13TH IMF STATISTICAL FORUM

MEASURING
CROSS-BORDER ECONOMIC
and **FINANCIAL LINKAGES**
in a Dynamic World

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The Anatomy of Value Creation: I-O Linkages, Policy Shifts, and Economic Impacts

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The GVC Measurement Conundrum

The Central Challenge for this Forum

- We are here to discuss the “Anatomy of Value Creation” – who is making what, with whom.
- This is not just an academic question. It is the central challenge in accurately measuring our national income, trade, and investment aggregates in an age of fragmented, “factoryless” global production.

The Paradox of Assembly-Led Growth

- India’s mobile phone production has surged, transforming the nation from a net importer to a major exporter. Gross exports grew from $0.17B (2016-17) to $11.1B (2022-23).
- Yet, this is met with sharp critiques: “Is this genuine value creation, or just low-value assembly?”
- Critics argue that high import bills for components render any trade surplus an illusion, questioning the very efficacy of industrial policy like **Production Linked Incentives (PLI)**.

The Measurement Gap

- How do we, as economists and statisticians, move beyond this binary debate? How do we actually measure the true Domestic Value Added (DVA) and employment generated by these GVCs?

India’s Mobile Phone Manufacturing

A Sector of Two Halves: Policy Regimes

Our case study examines the period 2016-17 to 2022-23, which straddles two distinct policy eras:

- **Phase 1 (2016-19):** Dominated by the **Phased Manufacturing Programme (PMP)**.
  - *Focus:* Import substitution, building domestic assembly capabilities.
- **Phase 2 (2019-23):** Driven by the **National Policy on Electronics (NPE) 2019** and the **PLI Scheme**.
  - *Focus:* Export-oriented production, achieving scale and global competitiveness.

The Core Research Questions

This policy shift provides a perfect natural experiment to ask:

- What is the actual contribution to **Domestic Value Addition (DVA)**, and how has its composition (direct vs. indirect) evolved?
- What is the real **employment** impact, disaggregated by skill and gender?
- Is there any quantifiable evidence of **upgrading,** or is India stuck in the “trough” of the smile curve?
- What is the veridical **net trade impact** once component imports are meticulously accounted for?

Methodological Innovation

The Problem with Standard IO Tables

Traditional Input-Output (IO) tables are often too aggregated. They cannot answer our questions because

- They **cannot distinguish** “telephones for cellular networks” (NPCMS code 4722200) from broader electronics categories.
- They **cannot trace** specific imported components (e.g., a display panel) to their actual use in the final product.
- This aggregation is what **fuels the critiques** – it’s easy to sum up all electronic component imports and claim they are all for mobile phones.

A New Approach: Granular SUTs & IOTs (Adhering to SNA2025)

To solve this, a pioneering methodology was adopted

- **Data Source:** Plant-level microdata from India’s Annual Survey of Industries (ASI) 2016-17 to 2022-23, allowing for pre- and post-policy shift analysis.
- **Granularity:** Constructed annual Supply-Use Tables (SUTs) and symmetric Input-Output Tables (IOTs) at the **7-digit NPCMS product level** (approx. +5,700 products).
- **Detail:** This allows us to use ASI schedule blocks to distinguish domestic inputs (Block H & G) from imported inputs (Block I) and link them to specific products (Block J & F).

This is precisely the kind of granular, data-driven framework the SNA2025 advocates for understanding modern economies.

Technical Core: From SUTs to Symmetric IOTs

The Challenge: Multi-Product Plants

- ASI data is at the plant (industry) level, but plants often make multiple products. How do we allocate inputs? We use the Industry Technology Assumption (ITA)
- **Assumption:** Each industry has a specific input structure, which is applied proportionally to all products it manufactures

Key Matrices

- V = Make Matrix (Supply)
- U_d = Domestic Use Matrix
- g = Vector of gross industry output
- x = Vector of gross product output

The Transformation Equations

- Product Mix Matrix (C): $C = V^T(\hat{g})^{-1}$ (C gives the share of each product in an industry's output.)
- Transformation Matrix (T): $T = C^T$(This reallocates industry inputs to product outputs.)

The Result: The Domestic Technical Coefficient Matrix (A_d)

- This transformation yields the (product-by-product) matrix we need: $A_d = U_d T(\hat{x})^{-1}$
- This A_d matrix is the 'DNA' of the domestic economy. It shows how much of domestic product i is required to produce one unit of domestic product j.

Applying the Leontief Framework

Once we have our highly granular A_d matrix, we can deploy the Leontief framework to answer our core questions with precision.

Calculate Domestic Leontief Inverse

- We compute the domestic Leontief Inverse, $(I - A_d)^{-1}$.
- This matrix captures the total (direct + indirect) domestic linkages

Quantify Economic Impacts

We can then precisely measure the impact w.r.t. embodied in output (x):

- **Domestic Value Added (DVA):** $dva = v(I - A_d)^{-1}x$ (where v is vector of direct DVA-to-output ratios)
- **Employment Impact:** $e = l(I - A_d)^{-1}x$ (where l is vector of employment-to-output ratios)

The Analytical Power

- This framework allows us to decompose DVA (dva) and Employment (e) into **Direct** (from the final product of the mobile sector) and **Indirect** (from all upstream domestic suppliers) components. This is where we find the real story.

Finding 1: The DVA Story - Beyond Assembly

This granular analysis provides a starkly different picture from the aggregate critiques.

Overall DVA Share

- The share of **Total DVA in Gross Output** rose markedly.
- **Phase 1 (PMP):** Averaged only **9%**.
- **Phase 2 (PLI):** Averaged more than **+22%**.
- *Insight:* The export-oriented, scale-focused policy coincided with a deepening of domestic value capture, not a hollowing out.

The Composition of DVA

Comparing the average annual DVA from Phase 1 to Phase 2:

- **Direct DVA (DDVA):** Grew by 283%. (This is the value added at the assembly plant).
- **Indirect DVA (IDVA):** Grew by an exceptional 604% (KLEMS-based, whole economy).

Research Insight

- This explosive growth in **IDVA** is the “smoking gun”.
- It is the quantifiable evidence of a **deepening of domestic backward linkages**.
- The PLI policy, by fostering scale, pulled a vast domestic supplier ecosystem (both organised and unorganised) along with it.

Finding 2: The Employment Story - Scale and Nuance

The DVA story translates directly into a massive employment story.

Headline Employment Generation (Phase 1 vs Phase 2 Averages)

- **Direct Employment (Organised Sector):** Grew by 497%. From 27,000 to 162,000 average employees.
- **Indirect Employment (Total Economy):** Grew by 87%. From 556,000 to 1.04 million average employees.
- **Total Jobs Supported:** Rose to an average of 1.2 million in Phase 2

Nuances for Critical Thinking

- **Export-Driven Jobs:** The primary driver. Direct employment linked to exports grew by 3327% on average.
- **Gender Dynamics:** A significant positive outcome. Direct female production employment rose by 180% on average, a crucial development for social upgrading.
- **A Policy Challenge:** A clear trend of contractualization. Contractual worker employment grew far faster (207%) than regular worker employment (17%). This has implications for job quality and stability.

Finding 3: Solving the Trade Critique

This is a core contribution for this IMF forum: How to correctly measure the trade balance.

The Flawed Critique

- Critics sum the import value of all electronic components (at the 8-digit HS code level) and subtract it from final mobile phone exports. This is methodologically flawed.

A Granular Supply Side IOT-based Adjustment

Our methodology allows for a far more precise calculation through the Supply Side IOTs

- **Mapping Codes:** We map trade (HS) codes to production (NPCMS) codes.
- **Allocation Coefficient:** Using our 7-digit supply-side IOT (**Ghosh Model**), we find the proportion of an imported component k allocated as an intermediate input to the mobile phone sector (NPCMS 4722200).
- **Adjusted Component Imports** = (Total Import Value of k) × (Allocation Coefficient of k)

The Real Trade Balance

- When we use this **Adjusted Trade Balance** – and crucially, add the **Foreign Exchange Saved** from Phase 1 – the data shows a **positive and growing net foreign exchange impact** for the sector since early 2019.

Finding 4: Evidence of Upgrading

Is India "locked in" to low-value assembly? The 'Smile Curve' concept posits that value lies in upstream (R&D, Design) and downstream (Marketing) activities, not midstream assembly.

We find tangible evidence of Product Upgrading

- **Rising Export Unit Values (UVs):**
  - India's export UVs for mobile phones have steadily increased, narrowing the gap with competitors like China and Vietnam.
  - This indicates a shift in the mix of exports towards higher-value smartphones
- **A Constructed Output Quality Index (OQI)**
  - Using plant-level unit prices from ASI, a quality index was constructed (Base 2016=100).
  - The average OQI **doubled** from 145 in Phase 1 (2016-18) to 318 in Phase 2 (2019-22).
  - This is a robust, micro-data-driven indicator of a shift towards higher-value, more sophisticated production, spurred by the entry of premium manufacturers.

The evidence suggests India's mobile phone manufacturing is not static; it is beginning the journey of moving up the value chain from basic assembly.

Conclusion: For the IMF Statistical Forum

Answering "Who Makes What With Whom?"

- **Aggregate data is misleading.** It hides the "Anatomy of Value Creation" and fuels policy cynicism.
- **"Who makes what?"** can only be answered by linking firm-level data (like ASI) to product-level classifications (like 7-digit NPCMS).
- **"With whom?"** is answered by building and using granular, annual SUTs and IOTs that distinguish domestic from imported inputs.

Implications for Measurement (SNA2025 / BPM7)

- This case study is a powerful argument for **investing in the statistical infrastructure** to build and maintain such granular, micro-data-based SUT/IOT frameworks.
- This methodology provides a robust way to **trace value creation** through MNEs and GVCs, separating true DVA from imported FVA.
- It allows us to **empirically measure** the "ripple effects" (indirect DVA and employment) that are at the heart of industrial policy, but are invisible in aggregate data.

Final Thought

- The Indian mobile phone story demonstrates that even an assembly-led GVC strategy, if coupled with policies that foster **scale** and **export-competitiveness**, can generate substantial domestic linkages, value addition, and employment. **But you can only know this if you can measure it correctly**.

Thank You

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