frac{\varepsilon_1 Y_e^{\mu_1} - \varepsilon_2 \bar{A}^{\mu_2} K(t)^{\alpha \mu_2}}{1 + \varepsilon_1 Y_e^{\mu_1} b}$$

$$\text{Foreign Tariff: } \tau(t) = b \cdot NX(t)$$

Dynamic Transition Effects of Decline in b

Phase 1: Immediate Response ($t = 0$)

When b declines at $t = 0$:

- Consumption jump: $\Delta C(0) = C_{\text{new}}(0) - C_{\text{old}}(0)$ The direction depends on the change in the present value of lifetime income.
- Capital unchanged: $K(0)$ remains fixed as physical capital cannot adjust instantly
- Trade balance shift: $\Delta NX(0) = NX_{\text{new}}(0) - NX_{\text{old}}(0) = (\varepsilon_1 Y_e^{\mu_1} - \varepsilon_2 \bar{A}^{\mu_2} K(0)^{\alpha \mu_2}) \left[\frac{1}{1 + \varepsilon_1 Y_e^{\mu_1} b_{\text{new}}} - \frac{1}{1 + \varepsilon_1 Y_e^{\mu_1} b_{\text{old}}} \right]$

Phase 2: Adjustment Process ($0 < t < \infty$)

$$\text{The linearized system around the steady state: } \begin{bmatrix} \dot{k} \\ \dot{c} \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} k \\ c \end{bmatrix}$$

where $k = K - K_{ss}$ and $c = C - C_{ss}$ and:

$$a_{11} = \alpha(\alpha - 1)\bar{A} K_{ss}^{\alpha-2} + \frac{\varepsilon_2 \bar{A}^{\mu_2} \alpha \mu_2 (\alpha \mu_2 - 1) K_{ss}^{\alpha \mu_2 - 2}}{1 + \varepsilon_1 Y_e^{\mu_1} b} - \delta < 0$$

$$a_{12} = -1 < 0$$

$$a_{21} = \frac{C_{ss}}{\sigma} \left[\alpha(\alpha - 1)\bar{A} K_{ss}^{\alpha-2} + \frac{\varepsilon_2 \bar{A}^{\mu_2} \alpha \mu_2 (\alpha \mu_2 - 1) K_{ss}^{\alpha \mu_2 - 2}}{1 + \varepsilon_1 Y_e^{\mu_1} b} \right] < 0$$

$$a_{22} = 0$$

The eigenvalues are: $\lambda_1 = \frac{a_{11} + \sqrt{a_{11}^2 + 4a_{21}}}{2} > 0$ (unstable)

$\lambda_2 = \frac{a_{11} - \sqrt{a_{11}^2 + 4a_{21}}}{2} < 0$ (stable)

Phase 3: New Steady State ($t \rightarrow \infty$)

1. Capital Stock: $K_{ss,new} > K_{ss,old}$ (increase in steady-state capital)
2. Output: $Y_{ss,new} > Y_{ss,old}$ (increase in steady-state output)
3. Trade Balance: $NX_{ss,new} = \frac{\epsilon_1 Y_e^{\mu_1} - \epsilon_2 \bar{A}^{\mu_2} K_{ss,new}^{\alpha \mu_2}}{1 + \epsilon_1 Y_e^{\mu_1} b}$
4. Foreign Tariffs: $\tau_{ss,new} = b_{new} \cdot NX_{ss,new}$

Welfare Analysis

The welfare change from a decline in b can be decomposed as: $\Delta W = \int_0^\infty e^{-\rho t} \left[\frac{C_{new}(t)^{1-\sigma}-1}{1-\sigma} - \frac{C_{old}(t)^{1-\sigma}-1}{1-\sigma} \right] dt$

Short-term Effects

- Consumption: Immediate adjustment based on anticipated path
- Investment: Adjusts based on changed trade dynamics
- Trade: Immediate response through denominator effect in NX

Long-term Effects

- Capital Stock: Increase in steady-state level
- Output: Increase in steady-state level
- Trade Position: Modified equilibrium through changed denominator in trade balance equation

Net Welfare Impact

The welfare effect depends on:

1. Discount rate ρ : Lower ρ increases weight on long-term effects
2. Intertemporal elasticity $1/\sigma$: Higher elasticity leads to smoother consumption adjustment
3. Trade elasticity parameters μ_1, μ_2 : Determine adjustment speed
4. Trade balance dynamics: Changes in trade flows affect consumption path

Conclusion

A decline in reciprocal tariff intensity b creates:

Short-term effects:

- Reduced tariff pressure

- Consumption adjustment (direction depends on parameters)
- Immediate trade balance response

Long-term effects:

- Increase in steady-state capital stock
- Increase in productive capacity
- Modified trade equilibrium through changed trade balance dynamics

2. Consumption smoothing during the transition period

3. Reduced tariff burden on exports

The net welfare effect depends on structural parameters, the economy's initial trade position, and the magnitude of the change in b .

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ABOUT THE AUTHORS



HINH T. DINH

Hinh T. Dinh is a Senior Fellow at the Policy Center for the New South, Morocco and President of Economic Growth and Transformation, LLC., VA, USA. Previously, he spent over 35 years working at the World Bank Group where his last position was Lead Economist in the Office of the Senior Vice President and Chief Economist. He has authored and co-authored books published by the World Bank, Oxford University, and the Policy Center for the New South, and has written articles in professional journals covering public finance, international finance, and industrialization. His latest books include *Tales from the Development Frontier* (2013), *Light Manufacturing in Vietnam* (2013), *Jobs, Industrialization, and Globalization* (2017), *Morocco* (2020), and *COVID-19 and Developing Countries* (2022).



CUONG LE VAN

Cuong Le Van is Professor Emeritus at the Paris School of Economics, Research Director Emeritus at the CNRS, and an affiliated Professor of Economics at IPAG Business School. He previously served as Head of the Centre d'Économie de la Sorbonne and as Scientific Deputy Head of the Institute of Humanities and Social Sciences at the CNRS. In 2003, he was awarded the prestigious CORE Prize. Professor Le Van has held research and teaching positions as a visiting professor at leading universities around the world, including Tilburg University, Universidad Carlos III de Madrid, Université Catholique de Louvain, the University of Alabama, Exeter Business School, the Research Institute for Economics and Business (RIEB) at Kobe University, and Bilkent University.

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Policy Center for the New South

Rabat Campus of Mohammed VI Polytechnic University,
Rocade Rabat Salé - 11103
Email : contact@policycenter.ma
Phone : +212 (0) 537 54 04 04
Fax : +212 (0) 537 71 31 54

www.policycenter.ma

