RESEARCH PAPER

JANUARY 2026

BIG PUSH INDUSTRIALIZATION, GLOBAL VALUE CHAINS, AND THE MIDDLE-INCOME TRAP

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RP - 01/26

This paper revisits Big Push industrialization theory in the context of open economies deeply integrated into global value chains (GVCs). While classical Big Push models emphasize demand complementarities and coordination failures in largely closed economies, many middle-income countries now industrialize through foreign-owned, import-intensive production networks. We develop an extended Big Push framework that incorporates GVC integration and import leakage, and show how these features can prolong the middle-income trap, despite rapid manufacturing expansion. Importantly, the analysis shows that without careful and well-designed industrial policy, large-scale investment programs inspired by Big Push logic may unintentionally reinforce import leakage, rather than generate self-reinforcing domestic demand spillovers. In this case, a Big Push can prolong the middle-income trap and lead to adverse outcomes. We characterize the conditions under which the domestic modern industry is left unviable, derive the critical industrial-policy threshold required to redirect domestic demand toward local production, and establish welfare rankings across alternative development strategies.

Using a panel of ten middle-income economies from 1989 to 2024, we provide empirical evidence consistent with the model's predictions: greater trade openness and higher investment-income payments are associated with systematically larger GDP-GNI wedges, reflecting structural income leakage rather than transitory price effects. Distributed-lag estimates show that investment-income outflows affect the wedge immediately, while trade integration operates with longer lags. The results imply that GVC participation alone does not guarantee national income convergence, and that successful late industrialization requires deliberate policy sequencing to convert export-led growth into domestic value capture.

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1. INTRODUCTION

Resurging interest in industrial policy and structural transformation has revived classic questions about how late-industrializing economies can escape low-income equilibria and sustain productivity-driven growth. The global economic environment confronting today's developing countries differs hugely from that faced by early industrializers, or by the economies studied in the original 'Big Push' literature, which appeared in the mid-twentieth century. Industrialization now proceeds predominantly through global value chains (GVCs), in which production is fragmented across countries, intermediate inputs are heavily imported, and profits are frequently repatriated abroad. Consequently, many middle-income economies have experienced rapid manufacturing expansion and export growth, without the commensurate gains in national income, domestic industrial depth, or upstream capability.

This paper argues that this pattern is no accident. Instead, it reflects a structural tension between GVC-led industrialization and the demand-coordination logic that underpins Big Push theory—a tension that can prolong the middle-income trap rather than resolve it. By revisiting the Big Push framework in an open-economy setting, the paper shows how manufacturing growth driven by foreign-owned, import-intensive production networks, may delay income convergence by weakening the domestic demand spillovers required for sustained indigenous industrialization. In that case, a large-scale investment drive modeled on Big Push principles—if not accompanied by carefully designed industrial policy—risks not resolving coordination failures, thereby prolonging the middle-income trap.

1.1. Big Push Theory and The Open-Economy Tension

The Big Push idea, originating with Rosenstein-Rodan (1943), emphasizes that late industrialization is constrained not by the absence of profitable projects in isolation, but by coordination failures across complementary activities. When firms invest individually, markets remain too small to justify fixed costs. When many firms invest simultaneously, incomes rise, demand expands, and industrialization becomes self-sustaining. Murphy et al (1989) formalized this logic in a general-equilibrium framework with increasing returns, demonstrating how multiple equilibria—a low-industrialization trap and a high-industrialization equilibrium—can arise.

A longstanding question, however, is whether this coordination logic survives in an open economy. If firms can export and consumers can import, does domestic demand coordination still matter? Much of the subsequent literature answered cautiously in the affirmative, emphasizing non-tradable inputs, localized learning, infrastructure complementarities, or agglomeration forces. Yet contemporary GVC-led industrialization has introduced a distinct mechanism that was largely absent from the original Big Push framework: import leakage.

1.2. GVC Integration, Import Leakage, and Prolonged Trap

In many middle-income economies, modern manufacturing is dominated by foreign-owned firms that combine imported intermediates with domestic labor to produce for export markets. These firms often pay wages well above domestic alternatives, raising aggregate purchasing power and generating the appearance of successful industrialization. However, because imports are highly competitive, and industrial policy is weak or absent, this purchasing power frequently flows back into imports rather than into domestically produced intermediates or final goods. Moreover, GVC firms typically enjoy preferential access to imported inputs through special economic zones and duty-drawback schemes, while domestic firms face tariff-inclusive prices, further weakening the link between domestic production and national income.

This paper shows that these features fundamentally alter Big Push dynamics. In contrast to the closed-economy setting of Murphy *et al* (1989), in which higher industrial wages expand domestic demand for other industrial goods, GVC-driven wage growth can generate negative spillovers for domestic industrialization. Higher wages increase demand, but that demand leaks into imports. GVC expansion therefore fails to raise, and may even reduce, the profitability of domestic modern firms. Under plausible conditions, the economy converges to an equilibrium characterized by high manufacturing output, strong export performance, and persistent dependence on imported value added—a configuration that **prolongs the middle-income trap by delaying domestic value capture and income convergence**. In this setting, a Big Push investment program focused narrowly on expanding production capacity can unintentionally amplify import leakage, weaken domestic demand spillovers, and delay convergence, rather than accelerate it.

1.3. Contributions

This paper makes three main contributions.

First, it develops an open-economy extension of Big Push theory that explicitly incorporates GVC integration and import leakage. The framework identifies a novel mechanism through which GVC success can delay rather than dissolve coordination failures in domestic industrialization, offering a theoretical explanation for the coexistence of manufacturing growth and weak national income gains.

Second, the model delivers sharp analytical results. It characterizes a prolonged middle-income-trap equilibrium, derives the critical industrial-policy threshold required to redirect domestic purchasing power toward domestic production, establishes welfare rankings across alternative development strategies, and shows how policy sequencing can leverage GVC-generated demand without entrenching import dependence. An extension with asymmetric import access—reflecting preferential regimes commonly granted to GVC firms—strengthens these results, and highlights the need for coordinated policy instruments.

Third, the paper provides empirical evidence consistent with the model's predictions. Using panel data from 1989 to 2024 for ten middle-income economies, we show that greater trade openness and higher investment-income payments are associated with systematically larger GDP-GNI wedges, reflecting structural income leakage rather than short-run price effects. Distributed-lag estimates show that investment-income outflows affect the wedge almost immediately, while trade integration operates with longer lags, consistent with the gradual maturing of GVC structures. These findings support the view that GVC-led industrialization, in the absence of domestic value-capture policies, can prolong the middle-income trap by slowing the translation of output growth into national income gains.

The analysis implies that industrialization without domestic value capture is not merely a transitional phase, but can constitute a persistent development pattern. GVC participation can raise GDP and manufacturing employment, while delaying the emergence of dense domestic supplier networks and sustained income convergence. Escaping the middle-income trap therefore requires more than openness or export success. It requires deliberate policy sequencing to redirect demand, retain value added, and transform GVC participation into a platform for domestic industrial deepening. A Big Push investment program that does not address these issues may generate adverse long-run outcomes.

The remainder of the paper is organized as follows. Section 2 reviews previous studies on the Big Push. Section 3 presents the theoretical model. Section 4 derives the main results and welfare implications. Section 5 examines trap stability and policy sequencing. Section 6 presents the empirical analysis. Section 7 discusses policy implications, and Section 8 concludes.

2. THE BIG PUSH THEORY

The 'Big Push' idea originates in Paul Rosenstein-Rodan's classic argument that late industrialization is inhibited not primarily by a lack of profitable projects in isolation, but by *coordination failures* across complementary activities. In his 1943 paper on the *"industrialization of Eastern and South-Eastern Europe"*, Rosenstein-Rodan emphasized indivisibilities (lumpy investments), non-appropriable spillovers, and demand complementarities: a modern factory may not be viable if the mass market remains small, but if *many* sectors industrialize together, workers' incomes and intermediate demand expand jointly, making industrial investment profitable at scale.

This early development-economics strand also intersected with mid-twentieth century debates on 'balanced growth' versus 'unbalanced growth', and the role of the state in coordinating complementary investments (Hirschman, 1958). The enduring analytical core, however, is the same: multiple equilibria can arise when private returns to modern investment are below social returns because key complementarities are missing.

But it was not until Murphy *et al* (1989; in full, Murphy, Schleifer, and Vishny, hereafter: MSV) that the Big Push theory was formalized in a general equilibrium setting with imperfect competition and increasing returns. In MSV, the key mechanism is pecuniary externalities through market size: when a firm modernizes, it raises incomes (e.g. via higher wages/productivity), and thereby expands demand for other sectors' goods, but an individual firm cannot capture the full benefit of the economy-wide demand expansion. This creates the possibility that: i) when only a *few* firms industrialize, demand is too low and modern production is unprofitable (a 'bad' equilibrium); and ii) when *many* firms industrialize simultaneously, demand is large enough to make industrialization profitable (a 'good' equilibrium). The Big Push, in MSV, is a coordinated move from the low-industrialization to the high-industrialization equilibrium, often requiring policy coordination, financing, or credible commitment devices.

Two features of MSV became foundational for later work: i) a tractable multi-sector framework for coordination failures and poverty traps; and ii) a policy interpretation: industrial policy, infrastructure, or coordination can be welfare-improving if they resolve the externality and move the economy to the high-output equilibrium.

<u>*Coordination failures as a central paradigm (1990s–2000s):*</u> a major strand of post-MSV work embedded Big Push logic within broader theories of development traps, highlighting how coordination failures can interact with institutions, information frictions, and expectations. Influential syntheses by Hoff and Stiglitz (2001) framed Rosenstein-Rodan/MSV as early examples of a larger class of models in which 'spillovers' and strategic complementarities can sustain inferior equilibria, and well-designed interventions can have *nonlinear* effects.

Rodrik (1996) developed a prominent policy-oriented model of coordination failures, motivated by East Asia and Eastern Europe, strengthening the link between Big Push logic and practical industrial policy questions: when and how can government coordination (or commitment) be growth-enhancing, rather than distortionary?

Rodríguez-Clare (2005) connected coordination failures to clusters and micro-foundations, helping bridge Big Push reasoning with the empirical industrial-cluster literature, and with modern industrial policy discussions centered on coordination between firms, suppliers, and public inputs.

Open economy, tradability, and global integration: a core question in the wake of MSV is whether Big Push reasoning survives in an open economy. If demand can be sourced from abroad, does domestic coordination still matter? One answer is yes: Big Push mechanisms can persist when critical inputs are non-tradable, when learning/technology diffusion is local, or when institutional/infrastructure complementarities are place-based. Skott (1997) explicitly analyzed Big Push logic with non-tradable inputs in an open economy.

Related strands have connected Big Push ideas to economic geography and core-periphery dynamics. Krugman (1991) showed how increasing returns and transport costs can generate agglomeration and multiple equilibria in spatial development—conceptually adjacent to Big Push industrialization, because market size and complementarities create self-reinforcing industrial cores.

Natural resources, booms, and 'catalysts' (or traps): Sachs and Warner (1999) applied Big Push reasoning to economies with natural resources, arguing that resource booms can in principle finance a push into modern sectors, but can also generate dynamics consistent with stagnation, depending on expectations and sectoral interactions. This literature helped connect Big Push ideas to debates on the 'resource curse' and structural change.

Empirics and quantitative modernizations (2010s–2020s): a large empirical literature has tested whether development exhibits poverty-trap nonlinearities. Kraay and McKenzie (2014) reviewed evidence on poverty traps and explicitly discussed Big Push mechanisms among the candidate theoretical channels, emphasizing that while traps may not be universal, they can exist in specific settings in which complementarities and constraints are strong.

Distortions, misallocation, and amplification: more recent work has reconnected Big Push logic with misallocation, distortions, and technology adoption. Buera *et al* (2020) developed a *"Big Push in distorted economies"* framework in which complementarities can generate multiple equilibria or, even absent multiplicity, can amplify the impact of distortions, linking Big Push ideas to modern macro-development concerns about productivity gaps and adoption frictions. A newer quantitative economic geography strand has embedded Big Push dynamics into spatial models to interpret large historical shocks or industrial surges. For instance, recent work on Second World War-related industrial reallocation has modeled 'Big Push dynamics' quantitatively, studying how initial conditions shape long-run regional outcomes.

Empirical evaluation has increasingly used the language of 'Big Push programs' to assess place-based policies and coordinated investment initiatives. For example, Cerrato (2024) studied macro effects of *"big push programs,"* emphasizing that general equilibrium spillovers can meaningfully change aggregate impacts relative to local effects, very much in the spirit of MSV's economy-wide demand spillovers.

Recent applied work has also examined historical industrial policy surges (e.g. Korea's Heavy and Chemical Industry drive) through a Big Push lens, combining sectoral data with modern empirical strategies. Across modern theory and evidence, the Big Push framework is best seen not as a single model, but as a *family* of mechanisms built on strategic complementarities:

- Demand complementarities (MSV): profitability rises with economy-wide industrialization and market size.
- Input and infrastructure complementarities: modern firms require coordinated provision of power, logistics, standards, skills, and supplier ecosystems.
- Learning and technology complementarities: adoption/innovation returns rise with greater local density of adopters and greater capability building.
- Spatial complementarities: agglomeration forces can generate industrial cores and persistent divergence.

In policy terms, the modern view is cautious but not dismissive: Big Push interventions can fail if they mis-target constraints, suffer governance failures, or ignore tradeoffs. But they can succeed when they ease binding complementarities and create credible coordination. The frontier has shifted toward quantification, micro-founded channels (adoption, misallocation, input networks), and general equilibrium evaluation, often asking *"how big is the Big Push?"* rather than debating the concept abstractly.

3. MODEL FRAMEWORK

This section develops a formal model extending the MSV framework (Murphy *et al*, 1989) to incorporate global value chains (GVCs) in open economies with import leakages. The key innovation is demonstrating how GVC integration can paradoxically impede domestic industrialization through a mechanism we term 'import leakage', whereby wages generated in GVC sectors flow to imported goods, rather than stimulating domestic production. Full details of the model including mathematical proofs are provided in the Mathematical Annex.

3.1. Model Setup

3.1.1. Economic Environment

The economy consists of a continuum of sectors q ∈ [0,1], a population of mass L > 0 identical agents, and three production technologies: cottage (C), modern domestic (M), and GVC (G). The economy operates under an open trade regime with import competition and industrial policy instruments.

3.1.2. Technology Specifications

Each technology exhibits distinct characteristics:

Cottage Technology: following MSV, cottage firms operate with constant returns to scale using only labor:

$$x^C(q) = l^C(q), F^C = 0, w^C = 1 \quad (1)$$

Modern Domestic Technology: modern domestic firms operate with increasing returns to scale:

$$x^M(q) = \alpha_M l^M(q) - F_M,\ \text{wage } w_M > 1 \quad (2)$$

where $\alpha_M > 1$ represents the productivity advantage of modern technology, and F_M is the fixed cost in terms of labor requirement.

GVC Technology: GVC firms are foreign-owned with modern technology but different input structure:

$$x^G(q) = \alpha_G z^G(q) - F^G, z^G(q) = [m^G(q)]^{\beta_G}[l^G(q)]^{1-\beta_G} \quad (3)$$

where $\alpha_G > 1, \beta_G \in (0.5,1), m^G(q)$ are imported intermediates, and $w^G > w^M > w^C = 1$.

Key assumptions for GVC sector: i) foreign-owned: all profits repatriated; ii) export-oriented: serves international markets primarily; and iii) import-intensive: relies heavily on imported intermediates.

3.1.3. Import Competition and Leakage

A central innovation of our framework is the import-leakage function, which captures how domestic purchasing power divides between domestic and imported goods:

$$\lambda\left(c^M, c^{im}, \sigma\right) = \frac{(1-\sigma) \cdot \left[c^{im}\right]^{-\epsilon}}{(1-\sigma) \cdot [c^{im}]^{-\epsilon} + [c^M]^{-\epsilon}} \tag{4}$$

where $c^M = \frac{w^M}{\alpha_M}$ is domestic production cost, $c^{im} = \tau \cdot e_t \cdot p^*$ is import cost (with tariff $\tau \geq 1$, exchange rate $e_t > 0$, and world price $p^* > 0$, **σ** ∈ [0,1] is the industrial policy parameter (**σ** = 0 denotes free trade, **σ** = 1 complete protection), and **ε** > 1 is the elasticity of substitution.

The import leakage **λ** represents the share of domestic demand captured by imports. When imports have cost advantages (: $c^{im} < c^M$) and industrial policy is weak (**σ** ≈ 0), **λ** approaches unity, meaning nearly all domestic purchasing power leaks to imports.

3.1.4. Core Assumptions

The model rests on three sets of assumptions that capture stylized features of developing economies integrated into global production networks:

Assumption 1 (Technology and Wage Hierarchy): wages exhibit a strict hierarchy $w^G > w^M > w^C = 1$, reflecting productivity differences and market access. $\alpha_G, \alpha_M > 1$ (modern technologies more productive than cottage), GVC production is import-intensive ($\beta_G \in (0.5,1)$), and both modern technologies incur positive fixed costs, $F^M, F^G > 0$.

Assumption 2 (Open Economy Trade Structure): under free trade, imports enjoy cost advantages ($c^{im} < c^M$ when $\sigma = 0$). GVC firms possess superior export access compared to domestic modern firms ($A_q^G > A_q^M$). Trade costs are finite (**τ** > 1), and domestic and imported goods are close substitutes (**ε** > 1).

Assumption 3 (Market and Policy Conditions): initial industrial policy is minimal ($\boldsymbol{\sigma}_0 \approx 0$). GVC wages contribute to domestic demand (: $\frac{\partial D^{\text{total}}}{\partial L_G} = w^G > 0$). Import leakage responds negatively to industrial policy ($\frac{\partial \lambda}{\partial \sigma} < 0$).

4. Main Results

4.1. The Enhanced Middle-Income Trap

Theorem 1 (Enhanced Middle-Income Trap with Import Leakage). *Under assumptions 1–3, there exists a stable middle-income trap equilibrium characterized by: (i) profitable GVC operation: $q^G > 0$ with $w^G > w^M$; (ii) high domestic purchasing power from GVC wages ($L_G \cdot w^G$); (iii) near-complete import leakage $\lambda(\cdot) \approx 1$ when $\sigma \approx 0$; and (iv) unviable domestic modern sector ($\pi^M < \rho F^M$) due to import competition.*

Mathematical proofs are presented in Annex I. The intuition proceeds as follows. GVC firms, with their established export networks and transfer pricing from multinational headquarters, operate profitably and pay high wages. Total domestic income in the trap equilibrium becomes:

$$Y^{\text{trap}} = L_C \cdot 1 + L_G \cdot w^G = L - L_G + L_G \cdot w^G = L + L_G(w^G - 1)$$

exceeding the cottage equilibrium by $L_G(w^G - 1)$. However, when imports enjoy cost advantages and industrial policy is absent, this purchasing power flows almost entirely to imports: $\boldsymbol{\lambda} \approx 1/(1 + r^{\epsilon}) \approx 1$ when $r = \frac{c^{im}}{c^M} < 1$. Consequently, modern domestic profit reduces to approximately export revenues alone: $\pi^M \approx R^{M,\exp}$. Given domestic firms' limited export capacity relative to GVC firms, these revenues are insufficient to cover fixed costs, rendering entry unprofitable. The equilibrium $(q^M, q^G) = \left(0, q^G_{\max}\right)$ is stable because GVC expansion reinforces import leakage rather than generating positive spillovers for domestic production.

4.2. The Case for Industrial Policy

Theorem 2 (Industrial Policy Necessity). *Under the conditions of theorem 1, industrial policy becomes theoretically necessary for domestic industrialization. There exists a critical threshold $\sigma^* \in (0,1)$ such that:*

$$\pi^M(\sigma^*) = \rho F^M \tag{7}$$

and $\frac{\partial \pi^M}{\partial \sigma} > 0$ for all $\sigma \in [0,1)$.

The proof (Annex I) establishes that modern domestic profits increase monotonically in industrial policy because:

$$\frac{\partial \pi^M}{\partial \sigma} = (p^M - c^M) \cdot D^{total} \cdot \left(-\frac{\partial \lambda}{\partial \sigma}\right) > 0$$

At the boundaries: $\pi^M(0) \approx R^{M,\text{exp}} < \rho F^M$ (free trade makes entry unprofitable), while $\pi^M(1) = (p^M - c^M) \cdot D^{\text{total}} + R^{M,\text{exp}} > \rho F^M$ under reasonable conditions (complete protection makes entry profitable). By the Intermediate Value Theorem, there exists a unique $\sigma^* \in (0,1)$ such that $\pi^M(\sigma^*) = \rho F^M$. This result provides rigorous theoretical grounding for the empirical observation that successful late industrializers have employed strategic industrial policy. The threshold σ^* represents the minimum intervention required to redirect sufficient domestic purchasing power toward domestic production.

4.3. GVC Wage Effects

Proposition 1 (GVC Wage Effect on Import Leakage). *Higher GVC wages increase import leakage through domestic demand effects:*

$$\frac{d\lambda}{dw^G} \cdot \frac{dw^G}{dL_G} > 0 \tag{8}$$

when industrial policy is weak (σ small).

While higher GVC wages boost domestic purchasing power, this translates into higher import volumes, rather than domestic industrial development. Total imports equal $\lambda \cdot [L + L_G(w^G - 1)]$, so even with constant import share **λ**, higher wages increase import volume by $\lambda \cdot L_G$. This creates the paradox at the heart of the middle-income trap: GVC success generates prosperity that simultaneously undermines domestic industrialization.

4.4. Welfare Ranking

Theorem 3 (Welfare Ranking). *The welfare ranking across development strategies is:*

$$W_{\text{full}}(\sigma^{\text{opt}}) > W_{\text{domestic}}(\sigma^{\text{opt}}) > W_{GVC}(\sigma^{\text{opt}}) > W_{GVC}(0) > W_{\text{cottage}} \tag{9}$$

where σ^{opt} is the welfare-maximizing industrial policy level.

This ordering reflects several mechanisms. GVC development without policy dominates cottage production by generating higher *per-capita* income $y_{GVC}(0) = 1 + \frac{L_G(w^G - 1)}{L}, g_{GVC} > 0$. Adding optimal industrial policy improves welfare by redirecting purchasing power domestically. Modern domestic development with policy outperforms GVC development because profits are retained rather than repatriated. Full industrialization capturing both sectors yields the highest welfare through stronger backward linkages and complete market utilization.

4.5. Optimal Policy Sequencing

Corollary 1 (Optimal Policy Sequencing). *The welfare-maximizing development sequence is: (i) allow initial GVC development to generate high wages and domestic demand; (ii) implement industrial policy* $\sigma \geq \sigma^*$ *before import leakage becomes entrenched; (iii) coordinate modern domestic investment to capture redirected domestic demand.*

This sequencing leverages GVC-generated purchasing power while preventing permanent import dependence. Starting with domestic industrialization alone might fail because of insufficient domestic demand; GVC wages create the market necessary for subsequent domestic production. However, policy must be implemented before import patterns become entrenched through consumer habits and distribution networks.

5. Trap Stability

Proposition 2 (Trap Stability Conditions). *The middle-income trap equilibrium is locally stable if and only if:*

$$\frac{\partial \pi^M}{\partial q^G} \cdot \frac{\partial q^G}{\partial \pi^M} < \frac{\partial \pi^M}{\partial q^M} \tag{10}$$

where the left side captures negative spillovers from GVC expansion to domestic modern prospects.

The Jacobian of the dynamic system reveals that $\frac{\partial \pi^M}{\partial q^G} < 0$: more GVC activity increases domestic demand, but this flows to imports, making modern domestic production less viable. This negative cross-effect ensures stability of the trap, contrasting sharply with the positive spillovers in MSV's closed-economy framework.

6. Extension: Asymmetric Import Access (Annex II)

In practice, GVC firms typically enjoy preferential access to imported inputs through special economic zones and duty drawback schemes, while domestic firms face tariff-inclusive prices. This asymmetry strengthens our results *a fortiori*.

Under dual tariffs, under which GVC firms pay world prices ($p_{GVC}^{int} = p_{world}^{int}$) while domestic firms pay tariff-inclusive prices ($p_{\text{domestic}}^{int} = p_{\text{world}}^{int}(1 + \tau^M)$), where $\tau^M > 0$ is the tariff rate on intermediate inputs, the additional unit cost burden for domestic modern firms is approximately $c^{M}_{\text{uniform}} \cdot \beta^{M} \cdot \tau^{M}$. This increases the critical policy threshold to **σ**** > **σ***, making escape from the middle-income trap more difficult.

The dual tariff structure also implies that single-instrument policies are insufficient for welfare maximization. The cross-partial derivative $\frac{\partial^2 W}{\partial \sigma \partial \tau^M} > 0$ indicates policy complementarity: reducing input tariffs increases the effectiveness of production subsidies. Optimal reform therefore requires coordinated adjustment of multiple instruments, with input market liberalization taking priority.

7. TESTABLE PREDICTIONS

The dynamic Big Push model adapted to open, GVC-integrated economies yields four distinctive and testable predictions:

1. GVC import intensity: countries with larger GVC sectors should exhibit higher import-to-GDP ratios, controlling for income levels.
2. Wage-import link: higher GVC wages should correlate positively with import intensity across countries.
3. Policy conditionality: industrial policy should be more effective when GVC wages are high, reflecting stronger GVC-generated domestic demand.
4. GDP-GNI divergence: the GDP-GNI wedge becomes more negative as GVC sector size and import intensity rise, because:
    - GVC firms repatriate profits abroad, while
    - GVC wages generate purchasing power that leaks into imports rather than domestic intermediates, causing divergence between domestic production (GDP) and national income (GNI).

Together, these predictions provide a unified explanation for why many middle-income economies with substantial employment in GVCs experience industrial expansion without commensurate national income capture, a mechanism that can stabilize a middle-income trap and contribute to premature deindustrialization.

Among the four hypotheses, (1) and (4) are most empirically tractable due to available macro balance-of-payments and trade aggregates. The wage-dependent hypotheses (2) and (3) require sector-level wage data, which remain systematically scarce and inconsistent in developing countries. The next section therefore focuses on testing the GVC-imports channel and the GDP-GNI leakage wedge.

8. EMPIRICAL EVIDENCE

8.1. Testing the GVC-Imports Channel

Motivation

GVC participation increases reliance on imported intermediates, capital goods, and tradable services used in export assembly. If the model's leakage channel is valid, then deeper GVC embeddedness should raise import intensity, even after controlling for income and country structure.

Data

A balanced country-year panel from the World Development Indicators (WDI), covering 10 middle-income economies discussed in the 2024 WDR[1] as facing middle-income trap issues, with 360 country-year observations:

- Bangladesh (BGD)
- Brazil (BRA)
- China (CHN)
- India (IND)
- Indonesia (IDN)
- Mexico (MEX)
- Morocco (MAR)
- South Africa (ZAF)
- Türkiye (TUR)
- Vietnam (VNM)

Key variables

- Dependent variable: IMGS/GDP—imports of goods and non-factor services as a share of GDP (%)
- GVC proxy: FDI inflows/GDP (%)
- Income control: log (GDP *per capita*, current USD)
- Country fixed effects: μ_c used to absorb structural differences. These fixed effects capture time-invariant factors such as geography, economic structure, policy regimes, trade infrastructure, and long-run institutional characteristics that jointly shape import intensity.

[1] World Bank. 2024. World Development Report 2024, page 26. The Middle-Income Trap. Washington, DC: World Bank. doi:10.1596/978-1-4648-2078-6. License: Creative Commons Attribution CC BY
3.0 IGO, page 26.

Main specification

$$IMGS/GDP_{c,t} = \alpha + \beta \cdot (FDI/GDP)_{c,t} + \gamma \cdot \log(GDPpc_{c,t}) + \mu_c + \varepsilon_{c,t}$$

Results

Table 1: Main regression results

Variable	Coefficient	Robust SE	p-value	N	R^2
FDI Inf/GDP	0.5833	0.3972	0.1419	360	0.8386
log GDP *per capita*	5.1937	0.5981	0.0000	360	0.8386

Country fixed effects: yes. Year fixed effects: no.

- The coefficient **β** measures the partial association between GVC embeddedness (FDI inflows) and import intensity, assuming a constant income level and netting out persistent country characteristics. A positive **β** is consistent with the hypothesis that deeper GVC integration requires greater imported input content.
- Income level remains a strong and highly significant predictor of import intensity.
- Removing country structure in the pooled model (available upon request) reduces R^2 sharply (to.2412), confirming that cross-country structural differences dominate import-share levels, and must be absorbed to isolate within-country GVC effects.

CONCLUSION

Within-country variation supports the model's prediction that GVC embeddedness increases import intensity, but most explanatory power comes from structural country features and income, not FDI alone.

8.2. Testing the GDP-GNI Leakage Wedge

Concept and identification strategy
The dependent variable is the GDP-GNI wedge, defined exactly as in the theoretical model:

$$Wedge_{c,t} = \frac{GDP - GNI}{GDP}$$

A larger wedge indicates larger foreign factor-income claims on domestic output, consistent with enclave-style production equilibria.

Our baseline specification is:

$$Wedge_{it} = \alpha_i + \gamma_t + \beta_1 openness_{it} + \beta_2 inv.paym._{it} + \varepsilon_{it},$$

where:

- i indexes country and t indexes year,
- $\alpha_i$are **country fixed effects**, absorbing all structural determinants that are constant over time within a country (institutions, geography, industrial structure, export composition, etc.)
- $\gamma_t$are **year fixed effects**, capturing global shocks common to all countries in a given year (commodity cycles, global financial conditions, pandemics, monetary tightening episodes, and trade regime shifts)
- trade openness = trade/GDP (trade openness is measured as total exports and imports of goods and non-factor services expressed as a share of GDP)
- investment-income payments/GDP = primary income outflows (fraction)
- Interaction trade × investment-income to capture overlapping leakage channels.

The last three regressors are constructed from WDI current USD aggregates.

8.2.1. Data Overview

Panel structure: the dataset consists of 360 country-year observations spanning 10 emerging market economies from 1989 to 2024 (36 years).

Countries included: Bangladesh (BGD), Brazil (BRA), China (CHN), India (IND), Indonesia (IDN), Mexico (MEX), Morocco (MAR), South Africa (ZAF), Turkey (TUR), and Vietnam (VNM).

Variable definitions:

- Wedge: (GDP-GNI)/GDP; a positive wedge indicates net factor income outflows (GDP > GNI); a negative wedge indicates net factor income inflows.
- Trade openness: (Exports + Imports)/GDP. Higher values indicate greater integration with global trade.
- Investment payment: investment income payment/GDP. Represents returns paid to foreign investors as a share of GDP.

Table 2: Descriptive Statistics

Statistic	Wedge	Inv. Payment	Trade Openness
Mean	0.0137	0.0154	0.5291
Std. Dev.	0.0243	0.0169	0.3063
Min	-0.0846	-0.0013	0.1439
Max	0.0762	0.1058	1.8668

8.2.2. Regression Results

All models include country and year fixed effects, with clustered standard errors at the country level. The dependent variable in all models is the wedge.

Table 3: Panel Regression Results

Variable	Model A	Model B	Model C	Model D
Trade Openness	0.0268***	—	0.0231	0.0249
Std. Err.)	(0.0067)	—	(0.0141)	(0.0176)
Investment Payment	—	0.4133**	0.2856	0.3820
(Std. Err.)	—	(0.2042)	(0.2171)	(0.4865)
Interaction (TO × IP)	—	—	—	-0.1367
(Std. Err.)	—	—	—	(0.4792)
Fixed Effects				
Country	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Model Statistics				
Observations	360	353	353	353
R^2 (Between)	0.414	0.240	0.471	0.463
R^2 (Overall)	0.340	0.222	0.389	0.381

*Notes: Clustered standard errors at country level in parentheses. *** p<0.01, ** p<0.05, * p<0.10.*

Table 4: P-Values

Variable	Model A	Model B	Model C	Model D
Trade Openness	0.0001	—	0.1041	0.1584
Investment Payment	—	0.0438	0.1892	0.4330
Interaction	—	—	—	0.7757

Technical Notes

Estimation method: panel OLS with two-way fixed effects (entity and time).

Standard errors: clustered at the country level to account for potential heteroskedasticity and serial correlation within countries.

Sample: 10 emerging market economies, 1989-2024, yielding 360 country-year observations (353 for models with Investment Payment due to missing data).

Software: Python 3 with linear models' package for panel regression estimation.

8.2.3. Interpretation of Results

Model A: Trade Openness Only

Trade openness has a highly statistically significant positive effect on the wedge (coefficient = 0.0268, $p = 0.0001$). This suggests that a 10-percentage point increase in trade openness is associated with a 0.27 percentage point increase in the wedge (i.e. more GDP relative to GNI, indicating greater net factor income outflows).

Economic interpretation: countries that are more integrated into global trade tend to have larger gaps between what is produced domestically (GDP) and what accrues to domestic residents (GNI). This is consistent with the hypothesis that greater trade openness—particularly through GVC participation—is associated with more foreign-owned production, which leads to profits and investment returns flowing abroad. The between-R^2 of 0.41 indicates that trade openness explains substantial cross-country variation in the wedge. Note that the overall R^2 of .41. excludes dummy mechanics and reflects fit on raw y. Including all FE dummy variance, the R^2 would rise to .85 and this is true for all the models.

Model B: Investment Payment Only

Investment payment shows a statistically significant positive effect on the wedge (coefficient = 0.4133, $p = 0.0438$). A 1 percentage point increase in investment payments (as a share of GDP) is associated with a 0.41 percentage point increase in the wedge.

Economic interpretation: higher investment income payments to foreigners directly increase the gap between GDP and GNI, as expected. The positive within-R^2 of 0.073 indicates that changes in investment payments within countries over time do help explain changes in the wedge. This confirms that countries paying more returns to foreign investors experience greater differences between domestic production and national income.

Model C: Both Variables

When both variables are included, neither achieves conventional statistical significance. Trade openness coefficient drops to 0.0231 ($p = 0.1041$) and investment payment to 0.2856 (p =

0.1892). However, the combined model achieves the highest between-R^2 (0.471) and overall-R^2 (0.389).

Economic interpretation: the loss of individual significance when both variables are included suggests multicollinearity—trade openness and investment payments are correlated. Countries that are more open to trade also tend to have higher foreign investment and thus higher investment payments. While each variable alone is significant, their shared variance means neither is significant when controlling for the other. Importantly, the overall explanatory power improves, suggesting both channels matter in explaining the wedge.

Model D: With Interaction Effect

The interaction term (trade openness × investment payment) is not statistically significant (coefficient = -0.1367, $p = 0.7757$). The inclusion of the interaction does not improve model fit compared to Model C.

Economic interpretation: there is no evidence that the effect of trade openness on the wedge varies with the level of investment payments, or vice versa. The relationship between these variables and the wedge appears to be additive rather than multiplicative. The negative (though insignificant) interaction coefficient would suggest, if anything, that the combined effect is slightly less than the sum of individual effects.

8.2.4. Key Findings and Conclusions

1. Both channels matter independently: When estimated separately (Models A and B), both trade openness ($p = 0.0001$) and investment payments ($p = 0.044$) significantly predict the wedge. This supports the theoretical framework that both GVC participation and foreign investment returns contribute to the gap between GDP and GNI.

2. Multicollinearity when combined: When both variables are included (Model C), neither is individually significant, suggesting they share explanatory variance. This is economically intuitive: countries that are more open to trade also tend to attract more foreign investment. The correlation between these variables makes it difficult to isolate their individual effects.

3. Trade openness has the stronger effect: Model A achieves strong significance ($p = 0.0001$) with a between-R^2 of 0.41, while Model B is marginally significant ($p = 0.044$) with a between-R^2 of 0.24. Trade openness appears to be the more important determinant of cross-country differences in the wedge.

4. No interaction effect: The effect of trade openness on the wedge does not depend on the level of investment payments. The relationship is additive, not multiplicative.

5. Cross-sectional vs. within variation: The high between-R^2 values (0.24-0.47) compared to lower within-R^2 values (-0.06 to 0.07) indicate that these variables better explain differences across countries than changes within countries over time. The wedge appears to be largely a structural feature driven by country-specific integration into the global economy.

8.2.5. Distributed Lag Analysis

To further investigate the effects of past policies on the GDP-GNI wedge, we employ a distributed lag structure to examine how trade openness and investment payments influence the wedge over three years (the contemporaneous year plus two lags), and compare these results with a five-year lag period. The five-year specification allows us to test whether the effects persist beyond three years, and whether additional lags reveal new dynamics. Annex III reports detailed results.

The primary finding of this analysis is that investment payments exert a much more immediate impact on the wedge than trade openness. Both the contemporaneous term and the one-year lag for investment payments are statistically significant, with a cumulative long-run multiplier of approximately 0.41 (Annex III). This indicates that income outflows affect national accounts almost immediately, and continue into the subsequent year. Interestingly, this pattern suggests the onset of an adjustment process, as the second-year lag for investment payments is negative, although not yet statistically significant across all specifications.

In contrast, the effects of trade openness are delayed significantly. In the three-year lag specification, the contemporaneous effect is negligible, and statistical significance emerges only at the one- or two-year lag. This delay reflects the real-world time required for foreign firms to establish operations and adjust supply chains, and for profit-repatriation patterns to stabilize. Despite this lagged response, the long-run multiplier for trade openness remains stable at approximately 0.032, consistent with results from simpler static models. Overall, the three-year lag model shows that investment payments drive immediate movements in the wedge, while trade integration operates as a slower, cumulative force.

We next compare the baseline three-year lag structure with an extended five-year period (t through t–4). Although the longer period reduces the number of observations, it provides a richer picture of within-country adjustment processes.

The extended five-year model (Annex III) yields several insights that are absent or only partially captured in the three-year specification:

- **Mean Reversion in Investment Payments:** the five-year model confirms a strong mean-reversion effect. A highly significant negative coefficient emerges at the three-year lag (t–3), indicating that countries eventually adjust to elevated income outflows. This adjustment reduces the long-run multiplier for investment payments by roughly 25% relative to the three-year model.
- **Oscillating Trade Dynamics:** although the total long-run effect of trade openness remains robust and stable at approximately 0.032, the five-year model shows that the adjustment path is not monotonic. Instead, it follows an oscillatory pattern, with positive effects at years two and four, and a significant negative effect at year three, suggesting cyclical adjustment dynamics.
- **Delayed Interaction Effects:** the five-year specification uncovers a significant negative interaction between trade openness and investment payments at the four-

year lag (t–4). This implies that, over longer horizons, the combined effect of high trade integration and high investment income outflows is less than additive, possibly reflecting long-term structural adjustments or policy responses.

- **Stability of the Trade Effect:** the long-run effect of trade openness (≈0.032) is virtually identical across both lag structures, confirming this relationship as a stable structural feature of the data.

9. Policy Implications: From Export Enclaves to Domestic Value Capture

The empirical results validate the paper's core message: while GVC participation can boost industrial output and accelerate manufacturing expansion, it does not by itself ensure national income capture. Absent deliberate and well-designed industrial policy, the gains from industrial expansion are easily dissipated through import leakage and repatriation of profits to foreign jurisdictions. In such circumstances, even large-scale investment programs inspired by Big-Push logic may fail to generate self-reinforcing domestic demand spillovers. Instead, they prolong the middle-income trap.

Crucially, the results imply that industrialization without domestic value capture is not merely an incomplete transition, but can generate unintended adverse consequences. When upstream domestic supplier networks remain thin and import dependence is high, rising wages and investment associated with GVC-led expansion translate into higher imports rather than stronger domestic production linkages. National income growth lags behind output growth, and the GDP-GNI wedge widens. Under these conditions, a Big Push investment drive—if focused narrowly on expanding production capacity or attracting foreign investors—risks amplifying income leakage rather than resolving coordination failures.

The evidence further shows that leakage is structural rather than dimensional. Similar GDP-GNI wedges appear across China, Brazil, Mexico, South Africa, Morocco, Bangladesh, and Türkiye, despite vast differences in economic size and income levels. Manufacturing expansion does not automatically translate into welfare gains. High trade openness can coexist with weak income retention when domestic upstream capacity is insufficient. GVC integration may support GDP growth, job creation, and rising manufacturing shares, but it can also scale foreign factor-income claims faster than domestic value added, thereby weakening the very demand complementarities on which Big-Push industrialization relies.

These findings lead to a critical qualification of the Big Push policy narrative in open economies. Without careful design, sequencing, and complementary instruments, a Big Push investment strategy can entrench enclave-style production and delay convergence, rather than accelerate it. Industrial policy is therefore not optional but fundamental: it must actively redirect domestic demand toward domestic production, foster local supplier development, retain intermediate value added, and encourage profit reinvestment at home. Policies that merely expand production or exports, without addressing import dependence and ownership structure, are unlikely to succeed.

Transition Requirement

Escaping the middle-income trap requires a transition from GVC assembly enclaves that import value, to income-retentive production networks that industrialize domestically. This transition hinges on strategic policy sequencing. GVC participation can serve as a stepping stone when institutional capacity is strong and policies are deployed to build domestic linkages. Conversely, when domestic supplier networks remain underdeveloped, GVC integration—and especially a poorly designed Big Push investment program—can act as a trap-prolonging mechanism.

Taken together, the econometric evidence supports the structural predictions of the extended Dynamic Big Push/GVC model. Middle-income economies more deeply integrated into global trade exhibit systematically larger GDP-GNI wedges not because of country size, but because foreign-owned production networks scale foreign factor-income claims faster than domestic upstream suppliers and profit retention can expand. Trade openness alone raises industrial output, but without simultaneous domestic supplier scaling and value retention, it magnifies income leakage into imports, while outward investment-income payments amplify the wedge as a transmission margin of that leakage. The central policy implication is therefore clear: Big Push strategies must be paired with coherent, well-targeted industrial policy to avoid prolonging the middle-income trap, and to convert industrial expansion into sustained national income growth.

10. Limitations

This paper advances a theoretical and empirical framework linking Big Push industrialization, GVCs, and import leakage in open middle-income economies. While the analysis yields clear insights, it is subject to theoretical and empirical limitations that warrant careful interpretation of the results, and which also point to avenues for future research.

Theoretical Limitations

First, the model abstracts from firm heterogeneity and endogenous entry dynamics within both the domestic modern sector and GVC activities. Firms are treated as representative within each production mode, which allows for analytical tractability but limits the ability to capture gradual upgrading, partial localization of inputs, or firm-level learning-by-doing processes. In practice, some domestic firms may reduce import dependence progressively, even in the absence of formal industrial policy, while others may remain permanently import-intensive. Incorporating firm-level heterogeneity could enrich the dynamics of transition, but would complicate the characterization of equilibrium and policy thresholds.

Second, the model focuses on import leakage as the central channel through which GVC-led industrialization weakens domestic demand spillovers. While this mechanism is empirically relevant and theoretically disciplined, it deliberately abstracts from other channels that may also affect income convergence, such as endogenous technological upgrading, skill accumulation, or financial constraints. The framework therefore emphasizes a necessary, not exhaustive, explanation of prolonged middle-income traps in open economies.

Third, industrial policy is modeled in a reduced-form manner as a parameter that redirects domestic demand toward domestic production by altering relative prices. This captures the essence of policy intervention, but abstracts from political economy constraints, implementation capacity, and policy misallocation. In reality, industrial policy effectiveness depends on governance, institutional quality, and coordination across multiple instruments. As a result, the model should not be interpreted as advocating generic protection or blanket intervention, but rather as highlighting the conditions under which policy coherence is necessary to overcome import leakage.

Finally, the model is static or quasi-static in its core formulation. While it characterizes stable equilibria and comparative statics clearly, it does not explicitly model transitional dynamics, adjustment costs, or expectation formation. These omissions limit the model's ability to describe short-run adjustment paths following policy changes, even though they do not undermine its long-run structural predictions.

Empirical Limitations

On the empirical side, the analysis relies on macroeconomic aggregates from national accounts, balance-of-payments statistics, and trade data. More precise GVC measures derived from input-output tables (e.g. Trade in Value Added (TiVA)) are updated too infrequently to support panel estimation over long horizons. Consequently, the empirical strategy focuses on structural correlations and within-country variation over time, rather than high-frequency adjustment dynamics.

Second, the wedge variable—defined as (GDP-GNI)/GDP—captures net factor income flows but does not distinguish between different types of foreign investment returns, such as portfolio investment income versus foreign direct investment profits. These components may have different implications for domestic economic development, and might respond differently to trade integration. Similarly, the trade-openness measure aggregates exports and imports without differentiating between GVC-intensive manufacturing trade and traditional commodity exports, potentially obscuring heterogeneous effects across trade types and sectoral compositions.

Finally, although the panel includes a diverse set of middle-income economies over a long period, the results should not be interpreted as causal in a narrow econometric sense. While the two-way fixed effects specification controls for time-invariant country characteristics and common year shocks, potential endogeneity concerns remain. Trade openness and investment payments are likely jointly determined with economic growth and structural transformation, raising questions about causal interpretation. Countries that attract more foreign investment may simultaneously pursue trade-liberalization policies, making it difficult to isolate independent effects. The distributed lag approach captures dynamic adjustments but does not fully address reverse causality or omitted variable bias from time-varying confounders, such as exchange rate movements, commodity price cycles, or shifts in domestic industrial policy.

Taken together, these limitations suggest that the paper's findings should be read as highlighting robust structural mechanisms, rather than providing a complete account of development dynamics. Future work combining firm-level data, richer GVC measures, and instrumental variable approaches would help further finetune and extend the framework developed here.

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ANNEX I

This annex provides complete mathematical foundations for the main paper, including all definitions, assumptions, propositions, theorems, and their rigorous proofs. The analysis extends the Murphy *et al* (1989; MSV) framework to incorporate global value chains (GVC) in open economies with import leakages, demonstrating how industrialization can be affected by GVC, the Big Push, imports, and the existence of multiple equilibria including a middle-income trap.

1. Model Foundations and Definitions

Definition 1.1 (Economic Environment). The economy consists of:

1. Time: $t \in [0, \infty)$, continuous
2. Population: Mass $L > 0$ of identical agents
3. Sectors: Continuum $q \in [0,1]$
4. Technologies: $\mathcal{T} = \{C, M, G\}$ where $C =$ Cottage, $M =$ Modern Domestic, $G = \text{GVC}$
5. Trade regime: Open economy with import competition and industrial policy instruments

Definition 1.2 (Technology Specifications). For each sector q and technology $i \in \mathcal{T}$:

Cottage Technology:

$$x^C(q) = l^C(q), F^C = 0, w^C = 1 \tag{1}$$

Modern Domestic Technology:

$$x^M(q) = \alpha_M l^M(q) - F^M, \alpha_M > 1, w^M > 1 \tag{2}$$

GVC Technology:

$$x^G(q) = \alpha_G z^G(q) - F^G, z^G(q) = [m^G(q)]^{\beta_G}[l^G(q)]^{1-\beta_G} \tag{3}$$

where $\alpha_G > 1, \beta_G \in (0.5,1), m^G(q)$ are imported intermediates, and $w^G > w^M > w^C = 1$.

Definition 1.3 (Import Competition and Industrial Policy).

1. Domestic Modern production cost: $c^M = \frac{w^M}{\alpha_M}$
2. Import cost: $c^{im} = \tau \cdot e_t \cdot p^*$ where $\tau \geq 1, e_t > 0, p^* > 0$
3. Industrial policy parameter: $\sigma \in [0,1]$ where $\sigma = 0$ is free trade, $\sigma = 1$ is complete protection
4. Import leakage function:

$$\lambda(c^M, c^{im}, \sigma) = \frac{(1-\sigma) \cdot [c^{im}]^{-\epsilon}}{(1-\sigma) \cdot [c^{im}]^{-\epsilon} + [c^M]^{-\epsilon}} \tag{4}$$

where $\epsilon > 1$ is the elasticity of substitution.

Note that in this framework, modern domestic firms are assumed to operate under the same import regime as GVCs. In reality, however, firms in most developing countries typically encounter higher tariffs on imported inputs because of the preferential incentives extended to GVCs. Under such circumstances, the conclusions derived herein apply *a fortiori* (see the Section on Dual Tariff Model with Asymmetric Import Access below).

Definition 1.4 (Profit Functions). Modern Domestic Profit:

$$\pi^M(q,t) = (p^M - c^M) \cdot [1 - \lambda(\cdot)] \cdot D^{total}(q,t) + R^{M,\exp} \tag{5}$$

where $D^{\text{total}}(q,t) = L_C \cdot 1 + L_M \cdot w^M + L_G \cdot w^G$ and $R^{M,\exp}$ are limited export revenues.

GVC Profit (USD terms):

$$\pi^G(q,t) = p^{USD} \cdot x^G - c^{im} \cdot m^G - \frac{w^G \cdot l^G + F^G}{e_t} \tag{6}$$

2 Fundamental Assumptions

Assumption 2.1 (Technology and Wage Hierarchy).

1. $w^G > w^M > w^C = 1$ (wage hierarchy reflecting productivity and market access)
2. $\alpha_G, \alpha_M > 1$ (modern technologies more productive than cottage)
3. $\beta_G \in (0.5, 1)$ (GVC sectors are import-intensive)
4. $F^M, F^G > 0$ (positive fixed costs for modern technologies)

Assumption 2.2 (Open Economy Trade Structure).

1. Import cost advantage: $c^{im} < c^M$ when $\sigma = 0$ (free trade)
2. Export advantages: $A_q^G > A_q^M$ (GVC firms have better export access)
3. Trade costs: $\tau > 1$ finite
4. High substitutability: $\epsilon > 1$ (domestic and imported goods are close substitutes)

Assumption 2.3 (Market and Policy Conditions).

1. Initial policy: $\sigma_0 \approx 0$ (minimal industrial policy initially)
2. GVC wages create domestic demand: $\frac{\partial D^{\text{total}}}{\partial L_G} = w^G > 0$
3. Import leakage sensitivity: $\frac{\partial \lambda}{\partial \sigma} < 0$

3 Main Results

Theorem 3.1 (Enhanced Middle-Income Trap with Import Leakage). Under Assumptions 2.1-2.3, there exists a stable middle-income trap equilibrium where:

1. GVC sector operates profitably: $q^G > 0$ with $w^G > w^M$
2. High domestic purchasing power: $L_G \cdot w^G$ creates strong domestic demand
3. Import leakage dominates: $\lambda(\cdot) \approx 1$ when $\sigma \approx 0$
4. Modern Domestic remains unviable: $\pi^M < \rho F^M$ due to import competition

Proof. We prove existence and stability of the trap equilibrium through four parts:

Part I: GVC Profitability

From equation (6), GVC profit in USD terms is:

$$\pi^G = p^{USD} \cdot x^G - c^{im} \cdot m^G - \frac{w^G \cdot l^G + F^G}{e_t}$$

For given transfer price p^{USD} set by multinational headquarters and production function $x^G = \alpha_G [m^G]^{\beta_G} [l^G]^{1-\beta_G} - F^G$, GVC firms choose optimal input mix by:

$$\min_{l^G, m^G} \left\{ c^{im} \cdot m^G + \frac{w^G \cdot l^G}{e_t} \right\}$$

subject to: $\alpha_G [m^G]^{\beta_G} [l^G]^{1-\beta_G} = x^G + F^G$
First-order conditions yield:

$$\frac{w^G / e_t}{c^{im}} = \frac{(1-\beta_G) m^G}{\beta_G l^G}$$

This gives optimal input ratio. Since p^{USD} is set to ensure profitability and GVC firms have established export networks (Assumption 2.2), we have $\pi^G > 0$.

The wage hierarchy $w^G > w^M > 1$ emerges because GVC firms have higher productivity (α_G) and access to international markets, allowing them to pay higher wages while remaining profitable.

Part II: Domestic Purchasing Power Generation

When GVC sector operates with employment $L_G > 0$, total domestic income becomes:

$$Y^{\text{total}} = L_C \cdot 1 + L_M \cdot w^M + L_G \cdot w^G$$

In the trap equilibrium where $q^M = 0$ (no Modern Domestic), we have $L_M = 0$, so:

$$Y^{\text{trap}} = L_C \cdot 1 + L_G \cdot w^G = L - L_G + L_G \cdot w^G = L + L_G (w^G - 1)$$

Since $w^G > 1$, GVC operation increases total domestic purchasing power by:

$$\Delta Y = L_G(w^G - 1) > 0$$

This creates strong domestic demand for manufactures: $D^{\text{total}} = Y^{\text{trap}} = L + L_G(w^G - 1)$.

Part III: Import Leakage Dominance

From the import leakage function (4):

$$\lambda = \frac{(1-\sigma)\cdot [c^{im}]^{-\epsilon}}{(1-\sigma)\cdot [c^{im}]^{-\epsilon} + [c^M]^{-\epsilon}}$$

Under Assumption 2.2, $c^{im} < c^M$, and under Assumption 2.3, $\sigma \approx 0$ initially.
Let $r = \frac{c^{im}}{c^M} < 1$. Then:

$$\lambda = \frac{(1-\sigma)\cdot r^{-\epsilon}}{(1-\sigma)\cdot r^{-\epsilon} + 1}$$

Taking the limit as $\sigma \to 0$:

$$\lim_{\sigma\to 0}\lambda = \frac{r^{-\epsilon}}{r^{-\epsilon}+1} = \frac{1}{1+r^{\epsilon}}$$

Since $r < 1$ and $\epsilon > 1$, we have $r^\epsilon < r < 1$. For realistic parameter values where imports have significant cost advantages, r^ϵ becomes very small, making $\lambda \approx \frac{1}{1+\text{ small number}} \approx 1$.

Part IV: Modern Domestic Unviability

From equation (5), Modern Domestic profit is:

$$\pi^M = (p^M - c^M)\cdot [1-\lambda]\cdot D^{total} + R^{M,\text{exp}}$$

For entry to be profitable, we need: $\pi^M \geq \rho F^M$.
Substituting values from Parts II and III:

$$\pi^M = (p^M - c^M)\cdot [1-\lambda]\cdot [L + L_G(w^G - 1)] + R^{M,\text{exp}}$$

Since $\lambda \approx 1$, we have $[1-\lambda] \approx 0$, so:

$$\pi^M \approx R^{M,\text{exp}}$$

Given that Modern Domestic firms have limited export capacity compared to GVC firms (Assumption 2.2: $A_q^M < A_q^G$), export revenues alone are insufficient:

$$R^{M,\text{exp}} < \rho F^M$$

Therefore: $\pi^M < \rho F^M$, making Modern Domestic entry unprofitable.

Part V: Equilibrium Stability

The trap equilibrium $(q^C, q^M, q^G) = (1 - q^G, 0, q^G)$ with $q^G > 0$ is stable because:

1. GVC expansion increases import leakage: $\frac{\partial \lambda}{\partial L_G} > 0$ since higher GVC employment increases domestic demand, but this demand flows to imports due to cost advantages.
2. Self-reinforcing mechanism: More GVC activity → Higher domestic demand → More imports → Less incentive for domestic modern production.
3. No spillover development: Unlike MSV's domestic spillovers, GVC-import leakage creates negative spillovers for potential domestic modern sectors.

The dynamic system:

$$\frac{dq^M}{dt} = \lambda_M \max\{0, \pi^M - \rho F^M\} = 0$$

$$\frac{dq^G}{dt} = \lambda_G \max\{0, \pi^G - \rho F^G\} > 0 \text{ until capacity constraints}$$

This confirms $(q^M, q^G) = \left(0, q^G_{\max}\right)$ as a stable equilibrium. This condition holds even if q^M is positive, as long as it is not sufficiently large to meet the fixed cost.

Theorem 3.2 (Industrial Policy Necessity). Under the conditions of Theorem 3.1, industrial policy becomes theoretically necessary for domestic industrialization. There exists a critical threshold $\sigma^* \in (0,1)$ such that:

$$\pi^M(\sigma^*) = \rho F^M \tag{7}$$

and $\frac{\partial \pi^M}{\partial \sigma} > 0$ for all $\sigma \in [0,1)$.
Proof. We prove both the existence of σ^* and the monotonicity of π^M in σ.

Monotonicity of Profits in Industrial Policy

From equation (5):

$$\pi^M(\sigma) = (p^M - c^M) \cdot [1 - \lambda(\sigma)] \cdot D^{total} + R^{M,exp}$$

Taking the partial derivative with respect to σ :

$$\frac{\partial \pi^M}{\partial \sigma} = (p^M - c^M) \cdot D^{total} \cdot \left(-\frac{\partial \lambda}{\partial \sigma}\right)$$

From equation (4):

$$\frac{\partial \lambda}{\partial \sigma} = \frac{\partial}{\partial \sigma}\left[\frac{(1-\sigma) \cdot \left[c^{im}\right]^{-\epsilon}}{(1-\sigma) \cdot [c^{im}]^{-\epsilon} + [c^M]^{-\epsilon}}\right]$$

Using quotient rule:

$$\frac{\partial \lambda}{\partial \sigma} = \frac{-\left[c^{im}\right]^{-\epsilon} \cdot [c^M]^{-\epsilon}}{[(1-\sigma) \cdot [c^{im}]^{-\epsilon} + [c^M]^{-\epsilon}]^2} < 0$$

Since $c^{im}, c^M > 0$ and $\epsilon > 1$, the numerator is negative and denominator is positive. Therefore: $\frac{\partial \lambda}{\partial \sigma} < 0$, which implies $\frac{\partial \pi^M}{\partial \sigma} > 0$ (assuming $p^M > c^M$ and $D^{\text{total}} > 0$).

Boundary Conditions

At $\sigma = 0$ (free trade):

$$\pi^M(0) = (p^M - c^M) \cdot [1 - \lambda(0)] \cdot D^{\text{total}} + R^{M,\exp}$$

From Theorem 3.1, $\lambda(0) \approx 1$, so $\pi^M(0) \approx R^{M,\text{exp}} < \rho F^M$.
At $\sigma = 1$ (complete protection):

$$\lambda(1) = \frac{0 \cdot \left[c^{im}\right]^{-\epsilon}}{0 \cdot [c^{im}]^{-\epsilon} + [c^M]^{-\epsilon}} = 0$$

So: $\pi^M(1) = (p^M - c^M) \cdot D^{\text{total}} + R^{M,\text{exp}}$
If domestic demand is sufficiently large relative to fixed costs:

$$\frac{(p^M - c^M) \cdot D^{\text{total}} + R^{M,\text{exp}}}{\rho} > F^M$$

then $\pi^M(1) > \rho F^M$.

Existence of Critical Threshold

Since: $\pi^M(\sigma)$ is continuous in σ; $\frac{\partial \pi^M}{\partial \sigma} > 0$ (strictly increasing); and $\pi^M(0) < \rho F^M$ and $\pi^M(1) > \rho F^M$ (under reasonable conditions)

By the Intermediate Value Theorem, there exists a unique $\sigma^* \in (0,1)$ such that:

$$\pi^M(\sigma^*) = \rho F^M$$

This σ^* represents the minimum industrial policy required to make Modern Domestic investment profitable. This is the Big Push argument.

Policy Necessity

The theorem demonstrates that without industrial policy ($\sigma = 0$), Modern Domestic industrialization cannot occur due to import competition, despite potentially strong domestic demand from GVC wages. Policy intervention becomes theoretically necessary to redirect domestic purchasing power toward domestic production.

Proposition 3.3 (GVC Wage Effect on Import Leakage). Higher GVC wages increase import leakage through domestic demand effects:

$$\frac{d\lambda}{dw^G} \cdot \frac{dw^G}{dL_G} > 0 \tag{8}$$

when industrial policy is weak (σ small).

Proof. The import leakage rate depends on total domestic demand through the total manufacturing demand D^{total} :

$$D^{\text{total}} = L_C + L_M w^M + L_G w^G$$

In the trap equilibrium with $L_M = 0$:

$$D^{\text{total}} = (L - L_G) + L_G w^G = L + L_G(w^G - 1)$$

The import leakage function can be written as:

$$\lambda = \lambda(c^M, c^{im}, \sigma, D^{total})$$

While λ doesn't directly depend on D^{total} in equation (4), higher domestic demand increases the absolute volume of imports even when the import share λ remains constant.

More precisely, total imports are:

$$M^{\text{total}} = \lambda \cdot D^{\text{total}} = \lambda \cdot [L + L_G(w^G - 1)]$$

Taking derivatives:

$$\frac{dM^{total}}{dw^G} = \frac{\partial M^{total}}{\partial \lambda} \cdot \frac{\partial \lambda}{\partial w^G} + \frac{\partial M^{total}}{\partial D^{total}} \cdot \frac{\partial D^{total}}{\partial w^G}$$

The second term is: $\frac{\partial M^{\text{total}}}{\partial D^{\text{total}}} \cdot \frac{\partial D^{\text{total}}}{\partial w^G} = \lambda \cdot L_G > 0$
Even if $\frac{\partial \lambda}{\partial w^G} = 0$ (import share unchanged), higher GVC wages increase total import volume, strengthening the leakage effect.

Furthermore, if higher wages signal stronger domestic demand, foreign suppliers might improve their competitive position, potentially increasing λ as well.

The relationship $\frac{dw^G}{dL_G} > 0$ follows from labor-market equilibrium where expanded GVC employment can bid up wages, especially in skill-intensive sectors.

Theorem 3.4 (Welfare Ranking with Industrial Policy). The welfare ranking across development strategies is:

$$W_{\text{full}}(\sigma^{\text{opt}}) > W_{\text{domestic}}(\sigma^{\text{opt}}) > W_{GVC}(\sigma^{\text{opt}}) > W_{GVC}(0) > W_{\text{cottage}} \tag{9}$$

where σ^{opt} is the welfare-maximizing industrial policy level.

Proof. Welfare in each equilibrium is given by:

$$W_i = \int_0^\infty e^{-\rho t} \ln(c_i(t)) dt = \frac{1}{\rho} \ln(y_i) + \frac{g_i}{\rho^2}$$

where y_i is steady-state *per-capita* consumption and g_i is the growth rate.

Cottage vs GVC Without Policy

In cottage equilibrium: $y_{\text{cottage}} = 1, g_{\text{cottage}} = 0$

$$W_{\text{cottage}} = \frac{1}{\rho} \ln(1) + \frac{0}{\rho^2} = 0$$

In GVC equilibrium without policy: $y_{GVC}(0) = 1 + \frac{L_G(w^G - 1)}{L}, g_{GVC} > 0$

$$W_{GVC}(0) = \frac{1}{\rho} \ln\left(1 + \frac{L_G(w^G - 1)}{L}\right) + \frac{g_{GVC}}{\rho^2} > 0$$

Therefore: $W_{GVC}(0) > W_{\text{cottage}}$.

Policy Effect on GVC Welfare

With optimal industrial policy, some domestic demand is redirected from imports to domestic production:

$$y_{GVC}(\sigma^{opt}) > y_{GVC}(0)$$

This occurs because industrial policy reduces import leakage, keeping more domestic purchasing power within the economy. The growth rate may also increase due to domestic production spillovers.

Therefore: $W_{GVC}(\sigma^{opt}) > W_{GVC}(0)$.

Domestic vs GVC with Policy

Modern Domestic development with policy generates: higher domestic value-added (no profit repatriation); stronger backward linkages; more complete utilization of domestic demand

Per-capita income: $y_{\text{domestic}}(\sigma^{\text{opt}}) = 1 + \frac{L_M(w^M - 1) + \pi^M}{L}$
Since profits π^M are retained domestically (unlike GVC profits which are repatriated):

$$y_{\text{domestic}}(\sigma^{opt}) > y_{GVC}(\sigma^{opt})$$

Therefore: $W_{\text{domestic}}(\sigma^{opt}) > W_{GVC}(\sigma^{opt})$.

Full vs Domestic Development

Full industrialization captures benefits from both modern sectors: retained profits from domestic modern sectors; high wages from both modern technologies; maximum spillover effects between sectors; complete utilization of domestic market

This yields: $y_{\text{full}}(\sigma^{\text{opt}}) > y_{\text{domestic}}(\sigma^{\text{opt}})$ and potentially $g_{\text{full}} > g_{\text{domestic}}$.
Therefore: $W_{\text{full}}(\sigma^{opt}) > W_{\text{domestic}}(\sigma^{opt})$.
The complete ranking follows from transitivity of the welfare ordering.

Corollary 3.5 (Optimal Policy Sequencing). The welfare-maximizing development sequence is:

1. Allow initial GVC development to generate high wages and domestic demand
2. Implement industrial policy $\sigma \geq \sigma^*$ before import leakage becomes entrenched
3. Coordinate Modern Domestic investment to capture redirected domestic demand

Proof. This follows directly from Theorem 3.4 and the dynamics of the import leakage mechanism.

Stage 1 Optimality: Initial GVC development creates the domestic purchasing power ($L_G w^G$) necessary to make subsequent domestic industrialization viable. Starting with domestic industrialization alone might fail because of insufficient domestic demand.

Stage 2 Timing: Policy must be implemented before import patterns become entrenched. Once $\lambda \approx 1$ is established, it becomes harder to redirect consumer behavior toward domestic products.

Stage 3 Coordination: With policy protection and enhanced domestic demand, Modern Domestic entry becomes profitable, potentially triggering the full industrialization equilibrium.

The sequencing is optimal because it leverages GVC-generated purchasing power, while preventing permanent import dependency through timely policy intervention.

4 Dynamic Analysis

Proposition 4.1 (Trap Stability Conditions). The middle-income trap equilibrium is locally stable if and only if:

$$\frac{\partial \pi^M}{\partial q^G} \cdot \frac{\partial q^G}{\partial \pi^M} < \frac{\partial \pi^M}{\partial q^M} \tag{10}$$

where the left side captures negative spillovers from GVC expansion to domestic modern prospects.

Proof. The dynamic system in the neighborhood of the trap equilibrium (q^M, q^G) = ($0, q^G$) is:

$$\frac{dq^M}{dt} = \lambda_M \max\{0, \pi^M(q^M, q^G) - \rho F^M\}$$
$$\frac{dq^G}{dt} = \lambda_G \max\{0, \pi^G(q^M, q^G) - \rho F^G\}$$

Linearizing around the equilibrium:

$$J = \begin{pmatrix} \lambda_M \frac{\partial \pi^M}{\partial q^M} & \lambda_M \frac{\partial \pi^M}{\partial q^G} \\ \lambda_G \frac{\partial \pi^G}{\partial q^M} & \lambda_G \frac{\partial \pi^G}{\partial q^G} \end{pmatrix}$$

For stability, both eigenvalues must be non-positive. The trace is:

$$\text{tr}(J) = \lambda_M \frac{\partial \pi^M}{\partial q^M} + \lambda_G \frac{\partial \pi^G}{\partial q^G}$$

Since q^G is at its profitable level, $\frac{\partial \pi^G}{\partial q^G} \leq 0$ (decreasing returns).
Since $q^M = 0$ is unprofitable, $\frac{\partial \pi^M}{\partial q^M} < 0$ (would become more unprofitable).
The determinant is:

$$\det(J) = \lambda_M \lambda_G \left[\frac{\partial \pi^M}{\partial q^M} \frac{\partial \pi^G}{\partial q^G} - \frac{\partial \pi^M}{\partial q^G} \frac{\partial \pi^G}{\partial q^M} \right]$$

The key insight is that $\frac{\partial \pi^M}{\partial q^G} < 0$ due to import leakage: more GVC activity increases domestic demand but this flows to imports, making Domestic Modern less viable.

If spillovers from Domestic Modern to GVC are positive ($\frac{\partial \pi^G}{\partial q^M} > 0$), the cross-partial term becomes negative, ensuring stability.

5 Empirical Implications

Theorem 5.1 (Testable Predictions). The enhanced model with import leakage generates the following testable predictions:

1. Import Intensity Hypothesis: $\frac{\partial (M/GDP)}{\partial (GVC\_Share)} > 0$
2. Wage-Import Correlation: $\text{corr}(w^G, M/GDP) > 0$ across countries

3. Policy Effectiveness: $\frac{\partial \text{ (Domestic\_Manufacturing)}}{\partial \sigma} > 0$ when GVC wages are high
4. GDP-GNI Gap: $\frac{GDP-GNI}{GDP}$ increases with GVC sector size and import leakage

Proof. These predictions follow directly from the model's structure: Prediction 1: From Proposition 3.3, greater GVC activity increases import volume through wage effects.

Prediction 2: Countries with higher GVC wages have more domestic purchasing power flowing to imports due to cost advantages.

Prediction 3: From Theorem 3.2, industrial policy becomes more effective when there's more domestic purchasing power to redirect.

Prediction 4: GVC profits are repatriated while generating domestic wages that flow to imports, creating divergence between domestic production (GDP) and domestic income (GNI).

6 Policy Analysis

Theorem 6.1 (Optimal Industrial Policy Design). The welfare-maximizing industrial policy level σ^{opt} satisfies:

$$\left.\frac{\partial W}{\partial \sigma}\right|_{\sigma^{opt}} = \frac{1}{\rho}\frac{1}{y}\frac{dy}{d\sigma} + \frac{1}{\rho^2}\frac{dg}{d\sigma} - MC(\sigma) = 0 \tag{11}$$

where $MC(\sigma)$ represents the marginal cost of protection (deadweight losses).
Proof. Social welfare is: $W = \frac{1}{\rho}\ln(y) + \frac{g}{\rho^2}$
Taking the derivative with respect to policy: $\frac{dW}{d\sigma} = \frac{1}{\rho}\frac{1}{y}\frac{dy}{d\sigma} + \frac{1}{\rho^2}\frac{dg}{d\sigma}$
The benefits of industrial policy come from:

1. **Income effect**: $\frac{dy}{d\sigma} > 0$ due to reduced import leakage and retained domestic profits

2. **Growth effect**: $\frac{dg}{d\sigma} > 0$ due to domestic production spillovers

The costs come from protection inefficiencies: reduced consumer choice, higher prices, potential rent-seeking.

The optimal policy balances marginal benefits against marginal costs: $\frac{\partial W}{\partial \sigma}$ = Marginal Benefits $MC(\sigma) = 0$

This gives the first-order condition in equation (11).
The second-order condition for maximum requires $\frac{\partial^2 W}{\partial \sigma^2} < 0$, which holds if marginal costs increase faster than marginal benefits (diminishing returns to protection).

Proposition 6.2 (Policy Effectiveness Conditions). Industrial policy is most effective when:

1. Import leakage rate is high: $\lambda \approx 1$
2. GVC wages create substantial domestic demand: $L_G w^G$ large
3. Domestic production cost disadvantage is moderate: c^M / c^{im} not too large
4. Substitution elasticity is finite: $\epsilon < \infty$

Proof. From Theorem 3.2, the effectiveness of policy is measured by: $\frac{\partial \pi^M}{\partial \sigma} = (p^M - c^M) \cdot D^{\text{total}} \cdot \left(-\frac{\partial \lambda}{\partial \sigma}\right)$

Condition 1: If $\lambda \approx 1$, there's substantial import leakage to redirect. If λ is already low, policy has limited scope for improvement.

Condition 2: Large $D^{\text{total}} = L_G w^G$ (in trap equilibrium) provides bigger market to redirect toward domestic production.

Condition 3: From equation (4), if $c^M \gg c^{im}$, even strong protection may not make domestic production competitive. The effectiveness decreases as: $\lim_{c^M / c^{im} \to \infty} \frac{\partial \lambda}{\partial \sigma} = 0$

Condition 4: If $\epsilon \to \infty$ (perfect substitutes), small cost differences lead to complete specialization. Policy becomes ineffective as consumers perfectly substitute based on price alone.

7 Robustness Analysis

Proposition 7.1 (Parameter Robustness). The main results are robust to:

1. Alternative specifications of import leakage function
2. Variations in wage determination mechanisms
3. Different assumptions about GVC profit repatriation rates
4. Heterogeneity in sector characteristics

Proof. Import Leakage Robustness: Alternative functional forms for λ (logistic, linear with bounds, nested CES) preserve the key property: $\frac{\partial \lambda}{\partial \sigma} < 0$ and $\lambda \approx 1$ when $\sigma \approx 0$ and $c^{im} < c^M$.

Wage Determination: Whether wages are determined by productivity, bargaining, or efficiency wage considerations, the hierarchy $w^G > w^M > w^C$ persists because of the international market access of GVC firms and their higher productivity.

Profit Repatriation: Even if repatriation rates vary across sectors or time, the qualitative result holds: domestic retention creates stronger welfare effects than foreign ownership.

Sector Heterogeneity: With heterogeneous sectors, some may be more suited for domestic development while others may be more suited for GVC integration. The model's insights apply to the marginal sectors in which development strategy choices are most relevant.

8 Multi-Country Extensions

Theorem 8.1 (Multi-Country Extensions). In a multi-country setting where several countries compete for GVC investment, the middle-income trap problem becomes more severe as:

$$\frac{\partial P(\text{ Trap })}{\partial N} > 0 \tag{12}$$

where N is the number of competing countries and P (Trap) is the probability of being trapped.
Proof. With N countries competing for GVC investment, each country faces:

1. **Pressure to maintain low wages** to remain competitive for GVC attraction

2. **Limited bargaining power** with multinational firms

3. **Race-to-the-bottom dynamics** in industrial policy (reducing σ to attract investment)

This creates a prisoner's dilemma: individual countries cannot implement optimal industrial policy without losing GVC investment to competitors.

The formal analysis requires a game-theoretic extension, but the intuition is clear: more competition for GVC investment makes it harder for individual countries to implement the industrial policies necessary to escape the middle-income trap.

9 Conclusion

This mathematical annex provides rigorous theoretical foundations for understanding how GVC integration in open economies can create middle-income traps through import leakage mechanisms. The key insights are:

1. Import Leakage Mechanism: GVC wages create domestic purchasing power that systematically flows to imports rather than spurring domestic industrialization
2. Policy Necessity: industrial policy becomes theoretically necessary rather than just empirically observed
3. Optimal Sequencing: GVC attraction followed by targeted industrial policy can maximize welfare
4. Welfare Implications: countries with strong institutional capacity for industrial policy can benefit from GVC integration; those without may face permanent traps

The mathematical framework demonstrates why many middle-income countries with significant manufacturing employment through GVCs still struggle with ‘premature deindustrialization’, and provides rigorous justification for strategic industrial policy in open economies.

Annex II: Dual Tariff Model with Asymmetric Import Access

In Section 1 of Annex I, we mentioned that modern domestic firms in most developing countries typically encounter higher tariffs on imported inputs than GVCs because of the preferential incentives extended to the latter. This Annex shows that under such circumstances, the conclusions derived herein apply *a fortiori*.

1 Model Setup and Key Assumptions

Assumption 1.1 (Asymmetric Import Access). Global Value Chain (GVC) firms have preferential access to intermediate inputs at world prices, while domestic modern sector firms face tariff-inclusive prices:

$$p_{GVC}^{int} = p_{world}^{int} \tag{1}$$
$$p_{\text{domestic}}^{int} = p_{\text{world}}^{int}(1+\tau^M) \tag{2}$$

where $\tau^M > 0$ is the tariff rate on intermediate inputs.

Assumption 1.2 (Sector-Specific Final Good Tariffs). Final good tariffs differ between GVC and domestic sectors:

$$\tau^G = \text{tariff rate for GVC final goods} \tag{3}$$
$$\tau^M = \text{tariff rate for domestic modern sector goods} \tag{4}$$

with typical relationship $\tau^M > \tau^G \geq 0$.

2 Enhanced Middle-Income Trap Mechanism

Theorem 2.1 (Enhanced Middle-Income Trap). Under a dual-tariff structure, the middle-income trap becomes more severe and stable. The unit cost disadvantage for domestic modern firms is:

$$c_{\text{dual}}^M = c_{\text{uniform}}^M + \frac{\tau^M \cdot p^{\text{int}}}{\alpha_M} \cdot \beta^M \tag{5}$$

where α_M is labor share in modern production and β^M is intermediate input intensity. This leads to a higher policy threshold:

$$\sigma^{**} > \sigma^* \tag{6}$$

where σ^{**} is the minimum subsidy rate needed to make domestic modern production viable under dual tariffs.

Proof. The unit cost function for domestic modern sector under dual tariffs becomes:

$$c_{dual}^M = \left(\frac{w}{\alpha_M}\right)^{\alpha_M} \left(\frac{p_{\text{world}}^{\text{int}}(1+\tau^M)}{\beta^M}\right)^{\beta^M} \tag{7}$$

Compared to uniform tariff case:

$$c_{uniform}^M = \left(\frac{w}{\alpha_M}\right)^{\alpha_M} \left(\frac{p_{world}^{int}}{\beta^M}\right)^{\beta^M} \tag{8}$$

The additional cost burden is:

$$c_{\text{dual}}^M - c_{\text{uniform}}^M = c_{\text{uniform}}^M \left[(1+\tau^M)^{\beta^M} - 1\right] \tag{9}$$

$$\approx c_{\text{uniform}}^M \cdot \beta^M \cdot \tau^M \text{ (for small } \tau^M) \tag{10}$$

$$= \frac{\tau^M \cdot p_{\text{world}}^{\text{int}} \cdot \beta^M}{\alpha_M} \tag{11}$$

For viability, we need $p^M(1-\sigma^{**}) \geq c_{\text{dual}}^M$, implying:

$$\sigma^{**} \geq 1 - \frac{p^M}{c_{dual}^M} > \sigma^* = 1 - \frac{p^M}{c_{uniform}^M} \tag{12}$$

3 Policy Coordination Necessity

Theorem 3.1 (Multi-Dimensional Policy Optimization). Under dual tariffs, single-instrument policies are insufficient for welfare maximization. The optimal policy requires coordination across multiple instruments:

$$W^* = \max_{\sigma,\tau^M,s} W(\sigma, \tau^M, s) \tag{13}$$

where s represents additional policy instruments (e.g. export promotion, infrastructure investment).

The first-order conditions exhibit policy complementarity:

$$\frac{\partial^2 W}{\partial\sigma\partial\tau^M} > 0 \tag{14}$$

Proof. The welfare function under dual tariffs incorporates multiple distortions:

$$W = W_{\text{production}} + W_{\text{consumption}} + W_{\text{tariff\_revenue}} + W_{\text{spillovers}} \tag{15}$$

Each component depends on the full policy vector (σ, τ^M, s):

$$\frac{\partial W}{\partial\sigma} = \frac{\partial\pi^M}{\partial\sigma} + \frac{\partial W_{\text{spillovers}}}{\partial\sigma} \tag{16}$$

$$\frac{\partial W}{\partial\tau^M} = \frac{\partial W_{\text{tariff\_revenue}}}{\partial\tau^M} - \frac{\partial W_{\text{distortion}}}{\partial\tau^M} \tag{17}$$

$$\frac{\partial W}{\partial s} = \frac{\partial W_{\text{infrastructure}}}{\partial s} + \frac{\partial W_{\text{spillovers}}}{\partial s} \tag{18}$$

The cross-partial derivative:

$$\frac{\partial^2 W}{\partial\sigma\partial\tau^M} = \frac{\partial^2 \pi^M}{\partial\sigma\partial\tau^M} + \frac{\partial^2 W_{\text{spillovers}}}{\partial\sigma\partial\tau^M} > 0 \tag{19}$$

This positive complementarity arises because reducing input tariffs ($\tau^M \downarrow$) increases the effectiveness of production subsidies (σ) by reducing the cost base.

4 Competitiveness Gap Analysis

Proposition 4.1 (Competitiveness Gap). The dual-tariff system creates a systematic competitiveness gap between domestic and GVC firms:

$$\Delta c_{dual} - \Delta c_{uniform} = \frac{(\tau^M - \tau^G) \cdot p_{world}^{int}}{\alpha_M} \cdot \beta^M > 0 \tag{20}$$

where $\Delta c = c^M - c^G$ represents the cost gap between domestic modern and GVC sectors.
Proof. Under uniform tariffs:

$$\Delta c_{\text{uniform}} = c_{\text{uniform}}^M - c_{\text{uniform}}^G \tag{21}$$

Under dual tariffs:

$$\Delta c_{\text{dual}} = c_{\text{dual}}^M - c_{\text{dual}}^G \tag{22}$$

$$= \left[c_{\text{uniform}}^M \cdot (1+\tau^M)^{\beta^M}\right] - c_{\text{uniform}}^G \tag{23}$$

$$= c_{\text{uniform}}^M \cdot (1+\tau^M)^{\beta^M} - c_{\text{uniform}}^G \tag{24}$$

The additional gap is:

$$\Delta c_{\text{dual}} - \Delta c_{\text{uniform}} = c_{\text{uniform}}^M \left[(1+\tau^M)^{\beta^M} - 1\right] \tag{25}$$

$$\approx c_{\text{uniform}}^M \cdot \beta^M \cdot \tau^M \tag{26}$$

$$= \frac{\tau^M \cdot p_{\text{world}}^{\text{int}} \cdot \beta^M}{\alpha_M} \tag{27}$$

Since typically $\tau^M > \tau^G$, this gap is positive and represents a structural disadvantage for domestic firms. ▯

5 Welfare Decomposition

Theorem 5.1 (Welfare Loss Decomposition). The welfare loss under dual tariffs can be decomposed into three distinct components:

$$\Delta W_{\text{dual}} = \Delta W_{\text{efficiency}} + \Delta W_{\text{spillovers}} + \Delta W_{\text{competition}} \tag{28}$$

where:

$$\Delta W_{\text{efficiency}} = \text{Static efficiency losses from tariff distortions} \tag{29}$$
$$\Delta W_{\text{spillovers}} = \text{Dynamic losses from reduced technology spillovers} \tag{30}$$
$$\Delta W_{\text{competition}} = \text{Losses from weakened domestic competition} \tag{31}$$

Proof. The welfare function can be written as:

$$W = \int_i U_i(c_i)di - \int_j C_j(q_j)dj + R_{\text{tariff}} + S_{\text{spillovers}} \tag{32}$$

Taking the differential with respect to the dual tariff policy:

$$dW = \sum_i \frac{\partial U_i}{\partial c_i}\frac{\partial c_i}{\partial \tau}d\tau + \sum_j \frac{\partial C_j}{\partial q_j}\frac{\partial q_j}{\partial \tau}d\tau \tag{33}$$
$$+\frac{\partial R_{\text{tariff}}}{\partial \tau}d\tau + \frac{\partial S_{\text{spillovers}}}{\partial \tau}d\tau \tag{34}$$

Grouping terms by economic mechanism:

$$\Delta W_{\text{efficiency}} = \left[\sum_i \frac{\partial U_i}{\partial c_i}\frac{\partial c_i}{\partial \tau} + \sum_j \frac{\partial C_j}{\partial q_j}\frac{\partial q_j}{\partial \tau} + \frac{\partial R_{\text{tariff}}}{\partial \tau}\right]d\tau \tag{35}$$
$$\Delta W_{\text{spillovers}} = \frac{\partial S_{\text{spillovers}}}{\partial \tau}d\tau \tag{36}$$
$$\Delta W_{\text{competition}} = \left[\sum_j \frac{\partial C_j}{\partial n_j}\frac{\partial n_j}{\partial \tau}\right]d\tau \tag{37}$$

where n_j represents the number of active firms in sector j. □

6 Empirical Predictions

Proposition 6.1 (Testable Hypotheses). The dual-tariff model generates the following empirically testable predictions:

H1 (Cost Gap Hypothesis):

$$E\left[\frac{c_i^M}{c_i^G}\middle| \tau_i^M > \tau_i^G\right] > E\left[\frac{c_i^M}{c_i^G}\middle| \tau_i^M = \tau_i^G\right] \tag{38}$$

H2 (Export Performance Hypothesis):

$$E[X_i^M \mid \tau_i^M] = X_0^M \cdot e^{-\beta\tau_i^M} \tag{39}$$

where X_i^M represents exports from domestic modern sector in country i.
H3 (Linkage Weakness Hypothesis):

$$\mathrm{Corr}\left(I_{it}^{GVC}, I_{it}^{M}\right) < \mathrm{Corr}\left(I_{it}^{\text{uniform}}, I_{it}^{M}\right) \tag{40}$$

where I_{it}^{GVC} and I_{it}^{M} represent investment flows in GVC and domestic modern sectors respectively.

7 Policy Implications

Corollary 7.1 (Coordinated Reform Necessity). Piecemeal policy reforms are suboptimal under dual tariffs. The optimal reform strategy requires simultaneous adjustment of multiple instruments:

$$\begin{cases} \dfrac{d\sigma}{dt} = \alpha_1(\sigma^* - \sigma_t) & (41) \\ \dfrac{d\tau^M}{dt} = -\alpha_2(\tau_t^M - \tau^{M*}) & (41) \\ \dfrac{ds}{dt} = \alpha_3(s^* - s_t) & (41) \end{cases}$$

where $\alpha_i > 0$ are adjustment speeds and starred variables represent optimal levels.
Corollary 7.2 (Sequencing Matters). When simultaneous reform is not feasible, the optimal sequencing prioritizes input market liberalization:

$$\left.\frac{\partial W}{\partial \tau^M}\right|_{t=0} > \left.\frac{\partial W}{\partial \sigma}\right|_{t=0} > \left.\frac{\partial W}{\partial s}\right|_{t=0} \tag{42}$$

8 Conclusion

The dual-tariff modification creates a mathematically rigorous framework for understanding why GVC integration alone is insufficient for sustained development. The model shows that institutional asymmetries in trade policy create structural barriers to domestic industrialization, requiring coordinated policy interventions rather than single-instrument approaches.

The key mathematical innovations—enhanced trap stability, policy complementarity, and welfare decomposition—provide both theoretical insights and empirical guidance for development policy in the contemporary global economy.

ANNEX III

Distributed Lag Panel Regression Analysis

The distributed lag model allows the effect of independent variables to be spread across multiple time periods. Instead of assuming that trade openness or investment payments affect the wedge only contemporaneously, we allow for lagged effects up to 3 years (t, t-1, t-2) (Model I) and to 5 years (Model II).

I. **Model I (3-year lag) Specification:**

Wedge it = **α**i + **γ**t + **β**0Xit + **β**1Xi,t-1 + **β**2Xi,t-2 + **ε**it

Where **α**i represents country fixed effects, **γ**t represents year fixed effects, and X is the independent variable (Trade Openness or Investment Payment). The **long-run (cumulative) effect** is calculated as **β**0 + **β**1 + **β**2.

Sample: 10 countries, 1991-2024 (333 observations after creating lags). Countries: Bangladesh, Brazil, China, India, Indonesia, Mexico, Morocco, South Africa, Turkey, Vietnam.

Model I Regression Results

Table 1: Distributed Lag Panel Regression Results (All Four Models)

Variable	Model A	Model B	Model C	Model D
Trade Open. (t)	0.0066	—	0.0010	0.0054
	(0.0091)	—	(0.0110)	(0.0133)
Trade Open. (t-1)	0.0158*	—	0.0003	0.0003
	(0.0095)	—	(0.0101)	(0.0091)
Trade Open. (t-2)	0.0097	—	0.0252**	0.0211***
	(0.0076)	—	(0.0125)	(0.0063)
Inv Payment (t)	—	0.3049**	0.2642**	0.5748*
	—	(0.1249)	(0.1254)	(0.3309)
Inv Payment (t-1)	—	0.2461**	0.2340*	0.1090
	—	(0.1068)	(0.1338)	(0.2342)
Inv Payment (t-2)	—	-0.1368	-0.2598*	-0.4560
	—	(0.0984)	(0.1534)	(0.3311)
Interaction (t)	—	—	—	-0.3618
	—	—	—	(0.3170)
Interaction (t-1)	—	—	—	0.0863
	—	—	—	(0.2554)
Interaction (t-2)	—	—	—	0.2879
	—	—	—	(0.2907)
Country & Year FE	Yes	Yes	Yes	Yes
Observations	333	333	333	333
R^2 (Within)	-0.081	0.094	-0.005	-0.003
R^2 (Between)	0.388	0.231	0.448	0.446
R^2 (Overall)	0.317	0.223	0.377	0.376

*Notes: *** p<0.01, ** p<0.05, * p<0.10. Clustered standard errors at country level in parentheses.*

Table 2: Long-Run (Cumulative) Multipliers ($\beta_0 + \beta_1 + \beta_2$)

Variable	Model A	Model B	Model C	Model D
Trade Openness	0.0321	—	0.0266	0.0267
Investment Payment	—	0.4142	0.2384	0.2278
Interaction	—	—	—	0.0124

3. Interpretation

Model A: Trade Openness with Distributed Lags

The distributed lag structure reveals that trade openness effects are **spread across time**. While the contemporaneous effect (t) is not significant (0.0066, p=0.47), the one-year lag (t-1) shows marginal significance (0.0158, p=0.097). The **cumulative long-run effect is 0.0321**, comparable to the static model estimate (0.0268).

Economic interpretation: The effect of trade openness on the wedge takes time to materialize. A country that increases trade openness does not immediately see the full impact on its GDP-GNI gap; rather, the effect builds up over 2-3 years as foreign firms establish operations, supply chains adjust, and profit repatriation patterns stabilize.

Model B: Investment Payment with Distributed Lags

Investment payments show **strong contemporaneous and lagged effects**. Both the current period (0.3049, p=0.015) and the first lag (0.2461, p=0.022) are statistically significant. Interestingly, the second lag is negative (-0.1368) though not significant, suggesting some mean reversion.

Economic interpretation: Investment income payments affect the wedge immediately and persist for at least one additional year. The cumulative long-run effect (0.4142) is virtually identical to the static model estimate (0.4133), confirming the robustness of this relationship. The negative coefficient at t-2 may reflect adjustment processes by which countries respond to high outflows by attracting offsetting inflows or domestic investment.

Model C: Combined Model with Distributed Lags

When both variables are included with their lags, the results reveal an interesting pattern. Investment payments remain significant at current (0.2642, p=0.036) and lagged (t-1: 0.2340, p=0.081) periods. Trade openness shows significance only at the **second lag** (0.0252, p=0.045), suggesting a delayed effect that emerges after controlling for investment dynamics.

Economic interpretation: The combined model suggests that investment payments have more immediate effects on the wedge, while trade openness operates with a longer lag. This is consistent with the theory that trade integration leads to foreign direct investment, which then generates investment income outflows. The negative coefficient on lagged investment payments (t-2: -0.2598, p=0.092) may indicate partial adjustment or policy responses.

Model D: Full Model with Interaction Effects

Model D includes trade openness, investment payment, and their interaction—all with distributed lags. Key findings:

1. **Trade Openness (t-2) is highly significant:** the coefficient of 0.0211 (p=0.001) is statistically significant at the 1% level. This confirms that trade openness effects materialize with a 2-year delay, even after controlling for investment payments and interaction effects.

2. **Investment Payment (t) is marginally significant:** the contemporaneous effect (0.5748, p=0.084) is larger than in Model C, but only marginally significant. The lagged effects are absorbed by the interaction terms.
3. **Interaction terms are not significant:** none of the interaction terms (current or lagged) achieve statistical significance. The p-values range from 0.25 to 0.74. This confirms the static model finding: there is no evidence that the effect of trade openness varies with investment payment levels.
4. **Long-run interaction effect is near zero:** the cumulative interaction effect (0.0124) is economically negligible, confirming that the relationship between trade openness, investment payments, and the wedge is additive rather than multiplicative.

5. Summary of Key Findings

- **Dynamic effects matter**: the distributed lag models reveal that the effects of trade openness and investment payments on the wedge are not purely contemporaneous but unfold over multiple years.
- **Delayed trade effects are robust:** across Models C and D, trade openness at t-2 is consistently significant ($p<0.05$), suggesting a 2-year lag for trade integration to affect the GDP-GNI gap. This is consistent with the time needed for trade integration to translate into foreign ownership patterns and profit flows.
- **Investment payments have immediate effects:** in Model B, both current and first-lagged investment payments are significant. Effects diminish when controlling for trade openness and interactions.
- **No interaction effects:** neither static nor distributed lag models find evidence of interaction between trade openness and investment payments. The effects are additive.
- **Long-run multipliers are stable:** trade openness long-run effect ≈ 0.027-0.032; Investment payment long-run effect ≈ 0.23-0.41 across specifications.
- **Model C is preferred:** given the lack of significant interaction effects and the principle of parsimony, Model C (both variables with lags, no interaction) provides the best balance of explanatory power and interpretability.

6. Technical Notes

Lag structure: 2 lags (t, t-1, t-2) were used based on annual data frequency. This captures effects up to 3 years.

Sample reduction: Creating 2 lags reduces observations from 360 to 333 (losing first 2 years per country).

Fixed effects: Country and year fixed effects are included in all specifications.

Standard errors: Clustered at country level to account for serial correlation.

II. COMPARISON BETWEEN 3-YEAR VS. 5-YEAR DISTRIBUTED LAG MODELS

This analysis compares the previous 3-year distributed lag model (t, t-1, t-2) to a 5-year window (t, t-1, t-2, t-3, t-4). The 5-year specification allows us to test whether effects persist beyond 3 years, and whether the additional lags reveal new dynamics.

Sample sizes: 3-year models: N=333 (1991-2024); 5-year models: N=313 (1993-2024)

Long-Run Multiplier Comparison

Table 1: Long-Run (Cumulative) Effects by Lag Structure

Model	Variable	3-Year Lag	5-Year Lag	Difference
Model A	Trade Openness	0.0321	0.0324	+0.0003
Model B	Investment Payment	0.4142	0.3184	-0.0958
Model C	Trade Openness	0.0266	0.0312	+0.0046
	Investment Payment	0.2384	0.0720	-0.1664
Model D	Trade Openness	0.0267	0.0326	+0.0059
	Investment Payment	0.2278	0.1327	-0.0951
	Interaction	0.0124	-0.0739	-0.0864

Note: Yellow highlighting indicates substantial differences (>0.05 in absolute value).

Significant Coefficients Comparison

Table 2: Statistically Significant Coefficients ($p < 0.10$)

3-Year Lag Models	5-Year Lag Models
Model A: TO(t-1) = 0.0158*	Model A: TO(t-2) = 0.0105*
Model B: IP(t) = 0.3049**	Model A: TO(t-3) = -0.0159**
Model B: IP(t-1) = 0.2461**	Model B: IP(t) = 0.2783**
Model C: TO(t-2) = 0.0252**	Model B: IP(t-1) = 0.2268**
Model C: IP(t) = 0.2642**	Model B: IP(t-3) = -0.2388***
Model C: IP(t-1) = 0.2340*	Model C: IP(t) = 0.2328*
Model C: IP(t-2) = -0.2598*	Model C: IP(t-1) = 0.1886*
Model D: TO(t-2) = 0.0211***	Model C: IP(t-3) = -0.2136**
Model D: IP(t) = 0.5748*	Model D: TO(t-4) = 0.0311**
	Model D: Interaction(t-4) = -0.3057**

Note: TO = Trade Openness, IP = Investment Payment. Yellow = new findings in 5-year model.

Key Differences and Insights

Trade Openness: Stable Long-Run Effect

The long-run effect of trade openness is **remarkably stable** across both lag structures (≈0.032 in all models). However, the 5-year model reveals an interesting **oscillating pattern**: positive effects at t-2 and t-4, but a **negative effect at t-3** (-0.0159, p=0.031 in Model A). This suggests trade openness effects may follow a cyclical pattern rather than monotonic decay.

Investment Payment: Mean Reversion Confirmed

The 5-year model reveals **strong mean reversion** in investment payment effects. The coefficient at t-3 is **highly significant and negative** (-0.2388, $p<0.001$ in Model B). This reduces the long-run multiplier from 0.41 (3-year) to 0.32 (5-year). The pattern suggests that initial positive effects of investment payments on the wedge are partially reversed after 3-4 years.

Interaction Effect: Emerges at Year 4

While the 3-year model found no significant interaction effects, the 5-year model revealed a **significant negative interaction at t-4** (-0.3057, p=0.013). This suggests that the combined effect of high trade openness and high investment payments is **less than additive in the long run**—a finding masked by the shorter lag structure.

Model Fit

The 5-year models generally show **improved within-R^2** (capturing more temporal variation), but **lower between-R^2 and overall-R^2**. This suggests the additional lags help explain within-country dynamics but add noise to cross-country comparisons.

Conclusions. Extending the model to five-year lag reveals significant dynamics:

- **Mean reversion in investment payments:** The strong negative coefficient at t-3 suggests countries partially adjust to high investment outflows, reducing the long-run effect by about 25%.
- **Oscillating trade effects:** The negative coefficient at t-3 followed by positive at t-4 suggests complex adjustment dynamics in trade integration.
- **Delayed interaction effect:** The significant negative interaction at t-4 suggests that a combination of high trade openness and high investment payments leads to smaller wedge increases in the long run—possibly due to policy responses or structural adjustments.
- **Trade openness effect is robust:** The long-run trade effect (≈0.032) is virtually identical across both specifications, confirming this as a stable structural relationship.

The 5-year lag structure thus provides richer insights into adjustment dynamics and should be preferred for understanding the full temporal pattern of effects. However, if the focus is on the stable long-run trade openness effect, the 3-year model is sufficient and more parsimonious.

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