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Chinese Outward Foreign Direct Investment and Export Upgrading in Africa

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Abstract: This article examines the association between Chinese outward foreign direct investment and African export upgrading, distinguishing changes in export composition from changes in the global income scale used to value products. Investment data cover 2007–2024, with a common estimation sample of 51 African countries over 2010–2024. Country and year fixed-effects models compare flows and stocks across total and manufacturing exports using annual and fixed product-income scores. Annual flows show no systematic positive association across the reported specifications. A positive stock association with fixed-score manufacturing income content weakens with additional controls and does not survive the main stock-family multiplicity adjustment. Product-level accounting across 53 countries shows that annual-score manufacturing income content rises while fixed-score income content falls in 19 economies. In 20 countries, annual-score increases coincide with a negative export-composition contribution. The results show that measured upgrading can reflect global product revaluation despite adverse basket reallocation. This distinction changes the assessment of African export upgrading and provides a more precise basis for interpreting its conditional association with Chinese investment.

Keywords: *Africa; Chinese Outward FDI; Export Sophistication; Export Upgrading; Manufacturing Exports; PRODY/EXPY.*

JEL Classifications: *F14; F21; F23; O14; O55.*

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I. INTRODUCTION

Foreign direct investment (FDI) can alter a host economy's export specialization through the activities of foreign affiliates and their links with domestic producers. Whether these channels produce broad upgrading depends on the sectors receiving capital, local productive capabilities and access to export markets. This distinction is particularly important in Africa, where large investment transactions can coexist with persistent commodity dependence. The relevant question is how far changes in foreign-capital exposure accompany a shift towards exports associated with higher-income producers, and whether that relationship extends beyond a narrow manufacturing segment.

The African panel illustrates why aggregate and manufacturing outcomes should be distinguished. Across 1,179 country-year observations, manufacturing averages 20.9% of merchandise exports, with a median share of 11.3%. A change in the income content of the dominant non-manufacturing basket can therefore outweigh substantial reallocation within industry. Evaluating export upgrading requires examining both the income profile of manufacturing exports and their weight in total trade.

Evidence on this relationship varies with the outcome and the level of analysis. Harding and Javorcik [1] find export-quality gains associated with investment promotion, while recent African studies report positive complexity relationships or effects conditional on human capital and institutions (Ajide et al. [2]; Masunda et al. [3]). These findings make the definition of upgrading central to the empirical comparison. A national income-content measure need not respond in the same way as product quality, diversification or economic complexity.

The study asks whether Chinese outward foreign direct investment (OFDI) exposure is associated with African export upgrading when exposure measures, product-income scales and estimation samples are made comparable. It examines three related questions: whether annual flows and accumulated stocks differ in their standardized associations; whether those associations differ between total and manufacturing export income content (EXPY) under annual and fixed product scores; and how much observed upgrading reflects export-basket reallocation rather than global product revaluation. Country and year fixed-effects regressions compare contemporaneous exposure and three separate annual lags on common observations. Product-level endpoint accounting then separates composition, revaluation and coverage contributions. The design is observational; the comparisons assess conditional associations and measurement differences.

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The contribution is to establish the empirical importance of separating export-basket reallocation from changes in the world product-income scale when assessing the investment–upgrading relationship. Prior work documents FDI relationships with several export margins and shows that product income scores (PRODY) depend on their construction. Building on Huber [4], it connects those strands through common-sample flow–stock comparisons and product-level accounting across 53 African economies. The accounting identifies how often rising annual-score EXPY accompanies deteriorating composition, while the regressions show how the investment association changes with the outcome scale and sample. Morocco and Nigeria illustrate the product-level sources of this distinction. The contribution is an application and empirical assessment of established measurement principles, rather than a new causal identification strategy.

The estimates provide little support for a systematic positive annual-flow relationship. The positive stock association with fixed-score manufacturing EXPY weakens on the smaller matched sample and with additional controls. Its sign remains positive after every individual country omission, while all corresponding adjusted p-values exceed 0.05. The measurement contrast is widespread: between 2007 and 2024, annual-score manufacturing EXPY rises while fixed-score EXPY falls in 19 of 53 economies. Morocco and Nigeria illustrate the product reallocations behind contrasting trajectories without assigning those changes to Chinese investors.

II. FOREIGN INVESTMENT AND EXPORT COMPOSITION

➢ *Productive Linkages and Investment Exposure*

The theoretical argument connecting FDI to export upgrading is built on capability accumulation rather than on capital inflow alone. Multinational firms possess production knowledge, organizational routines, quality-control systems, supply-chain relationships and information about foreign demand. When foreign affiliates source locally, train workers, demonstrate new technologies or impose higher standards on suppliers, part of those capabilities can diffuse to domestic firms. Rodríguez-Clare [5] and Markusen and Venables [6] formalize the importance of linkages between multinational enterprises and local producers, while Javorcik [7] provides influential evidence that backward linkages can generate productivity spillovers. Saggi [8] and Blomström and Kokko [9] emphasize, however, that technology transfer is conditional on domestic absorptive capacity and the structure of foreign-firm linkages. The meta-analysis by Havranek and Irsova [10] further shows that estimated vertical spillovers vary substantially with host conditions and empirical design.

Export upgrading is a plausible macro-level manifestation of these mechanisms. If foreign investment improves capabilities, firms may enter products that require more complex inputs, tighter quality standards, better logistics or more sophisticated managerial coordination. Harding and Javorcik [1] show that investment-promotion targeting is associated with higher export unit values in developing countries, consistent with quality upgrading. Eck and Huber [11] find that FDI spillovers can facilitate production of more sophisticated products. At the country level, Zhu and Fu [12] relate export upgrading to FDI together with education, innovation and institutions. Yet the theoretical path remains conditional: investment can increase production without changing the export basket, and resource-oriented investment can raise export values while reinforcing rather than reducing specialization.

Annual flows record net investment transactions; year-end stocks record investment positions, including valuation and other adjustments. Sustained affiliate activity and supplier learning are more plausibly related to accumulated presence than to a single year's transactions. Conversely, stock persistence can also reflect common country-specific trends in investment and exporting. Iwamoto and Nabeshima [13] distinguish flow and stock measures and obtain different temporal relationships with diversification and sophistication. The analysis therefore estimates the two exposure measures separately and compares their associations on a standardized scale.

These mechanisms motivate an expectation of positive investment–upgrading associations where productive linkages develop, with accumulated positions potentially more informative than annual transactions. The empirical comparisons assess that expectation across export baskets and income scales. The comparisons concern national export composition; a positive association alone does not establish productive linkages.

➢ *Evidence on African Export Upgrading*

Research on China in Africa increasingly rejects the idea of a single, homogeneous 'Chinese investment model'. Calabrese and Tang [14] review the channels through which Chinese firms may influence structural transformation and conclude that investment and infrastructure can contribute positively, but outcomes depend on local linkages, skills, innovation and the organization of production. Chen et al. [15] find a small positive association between Chinese FDI and industrialization, with stronger estimates among higher-recipient or higher-absorptive-capacity economies. Chen [16], using eight years of fieldwork in Angola and Ethiopia, shows that even Chinese manufacturing firms with similar origins can follow different developmental trajectories depending on institutional environments, policy frameworks and whether they are embedded in local markets or global production networks. These findings challenge macro studies to distinguish the quantity of Chinese capital from the way that capital becomes embedded in host production systems. Hoekman, Sanfilippo and Tambussi [17] find shifts towards modern sectors and higher-skilled occupations around foreign investment projects in African local labor markets. Their subnational evidence makes the spatial and sectoral concentration of structural change particularly relevant to the interpretation of national export aggregates.

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The closest empirical studies differ in their outcomes, samples and identification strategies. Positive findings are common, but they do not establish a single result for export upgrading. Amighini and Sanfilippo [18] study African economies and find that South-South FDI supports export diversification and, in selected manufacturing sectors, export quality. Rehman and Noman [19] report a positive association between Chinese OFDI and bilateral export sophistication across partner countries, including Sub-Saharan Africa. Shi et al. [20] find a positive relationship between Chinese OFDI and host-country EXPY in a Belt and Road sample and propose productivity as an important channel. Ajide et al. [2] find positive Chinese FDI and trade relationships with economic complexity in 34 African economies using Lewbel 2SLS, Driscoll-Kraay inference and quantile methods. In contrast, Buhari Isah [21] finds no significant Chinese FDI effect on export diversification in 34 African economies over 2003–2019. This contrast motivates comparing measures within one design, rather than treating diversification, complexity and EXPY as interchangeable outcomes.

The present analysis compares total and manufacturing export income content within a common national framework. It does not estimate quality, diversification or economic complexity as interchangeable outcomes. Evidence on those margins provides context for interpreting the income-content results.

Table 1 Evidence on Foreign Investment and Export Upgrading

Study	Design / outcome	Evidence and boundary
Harding and Javorcik [1]	Sector targeting; export unit values	Quality upgrading; not host EXPY
Amighini and Sanfilippo [18]	African sector panel; variety and quality	South–South differences; sector-specific
Rehman and Noman [19]; Shi et al. [20]	Chinese OFDI; bilateral sophistication / host EXPY	Positive; different samples and estimands
Ajide et al. [2]	34 African economies; complexity; Lewbel IV	Positive; not income-content EXPY
Buhari Isah [21]	34 African economies; diversification; IV	Insignificant; not a zero-effect proof
Masunda et al. [3]	35 SSA economies; total FDI; system GMM	Conditional positive interactions

- Notes: The table compares the outcomes and empirical scope of the cited studies. Reported findings refer to their respective designs.

➢ *Income Content and Export Upgrading*

The concept of upgrading is itself multidimensional. Export diversification asks how concentrated the basket is; economic complexity assesses the diversity and ubiquity structure of productive capabilities; unit values are frequently used as proxies for quality; EXPY measures the income content of the export basket. These outcomes can move in different directions. A country can diversify into many low-income products, increase unit values without changing product categories, or raise EXPY through resource products associated with high-income exporters. Consequently, conflicting FDI results may partly reflect different objects of analysis rather than inconsistent estimates of the same object. Firm-level evidence further shows that foreign competition can reduce exporters' product range as firms drop peripheral varieties and concentrate on core products (Wang, Liu and Wang [22]). Such specialization need not imply a decline in the income content of the retained basket.

The limitation is particularly important for aggregate EXPY. Hausmann, Hwang and Rodrik [23] developed the product income-content index (PRODY) and export income-content index (EXPY) to measure the income level associated with products and export baskets. Subsequent work has shown that the index is informative but not a direct measure of embodied technology. Xu [24], Wang and Wei [25], and Jarreau and Poncet [26] show in the Chinese context that processing trade, foreign-firm activity and within-product quality heterogeneity can complicate interpretations of sophistication. Huber [4] demonstrates more generally that sample definition, aggregation and construction choices can alter PRODY-based indicators.

A second measurement issue concerns time variation in PRODY. In a dynamic construction, a product's sophistication score is recalculated in each year using contemporaneous export shares and exporter income. This is attractive when the economic meaning of a product is itself evolving. But it also means that a country's EXPY can change even if its own export shares remain constant, because the countries exporting the same product and their incomes change. For a within-country FDI regression, that creates a distinction between composition change in the host and revaluation of the global product-income scale.

A fixed product scale tracks export-share changes against a common income benchmark, while annual scores incorporate changes in exporter incomes and world specialization. Related measurement work by Miao and Strik [27] separates basket and PRODY effects when comparing gross-export and value-added measures of sophistication. Their comparison differs from the temporal accounting used here, but reinforces the need to distinguish export composition from the product-income scale. The analysis retains both annual and fixed scores and examines their divergence in the product-level accounting; neither measure directly identifies technological change within products.

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Table 2. Research Questions and Observable Comparisons

Question	Comparison	Economic interpretation
Exposure	Flow versus stock; paired standardization	Annual transactions and accumulated presence
Timing	t/L1/L2/L3; common 2010–2024 observations	Timing at fixed sample composition
Export universe	Total versus manufacturing; manufacturing share	Basket reallocation and manufacturing weight
Product scores	Annual versus fixed; leave-one-out diagnostic	Domestic composition and global revaluation
Benchmark	China versus total inward FDI	Relation to economy-wide foreign capital

- Notes: Each comparison holds the remaining stated dimensions constant where data coverage permits.

Full coefficient tables, paired comparisons and supplementary measurement results are provided in the separate Supplementary Appendix (Tables A1–A17 and Fig. A1). Tables A9–A11 report matched-sample, country-influence and all-country endpoint diagnostics.

III. DATA AND EXPORT MEASUREMENT

The outcome panel covers 54 African countries over 2003–2024 and contains 1,179 country-year observations. MOFCOM's comparable all-industry investment window is 2007–2024, with records for 52 countries: Eswatini and Somalia have no investment observations in the assembled panel. Of 936 potential country-years, 861 flow and 917 stock values are reported; 860 and 916 respectively match the outcome panel. São Tomé and Príncipe has partial investment coverage but no observations meeting the joint current-and-lagged exposure requirements. The common FE-only sample therefore includes 51 countries and 666 country-year observations over 2010–2024. Missing values remain missing, and requiring log GDP and log population reduces the common sample to 644 observations. Table 3 documents the sources and construction choices.

Table 3 Sources and Construction Decisions

Source	Use	Period	Key decision
MOFCOM bulletins	Chinese OFDI flow/stock	2007-2024	52 economies; negative flows retained; missing values not zero-filled
CEPII BACI HS02 V202601	Bilateral merchandise trade	2002-2024 raw	Aggregated to exporter-product-year; global PRODY universe
World Bank WDI	PPP income for PRODY; current-dollar GDP and population for controls and investment ratios	2003-2024	PPP income: retrieved 13 July 2026. GDP/population releases: 2026-04-08.
UNSD concordance	HS02 -> SITC Rev.3	Static mapping	Manufacturing = sections 5-8 excluding 667 and 68
UNCTAD	Total inward FDI flow/stock	Available overlap	Secondary benchmark only

- Notes: Source-specific coverage is not the regression sample; exact samples are reported separately.

➢ *Investment Exposure*

Chinese OFDI flows and stocks are obtained from country tables in MOFCOM's annual Statistical Bulletin of China's Outward Foreign Direct Investment. The analysis uses 2007–2024 because these observations cover all industries on a comparable basis. Earlier country series follow a non-financial reporting regime and are excluded to avoid conflating a change in statistical coverage with investment growth.

Both series are expressed in USD million. The matched flows include 144 negative and six zero observations. Negative net transactions can reflect withdrawals or repayments while an established investment position remains in the host economy; they are retained in the analysis.

Flow is strongly skewed: the matched-sample mean is USD 68.4 million and the median USD 14.8 million. Stock averages USD 604.7 million. Flow uses asinh(x), with x measured in USD million; negative and zero values are retained. Stock uses ln(1+x). These are unit-dependent nonlinear scales, not universal percentage effects. Raw levels, GDP ratios, asinh(stock) and ln(stock) are sensitivity checks. Table 4 reports actual descriptive coverage, which differs between investment variables and the longer outcome panel.

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Table 4 Descriptive Statistics

Variable	N	Mean	Median	SD	Min	Max
Chinese OFDI flow, USD mn	860	68.4	14.8	215.5	-814.9	4807.9
Chinese OFDI stock, USD mn	916	604.7	183.3	1007.7	0.2	7472.8
Total EXPY, dynamic	1179	17379.4	16530.3	6401.2	3691.5	40609.4
Total EXPY, static	1179	16329.1	15071.8	6277.1	3210.0	37899.6
Manufacturing EXPY, dynamic	1179	25437.4	25527.3	6707.9	3903.6	55327.5
Manufacturing EXPY, static	1179	24186.4	24185.1	5537.9	7614.3	50924.3
Manufacturing export share	1179	0.209	0.113	0.218	0.001	0.988
Resource-core export share	1179	0.341	0.192	0.339	0.000	0.998

- Notes: Investment: matched 2007–2024 observations in USD million. Outcomes/shares: 2003–2024, N = 1,179; EXPY in constant 2021 international dollars. SD is the sample standard deviation. Unweighted country-year statistics.

Table A16 reports descriptive statistics for the exact common estimation sample, complementing the broader coverage in Table 4. It uses the logged outcomes and transformed investment measures entering the baseline regressions.

Fig. 1 reports annual cross-country medians and interquartile ranges for flows and stocks. These distributions describe the observed economies in each year; they do not measure transaction-level volatility or track a constant set of countries.

➢ *Product Scores and Export Baskets*

Export data come from CEPII BACI HS02 release V202601 (Gaulier & Zignago [28]), using a single harmonized HS revision over the full required period. Raw bilateral records are aggregated over importers to exporter-product-year trade. The article outcomes begin in 2003; 2002 is retained as source coverage but not used as the article outcome year. PRODY is calculated from a broad global exporter universe rather than from African countries alone. Restricting the income weights to Africa would make product sophistication partly a ranking within the African sample and would weaken the interpretation of EXPY as the income content of products in world trade.

Exporter income is measured by World Bank GDP per capita at purchasing power parity in constant 2021 international dollars, using the data release retrieved on 13 July 2026. This common real-income scale reduces the influence of nominal exchange rates and cross-country price-level differences on product rankings.

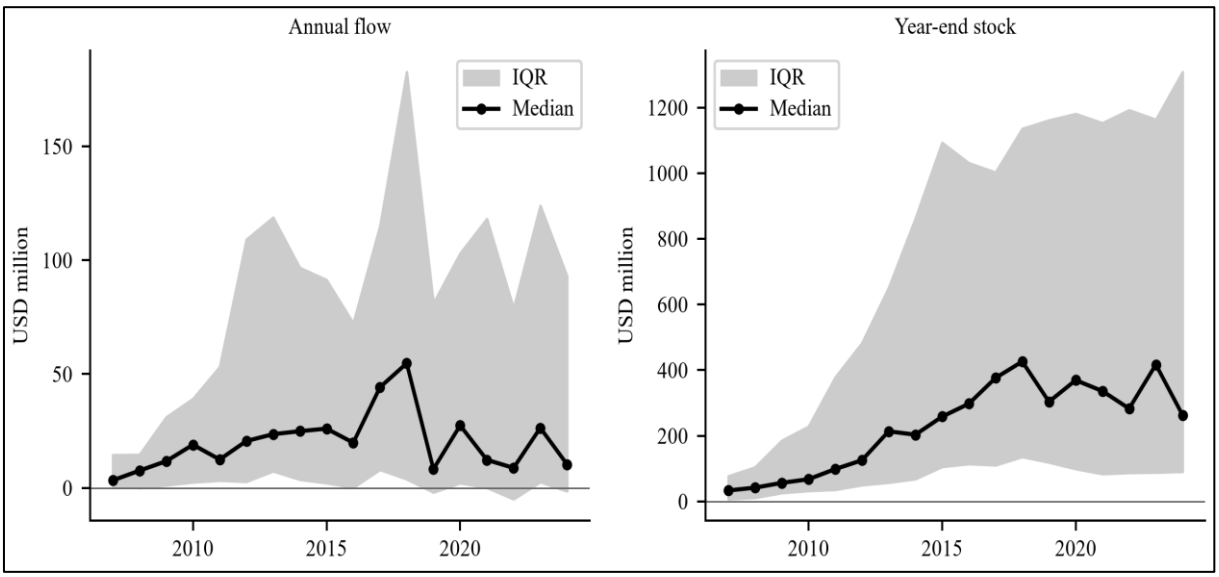


Fig 1 Annual Flow and Stock Distributions

- Notes: MOFCOM matched panel, 2007–2024; median and interquartile range across observed economies each year. Coverage varies by year; bands are dispersion, not confidence intervals.

For product k in year t, dynamic PRODY is computed using normalized revealed export shares:

$$\text{PRODY}_{kt} = \sum_j \frac{\frac{x_{jkt}}{x_{jt}}}{\sum_l \frac{x_{lkt}}{x_{lt}}} Y_{jt} \quad (1)$$

Country-level EXPY is then:

$$\text{EXPY}_{it} = \sum_k \frac{x_{ikt}}{x_{it}} \text{PRODY}_{kt} \quad (2)$$

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Here x is the export value of an HS4 product, X total merchandise exports and Y purchasing-power-adjusted income per capita. The global exporter index is j, and i denotes the African economy. Manufacturing EXPY uses the same product scores with shares normalized within manufacturing exports. Contributions with unavailable scores are omitted without renormalizing the remaining shares; the endpoint decomposition reports the corresponding coverage residual. EXPY enters the regressions in logarithms. The global PRODY denominator includes exporters with both observed trade shares and available income data; it is not restricted to the African estimation sample.

The fixed score is the arithmetic mean of available annual PRODY values in 2003–2006. This reference precedes the comparable investment window and keeps later changes in exporter incomes out of the benchmark. It provides a common scale for tracking basket reallocation over 2007–2024. Annual PRODY supplies a complementary measure in which the income content of products evolves with world trade. Neither scale measures within-product quality or domestic value added.

The article constructs total and manufacturing outcomes independently. Manufacturing is identified through the official UNSD correspondence from HS02 to SITC Revision 3. The operational definition follows SITC sections 5-8 excluding group 667 and division 68. At the working HS4 level, 857 codes have an unambiguous manufacturing classification; 15 mixed HS4 codes are excluded rather than assigned an arbitrary status. This conservative mapping protects the manufacturing basket from classification decisions that cannot be defended from the concordance.

Manufacturing EXPY measures income content conditional on the manufacturing basket; its economic weight is reported separately as the manufacturing share of merchandise exports. This separates upgrading within manufacturing from expansion of manufacturing in the export structure. The 15 excluded mixed HS4 groups account for 0.852% of pooled export value in 2003–2024.

Mean total annual-score and fixed-score EXPY are 17,379 and 16,329, compared with 25,437 and 24,186 for manufacturing. The total–manufacturing correlation is 0.388 under annual scores and 0.278 under fixed scores. Annual and fixed measures correlate at 0.952 for total exports and 0.741 for manufacturing (Fig. A1). Fig. 2 presents annual means indexed to 2007. These descriptive statistics use the available outcome panel, rather than the common regression sample.

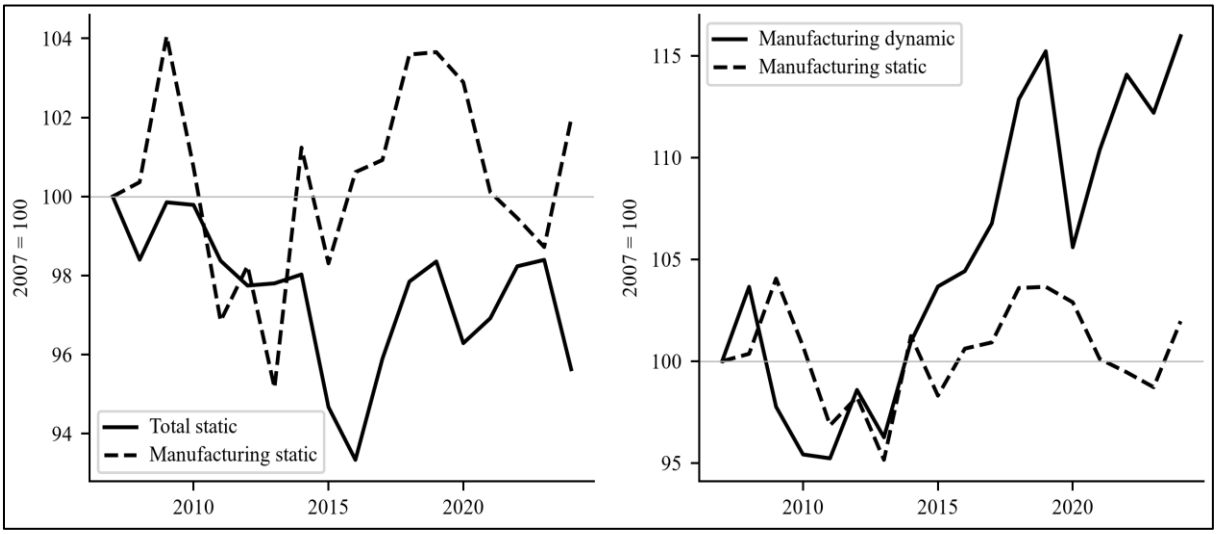


Fig. 2. Total, manufacturing and product-score trajectories

- Notes: BACI and WDI; unweighted means across economies observed in each year, indexed to 2007 = 100. Left: total and manufacturing EXPY under fixed scores. Right: manufacturing EXPY under annual and fixed scores. Country coverage can vary by year.

Morocco and Nigeria illustrate how the size and composition of manufacturing qualify the aggregate measure (Table 5). The endpoints, 2007 and 2024, span the comparable investment period. These contrasting baskets are used for descriptive accounting; investment ownership is not assigned to the observed product changes.

Morocco's passenger-vehicle share (HS 8703) rises from 0.34% to 12.89% of merchandise exports. At a fixed product score of 36,629, its contribution to total static EXPY increases by 4,597 points, exceeding the net aggregate gain of 3,984 because other products partially offset it. Insulated electrical conductors (HS 8544) gain share from 8.26% to 10.71%, but carry a lower score of 15,616. Manufacturing's share of merchandise exports rises from 63.00% to 76.90%. Fig. 3 reports the selected product contributions.

Nigeria's crude petroleum (HS 2709) has a fixed score of 26,759, well above that of electrical conductors. Its share falls from 86.02% to 63.49%, reducing its direct contribution by 6,029 points; changes in other products offset most of this loss, leaving total static EXPY only 673 points lower. Manufacturing remains approximately 2% of merchandise exports.

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Table 5 Export Composition and Income Content at Two Endpoints

Country / year	Mfg share, %	Total static	Mfg static	Mfg dynamic
MAR 2007	63.00	16998	18272	19289
MAR 2024	76.90	20983	22799	27297
NGA 2007	2.14	26951	22607	23657
NGA 2024	2.00	26278	21325	24939

- Notes: BACI HS02; article manufacturing concordance; fixed 2003–2006 scores. EXPY: constant 2021 international dollars. Mfg share uses all merchandise exports as denominator. MAR = Morocco; NGA = Nigeria.

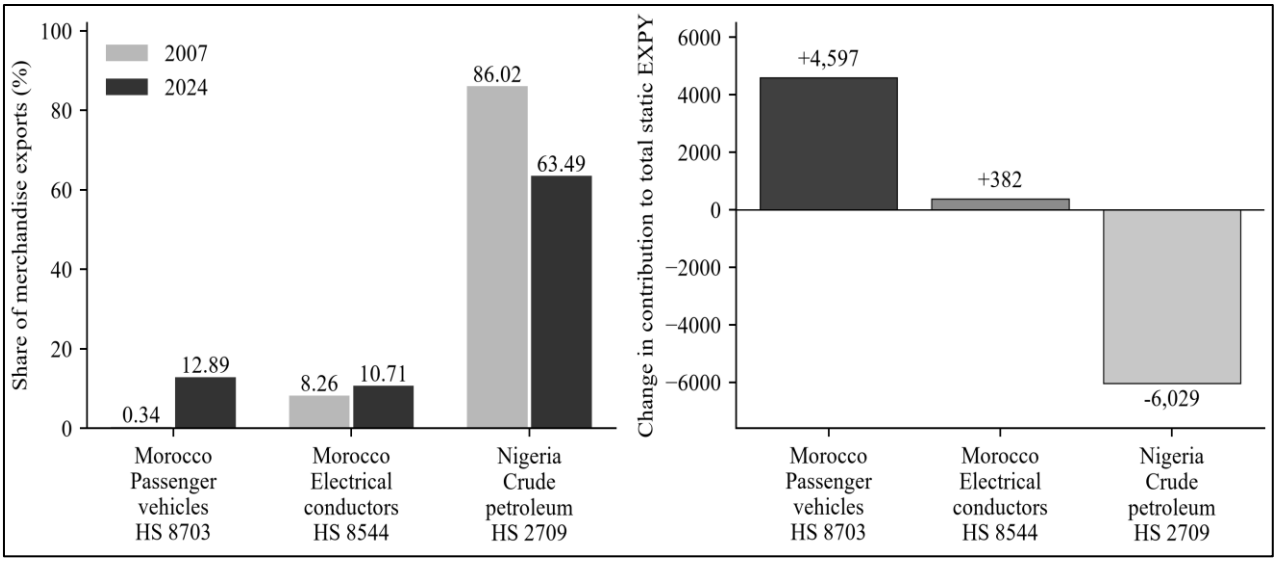


Fig 3 Product Shares and Contributions to Export Income Content

- Notes: BACI HS02, 2007 and 2024; fixed PRODY averaged over 2003–2006. Left: share in all merchandise exports. Right: change in share × fixed PRODY, in constant 2021 international dollars. Selected products are illustrative and do not sum to the total change.

As a measurement diagnostic, leave-one-country-out PRODY excludes the evaluated exporter from both the income-weighted numerator and the product-share denominator. Four common-sample L1 flow regressions use these outcomes to assess whether the host country's own contribution to global product scores drives the annual-flow findings.

Income and population can influence investment allocation and export composition, while also responding to investment. Model B therefore adds contemporaneous natural logs of GDP in current US dollars and total population as a sensitivity specification. The controls use World Bank WDI series NY.GDP.MKTP.CD and SP.POP.TOTL, respectively, from archived releases last updated 2026-04-08. The same current-dollar GDP series supplies the denominator of the investment-to-GDP ratios. This GDP control differs from the constant-2021-PPP per-capita income used to construct PRODY. Table A1 in the separate Supplementary Appendix reports all 32 investment coefficients on Model B's common sample, with standard errors and p-values.

UNCTAD inward FDI flows and stocks provide a benchmark for economy-wide foreign-capital exposure. These totals include Chinese investment and have their own statistical coverage and valuation rules. The analysis estimates analogous outcome and horizon comparisons without subtracting MOFCOM values from UNCTAD totals.

➢ *Endpoint Accounting*

Endpoint accounting separates changes in annual-score EXPY between 2007 and 2024 into a symmetric export-share component, a product-score component and a coverage component. Let E denote annual-score EXPY, s a product's share in the relevant export basket, P its annual PRODY score, and J the set of products with scores at both endpoints. Bars denote arithmetic means of the two endpoint values and Δ denotes the later value minus the earlier value. For each country and export basket, the exact identity is:

$$\Delta E_i = C_i + R_i + K_i = \sum_{k\in J} \Delta s_{ik} \overline{P}_k + \sum_{k\in J} \Delta P_k \overline{s}_{ik} + K_i \quad (3)$$

The first sum is composition C; the second is global product revaluation R. Coverage K is the later minus earlier contribution from products with a score at only one endpoint. A missing score contributes nothing at that endpoint; retained export shares are not renormalized. Products absent from an endpoint basket have zero export value there. The identity is checked against the constructed EXPY outcomes for every country. Results are expressed in constant 2021 international dollars.

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Fixed-score EXPY instead evaluates both baskets using product scores averaged over 2003–2006. Its change is therefore distinct from C, which uses the mean of the two endpoint scores. The fixed scale answers how export composition changes under a historical income benchmark; annual scores also incorporate changing world income and specialization. Neither scale directly measures technological progress within a product. Endpoint results describe 53 countries with both endpoints; South Sudan is excluded from this accounting because 2007 coverage is unavailable.

IV. EMPIRICAL STRATEGY

➢ *Specification and Sample Comparability*

The baseline equation is:

$$\ln(\text{EXPY}_{it}^{m}) = \beta_h \text{FDI}_{i,t-h} + \alpha_i + \lambda_t + \varepsilon_{it} \quad (4)$$

Here i denotes the host economy, t the year, m one of the four outcome measures and h the exposure horizon, from zero to three years. FDI is asinh(flow in USD million) or ln(1 + stock in USD million), estimated separately. Country and year effects are α and λ.

Country fixed effects absorb persistent national characteristics; year effects absorb common annual shocks. Identification is therefore based on deviations of investment exposure and export sophistication from their country and year components. The coefficients summarize conditional within-country associations.

Time-varying policies, commodity shocks and anticipated export opportunities can jointly affect investment and exports. The specification does not eliminate these sources of confounding or reverse causality, so β_h is not assigned a causal interpretation. The separate horizon coefficients describe associations with dated exposure rather than a jointly estimated distributed-lag response.

Model A includes country and year fixed effects. Model B adds log GDP and log population. The original common samples contain 666 and 644 observations, respectively. To separate the role of coverage from that of conditioning, A is also estimated on exactly the same 644 observations as B for every exposure, horizon and outcome. The A-original to A-matched change describes sample sensitivity; the A-matched to B-matched change describes conditioning on those observations. These coefficient differences are descriptive comparisons, not tests of a causal contribution of the controls. Investment transformations, outcome definitions and horizons remain unchanged.

The full-available samples begin in 2007 for contemporaneous exposure, 2008 for L1, 2009 for L2 and 2010 for L3. A lag profile estimated on these samples combines a change in exposure timing with the removal of early observations. This matters if investment allocation or export composition differs across the omitted years and countries.

The analysis therefore prioritizes a common sample of 666 observations from 51 economies over 2010–2024, identical across both exposures, all four outcomes and all four horizons. Full-available estimates retain more observations at each horizon and show the sensitivity to this restriction. The comparison identifies sample dependence; it does not separately attribute that dependence to particular early years or countries.

➢ *Inference and Exposure Comparison*

Country-clustered inference permits heteroskedasticity and serial dependence within economies, conditional on independence across clusters. Residual diagnostics examine consecutive-year correlation, a fitted-value Breusch–Pagan variance proxy and pairwise cross-sectional dependence. The proxy uses a conventional reference distribution rather than a cluster-robust auxiliary test. Non-rejection of cross-sectional dependence does not establish independence. CR1 correction and t inference with 50 degrees of freedom are used for the 51-country common sample. The cluster correction follows Cameron and Miller [29]; its exact implementation is specified in the Supplementary Appendix.

Driscoll–Kraay standard errors with a Bartlett kernel and bandwidth two provide a complementary calculation allowing cross-sectional and temporal dependence (Driscoll and Kraay [30]). Country-clustered CR1 inference remains the baseline. The common sample spans only 15 years, so the alternative covariance estimate is treated as a sensitivity check, not as decisive evidence of more accurate inference.

The analysis reports coefficient magnitudes and confidence intervals alongside p-values. The results are evaluated across outcomes and horizons because an isolated rejection provides limited support for a general upgrading relationship. The intervals also show the range of associations consistent with the estimated sampling uncertainty.

Benjamini and Hochberg [31] adjusted p-values, denoted q-values, are calculated within 16-test families consisting of four outcomes and four horizons, separately by exposure, control specification and sample design. Named robustness checks use four-outcome families. The conventional log-stock estimates and the paired stock–flow comparisons each form a separate 16-test family. These adjustments address multiplicity within the stated comparisons, not across the entire article. The procedure targets the false discovery rate under its dependence conditions; it does not control the probability of any false rejection across the article.

Raw flow and stock coefficients are not directly comparable because IHS flow and ln(1 + stock) have different scales and within-country variation. To compare exposures directly, the supplementary comparison converts each coefficient into a standardized within-country association:

$$\beta_{std} = \beta \times \frac{\text{SD(FE−residual FDI)}}{\text{SD(FE−residual ln EXPY)}} \quad (5)$$

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SD is calculated after residualizing each variable on country and year fixed effects on the same 666 observations. A paired bootstrap resamples the 51 country clusters with replacement 2,000 times, refits both regressions and recalculates the standard deviations in each replication. Table A4 reports all 16 stock-minus-flow contrasts, percentile 95% intervals, two-sided centered-bootstrap p-values with a plus-one correction and family-adjusted q-values. The comparison concerns standardized associations rather than equal-dollar interventions. Product-score estimation uncertainty is not included in these intervals.

The robustness analysis varies investment scaling, sample composition and the covariance estimator while preserving the baseline definitions. Table A14 reports the L1 fixed-score manufacturing comparisons; Table A6 supplies their unstandardized coefficients. Tables A5, A7 and A8 contain the full log-stock, full-available flow and full-available stock matrices. A UNCTAD benchmark applies the same outcome and horizon framework to total inward FDI.

V. RESULTS

➢ *Residual Diagnostics*

For the four common-sample L1 flow models, residual AR(1) is approximately 0.30–0.46 (Table 6). The fitted-value variance proxy indicates nonconstant variance; the cross-sectional-dependence tests have p-values above 0.05. Table A15 reports the stock diagnostics. For baseline L1 fixed-score manufacturing stock, residual correlation is 0.311, the variance-proxy p-value is 0.018 and the cross-sectional-dependence p-value is 0.414. With GDP and population controls, the respective values are 0.363, 0.020 and 0.510.

Table 6 Common-Sample L1 Flow Diagnostics

Outcome	Residual AR(1)	BP stat.	BP p	Pesaran CD	CD p
Total dynamic	0.462	28.64	8.70e-08	0.142	0.887
Total static	0.382	30.52	3.31e-08	1.517	0.129
Manufacturing dynamic	0.361	116.26	4.17e-27	-0.780	0.435
Manufacturing static	0.302	4.30	3.81e-02	-0.564	0.573

- Notes: Four FE-only L1 flow models, 666 observations, 51 countries. BP uses the fitted-value proxy. Non-rejection of CD does not establish independence.

➢ *Annual Transactions and Accumulated Positions*

Table 7 reports contemporaneous estimates on the common sample used for all exposure and horizon comparisons. Tables A2–A3 and Figs. 4–5 show the full common-sample profiles. All use 666 observations from 51 economies over 2010–2024. The flow estimates for total annual-score EXPY are 0.0008, 0.0001, −0.0002 and −0.0005 from t through L3, with p-values between 0.693 and 0.918. Total fixed-score estimates also remain imprecise. Manufacturing annual-score estimates are positive at t–L2 and approximately zero at L3.

Table 7 Contemporaneous Estimates on the Common Sample

Outcome	Flow β (SE)	p / N	Stock β (SE)	p / N
Total dynamic	0.0008 (0.0019)	0.693 / 666	0.0110 (0.0256)	0.668 / 666
Total static	-0.0001 (0.0020)	0.960 / 666	0.0022 (0.0252)	0.931 / 666
Manufacturing dynamic	0.0037 (0.0031)	0.240 / 666	0.0193 (0.0283)	0.498 / 666
Manufacturing static	0.0035 (0.0017)	0.052 / 666	0.0285 (0.0181)	0.121 / 666

- Notes: Identical 666 observations, 51 countries, 2010–2024; country/year FE; country-clustered CR1 SE. Outcome: ln EXPY. Flow: asinh(USD million); stock: ln(1 + USD million). Raw p-values; no coefficient passes its corresponding 16-test exposure-family adjustment. Full-available estimates: Table A17.

Fixed-score manufacturing gives the clearest positive flow estimates, but they decline from 0.0035 at t (p = 0.052) to 0.0021 at L1 (p = 0.182), 0.0018 at L2 (p = 0.185) and 0.0009 at L3 (p = 0.585). Fig. 4 shows this attenuation alongside the absence of a comparable aggregate pattern. The point estimates decline across the four separately estimated horizons.

➢ *Accumulated Exposure and Temporal Differences*

The stock results differ by export universe (Table A3 and Fig. 5). For total dynamic EXPY, the coefficient increases from 0.0110 at t to 0.0416 at L3 (p = 0.068). Total static EXPY reaches 0.0372 at L3 (p = 0.093).

For fixed-score manufacturing EXPY, the common-sample stock coefficient is 0.0285 at t, 0.0356 at L1, 0.0259 at L2 and 0.0181 at L3; the corresponding p-values are 0.121, 0.033, 0.144 and 0.272. At L1 the standardized association is 0.137 residual standard deviations. Only L1 is nominally significant, and none of the 32 core common-sample coefficients passes its exposure-specific family adjustment. Annual-score manufacturing estimates remain close to zero.

Fig. 6 and Table A12 show the sensitivity of stock estimates to the common-sample restriction. The full-available L1 coefficient for fixed-score manufacturing is 0.0434, compared with 0.0356 on the common sample; contemporaneous and L2 estimates lose nominal significance after the restriction. Table A17 reports the full-available contemporaneous comparison.

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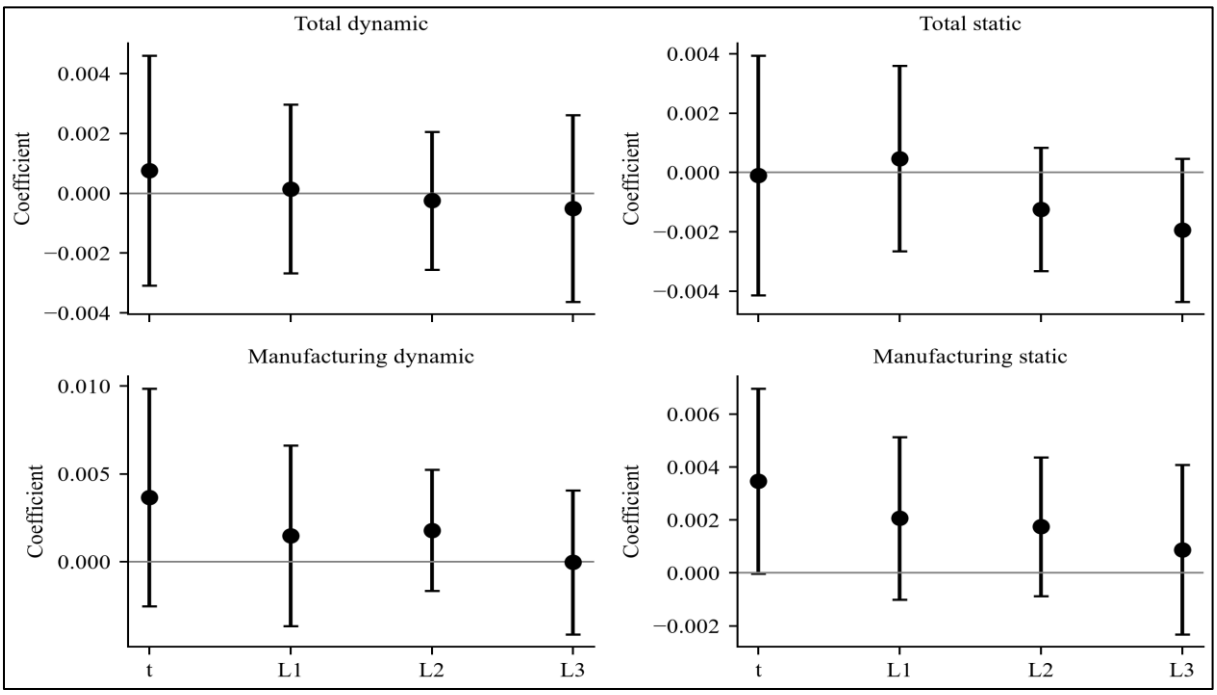


Fig 4 Common-Sample Flow Estimates

- Notes: 666 identical observations, 51 countries, 2010–2024; country/year FE; cluster-t 95% CI, df = 50; zero reference. Separate regressions, not a distributed-lag model. Exact coefficients and p-values: Tables A2–A3.

Standardization expresses each exposure association in residual standard deviations of the outcome per residual standard deviation of investment. Table A13 focuses on fixed-score manufacturing; Table A4 and Fig. 7 show every paired stock–flow contrast. Pairing preserves the common country-year information in the two estimates.

For fixed-score manufacturing, the contemporaneous standardized flow and stock coefficients are 0.099 and 0.110, a small difference of 0.011. At L1 they are 0.056 and 0.137, a difference of 0.081 with a 95% interval of [−0.038, 0.194].

The largest standardized stock–flow differences occur for total exports at L3: 0.160 for annual-score EXPY (95% CI [0.009, 0.300], p = 0.031) and 0.187 for fixed-score EXPY ([0.048, 0.320], p = 0.009). Their q-values are 0.248 and 0.152; neither survives adjustment across the 16 comparisons.

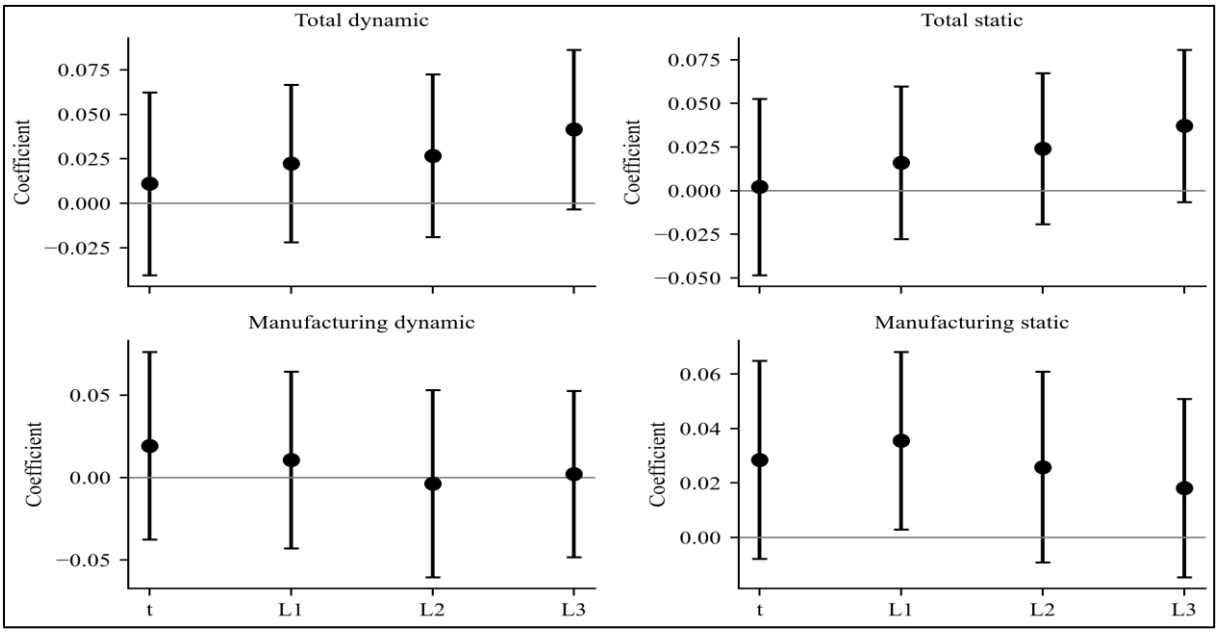


Fig 5 Common-Sample Stock Estimates

- Notes: 666 identical observations, 51 countries, 2010–2024; country/year FE; cluster-t 95% CI, df = 50; zero reference. Separate regressions, not a distributed-lag model. Exact coefficients and p-values: Tables A2–A3.

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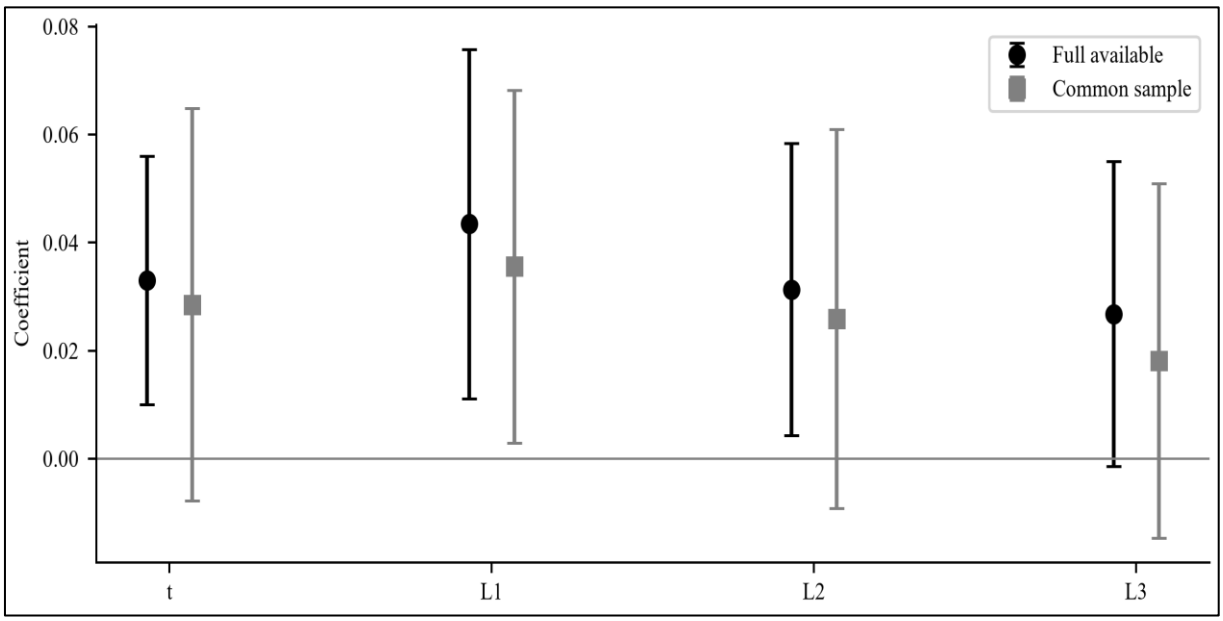


Fig 6 Stock Profile and Sample-Composition Sensitivity

- Notes: Static manufacturing EXPY; same specifications as Table A12; cluster-t 95% intervals; full and common estimates are dependent, not independent treatment groups.

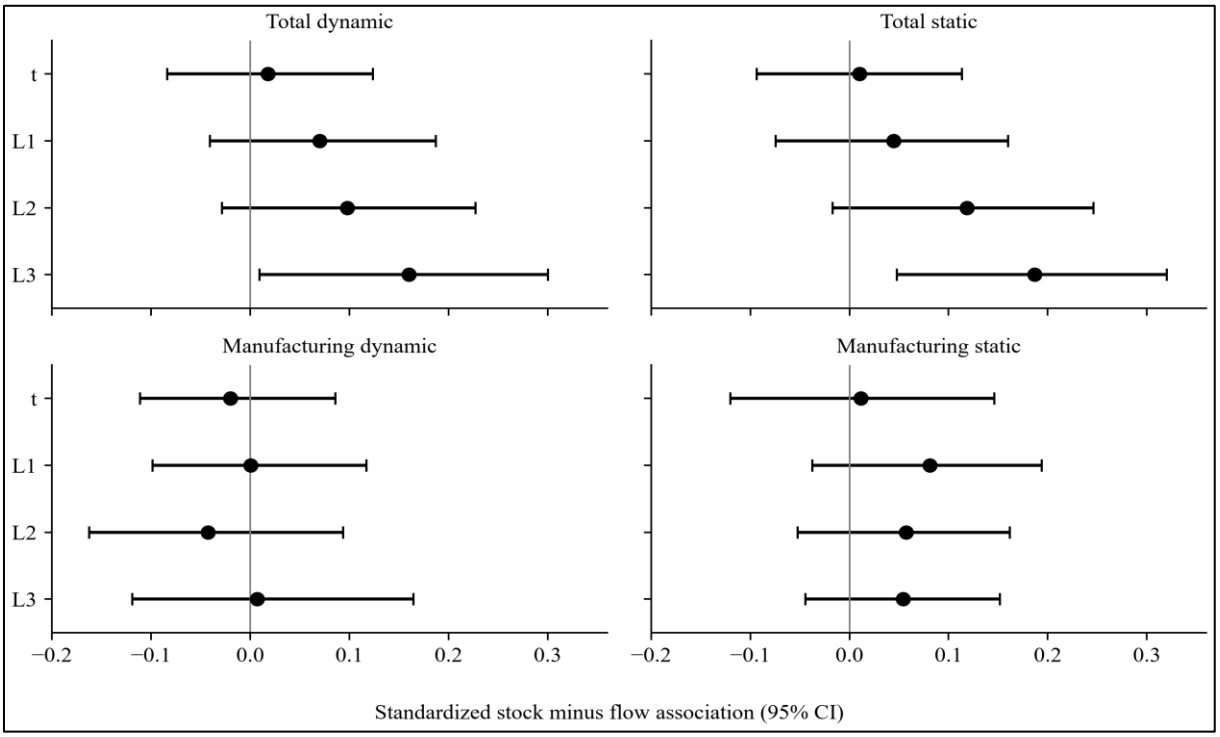


Fig 7 Stock–Flow Differences by Basket and Horizon

- Notes: All 16 contrasts in Table A4; N = 666, 51 economies, 2010–2024. Dots: standardized stock minus flow association. Bars: paired country-bootstrap 95% intervals, 2,000 replications. Intervals are not multiplicity-adjusted.

➢ *Basket Reallocation and Global Product Revaluation*

The endpoint accounting defined in Section III.C covers 53 countries with usable 2007 and 2024 observations. Table 8 summarizes the incidence of contrasting trajectories; Table A11 reports every country, and Fig. 8 illustrates the components for Morocco and Nigeria. This descriptive sample differs from the 51-country regression sample. Fixed-score changes are shown alongside the symmetric composition component because the historical and endpoint-mean product weights answer different measurement questions.

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In Nigeria, manufacturing dynamic EXPY increases by 1,282 points between 2007 and 2024 even as its fixed-score counterpart falls by 1,282. The symmetric decomposition attributes −753 points to changes in product shares and +2,036 to global product revaluation, with a −1.48-point coverage residual. Revaluation thus more than accounts for the entire positive dynamic change.

Morocco displays a different combination: composition contributes 4,586 points and revaluation 3,422 to the 8,008-point dynamic manufacturing increase, with a −0.26 coverage residual. Its fixed-score increase is 4,528. Basket change and global revaluation therefore reinforce one another, although revaluation accounts for about 43% of the dynamic increase.

Across the 53 countries, annual-score manufacturing EXPY rises in 41 economies, but fixed-score EXPY rises in only 28. Nineteen economies combine an annual-score increase with a fixed-score decline, and 20 combine an annual-score increase with a negative symmetric composition component. For total exports, the corresponding divergence counts are 14 and 17. Revaluation and composition have opposite signs in 30 manufacturing baskets and 32 total baskets.

Table 8 Prevalence of Contrasting Export-Income Trajectories

Basket	Countries	Annual rises	Fixed rises	Annual up / fixed down	Annual up / composition down
Manufacturing	53	41	28	19	20
Total	53	35	22	14	17

- Notes: Endpoint comparison, 2007–2024. Counts refer to the 53 countries with both endpoints, not the regression sample. Complete country results: Table A11.

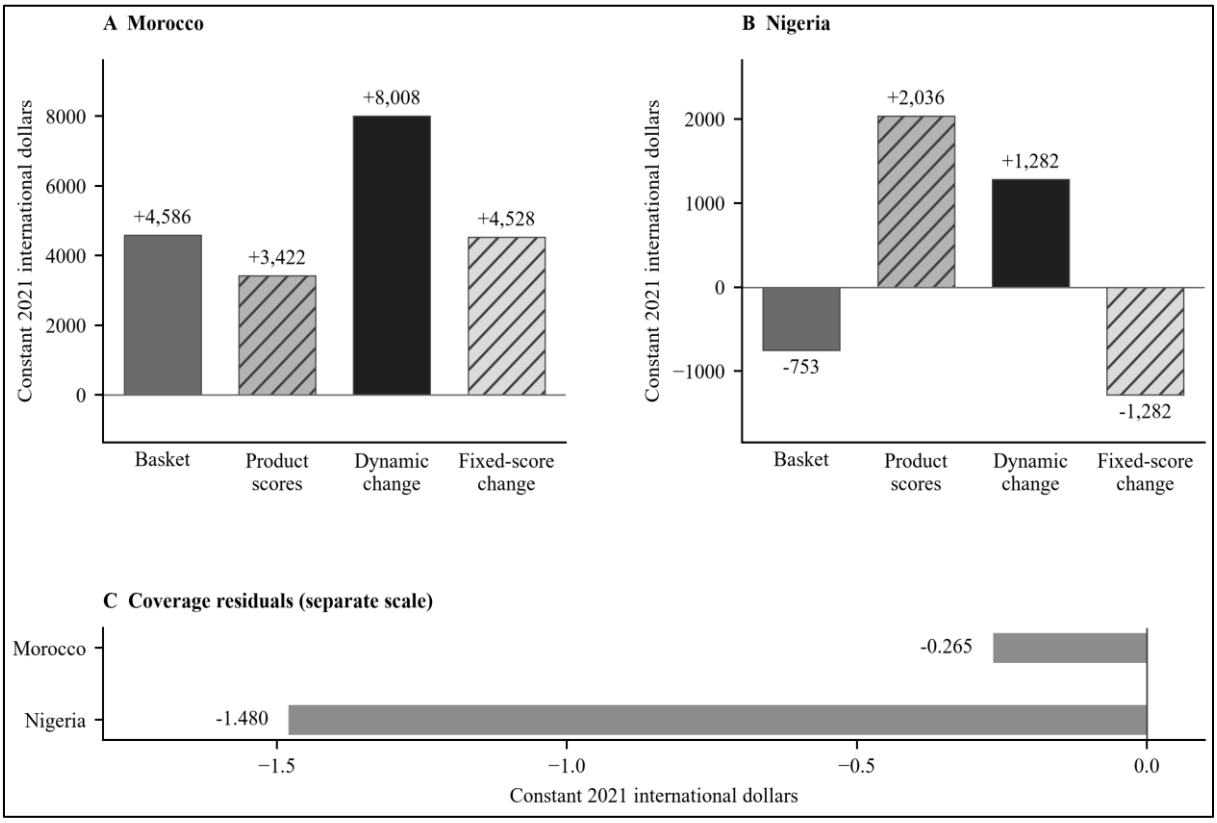


Fig 8 Manufacturing EXPY Change: Composition and Revaluation, 2007–2024

- Notes: BACI product records and WDI scores. For shares s and scores P, composition = $\Sigma\Delta s(P_{2007} + P_{2024})/2$ and revaluation = $\Sigma\Delta P(s_{2007} + s_{2024})/2$ on products with both scores. Coverage is the remaining contribution from products lacking an endpoint score. Their sum equals dynamic change. The fixed-score change is shown separately. Units: constant 2021 international dollars. Panel C uses a separate scale: coverage residuals are −0.265 for Morocco and −1.480 for Nigeria.

For the four L1 flow specifications examined, excluding the host exporter from PRODY leaves the coefficients statistically imprecise: −0.0009 for total annual-score EXPY (p = 0.660), 0.0005 for total fixed-score EXPY (p = 0.795), approximately −0.0003 for manufacturing annual-score EXPY (p = 0.902), and 0.0014 for manufacturing fixed-score EXPY (p = 0.254). This diagnostic covers the four L1 flow specifications only.

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➢ *Investment Intensity and Robustness*

Table A14 reports the investment-scaling comparisons. At L1, the standardized stock association is approximately 0.137 under ln(1 + stock), asinh(stock) and ln(stock), but only 0.007 in raw dollar levels. Stock/GDP gives a larger standardized estimate of 0.184 (raw β = 0.9752, p = 0.0039, q = 0.0156). Flow/GDP gives 0.095 (p = 0.0237, q = 0.095). The GDP-ratio estimates use 646 observations. The full ln(stock) matrix appears in Table A5; its L1 fixed-score manufacturing estimate is 0.0349 (p = 0.033, q = 0.449).

The matched-sample comparison isolates two sources of attenuation (Table A9). For L1 fixed-score manufacturing stock, A falls from 0.0356 on 666 observations to 0.0298 on the 644 observations shared with B (p = 0.077). Adding GDP and population on those same observations lowers the coefficient to 0.0274 (p = 0.121). The sample change is −0.0058 and the further conditioning change is −0.0024. The separate flow restrictions in Fig. 9 yield standardized estimates of 0.062 after removing the three largest cumulative-flow recipients and 0.062 in the balanced panel; excluding resource-intensive economies yields 0.101 (p = 0.057).

Sequentially omitting each of the 51 countries leaves the focal stock coefficient positive in every re-estimation, ranging from 0.0248 to 0.0395 (Table A10). Seychelles produces the largest absolute change from the full-sample estimate. Forty-four omissions retain an unadjusted p-value below 0.05; none retains q below 0.05 when the 16 stock outcomes and horizons are adjusted within each omission exercise. This diagnostic concerns regression leverage and is distinct from the leave-one-out PRODY construction. Changing covariance estimation also affects precision: for L1 fixed-score manufacturing flow, Driscoll–Kraay lowers the standard error from 0.00153 to 0.00090, while leaving the coefficient at 0.0021. Its p-value changes from 0.182 to 0.037.

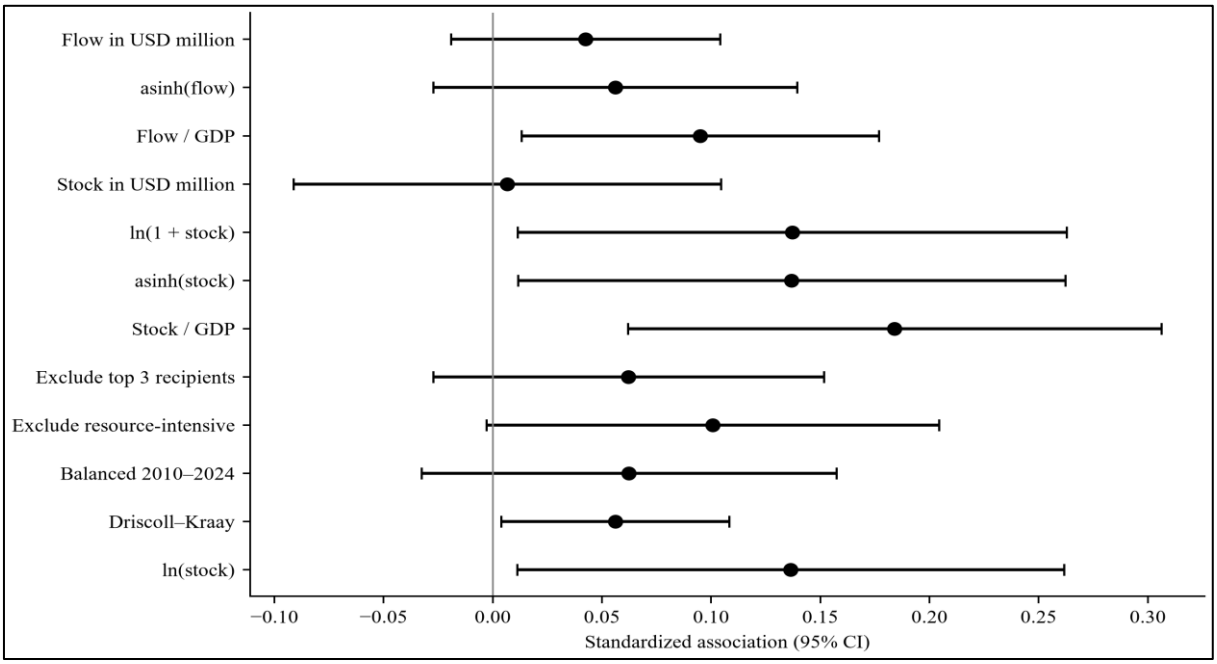


Fig 9 Standardized Robustness by Methodological Category

- Notes: Estimates correspond to Table A14. Horizontal bars indicate 95% confidence intervals. The vertical line marks zero.

Table 9 summarizes the total inward-FDI benchmark. Of 128 estimates combining exposures, horizons, outcomes, control specifications and sample designs, only one has p < 0.05 and none passes its family-level BH adjustment. The exception is full-available global stock at L3 for fixed-score manufacturing EXPY: β = −0.0274, SE = 0.0127, p = 0.036 and q = 0.515, using 948 observations from 53 economies over 2007–2024.

Table 9 Global Inward-FDI Contextual Benchmark

Temporal design	Exposure	Controls	Models	Raw p < 0.05	BH q < 0.05
Common sample	Flow	FE only	16	0	0
Common sample	Flow	GDP and population	16	0	0
Common sample	Stock	FE only	16	0	0
Common sample	Stock	GDP and population	16	0	0
Full available	Flow	FE only	16	0	0
Full available	Flow	GDP and population	16	0	0
Full available	Stock	FE only	16	1	0
Full available	Stock	GDP and population	16	0	0

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- Notes: UNCTAD total inward FDI, including China. There are 16 tests in each exposure/control/sample family, with BH adjustment within that family. The comparison uses UNCTAD coverage and is not a matched comparison of investment origins.

VI. DISCUSSION

The investment results qualify the expectation that accumulated foreign-capital presence is more closely associated with upgrading than annual transactions. The positive fixed-score manufacturing stock estimate is sensitive to sample composition and conditioning, and the paired comparisons do not establish a general stock advantage after adjustment. This evidence is narrower than the positive relationships reported for bilateral sophistication by Rehman and Noman [19] and for host-country EXPY by Shi et al. [20]. Different geographical coverage, trade outcomes and specifications limit a direct comparison. The absence of a systematic positive annual-flow association is closer to Buhari Isah's [21] finding for African export diversification, although diversification and income content measure different outcomes.

The endpoint accounting provides the article's clearest contribution to the measurement literature. The contrasts documented across 53 economies show that the construction sensitivity identified by Huber [4] is empirically consequential for African upgrading assessments. The separation of basket and product-score changes complements Miao and Strik [27], whose gross-export and value-added comparison addresses a different source of measurement variation. Here, rising annual-score EXPY frequently accompanies declining fixed-score income content or a negative composition contribution. Annual-score growth alone is therefore insufficient evidence of favorable basket reallocation.

The country examples give this distinction an economic interpretation. Morocco combines a rising manufacturing share with expansion of passenger vehicles, a product with a higher fixed income score than electrical conductors. Nigeria's aggregate score is heavily influenced by crude petroleum, while its manufacturing income-content increase under annual scores is accounted for by global revaluation despite a negative composition contribution. These are value-based changes in product composition. They do not identify within-product quality gains, domestic value added or the investors financing the observed exports.

Sectoral aggregation offers a plausible explanation for weak national associations alongside visible product reallocation. MOFCOM totals combine investment activities with different export orientations, while total EXPY combines resource products and manufactures. The heterogeneity documented among Chinese manufacturing firms by Chen [16] makes this explanation economically credible. The country-level estimates, however, cannot distinguish foreign-affiliate exports, domestic supplier upgrading and investment selection. The product examples establish changes in the export basket, not the ownership or financing of the firms responsible for them.

Sample matching is consequential for interpreting the stock result: part of the attenuation occurs when observations are restricted, before GDP and population are added. Country omissions preserve the positive sign but do not restore family-adjusted significance. The stock/GDP result concerns a different exposure scale and a smaller sample; it is evidence of sensitivity to how investment intensity is measured, rather than a replacement for the principal stock-family result. Similarly, separate lag coefficients do not identify the timing of a productive response. Annual transactions include reinvestment and withdrawals, while accumulated positions include valuation changes.

Because UNCTAD totals include Chinese investment and have different coverage, this benchmark cannot identify an origin-specific China effect. It supplies context for the weak national relationship between aggregate investment exposure and export income content.

For the assessment of investment policy, these findings support reporting export composition and manufacturing participation alongside aggregate capital flows. Supplier capabilities and export-network participation remain plausible channels in the literature, but the national estimates do not identify which policy instruments strengthen them. The product evidence helps describe the margins on which upgrading occurs; it does not attribute those changes to a particular investment policy.

The interpretation is bounded by country-level identification and measurement. Time-varying selection and common host-country shocks can generate investment–export comovement; the fixed effects and lags do not resolve this endogeneity. MOFCOM country totals also lack the sectoral and ownership detail needed to assign product changes to particular investors. EXPY measures export income content rather than within-product quality or domestic value added, and uncertainty in the estimated product scores is not propagated into the regression intervals. These limits qualify the mechanisms behind the observed associations, while leaving the documented sample and measurement contrasts intact. Persistent country-specific trends may also influence the stock association; country-specific trends and stationarity are not assessed in these specifications.

VII. CONCLUSION

Annual Chinese OFDI flows show no systematic positive association with African export income content. The baseline L1 stock estimate for fixed-score manufacturing weakens with GDP and population controls on identical observations and does not pass the 16-test stock-family adjustment. Its sign remains positive after every individual country omission, but none of those focal estimates passes the corresponding family adjustment. The stock/GDP sensitivity check is significant within its separate four-outcome family; it concerns a different exposure scale and a smaller sample. None of the 16 paired stock–flow

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comparisons survives adjustment. The evidence supports a selective descriptive manufacturing association rather than a general superiority of stocks or an identified investment effect.

The clearest finding concerns measurement. Across 53 countries, annual-score manufacturing EXPY rises while fixed-score EXPY falls in 19; in 20, the annual-score rise coincides with a negative symmetric composition component. Product revaluation can therefore account for measured upgrading even when export-share reallocation moves in the opposite direction. Morocco and Nigeria illustrate the product-level sources of that divergence. Evaluating the association with Chinese investment requires preserving this distinction: the data provide limited support for a general positive investment relationship, while showing that the choice of product-income scale materially changes the description of export upgrading.

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