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Tourism-Derived Revenue Dependence and Within-Year Variability Along the China–Pakistan Economic Corridor: Merchant and Visitor Evidence

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Abstract

Tourism-attributed revenue dependence and within-year variability were examined among sampled merchants along the China–Pakistan Economic Corridor, with visitor and product-market observations providing supporting evidence. The analysis used 240 merchant-month records from 20 merchants in 2024, 1000 visitor-survey responses, 70 matched merchant–trade product-category-month records, and a 720-observation monthly price panel covering 2020–2025. Estimated tourism-attributed merchant sales totaled CNY 2.92 million (64.80% of recorded revenue). The mean coefficient of variation (CV) for tourism-attributed monthly sales exceeded that of total monthly sales (0.369 versus 0.330; paired $t(19) = 3.765$, $p = 0.0013$). Merchant tourist share and QR-scan activity were not significantly associated with adjusted monthly sales. In the visitor survey, QR-code scanning ($\beta = 0.667$), satisfaction ($\beta = 0.319$), and product-category exposure ($\beta = 0.229$) were positively associated with stated post-visit purchase intent (all $p < 0.001$); expenditure and trip duration were not. Matched product-category trade associations were generally imprecise, and the nominal product-price ratio showed no significant category-adjusted monthly trend ($p = 0.283$). These distinct observational records describe merchant revenue dependence, within-year dispersion, and reported visitor intentions but do not identify a causal linkage to exports or long-term business resilience.

Keywords: China–Pakistan Economic Corridor; tourism-derived revenue; economic sustainability; revenue variability; post-visit purchase intent; QR-code engagement; merchant sales; cross-border product prices

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1. Introduction

Tourism-related commercial activity can provide an important source of demand for small retailers and service businesses; however, its contribution to revenue is not necessarily distributed evenly over time. Tourism seasonality has been linked with differences in firm performance and livelihood conditions in tourism-dependent settings [1,2]. Research on destination vulnerability also identifies exposure to external disruptions and concentrated visitor demand as sources of economic risk [3,4]. At the enterprise level, resilience involves capabilities that extend beyond recorded sales, including adaptation, access to resources, and the capacity to respond to disruptions [5,6]. Consequently, the extent to which a merchant relies on visitor purchases and the temporal variability of those purchases are relevant, but distinct, aspects of tourism-related economic sustainability.

Revenue dependence can be expressed as the proportion of recorded sales attributed to tourists, whereas within-year variability concerns changes in monthly revenue relative to

its mean. A substantial tourist-attributed share indicates the importance of visitor demand for the sampled business; it does not establish profitability, financial resilience, or the capacity to withstand future shocks. Likewise, dispersion over twelve months describes variability within the observation year rather than longer-term stability. These distinctions are important when tourist-attributed revenue is estimated from total sales and a merchant-recorded tourist share: changes in the attributed share can alter the variability of the derived revenue series even when the underlying total-sales pattern is unchanged. Research on tourism economic resilience provides a broader setting for these measures but does not make them interchangeable with organizational resilience [7].

The China–Pakistan Economic Corridor (CPEC) provides a setting in which tourism activity, transport connectivity, local retail trade, and development policy intersect. Research in Gilgit-Baltistan has considered tourism demand alongside environmental concerns [8], while studies of community participation and rural development have examined local support and expectations surrounding corridor-related tourism and economic activity [9,10]. Work on transport infrastructure has addressed changes in prospective connectivity [11], and related research has considered tourism and the quality of life of local communities [12]. Institutional studies of CPEC also identify legal and management conditions as part of its wider sustainability context [13]. These strands of evidence explain why the commercial effects of visitor activity warrant attention, but none establishes how much of an individual merchant's monthly revenue is attributable to tourists or whether that component is more variable than total sales.

Visitor experience offers a separate perspective on demand that may persist after travel. Destination satisfaction and country or product image have been associated with post-visit intentions and evaluations of products connected with a destination [14–16]. The theory of planned behavior distinguishes stated intention from subsequent action [17], and tourism research relates experience quality and satisfaction to behavioral intention [18]. A favorable assessment of locally encountered products may therefore be associated with an intention to purchase similar goods after returning home. Such an association cannot be read as evidence of a completed purchase or a transaction recorded by a particular merchant. Nor do expenditure during a trip and the duration of travel necessarily measure the degree of interest in products available for later purchase.

Digital interaction adds another dimension to visitor–merchant contact. Customer-journey research treats informational and transactional touchpoints as potentially different parts of the consumption process [19]. Smart-tourism research describes how technology shapes access to information and the travel experience [20,21], while studies of mobile and tourism payment systems emphasize convenience, acceptance, and payment context [22,23]. A merchant QR-code scan may represent payment, product information, authentication, a coupon, or another brief interaction; a binary indicator does not establish the duration or depth of engagement. Evidence synthesized for social-media influencer marketing links digital engagement with purchase intention in that setting [24], but it does not validate QR scanning as an equivalent measure. Visitor-reported QR activity is therefore best interpreted as a limited indicator of contact with a merchant's digital interface.

The possible relation between visitor encounters and wider product markets requires a further distinction in observational scale. Earlier tourism–trade research identified associations between international travel and bilateral trade flows, including models motivated by information acquisition and reduced uncertainty [25–27]. Product-level trade values and cross-border prices, however, reflect transport costs, border frictions, exchange-rate adjustment, distribution margins, and differences in product composition [28–31]. Retail categories reported by merchants may also be broader than the corresponding customs classifications. Category-level associations can describe contemporaneous patterns, but

without matched purchases or shipments they cannot trace the conversion of individual visitor intentions into exports. A ratio of prices stated in different local currencies is likewise not a common-currency measure of price convergence.

The principal empirical question is how strongly tourism-attributed revenue contributes to sales among sampled CPEC merchants and how its within-year variability compares with variability in their total revenue. Monthly records for 20 merchants during 2024 provide the basis for this comparison, including merchant-specific revenue shares and coefficients of variation. A separate survey of 1000 visitors supplies supporting evidence on QR-code contact, satisfaction, product exposure, and stated post-visit purchase intentions. Matched product-category trade observations for 2024 and a distinct 2020–2025 nominal price series provide exploratory market context.

2. Materials and Methods

2.1. Study Design and Data Structure

The primary analytical unit was the merchant-month. A balanced panel contained monthly observations for 20 sampled establishments across January–December 2024 (N = 240). Recorded monthly sales and the merchant-attributed tourist share were used to estimate tourism-derived revenue, after which the tourist-attributed contribution to recorded sales and within-year coefficients of variation were calculated for each establishment. The comparison of tourism-derived and total-revenue variability was intended to describe the observed components of merchant sales, not long-term financial resilience. Merchant QR-scan counts and a dated policy-event indicator were examined as descriptive covariates in the monthly sales specification. The policy register contained 40 dated records covering 2018–2025; its overlap with the 2024 merchant panel was limited, as described in Section 2.3.

Two additional observational units supplied contextual evidence rather than identified links in a causal chain. The visitor component comprised 1000 anonymized survey records analyzed at respondent level, with post-visit purchase intention measured as a reported ordinal outcome. Visitor identifiers could not be joined to individual merchants or subsequent transaction records. At the product-market level, merchant sales were aggregated by their recorded product-category label and calendar month for comparison with 70 corresponding 2024 trade observations. A separate panel of ten recorded product categories observed monthly from January 2020 through December 2025 contained 720 price observations. Product-category matching was based on reported category labels rather than verified product or shipment identifiers. The nominal price ratios retained their original local-currency units, so they were not treated as measures of common-currency price convergence or market integration. Figure 1 depicts the distinct observation units and the limited aggregation used in the product-category comparison.

2.2. Visitor Survey Variables

The visitor workbook contained 15 fields: anonymized respondent identifier, nationality, residence country, origin-city tier, age band, gender, travel purpose, party type, first-visit status, trip duration, expenditure in CNY, exposure-category count, merchant QR-code engagement, satisfaction, and post-visit purchase intent. Satisfaction and purchase intent were recorded on seven-point ordinal scales. The questionnaire anchored satisfaction from "very dissatisfied" to "very satisfied" (E1) and purchase intention from "extremely unlikely" to "extremely likely" (E2); trip duration and expenditure correspond to C2 and C5. The eligibility questions addressed adult age, corridor travel, and consent (A1–A3). Exposure represented the number of distinct product or service categories encountered (0–5); QR engagement indicated whether the respondent scanned at least one merchant QR code.

These measures correspond to the questionnaire's product-exposure item (D1) and QR-scan item (D3). The highest exposure response in the questionnaire is "5 or more," so the recorded value of 5 is a top-coded category rather than an exact count for respondents above that threshold. QR engagement records a reported scan, without distinguishing payment, product information, or subsequent purchasing. The primary multivariable model included categorical controls for nationality, travel purpose, age band, gender, and party type. The analytic sample consisted of the 1000 recorded responses, without survey weights. All variables required for the reported visitor analyses were complete. The optional post-visit follow-up module was not analyzed in the reported cross-sectional visitor models. The baseline instrument is provided as Supplementary File S1. Although the baseline questionnaire requested trip start and end dates (C1) and visited corridor nodes (C3), these fields and interview dates were not retained in the 15-variable analytical extract. Consequently, the visitor records could not be allocated to individual recruitment months or corridor locations. The visitor survey was covered by an institutional determination of exemption from ethics review.

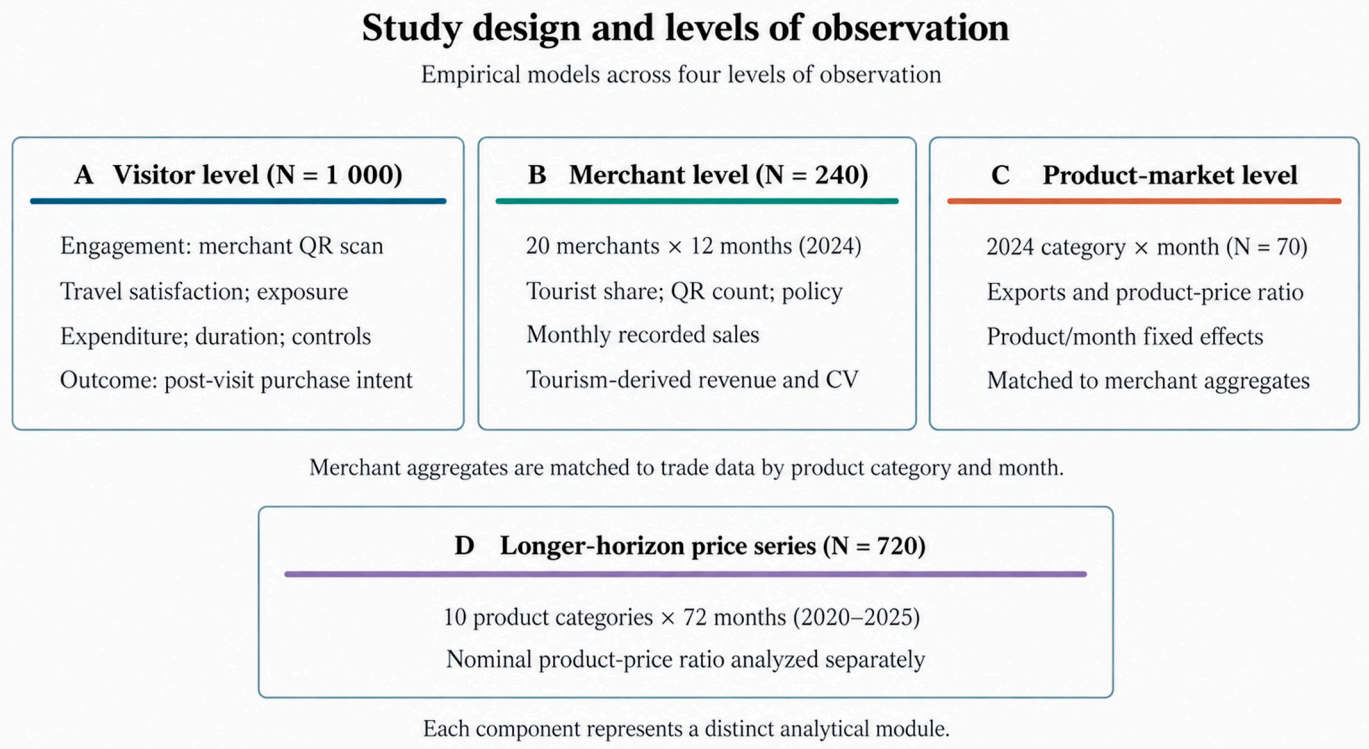


Figure 1. Study design and levels of observation.

2.3. Merchant and Policy Data

The merchant panel covered Gilgit, Hunza, Islamabad, Kashgar, Khunjerab, Lahore, and Sost. Five establishments were recorded in Khunjerab, three each in Gilgit, Islamabad, and Lahore, and two each in Hunza, Kashgar, and Sost. Each establishment contributed monthly observations from January through December 2024 containing sales value (CNY), transaction count, the percentage attributed to tourists, QR-scan count, and a recorded product-category label. The category label could differ across months for the same merchant. Category-month aggregation therefore assigned each merchant-month's recorded sales to its corresponding label. Estimated tourism-derived sales were obtained from the recorded tourist-attributed sales percentages. The tourist-attributed percentage is a recorded merchant-level field, not a count of identified visitor purchases. No purchaser-level classification or transaction-based validation of this percentage is available in the analytical panel;

the attributed revenue is therefore an estimate conditional on the recorded share. Merchant QR counts likewise do not distinguish payment-related scans from other QR interactions.

The policy-event dataset comprised dated entries specifying affected nodes and a binary treatment classification. Events were aligned with merchant records by calendar month and affected node. One positively classified node-month overlapped with the merchant panel: Khunjerab in October 2024, representing five merchant-month observations. The model included this event indicator as a control. The COVID-related indicator was constant across the 2024 observations and was excluded.

2.4. Trade and Price Records

The trade workbook contained HS6 codes, product-category labels, observation month, reported China export value to Pakistan (USD), Pakistan import value (USD), China-side average unit price (CNY/kg), Pakistan-side average unit price (PKR/kg), a separately recorded currency-rate field, and the recorded nominal price ratio. Ten HS6 categories were observed monthly over 2020–2025 (N = 720). Six broad category labels appeared in both the 2024 merchant and trade files—tea, textiles, dry fruit, gemstones, cosmetics, and souvenirs—yielding 70 matched category-month cells. The matching refers to broad recorded labels; the HS6 categories identify more specific product groups, including HS 570110 for wool or fine-animal-hair carpets and HS 950300 for toys. Product-category results are interpreted at the level of these label-based matches. A broad merchant category can contain goods outside its mapped HS6 class. The resulting category-month associations must not be interpreted as product- or shipment-level links. The six label-to-code matches are listed in Supplementary Table S4 in File S2.

The nominal product-price ratio was checked arithmetically against the recorded unit prices and equals the Pakistan-side price divided by the China-side price within rounding precision. The separate currency-rate field varied across product categories within the same calendar month and was excluded from the analysis. Accordingly, the price series is reported as the nominal PKR/CNY ratio of two recorded local-currency prices. The analysis concerns the temporal behavior of that recorded ratio, not currency-adjusted price convergence.

2.5. Derived Variables

Total trip expenditure and merchant sales were transformed using $\ln(\text{value} + 1)$ in the specified regressions. Estimated tourism-derived sales for merchant m in month t were defined as $\text{TouristSales}_{mt} = \text{Sales}_{mt} \times \text{TouristShare}_{mt}/100$. The annual tourism-derived share was calculated as $100 \times \Sigma\text{TouristSales}_{mt}/\Sigma\text{Sales}_{mt}$. Merchant-specific monthly revenue variability was measured using $CV_m = SD(R_{m1}, \ldots, R_{m12})/\text{mean}(R_{m1}, \ldots, R_{m12})$, calculated separately for total and tourism-derived sales. Node-level CVs were obtained from 12 monthly totals aggregated within each corridor node. For a given merchant with a positive constant tourist share, the CV of attributed tourism sales equals the CV of total sales. Differences between the two CVs therefore also reflect monthly changes in attributed tourist share and its co-movement with sales; they do not directly measure liquidity or longer-term business resilience.

Merchant monthly sales and QR-scan counts were summed by category-month, while tourist-attributed percentages were aggregated using the unweighted arithmetic mean of merchant percentages. Contemporaneous dependent variables were $\ln(\text{China export value} + 1)$ and the nominal product-price ratio, defined as Pakistan-side mean price (PKR/kg) divided by China-side mean price (CNY/kg). The longer product-price series was summarized using 120 observations per year (ten categories × twelve months). All reported models used available observations without imputation or winsorization.

2.6. Statistical Estimation

The visitor-level OLS model specified purchase intent as a function of QR engagement, satisfaction, exposure category count, ln(expenditure + 1), trip duration, first-visit status, and categorical controls for nationality, travel purpose, age group, gender, and party type. HC3 heteroskedasticity-consistent standard errors were used. An ordered-logistic specification with identical predictors assessed the stability of estimates to the ordinal measurement of intent. The regressions estimate conditional associations among survey variables. OLS treats the seven-category outcome as an approximately linear conditional-mean measure, whereas ordered logit respects the ordering of response categories; differences in raw coefficient magnitudes between these estimators are not directly comparable. Unobserved product preferences and prior brand familiarity may influence both engagement and stated intent, precluding causal interpretation. Variance-inflation factors were calculated for the non-intercept regressors in the visitor OLS specification.

The merchant model specified ln(monthly sales + 1) as a function of tourist-attributed sales percentage, merchant QR-scan count, positive-policy indicator, and location-node, recorded product-category, and month fixed effects. Standard errors were clustered by merchant to account for repeated monthly observations (20 clusters). Robustness checks used HC3 standard errors and a specification replacing location-node fixed effects with merchant fixed effects. The policy indicator was retained as an exploratory control because exposure was confined to one node-month. Month effects account for seasonality common to the sampled establishments during 2024, whereas merchant effects absorb time-invariant establishment differences. With only 20 merchant clusters, asymptotic cluster-based inference may be imprecise; the HC3 and merchant-effects specifications serve as sensitivity checks rather than eliminating this limitation. Tourist-share and QR activity coefficients are interpreted as contemporaneous associations. Additional small-cluster sensitivity tests used a restricted Rademacher wild-cluster bootstrap at the merchant level (1999 draws) for the three focal covariates.

Two category-month models estimated associations of aggregated merchant sales, mean tourist share, and QR-scan total with (i) log China export value and (ii) the recorded nominal product-price ratio. Both models included category and month fixed effects and used HC3 standard errors (N = 70). Six focal trade-model coefficients were evaluated; an additional Bonferroni comparison used a threshold of $0.05/6 = 0.0083$. Mean within-merchant CV differences were assessed using paired-samples t and Wilcoxon signed-rank tests. The 2020–2025 monthly nominal ratio was modeled using a linear time index and product-category fixed effects, with HC3 standard errors and sensitivity analyses based on product clustering and 12-lag panel HAC. Given the 70 aggregate cells and broad category-label matches, the trade regressions remain exploratory. Their coefficients cannot identify subsequent visitor purchases or bilateral trade generated by the surveyed visitors. A nonparametric merchant-level bootstrap (20,000 resamples) assessed the mean paired CV difference. Trade-model sensitivity analyses excluded the textile and souvenir matches and, in a stricter specification, the dried-fruit match.

Analyses were conducted in Python (version 3.13.5) with pandas (version 2.2.3), NumPy (version 2.3.5), statsmodels (version 0.14.6), and SciPy(version 1.17.0). Two-sided tests were used throughout, with $p < 0.05$ as the conventional significance threshold except where multiple-testing adjustment is noted. Sample sizes and units of analysis are specified for individual models.

3. Results

3.1. Visitor Characteristics and Post-Visit Purchase Intent

The visitor sample comprised 1000 respondents: 52.5% Chinese, 35.1% Pakistani, and 12.4% other nationalities. Leisure travel accounted for 59.7% of responses, and 61.8% were first-time visitors. Mean trip duration was 7.06 days (SD = 2.47), mean expenditure was CNY 3043.25 (SD = 1666.34), mean satisfaction was 4.68 (SD = 0.76), and mean purchase intent was 4.22 (SD = 1.07). QR engagement was reported by 176 visitors (17.6%; Table 1).

Table 1. Visitor characteristics and descriptive statistics (N = 1000).

Variable	Category or Statistic	*n*	% or Mean (SD)
Nationality	China	525	52.5%
	Pakistan	351	35.1%
	Other	124	12.4%
Travel purpose	Leisure	597	59.7%
	Visiting friends/relatives	158	15.8%
	Business	101	10.1%
	Religious	78	7.8%
	Other	66	6.6%
Age group	18–24	174	17.4%
	25–34	342	34.2%
	35–44	224	22.4%
	45–54	144	14.4%
	55–64	76	7.6%
	≥65	40	4.0%
Gender	Male	577	57.7%
	Female	397	39.7%
	Non-binary	16	1.6%
	Prefer not to say	10	1.0%
Travel party	Solo	298	29.8%
	Couple	242	24.2%
	Family	191	19.1%
	Friends	163	16.3%
	Group tour	106	10.6%
First-time corridor visit	Yes	618	61.8%
	No	382	38.2%
Merchant QR engagement	Yes	176	17.6%
	No	824	82.4%
Trip duration (days)	Mean (SD)	1000	7.06 (2.47)
Total expenditure (CNY)	Mean (SD)	1000	3043.25 (1666.34)
Exposure categories	Mean (SD)	1000	0.55 (0.75)

Table 1. *Cont.*

Variable	Category or Statistic	*n*	% or Mean (SD)
Overall satisfaction (1–7)	Mean (SD)	1000	4.68 (0.76)
Post-visit purchase intent (1–7)	Mean (SD)	1000	4.22 (1.07)

Note: Categorical values are frequencies and percentages. Continuous values are means (sample SD). QR engagement indicates at least one merchant QR scan during the trip.

Visitors reporting QR engagement had mean purchase-intent scores of 4.86, compared with 4.09 among respondents without QR engagement (Figure 2). In the adjusted OLS model, QR engagement ($\beta = 0.667$, HC3 SE = 0.086, $p < 0.001$), satisfaction ($\beta = 0.319$, SE = 0.043, $p < 0.001$), and exposure-category count ($\beta = 0.229$, SE = 0.048, $p < 0.001$) were positively associated with intent. First-visit status, log expenditure, and trip duration had non-significant coefficients. Model R^2 was 0.171 (adjusted $R^2 = 0.151$). Ordered-logistic estimates showed corresponding positive relationships, with odds ratios of 3.63 for QR engagement, 1.80 per satisfaction point, and 1.56 per exposure category (Table 2; Figure 3). The maximum variance-inflation factor in the fitted visitor OLS model was 2.97 (Supplementary Table S1 in File S2).

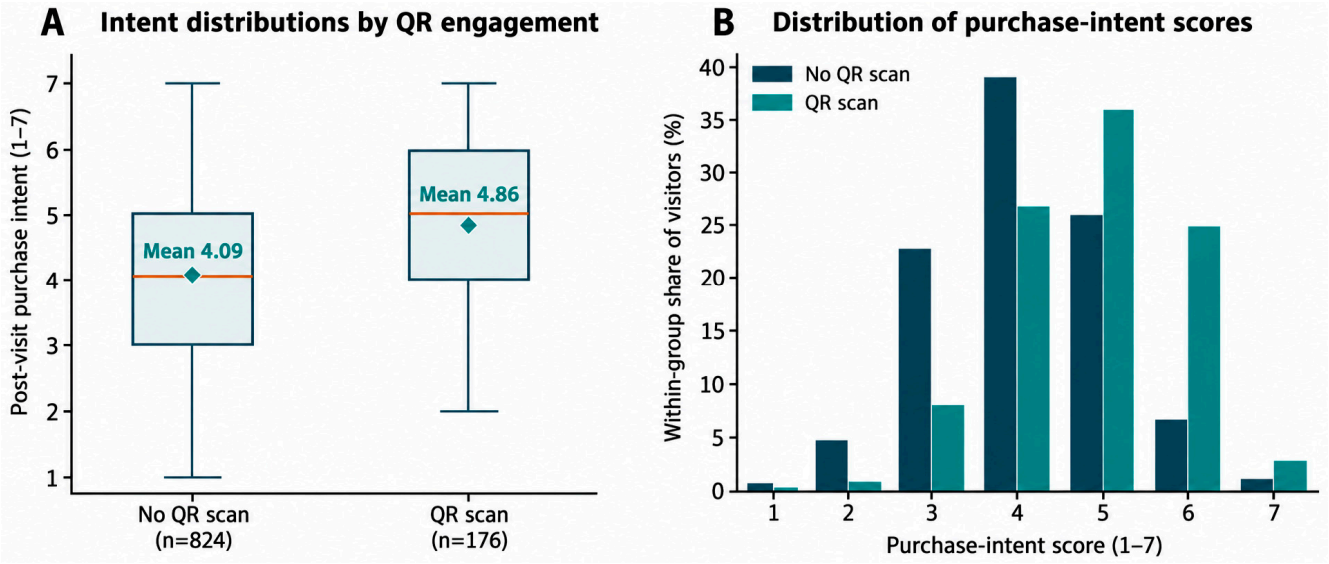


Figure 2. QR-code engagement and post-visit purchase intent among 1000 visitors. (**A**) Distributions for no QR engagement ($n = 824$) and QR engagement ($n = 176$). (**B**) Within-group percentages by intent score. The descriptive means were 4.09 and 4.86, respectively.

Table 2. Adjusted visitor-level models of post-visit purchase intent.

Predictor	OLS β (HC3 SE)	*p*	Ordered-Logit β (SE)	OR (95% CI)	*p*
QR-code engagement	0.667 (0.086)	<0.001	1.289 (0.164)	3.63 (2.63–5.01)	<0.001
First-time corridor visit	0.079 (0.067)	0.240	0.120 (0.122)	1.13 (0.89–1.43)	0.327
Overall satisfaction	0.319 (0.043)	<0.001	0.586 (0.081)	1.80 (1.53–2.11)	<0.001
Log(total expenditure + 1)	−0.043 (0.084)	0.612	−0.128 (0.156)	0.88 (0.65–1.19)	0.412
Trip duration (days)	−0.007 (0.018)	0.693	−0.011 (0.034)	0.99 (0.93–1.06)	0.737
Exposure categories	0.229 (0.048)	<0.001	0.446 (0.086)	1.56 (1.32–1.85)	<0.001

Note: N = 1000. Both models adjust for nationality, travel purpose, age group, gender, and party type. OLS $R^2 = 0.1713$; adjusted $R^2 = 0.1509$. HC3 standard errors are shown for OLS. The ordered-logistic model uses the original 1–7 ordinal outcome; OR = exp(β). All tests are two-sided.

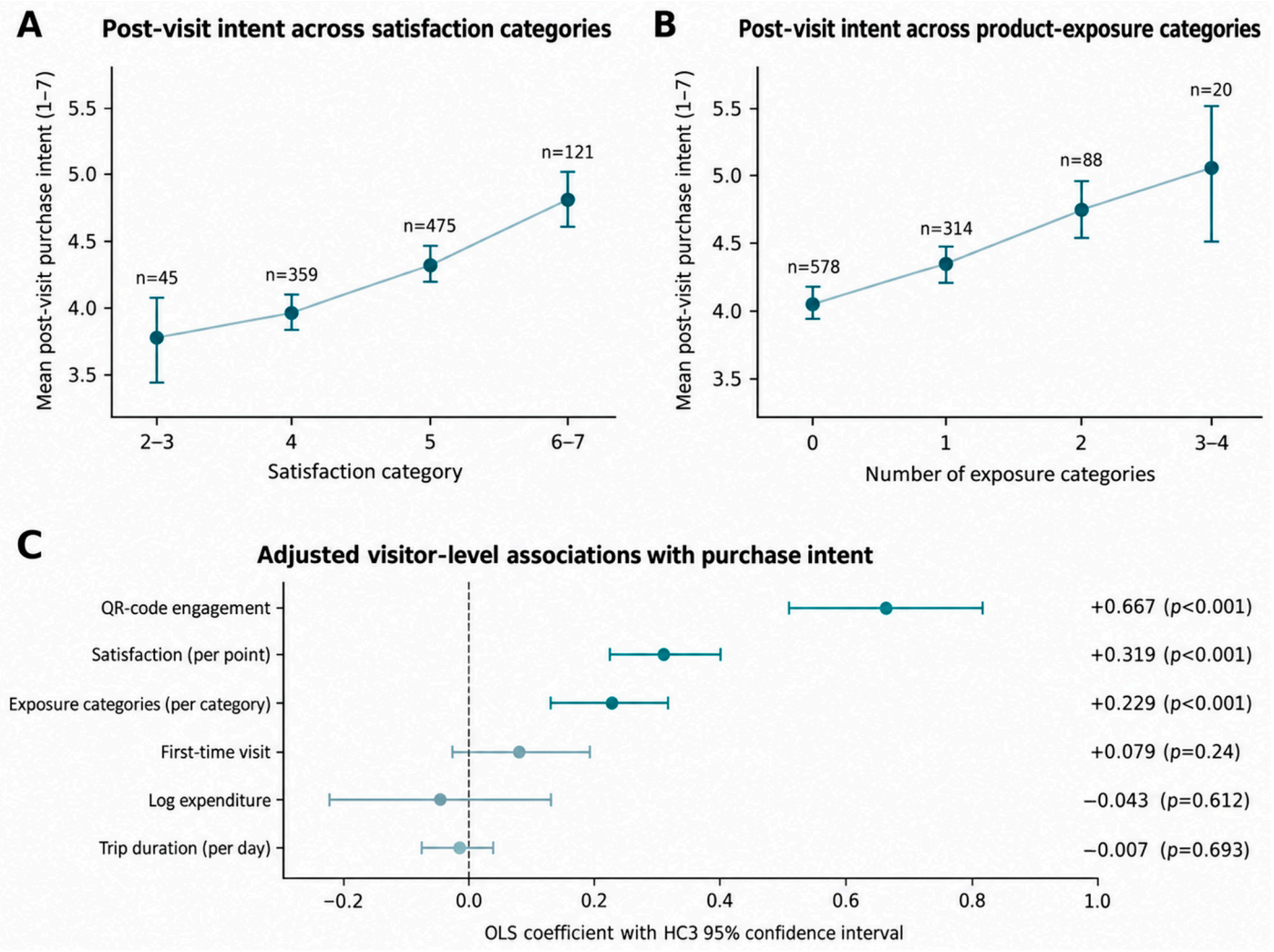


Figure 3. Associations of visitor satisfaction, product exposure, and travel characteristics with post-visit purchase intent. (**A**) Mean purchase-intent scores across satisfaction categories and (**B**) across product-exposure categories, with error bars representing 95% confidence intervals of the group means. (**C**) Estimated ordinary least-squares regression coefficients and HC3 heteroskedasticity-robust 95% confidence intervals for QR-code engagement, satisfaction, product exposure, first-time visit status, expenditure, and trip duration. The regression included categorical controls for nationality, travel purpose, age group, gender, and travel-party type (N = 1000). The dashed vertical line represents a coefficient of zero.

3.2. Merchant Sales

The balanced 2024 panel comprised 240 merchant-month observations from 20 merchants across seven locations. Recorded sales totaled CNY 4,507,694.98. Khunjerab contributed the highest aggregate sales and the largest number of sampled merchants. Supplementary Figure S1 presents monthly sales by node.

With location, recorded product-category, and month fixed effects, tourist-attributed percentage ($\beta = -0.0025$, merchant-clustered SE = 0.0016, $p = 0.123$), QR-scan count ($\beta = 0.0003$, SE = 0.0008, $p = 0.656$), and the positive-policy indicator ($\beta = -0.2357$, SE = 0.1553, $p = 0.129$) were not statistically significant (Table 3). Inference was similar under HC3 estimation and merchant fixed effects. The policy indicator was observed for only five merchant-months in one Khunjerab node-month; Merchant-level wild-cluster-bootstrap p-values were 0.138 for tourist share, 0.651 for QR scans, and 0.204 for the policy indicator (Supplementary Table S2 in File S2).

Table 3. Tourism-related indicators and log monthly merchant sales.

Predictor	Primary β (Cluster SE)	*p*	Merchant-FE β (Cluster SE)	*p*
Tourist share (percentage points)	−0.0025 (0.0016)	0.123	−0.0024 (0.0017)	0.160
Monthly QR-scan count	0.0003 (0.0008)	0.656	0.000023 (0.0008)	0.978
Positive-policy indicator	−0.2357 (0.1553)	0.129	−0.2370 (0.1573)	0.132

Note: N = 240 merchant-months from 20 merchants (January–December 2024); dependent variable = ln(monthly sales + 1). Primary model: location-node, product-category, and month fixed effects; $R^2 = 0.3384$, adjusted $R^2 = 0.2576$. Sensitivity model: merchant, product-category, and month fixed effects; $R^2 = 0.3553$, adjusted $R^2 = 0.2296$.

3.3. Tourism-Derived Revenue and Within-Year Variability

Estimated tourism-derived sales totaled CNY 2,921,080.46 in 2024, equivalent to 64.80% of recorded merchant revenue. The attributed share ranged from 61.36% in Sost to 68.05% in Kashgar; Khunjerab contributed the largest absolute amount (Table 4; Figures 4 and 5). The amounts were calculated using the recorded tourist percentages for each merchant-month.

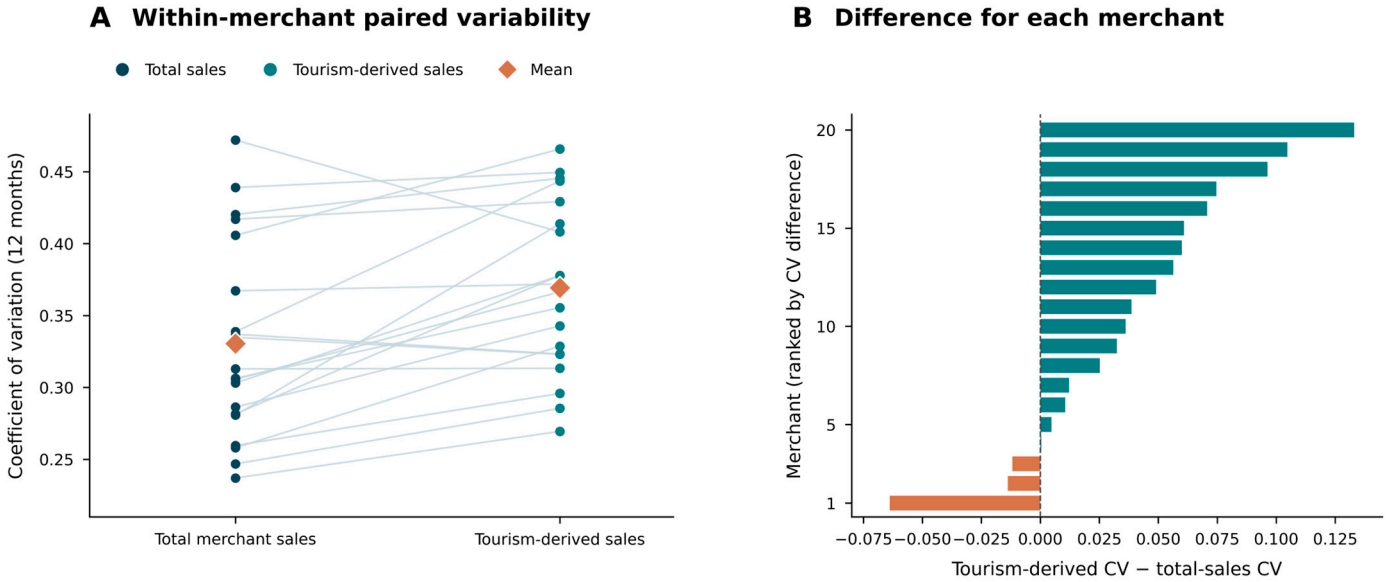


Figure 4. Within-year variability of total and tourism-derived revenue across 20 merchants. (**A**) Paired CVs calculated using 12 monthly observations per merchant. (**B**) Differences in merchant CVs. Mean CVs were 0.330 and 0.369, respectively; the tourism-derived CV was higher for 17 merchants.

Table 4. Tourism-derived revenue and within-year variability across corridor nodes.

Node	Merchants (*n*)	Total Sales (CNY)	Tourism Sales (CNY)	Tourist Share (%)	Total CV	Tourism CV
Gilgit	3	763,914.33	491,571.36	64.35	0.221	0.211
Hunza	2	488,259.28	331,581.14	67.91	0.231	0.280
Islamabad	3	639,455.69	411,362.07	64.33	0.267	0.296
Kashgar	2	385,099.90	262,074.55	68.05	0.243	0.285
Khunjerab	5	1,163,216.30	749,080.23	64.40	0.258	0.272
Lahore	3	565,766.29	367,381.85	64.94	0.218	0.214

Table 4. *Cont.*

Node	Merchants (*n*)	Total Sales (CNY)	Tourism Sales (CNY)	Tourist Share (%)	Total CV	Tourism CV
Sost	2	501,983.19	308,029.25	61.36	0.256	0.272
All merchants	20	4,507,694.98	2,921,080.46	64.80	—	—

Note: Tourism-derived sales = monthly sales × (tourist share/100). Each node CV uses 12 monthly node-level aggregate revenues. The paired inference uses 20 individual merchants: mean total-sales CV = 0.330, mean tourism-sales CV = 0.369; mean difference = 0.0388 (95% CI 0.0172–0.0604); paired $t(19) = 3.765$, $p = 0.0013$; Wilcoxon W = 25, $p = 0.0017$.

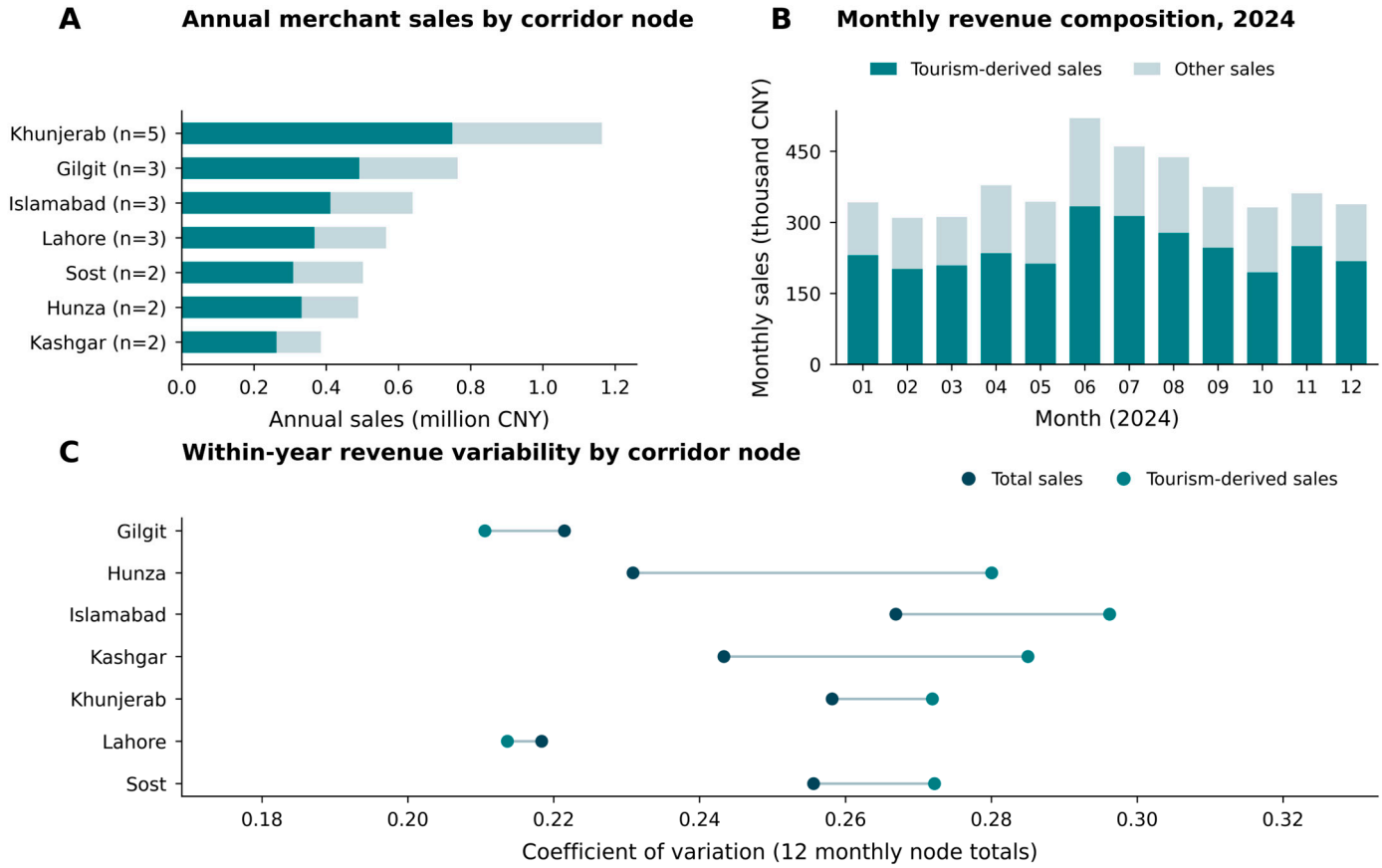


Figure 5. Spatial distribution, monthly composition, and within-year variability of merchant revenue across the China–Pakistan corridor. (**A**) Annual recorded sales across seven corridor nodes, separated into tourism-derived and other sales. (**B**) Monthly aggregate merchant revenue composition from January to December 2024. (**C**) Comparison of coefficients of variation for total and tourism-derived monthly sales at the corridor-node level. Tourism-derived revenue was estimated by multiplying recorded merchant sales by the corresponding tourist share of sales. Node-level CVs were calculated from 12 monthly aggregate observations per location. The analysis comprised 20 merchants and 240 merchant-month observations.

The mean merchant CV was 0.330 for total monthly sales and 0.369 for estimated tourism-derived sales; the latter was higher for 17 of 20 merchants. The mean paired difference was 0.0388 (95% CI: 0.0172–0.0604; $t(19) = 3.765$, $p = 0.0013$). The Wilcoxon signed-rank test gave $p = 0.0017$. The paired comparison concerns the 12 months of 2024 and does not establish longer-term revenue stability. Because tourism-derived sales were estimated from total sales and recorded tourist shares, differences in the CVs also reflect monthly variation in those shares. A merchant-level bootstrap yielded a 95% percentile

confidence interval of 0.0188–0.0584 for the mean paired CV difference (Supplementary Table S3 in File S2).

3.4. Merchant–Trade Linkages

The 2024 merchant–trade merge contained 70 observations across six broad product-category labels. Mean aggregated merchant sales were CNY 50,519.88 per matched category-month; the corresponding mean recorded China export value was USD 3.35 million. Aggregated sales and tourist share were not significant in the log export model. QR-scan count had a negative coefficient ($\beta = -0.004755$, HC3 SE = 0.002342, nominal $p = 0.042$), which did not meet the Bonferroni-adjusted threshold of $p < 0.0083$. Merchant-side predictors were not statistically significant in the nominal product-price-ratio model (Table 5; Figure 6). These category-level matches were based on broad merchant labels rather than product or shipment identifiers; the estimated associations cannot be interpreted as direct merchant-to-export linkages. Removing the textile and souvenir category matches gave 46 observations and an HC3 p-value of 0.094 for the QR–export coefficient. Excluding the dried-fruit match as well left 34 observations ($p = 0.217$; Supplementary Table S4 in File S2).

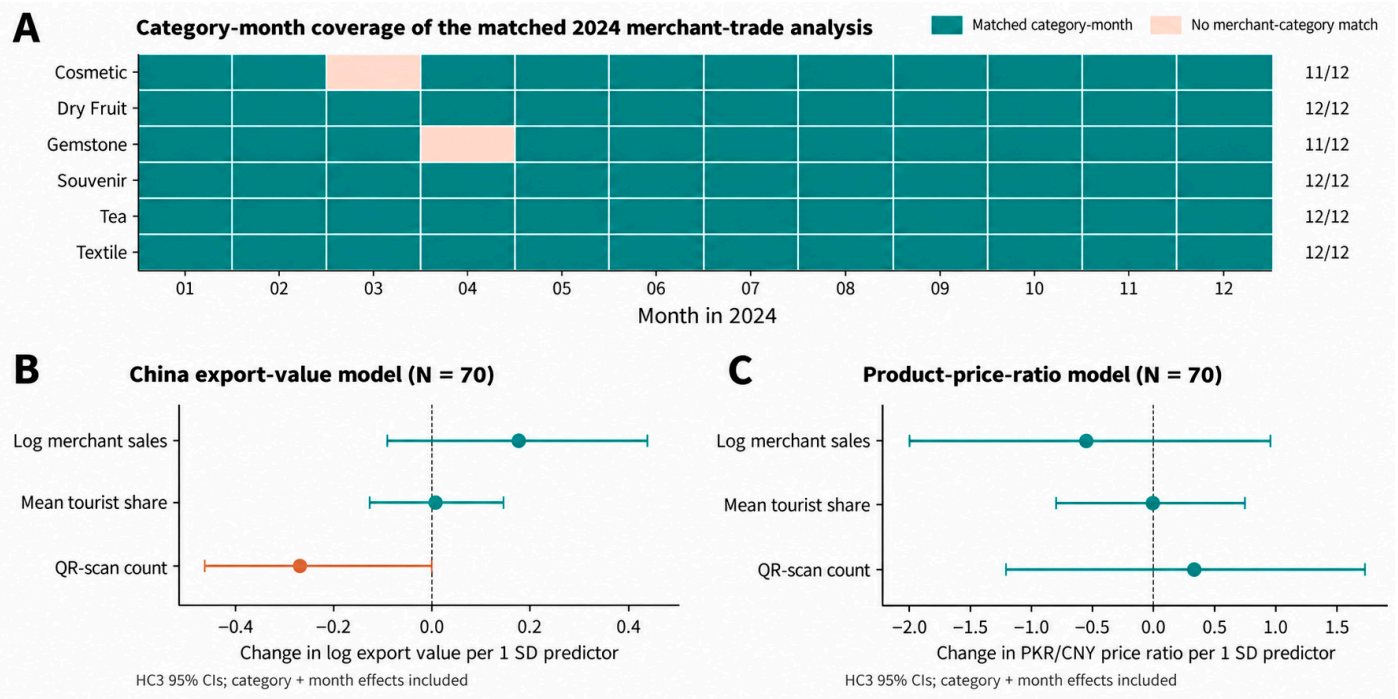


Figure 6. Matched merchant–trade coverage and adjusted associations with product-level trade outcomes in 2024. (**A**) Availability of matched product-category-month observations across six categories, with colored cells distinguishing matched observations from category-month combinations without corresponding merchant records. The matched dataset comprised 70 observations. (**B**) Estimated associations of aggregated merchant sales, mean tourist share, and QR-scan count with log China export value. (**C**) Corresponding associations with the nominal Pakistan-to-China product-price ratio (PKR/CNY). Points represent regression coefficients expressed per one-standard-deviation increase in each predictor, and horizontal lines indicate HC3 robust 95% confidence intervals. Both regression specifications included product-category and month fixed effects; dashed vertical lines indicate zero coefficients.

Table 5. Associations of merchant indicators with product-category trade outcomes in 2024.

Predictor	Log Export Value β (HC3 SE)	*p*	PKR/CNY Price-Ratio β (HC3 SE)	*p*
Log aggregated merchant sales	0.3123 (0.2282)	0.171	−0.9670 (1.3016)	0.458
Mean merchant tourist share	0.0017 (0.0086)	0.842	−0.0042 (0.0502)	0.934
Total merchant QR scans	−0.0048 (0.0023)	0.042	0.0045 (0.0141)	0.749

Note: N = 70 product-category-month matched records from six categories (tea, textiles, dry fruit, gemstones, cosmetics, souvenirs). Both models control for product-category and month fixed effects. Log China export-value model: $R^2 = 0.3732$; adjusted $R^2 = 0.1350$. Product-price-ratio model: $R^2 = 0.2912$; adjusted $R^2 = 0.0219$. HC3 standard errors are shown. QR association with export value is nominal ($p = 0.042$) and should not be interpreted causally.

3.5. Nominal Product-Price Ratios, 2020–2025

The mean recorded nominal product-price ratio was 28.74 (SD = 2.64) in 2020 and 28.12 (SD = 2.58) in 2025 across ten HS6 categories. Intermediate annual means were 28.54 (2021), 28.26 (2022), 28.51 (2023), and 28.55 (2024) (Table 6). A model with product-category fixed effects estimated a monthly trend of β = −0.00509 (HC3 SE = 0.00474; 95% CI: −0.01438 to 0.00420; $p = 0.283$; N = 720). Product-clustered and 12-lag panel-HAC sensitivity estimates were also non-significant. Figure 7 illustrates annual averages, monthly variation, and changes across product categories. All measures are nominal PKR/CNY price ratios. Because the recorded prices remain denominated in different currencies and direct product comparability has not been established, the ratios do not measure exchange-rate-adjusted price convergence, relative purchasing costs, or market integration.

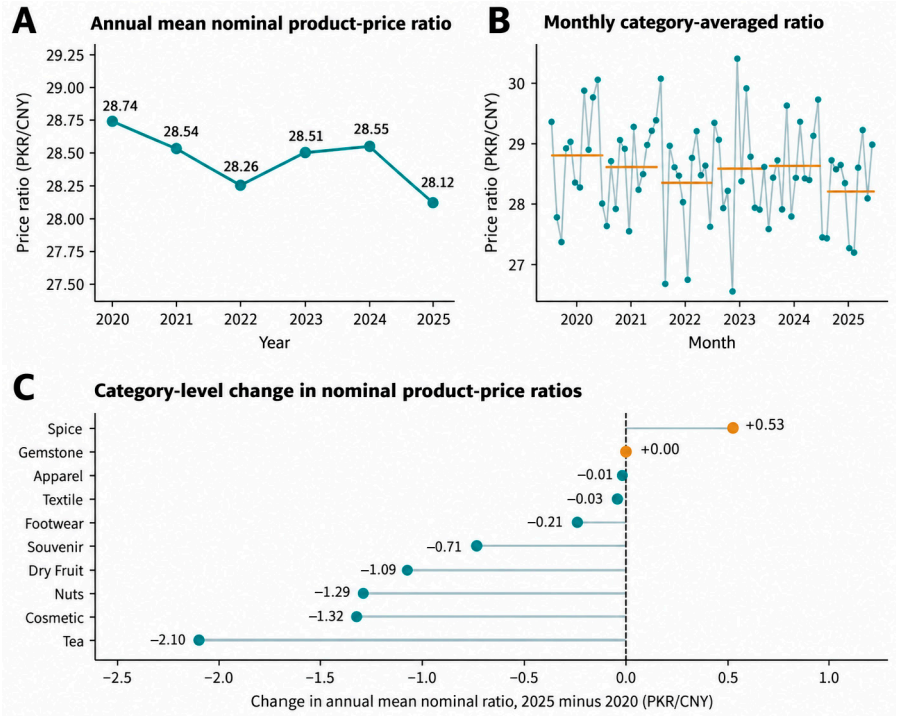


Figure 7. Temporal patterns and product-category differences in nominal China–Pakistan product-price ratios, 2020–2025. (**A**) Annual mean nominal product-price ratios across 10 product categories, shown by teal markers and connecting lines. (**B**) Monthly category-averaged nominal ratios, represented by teal markers connected by pale blue-gray lines, with horizontal orange segments indicating annual means. (**C**) Changes in category-specific annual mean ratios between 2020 and 2025, calculated

as the 2025 mean minus the 2020 mean. Teal markers indicate negative changes, while orange markers indicate zero or positive changes; pale blue-gray horizontal lines extend from the zero reference to the corresponding values. The nominal ratio was calculated by dividing the Pakistan-side product price (PKR/kg) by the corresponding China-side product price (CNY/kg) and is expressed in PKR/CNY. The analysis included 720 product-category-month observations.

Table 6. Annual nominal cross-border product-price ratios, 2020–2025.

Year	*n*	Mean Nominal Ratio (PKR/CNY)	SD
2020	120	28.74	2.64
2021	120	28.54	2.56
2022	120	28.26	2.73
2023	120	28.51	2.49
2024	120	28.55	2.62
2025	120	28.12	2.58

Note: The nominal price ratio equals the recorded Pakistan-side mean price (PKR/kg) divided by the China-side mean price (CNY/kg). Values were calculated from 120 product-month observations per year (10 HS6 categories × 12 months) and summarized without currency conversion. The recorded ratio is rounded to two decimal places. SD = sample standard deviation. The product-category fixed-effects trend was $\beta = -0.00509$ PKR/CNY per month (HC3 SE = 0.00474, 95% CI −0.01438 to 0.00420, $p = 0.283$; N = 720, $R^2 = 0.0117$). The trend was also not significant with product-clustered or panel-HAC standard errors.

4. Discussion

4.1. Visitor Engagement and Product Interest

QR engagement, satisfaction, and product exposure were associated with stated post-visit purchase intent, while trip duration and expenditure had non-significant adjusted coefficients. The satisfaction and product-exposure findings accord with research on destination evaluations, product attitudes, and behavioral intention [14–18]. Digital customer-journey studies describe information access and merchant interaction at successive stages of the consumption process [19–23,32,33]. The ordered-logistic specification retained the main directional findings. Selection into QR use and prior product interest remain relevant explanations for the observed association.

Research on smart-tourism technologies relates technology readiness, engagement, and experience evaluations to behavioral intention [34–36]. Field-experimental and museum research also identifies technology-mediated influences on travel experiences [37,38], while hospitality adoption research emphasizes usefulness and service context [39]. QR engagement may allow visitors to retain product or merchant information after a physical encounter. Its observed association with purchase intention is consistent with active engagement; however, the recorded QR indicator combines several possible uses, including information search, payment, and product verification.

Exposure to a larger number of product or service categories showed a positive adjusted association with intent. Additional encounters can increase familiarity and opportunities for comparison, while visitors with an existing interest in purchasing may deliberately seek broader exposure. Expenditure covered the full trip and may have been concentrated in transport, accommodation, or food rather than products suitable for later purchase.

4.2. Merchant Sales and Tourism Dependence

The merchant and visitor models concern different commercial outcomes: stated product interest at the individual level and recorded sales at the establishment-month level.

Merchant revenues reflect tourist and resident purchases alongside operating conditions, product mix, inventory, and pricing. Studies on tourism seasonality and destination vulnerability document how tourism dependence interacts with recurring fluctuations and exposure to shocks [1,3]. National-level evidence also indicates that the economic implications of tourism dependence vary with structural conditions [4,40]. The substantial recorded tourist-attributed sales share provides a complementary measure of tourism's contribution among sampled merchants.

Merchant QR scans measure observed digital activity rather than the value of resulting transactions. Research on small tourism enterprises identifies social networks, adaptive capability, collaboration, and organizational resources as relevant to resilience [5,6]. Digital transformation and public support may influence business adaptation in particular circumstances [41,42]. The policy-event variable in the present analysis records one positive node-month and is treated as an exploratory covariate.

The estimated tourist-attributed share was 64.80% of merchant sales in the study sample, and the tourism-derived component had a higher mean monthly CV than total revenue. Tourism seasonality has been associated with uneven business activity and livelihood outcomes [1,2]. The CV comparison reflects both monthly total-sales changes and variation in the recorded tourist share, making it a measure of the observed revenue component rather than a direct estimate of visitor-arrival seasonality. As an indicator, the CV describes within-year revenue dispersion; liquidity, profitability, and longer-term recovery capacity are separate business characteristics.

4.3. Corridor Development and Product Markets

Prior CPEC research has examined community expectations, tourism support, regional development, and tourism-related welfare [8–12]. Work on wider regional cooperation has also identified relationships among transport connectivity, trade facilitation, and tourism flows [43]. In the matched product-category analysis, merchant-side variables showed limited contemporaneous correspondence with exports and the nominal price ratio. The negative QR–export coefficient was nominally significant but did not reach the adjusted threshold for the six focal comparisons. Differences in category coverage, distribution channels, and shipment timing are relevant to the interpretation of this estimate.

Customs classifications represent specified goods and distribution channels that may differ from the broader retail categories used by sampled merchants. In the matching file, "souvenirs" corresponded to HS 950300 and "textiles" to HS 570110. These particular HS codes cover toys and certain knotted wool or fine-animal-hair carpets, respectively. The six-category merge is therefore a broad-label analytical comparison, interpreted alongside recognized determinants of relative pricing, including exchange-rate movements and quality adjustment [44–46].

4.4. Interpretation of Nominal Product-Price Ratios

Exchange-rate pass-through is heterogeneous across products, firms, currencies of invoicing, and retail markets [47,48]. Persistent price differences can occur even across relatively integrated national markets [49]. Meta-analytic and wholesale-price analyses likewise document differences in the magnitude and timing of pass-through [50,51], while global-value-chain participation can influence price adjustment [52]. A ratio between prices expressed in different currencies cannot separate relative local-price movements from currency effects. The mean recorded nominal PKR/CNY ratio changed only modestly between 2020 and 2025, and the category-adjusted monthly trend was not statistically significant. The ratio compares local-currency prices in two markets and incorporates

currency and product-composition differences. As reported, it describes variation in the recorded nominal relative-price series rather than a structural estimate of market integration.

4.5. Economic Sustainability and Practical Implications

Tourist-attributed sales represented 64.80% of recorded annual revenue among sampled merchants, and the within-year variation in this component exceeded that of total monthly sales. Revenue contribution and revenue dispersion describe different dimensions of tourism dependence; neither establishes profitability, liquidity, or recovery capacity. Separating verified tourist and non-tourist receipts, where feasible, could help individual merchants assess seasonal concentration and inform inventory and working-capital decisions. Research on tourism SMEs identifies adaptive capability and access to resources as relevant to business resilience [53].

QR engagement was associated with stated post-visit purchase intention in the visitor survey, but merchant QR counts were not significantly associated with adjusted monthly sales. Digital product catalogues, information retained after travel, and post-visit ordering channels are therefore options for evaluation rather than measures shown to increase merchant revenue. Assessment of these options would require verified transaction outcomes and implementation costs. For regional policy, more consistent recording of tourist-attributed transactions and product categories could improve the measurement of local commercial exposure to tourism. The positive-policy indicator covered a single node-month and does not identify the effect of a corridor policy intervention.

4.6. Study Limitations

The merchant panel covers 20 establishments during the 12 months of 2024 and cannot establish multi-year revenue stability or recovery after economic shocks. Tourism-derived sales were calculated using merchant-recorded monthly tourist shares rather than purchaser-linked transactions; the estimated component and its coefficient of variation are consequently sensitive to variation in those shares. The small number of merchant clusters limits statistical inference, and unmeasured business characteristics may affect estimated associations. Visitor responses are not linked to merchant transactions, so stated purchase intentions cannot be interpreted as realized sales. The analytical visitor extract does not contain interview dates, trip dates, or visited-node identifiers, preventing month-specific or location-specific analysis of respondents. The binary QR indicator combines potentially different uses, including information access, payment, and verification, and may be influenced by prior product interest. Broad merchant-category matches with HS6 trade records do not establish direct merchant-to-export linkages, and nominal prices expressed in PKR and CNY do not establish common-currency price convergence. Environmental outcomes, resident welfare, employment conditions, and longer-term business resilience are not measured by these data.

5. Conclusions

Among 20 merchants sampled across seven China–Pakistan Economic Corridor locations, estimated tourism-attributed sales totaled CNY 2.92 million, representing 64.80% of recorded revenue in 2024. The tourism-attributed component had a higher mean monthly coefficient of variation than total revenue (0.369 versus 0.330; paired $t(19) = 3.765$, $p = 0.0013$). Because the attributed component was calculated from total sales and merchant-recorded tourist shares, its greater variability also reflects changes in those shares and cannot establish long-term financial instability. Tourist share and merchant QR-scan activity were not significantly associated with adjusted monthly sales. In a separate survey of 1000 visitors, QR scanning, satisfaction, and exposure to additional product categories were pos-

itively associated with stated post-visit purchase intent; expenditure and trip duration were not. The visitor responses were not linked to merchant transaction records. The category-level merchant–trade comparisons showed limited contemporaneous associations with exports and nominal price ratios, and the nominally significant QR–export coefficient did not meet the multiple-testing threshold. The 2020–2025 nominal price-ratio series exhibited no significant product-category-adjusted monthly trend and cannot establish exchange-rate-adjusted convergence. For merchants, separate recording of tourist and non-tourist receipts could inform assessment of seasonal revenue concentration; the effectiveness of post-visit digital sales channels remains untested. Longer merchant panels and linked visitor-purchase records would be required to assess business resilience and possible tourism–trade pathways.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su182211571/s1, Supplementary File S1, Visitor Questionnaire and Post-Visit Panel, provides the baseline survey instrument and the optional follow-up questions. Supplementary File S2, Reports the additional diagnostic and robustness results and the six-category HS6 label-matching crosswalk. Figure S1: Presents monthly recorded merchant sales across seven China–Pakistan corridor nodes in 2024: (A) monthly aggregate recorded sales; (B) monthly sales per observed merchant.

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Institutional Review Board Statement: Ethical review and approval were waived for this study by the Human Research Ethics Committee of Gansu Agricultural University because the research involved an anonymous, minimal-risk household questionnaire survey without the collection of direct personal identifiers.

Informed Consent Statement: Informed consent was obtained from all respondents included in the visitor survey before data collection.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

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Abbreviations

The following abbreviations are used in this manuscript:

CPEC	China–Pakistan Economic Corridor
QR	Quick Response
CV	Coefficient of Variation
CNY	Chinese Yuan
PKR	Pakistani Rupee
USD	United States Dollar
OLS	Ordinary Least Squares
HC3	Heteroskedasticity-Consistent Covariance Estimator, Type 3

HS6	Six-Digit Harmonized System Code
CI	Confidence Interval
SE	Standard Error
SD	Standard Deviation
OR	Odds Ratio
FE	Fixed Effects

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