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Functional Differentiation or Industrial Isomorphism? Testing the Greater Bay Area's Functional Map

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Abstract

Chinese regional plans have long described the mainland cities of the Greater Bay Area as exhibiting industrial isomorphism and have prescribed functional differentiation in response. Existing assessments, however, rely on broad sectors that treat manufacturing as a single category. We construct an annual eleven-city, fifteen-sector employment panel for 2004–2024 and a census panel covering five census years with twenty-six manufacturing divisions. At the regional level, average structural distance declines as the mainland cities move toward the service-heavy employment structure of Hong Kong and Macao, while the nine mainland cities become less alike. Within manufacturing, division-level data reveal distinct city-level patterns of industrial specialization. The evidence therefore does not support industrial isomorphism as a region-wide condition. Instead, the GBA exhibits a division of labour that is obscured by coarse industrial classification. The official plans capture the broad separation between a service-oriented core and a production-oriented belt, but the observed differentiation was already underway before the 2017 and 2019 GBA policy milestones.

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1 Introduction

For two decades, Chinese regional plans have described the mainland cities of the Greater Bay Area (GBA) as suffering from industrial isomorphism: the replication of similar industrial structures in place of a complementary division of labour (General Office of the People's Government of Guangdong Province, 2010; National Development and Reform Commission, 2009). The prescribed response has been functional differentiation. This agenda culminated in the 2019 *Outline Development Plan for the Guangdong–Hong Kong–Macao Greater Bay Area*, which assigns distinct roles to each of the region's eleven cities. This paper asks two related questions: whether the formal employment record shows the duplication diagnosed by the plans, the differentiation they prescribe, or a combination of the two; and where any remaining structural overlap is located. [1]

The question has not previously been tested at the required industrial resolution. Official and academic assessments of industrial isomorphism have relied largely on similarity indices constructed from broad sectors, often treating the whole of manufacturing as a single category. However, pooling industries can reduce the measured structural distance between two cities because differences within the pooled category may cancel. A coarse-grained measure can therefore reveal differentiation, but apparent similarity at the coarse level is inconclusive: it may reflect genuinely duplicated structures or sharply different specializations concealed within the same aggregate sector. This problem is particularly acute in the GBA's seven node cities, where manufacturing accounts for between one-third and three-fifths of formal employment.[2] Without a harmonized city panel below

[1] The Greater Bay Area is a recent designation: the term entered national policy in 2015, and the nine Guangdong cities it covers were previously grouped as the Pearl River Delta. We retain "Pearl River Delta" in the titles of policy documents and in quotations from them, and refer to these nine cities as the mainland GBA cities elsewhere.

[2] The seven node cities are Dongguan, Foshan, Zhuhai, Zhongshan, Huizhou, Jiangmen, and Zhaoqing. See Section 2 for details.

the sector level, the industrial-isomorphism diagnosis has remained untested at the grain at which duplication would have to appear.

We construct two complementary employment panels. The annual panel covers all eleven GBA cities from 2004 to 2024 in a common fifteen-sector classification. The census panel covers the nine mainland cities in five census years and harmonizes 80 industrial divisions, including 26 within manufacturing. We measure the distance between two cities as the share of employment that would have to change industry for their structures to coincide. The annual panel is used to trace regional and functional-tier changes, while the census panel disaggregates manufacturing. Location quotients identify the sectors and manufacturing divisions in which each city is concentrated.

The eleven-city average structural distance declines over the sample period, largely because mainland employment shifts toward the service-heavy structure of Hong Kong and Macao. Over the same period, the nine mainland cities become less alike after a trough around the start of the 2010s. The broad-sector data also show a widening separation between Guangzhou and Shenzhen and the seven node cities. Within manufacturing, division-level data identify an electronics group comprising Dongguan, Huizhou, and Zhuhai and an electrical-machinery group comprising Foshan and Zhongshan. Jiangmen and Zhaoqing have the broadest overlap among the belt cities, with similar concentrations across seven manufacturing divisions and a declining pairwise distance since 2008.

These findings provide a qualified comparison with the policy map. The broad distinction between a service-oriented core and a production-oriented belt is visible in the employment data. The named node-city groupings, however, do not coincide with clusters of cities that have similar manufacturing employment profiles. This result should not be read as evidence that the groupings are economically inappropriate: a policy grouping may be intended to connect cities with differ-

ent but complementary functions, whereas employment shares measure structural similarity and cannot identify value-chain complementarity or product-market rivalry. The observed mainland divergence, core–belt separation, and two-group manufacturing pattern were also visible before the 2017 Framework Agreement and the 2019 Outline Development Plan. Because Guangdong adopted an earlier differentiated-development agenda beginning in 2008, the timing establishes neither the absence nor the size of a policy effect.

The paper contributes to the literature in three ways. First, it shows that industrial aggregation can materially compress measured structural distance in a region where employment is concentrated in manufacturing. Second, it provides a harmonized account of specialization across the GBA and shows that regional convergence can coexist with increasing differentiation among mainland cities. This result qualifies earlier evidence on the convergence of Chinese regional industrial structures (Bai et al., 2004; Young, 2000) and complements work on increasing specialization in Europe (Amiti, 1999; Brülhart & Torstensson, 1996; Midelfart-Knarvik et al., 2000). Third, the separation between a service-intensive core and a production belt is consistent with the functional urban specialization described by Duranton and Puga (2005), although employment by industry does not identify the organizational mechanism.

The remainder of the paper proceeds as follows. Section 2 reconstructs the official diagnosis of industrial isomorphism and the functional map prescribed in regional plans. Section 3 describes the two employment panels and explains why industrial resolution matters for the measurement of structural similarity. Section 4 defines the measures of structural distance and specialization. Section 5 presents the results at the regional, functional-tier, and manufacturing-division levels, and Section 6 concludes.

2 The Official Diagnosis and the Functional Map

National and provincial planning documents provide the policy benchmark for the analysis. Since the late 2000s, they have described duplicated industrial structures as a problem in the mainland GBA and have promoted a differentiated division of labour. By 2019, the policy framework assigned named functions to all eleven cities.

The diagnosis appears directly in provincial planning instruments. The 2008 *National Outline Plan for the Pearl River Delta* listed an "irrational layout of productive forces" among the region's outstanding problems (National Development and Reform Commission, 2009). The province's 2010 *Industrial Layout Integration Plan* made the concern more explicit. It argued that, in the absence of unified planning, the region's cities competed for the same resources and projects within an "administrative-region economy," while their industries exhibited structural convergence and intense homogeneous competition (General Office of the People's Government of Guangdong Province, 2010). The plan concluded that the mainland GBA cities had not yet developed an effective industrial division of labour.

The prescribed response has been consistent in wording and has risen in authority. The recurring prescription is differentiated, complementary development. The 2008 provincial decision *Yue Fa No. 7* required the nine mainland GBA cities to coordinate their positioning along complementary lines (CPC Guangdong Provincial Committee and People's Government of Guangdong Province, 2008). The 2010 plan then assigned named functions to each city: Guangzhou to industrial services, Shenzhen to industrial innovation, Foshan and Dongguan to manufacturing, and so on (General Office of the People's Government of Guangdong Province, 2010). The 2017 framework agreement raised coordination among the NDRC and the governments of Guangdong, Hong Kong, and Macao (National Development and Reform Commission and the Governments of Guangdong Province, the Hong

Kong SAR and the Macao SAR, 2017). The 2019 outline development plan also made it a national strategy for all eleven cities. The plan proposed a layout of poles and axes intended to promote a rational division of labour and functional complementarity, with Hong Kong, Macao, Guangzhou, and Shenzhen as core engines and seven node cities with distinctive production functions (CPC Central Committee and State Council, 2019). Table 1 sets the two vintages of assignments side by side.

The assignments can be compared with employment data because the plans name both cities and functions. They also contain several multi-city groupings. Foshan is grouped with Dongguan in both plans, while Zhongshan moves from a grouping with Jiangmen in 2010 to one with Zhuhai in 2019, and Jiangmen enters a broader relocation grouping. These groupings are used here as a descriptive benchmark. A policy grouping need not imply that its members should have similar industrial structures; it may instead be intended to connect cities with complementary functions. The empirical comparison therefore asks whether the named groupings coincide with clusters of similar employment profiles, not whether the groupings are economically optimal.

Existing assessments have generally used broad sectors, with manufacturing treated as a single category. A fine-grained comparison is needed to determine whether apparent similarity among manufacturing cities reflects overlap across divisions or different specializations within the same aggregate sector. The census panel provides that comparison. Widespread division-level overlap would support the industrial-isomorphism diagnosis, while more differentiated profiles would limit its scope.

Table 1: Two generations of official functional assignments

City	2010 Provincial Layout Plan	2019 Outline Development Plan
Hong Kong	Not covered	International finance, shipping and trade centre; international aviation hub; global offshore RMB business hub
Macao	Not covered	World tourism and leisure centre; commerce platform between China and Lusophone countries
Guangzhou	International industrial-services centre	International commerce centre; comprehensive transport hub; science, education and culture centre
Shenzhen	International industrial-innovation centre	National economic-centre city; innovation and creativity capital
Zhuhai	International major-equipment manufacturing centre	Equipment manufacturing and modern services (with Zhongshan)
Foshan	International manufacturing centre (with Dongguan)	Advanced manufacturing base (with Dongguan)
Huizhou	World-class petrochemical base	Industrial relocation and land-intensive production (with Jiangmen, Zhaoqing)
Dongguan	International manufacturing centre (with Foshan)	Advanced manufacturing base (with Foshan)
Zhongshan	National advanced-manufacturing base (with Jiangmen)	Equipment manufacturing and modern services (with Zhuhai)
Jiangmen	National advanced-manufacturing base (with Zhongshan)	Industrial relocation and land-intensive production (with Huizhou, Zhaoqing)
Zhaoqing	Upgrading cluster for traditional industries; major-equipment supporting base	Industrial relocation and land-intensive production (with Huizhou, Jiangmen)

Notes. "Not covered indicates that the city was outside the scope of the provincial plan. The 2010 column reproduces the city positioning in General Office of the People's Government of Guangdong Province (2010); the 2019 column follows the city designations in CPC Central Committee and State Council (2019).

3 Data and the Resolution Problem

3.1 Two Panels

The analysis uses two employment panels that observe the same region at different industrial resolutions. The first is an annual panel covering all eleven GBA cities, fifteen sectors, and the period 2004–2024. The second is a five-wave census panel covering the nine mainland cities at the division level in five census years. The two panels serve different purposes. Comparisons of whole structures and functional tiers require broad coverage and annual frequency, whereas analysis within manufacturing requires the industrial detail available only in the censuses. Table 2 summarizes both panels.

Table 2: The two employment panels

Panel	Coverage	Industrial resolution	Years
Annual	11 GBA cities	15 harmonized sectors (Table 3)	2004–2024, annual
Census	9 mainland cities	80 divisions, 26 within manufacturing (Table 4)	2004, 2008, 2013, 2018, 2023

Notes. Employment is measured in persons on a legal-person-unit basis. Mainland figures are benchmarked to the economic and national censuses and interpolated between benchmarks using the statistical yearbooks. The Hong Kong and Macao figures are published by the Census and Statistics Department and the Statistics and Census Service, respectively. Full sources, the construction of the mainland annual series, and both classification concordances are in Appendix A.

The annual panel places the SAR economies and the mainland cities in a common measurement frame. Mainland employment by sector comes from the statistical yearbooks, while the two SAR series come from their respective statistical agencies. The three source classifications are mapped to a common fifteen-sector framework, with several categories pooled to ensure comparability. Information services are combined with transport and post, and gaming is combined with culture and entertainment. Including Hong Kong and Macao is itself a departure

from the isomorphism literature, which focuses almost entirely on the mainland. The mainland series uses the census definition of employment. In census years, employment equals the census count; between censuses, it is interpolated from the census benchmarks using the growth path of the annual non-private series, the only city-by-sector series reported every year. The annual and census panels therefore coincide exactly in census years after aggregation to the fifteen sectors. Hong Kong and Macao publish annual series consistently, and those series enter as published. Appendix A.1 describes the procedure. We restrict the panel to city–sector cells observed in every year, so every index is computed over a constant set of cells, and verify the constructed series against the published census totals at each benchmark.

The census panel disaggregates the single manufacturing cell. It draws on city tabulations from the economic and national censuses for the nine mainland cities in five census years. These tabulations report manufacturing employment directly for twenty-six categories. Only census data are used because they enumerate the full population of legal-person units using a common method within each census year, and no comparable annual series exists at this level of detail. No value in this panel is interpolated. Interpolating across census re-enumerations or classification revisions would risk fabricating the structural changes that the indices are intended to detect. The five-year three editions of the industrial classification (GB/T 4754-2002, GB/T 4754-2011, and GB/T 4754-2017). A small number of categories changed definition across editions; we reconcile them to a single classification held fixed across years, yielding 80 divisions, 26 of which are in manufacturing.

3.2 Why coarse sectors mislead

The resolution at which employment is measured can reverse the conclusion about whether two cities are alike, and the direction of this bias bears directly on

the isomorphism diagnosis. Pooling industries into a single cell can only reduce the measured distance between two cities because differences with opposite signs inside the pooled cell cancel before the absolute distance is calculated.[3] Aggregation can hide a division of labour but cannot create one. A coarse measure that finds two cities different is therefore conclusive, whereas a coarse measure that finds them alike is uninformative: the result is equally consistent with true replication and with a complete division of labour concealed within the pooled cells.

The fifteen-sector framework falls into this uninformative case for the cities of interest. The tertiary sector is divided into ten cells, the secondary sector into four, and manufacturing into only one. That single manufacturing cell contains between one-third and three-fifths of employment in the seven node cities.[4] Any division of labour within manufacturing is therefore invisible in the fifteen-sector panel by construction. Consider two cities that each have 60% of employment in manufacturing and identical employment shares elsewhere. They register zero distance at the sector level even if one specializes entirely in electronics and the other in electrical machinery. Their division-level distance would be 0.6, meaning that three-fifths of one city's workers would have to change divisions for the two structures to match.

This is why coarse similarity coefficients cannot settle the isomorphism question and why this paper constructs the census panel. The coefficients discussed in Section 2 were calculated using three-sector classifications or broad two-digit categories for cities whose employment is concentrated in the pooled manufacturing cell. Coarse-grained similarity is therefore weakly greater than fine-grained similarity by construction. The annual fifteen-sector panel is used for whole-structure and tier comparisons, where the relevant distinctions are observed, while the cen-

[3] By the triangle inequality, the index in equation (1), when calculated on pooled cells, is bounded above by the same index calculated on their components. Equality holds only when all within-cell differences have the same sign.

[4] In 2023, the share ranged from 34.8% in Zhuhai to 60.7% in Dongguan.

sus panel is used for within-manufacturing comparisons, where industrial detail is decisive. Similarity that survives at the division level cannot be an artifact of aggregation.

Table 3 lists the fifteen sectors, and Table 4 lists the twenty-six manufacturing divisions that disaggregate the single manufacturing cell. The latter distinguishes activities that the annual panel cannot separate: electrical machinery from electronic equipment, textiles from apparel, and general-purpose from special-purpose machinery.

Table 3: The fifteen-sector frame of the annual panel

Primary (1 sector)	
1	Agriculture, Forestry & Fishing
Secondary (4 sectors)	
2	Mining & Quarrying
3	Manufacturing
4	Electricity, Gas, Water & Environmental Services
5	Construction
Tertiary (10 sectors)	
6	Wholesale & Retail Trade
7	Transport, Storage, Post & ICT
8	Accommodation & Food Services
9	Finance & Insurance
10	Real Estate, Renting & Business Services
11	Education
12	Health & Social Work
13	Culture, Sports, Entertainment & Gaming
14	Public Administration & Social Security
15	Resident, Repair & Other Personal Services

Notes. Sector labels are those used in the harmonized panel; pooling reflects the concordance across the mainland and SAR classifications (Appendix A). Manufacturing is a single cell in this framework and accounted for 34.8% (Zhuhai) to 60.7% (Dongguan) of legal-person employment across the seven node cities in 2023.

Throughout the paper, employment refers to employment in legal-person units, and this measurement frame has limitations. It undercounts agricultural and household self-employment. Services may also enter the legal-person count faster

Table 4: The 26 harmonized manufacturing divisions of the census panel

	Division		Division
1	Agro-food processing	14	Chemical fibres
2	Food manufacturing	15	Rubber & plastic products†
3	Beverages, alcohol & refined tea	16	Non-metallic mineral products
4	Tobacco products	17	Ferrous-metal smelting & rolling
5	Textiles	18	Non-ferrous-metal smelting & rolling
6	Apparel, leather & footwear†	19	Metal products
7	Timber & wood, bamboo, rattan products	20	General-purpose machinery
8	Furniture	21	Special-purpose machinery
9	Paper & paper products	22	Transport equipment (incl. automobiles)†
10	Printing & recorded media	23	Electrical machinery & apparatus
11	Petroleum refining, coking & nuclear fuel	24	Computers, communications & electronic equipment
12	Chemical raw materials & products	25	Waste-resource recovery
13	Pharmaceuticals	26	Instruments; stationery, art & sports goods; other manufacturing (incl. machinery repair)†

Notes. Divisions follow the ordering of the national industrial classification. A dagger marks a division pooled across GB/T 4754 editions under the smallest-conserved-union rule.

than their value-added shares increase, so the measured shift toward services may precede the corresponding shift in value added. The results therefore describe the structure of formal employment in legal-person units, which is the framework used in the official statistics and in the isomorphism debate, rather than total labour input.

4 Methodology

The paper's two questions require two measures: a distance between complete employment structures, used to assess whether and where cities have differentiated, and a measure of specialization in named industries, used to identify where

overlap remains. This section defines the Krugman specialization index and its decomposition for the first purpose, and the location quotient for the second. It also states what each measure can and cannot establish.

Distance between structures. The distance between two cities' employment structures is the share of employment that would have to change industry for the two structures to match. Let v_i^k denote industry k's share of legal-person employment in city i. Then

$$\mathrm{KSI}_{ij} \;=\; \tfrac{1}{2}\sum_k \left|v_i^k - v_j^k\right|, \qquad \mathrm{KSI}_{ij} \in [0,1], \tag{1}$$

where the index equals zero when the two cities have identical structures and one when they have no industries in common. The factor of one half places the index on the unit interval and gives it a direct reallocation interpretation.[5] Values near zero indicate that the cities have similar employment shares across industries, whereas larger values indicate greater structural differentiation.

Locating distance among groups. An average distance across all city pairs cannot distinguish a division of labour from fragmentation because it does not identify which pairs account for the distance. A division of labour is relational: cities in different roles become more distant from one another, while cities that share a role remain close. The test therefore requires splitting the average into between-group and within-group components. For any partition of the cities,

$$\bar{K} \;=\; \omega_W \bar{K}_W + \omega_B \bar{K}_B, \qquad \omega_W + \omega_B = 1, \tag{2}$$

[5]Without this factor, the index ranges from 0 to 2 and equals twice the reallocation share; the normalization is therefore cosmetic.

where $\bar{K}_W$ and $\bar{K}_B$ are the average within-group and between-group distances, and ω_W and ω_B are the corresponding shares of city pairs. A division of labour is characterized by a large $\bar{K}_B$ and a small $\bar{K}_W$. Fragmentation would also raise $\bar{K}_W$, while uniform replication would leave both components small. The overall average is consistent with all three patterns, but its components are not. Matching the partition to the policy's functional tiers, namely SARs versus the mainland, the core versus the belt, and comparisons among node cities, turns the decomposition into a direct test of the prescribed differentiation.

Locating distance over time. Because the partition is fixed and the panel is balanced, the pair weights are constant, so the identity also holds for changes:

$$\Delta\bar{K} \;=\; \omega_W \Delta\bar{K}_W + \omega_B \Delta\bar{K}_B. \tag{3}$$

This identity attributes a change in the overall average to changes in its components. A falling average could reflect convergence across all pairs, or it could reflect one gap closing while other gaps open. These histories are indistinguishable from $\bar{K}$ alone. With constant weights, the change in the overall average is the exact weighted sum of the component changes, with no interaction term. When the components move in opposite directions, the identity therefore measures the extent to which they offset one another. Section 5.1 documents precisely this configuration: the aggregate falls while one component rises.

Specialization in named industries. The decomposition shows whether and where employment structures differ, but it does not identify the industries responsible. The second question, concerning where overlap remains and in which activities cities are concentrated, requires an industry-specific measure. We use

the location quotient:

$$\mathrm{LQ}_i^k \;=\; \frac{v_i^k}{\bar{v}^{\,k}}, \tag{4}$$

where $\bar{v}^{\,k}$ is industry k's share of aggregate regional employment. We classify city i as specialized in industry k when $\mathrm{LQ}_i^k \geq 1.5$. The regional base is all eleven cities in the annual panel and the nine mainland cities in the census panel. The location quotient identifies the content of specialization and, at the division level, the activities in which structural overlap is concentrated. However, similar location-quotient profiles do not by themselves distinguish complementarity within a value chain from rivalry in the same product market. Specialist counts are descriptive rather than inferential; without a null model of random allocation (Ellison & Glaeser, 1997), the threshold does not carry a probability statement.

5 Results

5.1 SAR–mainland convergence, mainland divergence

The region's cities are growing more alike on average, yet the mainland cities among them are growing less alike. Figure 1(a) shows both at once. The upper line is the average structural distance across all eleven cities, the share of employment that would have to change industry for two cities to match, averaged over every pair, and it drifts downward from a peak in the mid-2000s. The lower line is the same average computed over the nine mainland cities alone, and it does the opposite: it falls to a trough at the start of the 2010s and rises for the rest of the period. A measure of convergence for the whole region thus coexists with divergence in its mainland interior.

The closing of one gap more than accounts for the region-wide convergence. Figure 1(b) decomposes the eleven-city average into two types of pairs: those that

cross the boundary between the SAR economies and the mainland, and those that remain within either group. The crossing pairs are much more distant because Hong Kong and Macao have employment structures that differ sharply from those of the mainland cities. Yet their average distance shrinks steeply, while the within-group average edges upward. Because the mix of pairs is fixed, the change in the overall average is the exact weighted sum of the changes in these two components. Here the components move in opposite directions. The narrowing SAR–mainland gap alone would have reduced the regional average by nearly twice the observed amount, while widening distances among the mainland cities offset almost half of that decline. Regional convergence, therefore, reflects one large gap closing, while the mainland interior moves in the opposite direction.

The closing SAR–mainland gap reflects structural catch-up rather than integration into a common structure. The mainland cities are moving toward the service-heavy composition that the SAR economies reached much earlier. Services rose from less than one-third of mainland employment at the start of the period to more than one-half by its end, compared with roughly nine-tenths in Hong Kong and Macao throughout. The mainland therefore underwent a large compositional shift while the already service-oriented SARs changed little. As a result, the distance for almost every SAR–mainland pair narrowed, regardless of what the mainland cities were doing relative to one another. Regional convergence is thus driven primarily by this catch-up process. The remaining relevant question is what the widening gap among mainland cities entails, which the overall average cannot reveal.

The coexistence of these two movements is not paradoxical. Standard economic geography predicts that falling barriers between locations can coexist with, and even reinforce, the concentration of industries in particular places. Integration and internal specialization may therefore proceed together (Krugman & Venables,

1996); under increasing returns and falling transport costs, an initial concentration may be amplified rather than eroded (Krugman, 1991). The regional average conceals this process because it combines two changes: the mainland's shift toward services, which every SAR–mainland pair registers as convergence, and the relocation of activity among mainland cities, which only the mainland–mainland component registers. Aggregate convergence is therefore not evidence that the region is becoming a single undifferentiated economy. The rest of the section examines the two components of the mainland gap: the core versus the belt and differentiation within the belt.

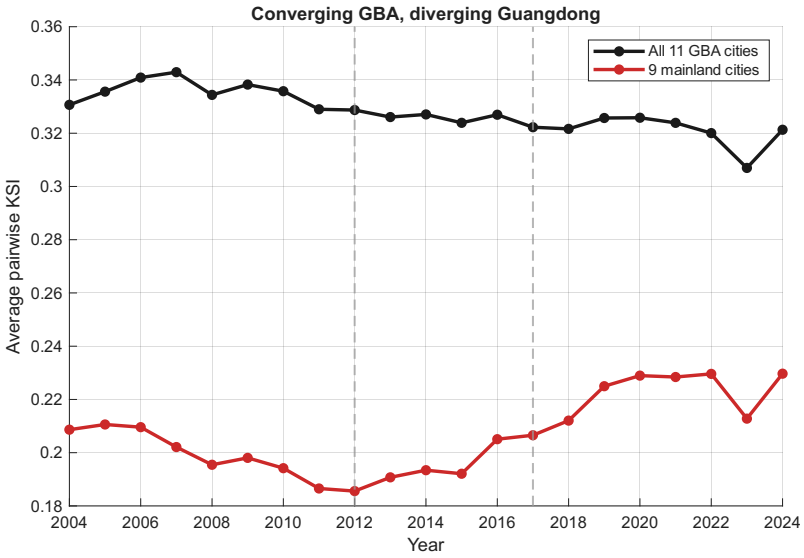
5.2 A services core separating from a production belt

Three of the four core cities are concentrated in precisely the functions that the 2019 Plan assigns to them. Table 5 reports each sector's share of city employment relative to the regional norm. Hong Kong is heavily concentrated in finance and has very little manufacturing; Macao is extremely concentrated in tourism-related sectors; and Guangzhou has the highest mainland concentrations in business services and in transport and logistics, consistent with its assigned roles in commerce and transport. Finance is not concentrated in Guangzhou, consistent with a plan that assigns that function to Hong Kong.

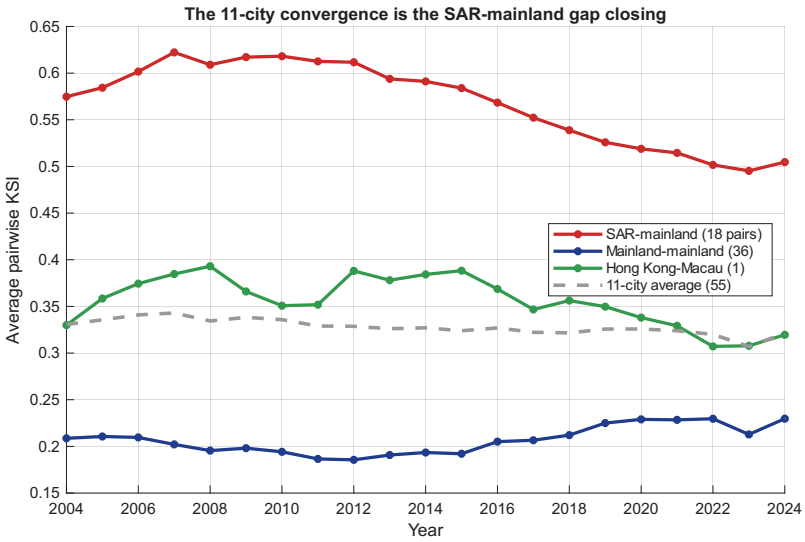
Shenzhen is the only core city whose assigned function is not visible in this table, and the reason is substantive rather than presentational. Unlike the other core cities, Shenzhen has retained a large manufacturing base. Its manufacturing location quotient is 0.88, compared with 0.49 in Guangzhou and values near zero in the two SARs. At the fifteen-sector level, Shenzhen therefore resembles a belt city with a large service sector. Its average distance from the seven node cities is 0.25, compared with 0.35 for Guangzhou. The coarse framework cannot reveal the composition of Shenzhen's manufacturing base. Section 5.3 shows that Shenzhen

Figure 1: Aggregate convergence, mainland divergence, 2004–2024

(a) Eleven-city average versus mainland-nine average



(b) The eleven-city average, split by pair type



Notes. Structural distance is the share of employment that would have to change industry for two citiesśtructures to coincide; higher values mean less similarity. Panel (a) shows that the eleven-city average (upper line) falls, while the average among the nine mainland cities (lower line) reaches a trough at the start of the 2010s and then rises. Panel (b) decomposes the eleven-city average into SAR–mainland pairs (upper line, large but falling) and within-group pairs (lower line, smaller but rising). Annual panel, fifteen sectors.

aligns with the electronics pole.

The core and the belt are separating, and this process began before the policy intended to promote it. Figure 2 plots the average distance between the two mainland core cities and the seven node cities. The line traces a V-shaped pattern: the tiers converge through the late 2000s, reach their closest resemblance around the start of the 2010s, and separate steadily thereafter. This is the vertical component of mainland divergence, with the coordinating and the producing tier becoming less alike as each concentrates on its role. The turning point precedes the 2017 and 2019 policy milestones by several years, a timing issue examined in Section 5.4.

Hub functions are concentrated in the core out of proportion to its size, and this disproportion persists throughout the census record. Guangzhou and Shenzhen together account for 69% to 76% of total hub-function employment in the nine mainland cities, including business services, ICT and software, professional and technical services, and research. Over the same five censuses, they account for only 46% to 55% of total employment. The gap between these ranges, rather than the level of either range, indicates a tiered division of labour: coordinating work is about 1.5 times as concentrated in the core as total employment and has been throughout the period.

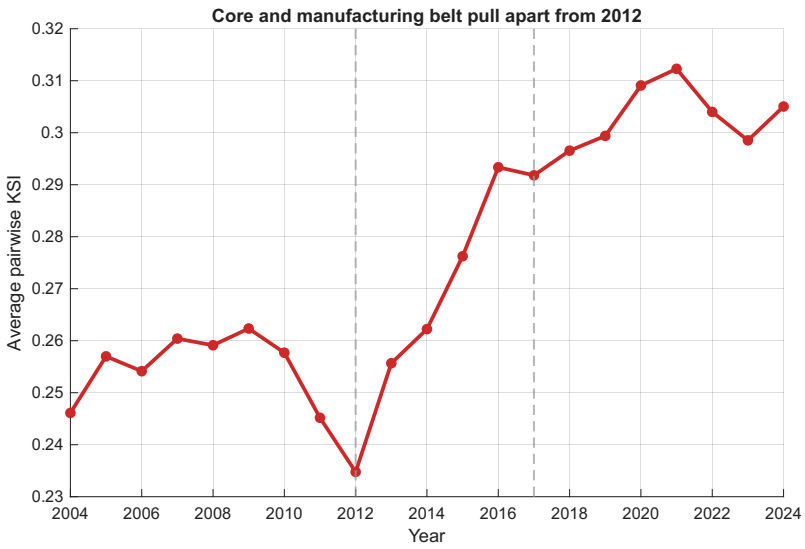
The pattern is well established in the urban literature. Duranton and Puga (2005) document a shift from sectoral to functional urban specialization, in which larger cities increasingly host headquarters and business services while production plants concentrate in smaller cities. Cities thus specialize by function rather than by industry. The separation between the core and the belt documented here follows this pattern within a single region. The two mainland core cities occupy different positions within it: Guangzhou concentrates in diversified services, transport, and research, while Shenzhen combines advanced services with a substantial manufacturing base.

Table 5: Sectoral location quotients of the four core cities (2023, eleven-city base)

Sector	Hong Kong	Macao	Guangzhou	Shenzhen
Agriculture, Forestry & Fishing	2.89	0.00	1.42	0.12
Mining & Quarrying	0.05	0.00	0.17	1.35
Manufacturing	0.06	0.05	0.49	0.88
Electricity, Gas, Water & Env. Services	0.43	0.44	1.25	0.99
Construction	1.26	1.03	1.15	1.09
Wholesale & Retail Trade	1.36	0.95	1.16	1.08
Transport, Storage, Post & ICT	1.31	0.64	1.46	1.42
Accommodation & Food Services	2.32	4.34	1.25	0.93
Finance & Insurance	4.70	2.42	0.67	1.08
Real Estate, Renting & Business Services	0.86	0.50	1.50	1.12
Education	1.61	1.45	1.14	0.74
Health & Social Work	2.74	1.90	1.26	0.66
Culture, Sports, Entertainment & Gaming	1.32	18.61	1.15	0.78
Public Administration & Social Security	1.15	2.70	1.07	0.70
Resident, Repair & Other Personal Services	4.36	2.54	0.83	0.94

Notes. A location quotient is the sectorś share of city employment divided by the sectorś share of eleven-city employment. A value of 1 means that the city matches the regional norm, and a value of 1.5 or above indicates specialization. Readings in very small sectors (agriculture and mining) reflect the treatment of state and auxiliary units and are not interpreted substantively.

Figure 2: The core and the belt separate from the early 2010s



Notes. The line is the average structural distance between the two core cities (Guangzhou, Shenzhen) and the seven node cities; higher means less alike. It troughs around the start of the 2010s and widens thereafter. Annual panel, fifteen sectors.

5.3 Manufacturing differentiation within the belt

Figure 3 compares the node cities at two industrial resolutions. Using fifteen sectors, their broad employment structures are generally similar. Once manufacturing is divided into twenty-six divisions, two groups become visible. Dongguan, Huizhou, and Zhuhai are relatively close to one another, as are Foshan and Zhongshan, while distances across the two groups are larger. The first group is concentrated in computers, communications, and electronic equipment; the second is concentrated in electrical machinery. Several city pairs that are close in the broad-sector data therefore have substantially different manufacturing profiles.

The concentrations are large enough to identify the poles clearly. In 2023, computers, communications, and electronic equipment accounted for 22.8% of manufacturing employment in Dongguan, 32.8% in Huizhou, and 27.6% in Zhuhai. Electrical machinery and apparatus accounted for 18.7% in Foshan and 28.3% in Zhongshan. In each of the five cities, the pole-defining division is the largest single

division of manufacturing employment.

Specialization is broad-based rather than confined to these two divisions. Twenty-two of the twenty-six manufacturing divisions have at least one specialist among the nine mainland cities (Figure 4). The belt therefore does not consist of cities that differ in only one dimension while remaining alike in all others. Broad duplication would instead produce more similar location-quotient profiles across cities and less differentiation across divisions.

Differentiation also occurs within the core. The Guangzhou–Shenzhen pair is among the most distant pairs in the region's manufacturing sector, with a distance of 0.37, greater than that of any cross-pole belt pair. Shenzhen is close to the electronics-pole cities, with distances of 0.19 from Zhuhai, 0.20 from Huizhou, and 0.25 from Dongguan. It is much farther from the electrical-machinery pole, with distances of 0.45 from Foshan and 0.40 from Zhongshan. Guangzhou aligns with neither pole, with distances ranging from 0.30 to 0.36 from all five cities. The region's manufacturing structure therefore contains two poles and one large city that aligns with neither.

The cross-group pattern is already present in the 2004 census and becomes more pronounced by 2013. Table 6 follows the corresponding distances across the five censuses. Cross-group distance exceeds within-group distance in every census. Within-group distances also rise, so the group labels indicate relative similarity rather than identical manufacturing profiles or a common production network.

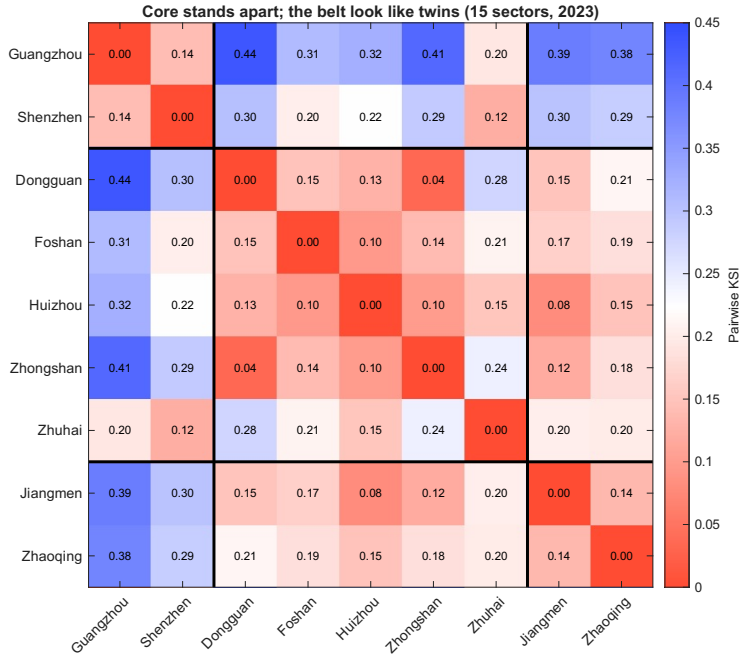
Table 7 compares the multi-city groupings in the 2010 and 2019 documents with the employment-based manufacturing groups. Each official grouping spans the two groups or combines a group member with a peripheral city. The groupings therefore should not be interpreted as clusters of cities with similar manufacturing employment structures. This comparison does not show that the groupings are misguided, since they may have been designed to connect cities with different but

potentially complementary functions. Employment shares cannot evaluate that form of complementarity.

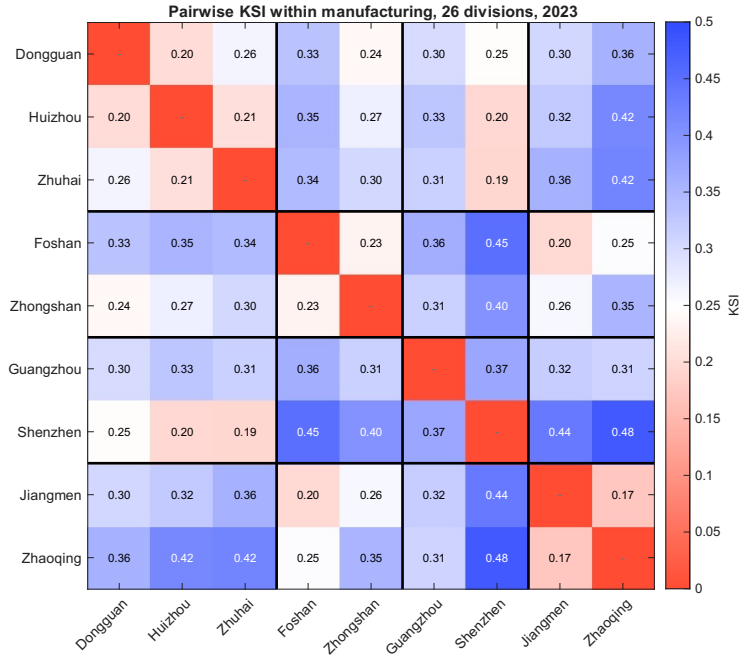
Jiangmen and Zhaoqing show the broadest manufacturing overlap among the belt cities. Figure 5(a) plots their within-manufacturing distance across the five censuses. The distance widened through 2008 and then declined. In 2018 and 2023, they were the closest of the twenty-one belt pairs, with a distance of 0.174 in 2023 compared with 0.227 for the average pair within a pole. Their location-quotient profiles overlap in seven divisions: agro-food processing, food manufacturing, textiles, wood products, non-metallic mineral products, metal products, and waste-resource recovery. Metal products is the largest manufacturing division in both cities, accounting for 18.9% of manufacturing employment in Jiangmen and 17.8% in Zhaoqing. Shenzhen and Zhuhai, by comparison, are close mainly because both have high employment shares in one advanced division. Employment shares cannot determine whether either pattern reflects rivalry or complementarity, but they show that the overlap between Jiangmen and Zhaoqing extends across a wider set of divisions. Among the belt pairs, their profiles are the most consistent with the isomorphism diagnosis.

The Jiangmen–Zhaoqing result narrows the scope of the isomorphism diagnosis rather than eliminating it. The 2019 Plan discusses overcapacity, homogeneous competition, and resource mismatch in particular places and industries (CPC Central Committee and State Council, 2019). The employment data identify broad structural overlap between these two cities, but they do not establish homogeneous competition or overcapacity. Those questions require evidence on products, prices, inventories, and capacity utilization.

Figure 3: Structural similarity at sector and manufacturing-division levels (2023)



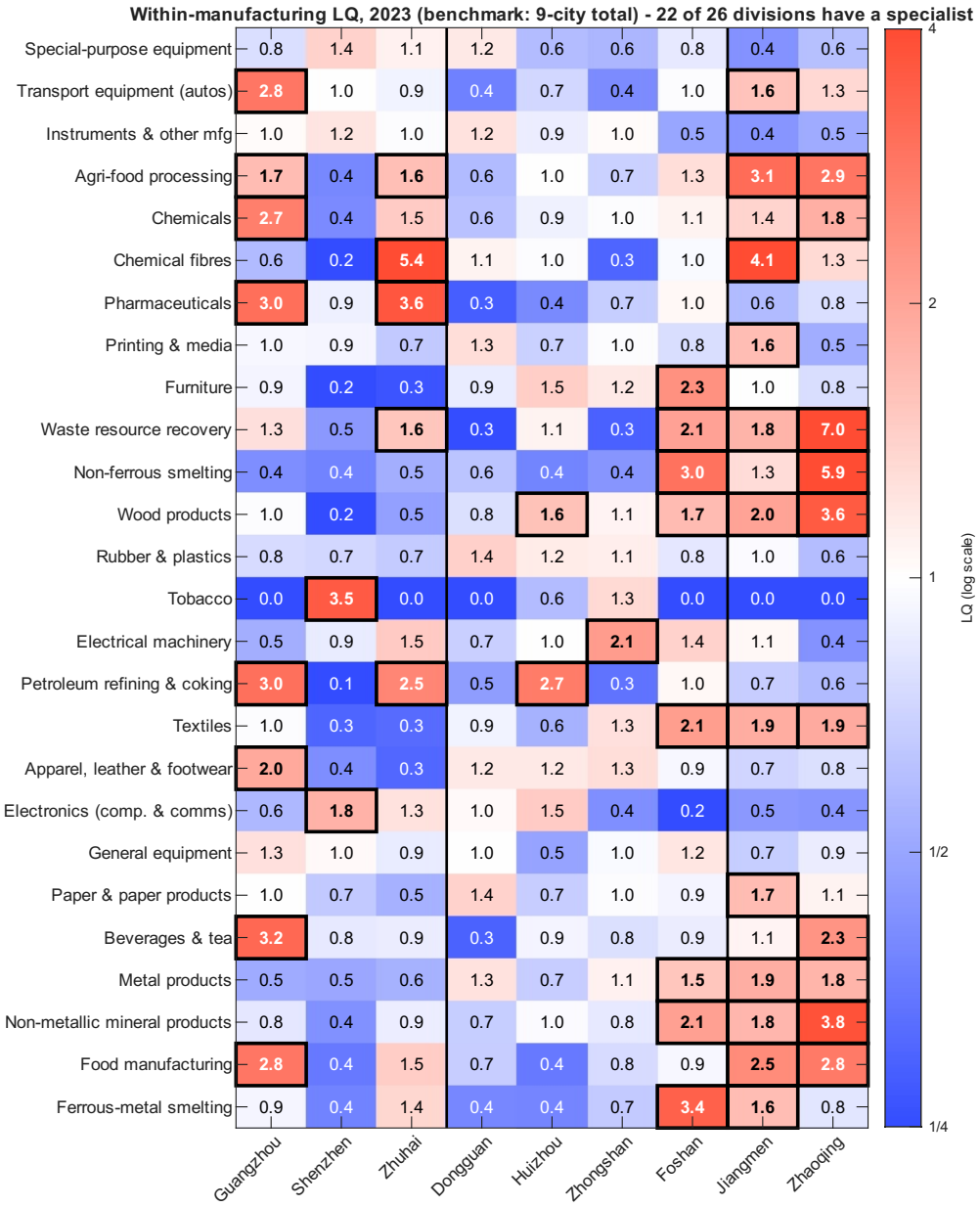
(a) Fifteen sectors: the node cities have similar broad structures



(b) Twenty-six manufacturing divisions: two groups are visible

Notes. Each cell is the structural distance between a pair of cities; darker cells indicate greater distance. At the sector level, panel (a) shows that the node cities are uniformly close. Within manufacturing, panel (b) reveals an electronics pole (Dongguan, Huizhou, Zhuhai) and an electrical-machinery pole (Foshan, Zhongshan), with cross-pole distances exceeding within-pole distances. Jiangmen and Zhaoqing belong to neither pole.

Figure 4: Where each city specializes inside manufacturing (2023)



Notes. Each cell is a location quotient calculated from within-manufacturing employment shares using the nine mainland cities as the regional base. The colour scale is logarithmic; an LQ of 1 is the regional norm, and an LQ of 1.5 or above indicates specialization. Twenty-two of the twenty-six divisions have at least one specialist city.

Table 6: Within- and cross-group manufacturing distances across censuses (26 divisions)

Census year	Within-pole avg.	Cross-pole avg.	Dongguan–Zhongshan	Jiangmen–Zhaoqing
2004	0.181	0.255	0.162	0.189
2008	0.198	0.299	0.233	0.223
2013	0.212	0.317	0.201	0.216
2018	0.228	0.311	0.206	0.192
2023	0.227	0.308	0.241	0.174

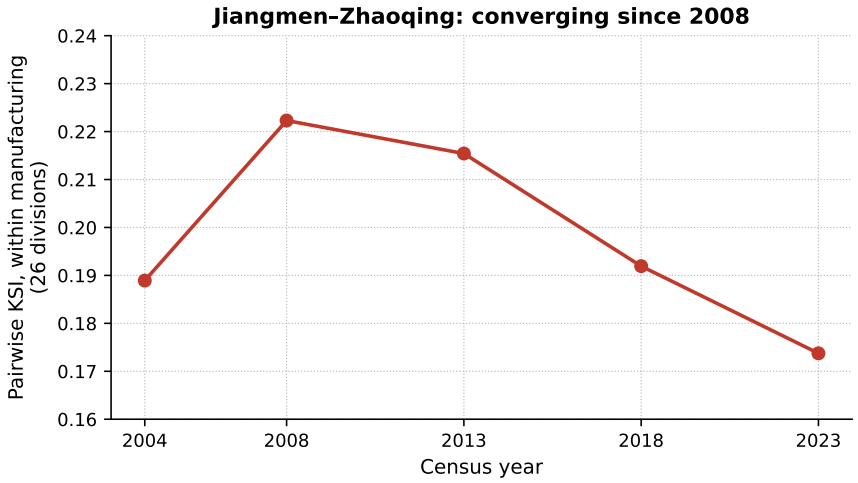
Notes. Entries are structural distances calculated from within-manufacturing employment shares: the share of a cityś manufacturing employment that would have to change division for its structure to match that of another city. The cross-pole average exceeds the within-pole average in every census. The Dongguan–Zhongshan pair is very close at the sector level but far apart within manufacturing; the Jiangmen–Zhaoqing pair shows the reverse. Poles: electronics (Dongguan, Huizhou, Zhuhai) and electrical machinery (Foshan, Zhongshan).

Table 7: Official groupings and employment-based manufacturing groups

Official grouping	Vintage	Measured position of members	Relation to measured groups
Foshan–Dongguan	2010, 2019	Electrical-machinery pole; electronics pole	Spans the poles
Zhuhai–Zhongshan	2019	Electronics pole; electrical-machinery pole	Spans the poles
Huizhou–Jiangmen–Zhaoqing	2019	Electronics pole; overlap pair	Mixed
Zhongshan–Jiangmen	2010	Electrical-machinery pole; periphery	Spans pole and periphery

Notes. Groupings from the plans (Table 1); pole memberships from Figure 3(b) and Table 6. All four named groupings, across both vintages, join cities that the census data place on opposite poles or on opposite sides of the pole–periphery boundary; none groups two cities of the same pole.

Figure 5: Broad manufacturing overlap between Jiangmen and Zhaoqing



(a) Their distance shrinks across the censuses

(b) Their specialization profiles overlap across seven divisions

Notes. Panel (a) shows the within-manufacturing distance between Jiangmen and Zhaoqing, calculated from employment shares across the 26 divisions. The distance widens through 2008 and then falls; by 2018 and 2023, they are the closest of the twenty-one belt pairs. The series is the last column of Table 6. Panel (b) shows divisions in which one or both cities specialize (location quotient at least 1.5). Their profiles overlap across a broad set of land-intensive, lower-technology divisions, indicating broad structural overlap rather than concentration in only one common division.

5.4 Timing relative to the GBA policy framework

The main structural changes documented in this paper were visible before the two GBA-level policy milestones. Mainland divergence and core–belt separation begin around the start of the 2010s. The cross-group manufacturing pattern is present in 2004 and is clearer by the 2013 census, while the Jiangmen–Zhaoqing distance declines from 2008 onward. Table 8 places these changes alongside the 2017 Framework Agreement and the 2019 Outline Development Plan.

This sequence shows that the GBA-level framework was introduced after the observed employment patterns had begun to develop. It does not identify the effect of policy. Guangdong adopted a provincial differentiated-development agenda in 2008 and introduced named city assignments in 2010, both before the mainland divergence reported here. Other economic forces may also have contributed. The evidence therefore establishes temporal ordering relative to the GBA-level plans, not a causal distinction between policy and market forces. Similarly, the fact that the official groupings span the employment-based manufacturing groups shows that they are not similarity clusters; it does not determine whether they facilitate complementarity.

Table 8: Timing of observed structural changes and policy milestones

Strand	Panel (grain)	Turning point
Mainland-nine divergence	Annual (15 sectors)	Trough at the start of the 2010s; rising since
Core–belt separation	Annual (15 sectors)	Trough at the start of the 2010s; widening since
Two-group manufacturing structure	Census (26 divisions)	Present in 2004; more pronounced by 2013
Jiangmen–Zhaoqing convergence	Census (26 divisions)	Falling since 2008; no break at policy dates
Policy milestones	Not applicable	Framework Agreement 2017; Outline Plan 2019

6 Conclusion

This paper examines the employment structure of the eleven Greater Bay Area cities at both broad-sector and manufacturing-division levels. Average structural distance across all eleven cities declines from 2004 to 2024, mainly as the mainland cities move toward the service-heavy employment structure of Hong Kong and Macao. Among the nine mainland cities, however, structural distance rises after the early 2010s. Guangzhou and Shenzhen account for a disproportionate share of coordinating activities, while the seven node cities retain more production-oriented profiles. Within manufacturing, Dongguan, Huizhou, and Zhuhai form an electronics-based group, while Foshan and Zhongshan form an electrical-machinery group. Jiangmen and Zhaoqing show the broadest division-level overlap among the belt cities.

The employment data support the plans' broad distinction between a core and a production belt, but the named node-city groupings do not coincide with clusters of similar manufacturing profiles. This is a descriptive comparison, not an assessment of whether the groupings are suitable policy instruments. The plans may group cities precisely because their functions differ and could be complementary. Determining that requires evidence on production links, trade, or firm networks rather than employment shares.

The timing also requires a limited interpretation. The main patterns were visible before the 2017 Framework Agreement and the 2019 Outline Development Plan, so those GBA-level documents were introduced after the observed differentiation had begun. An earlier provincial agenda dating from 2008, however, may have contributed to the subsequent changes. The results therefore establish temporal ordering but do not identify a policy effect. This interpretation is compatible with evidence that the 2017 announcement affected cross-boundary investment flows (C. Zhang et al., 2022; X. Zhang et al., 2022): flows may respond to a policy

announcement even when broader employment structures have earlier origins.

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A Data Construction and Classification Concordances

The annual panel is a balanced array of 11 cities × 15 sectors × 21 years (2004–2024), with employment measured in persons and every cell populated. The Hong Kong and Macao series are published in persons by the Census and Statistics Department and the Statistics and Census Service, respectively. The mainland series is constructed as described below. The panel is bounded below by the start of the mainland series in 2004 and above by the common end year of 2024.

Construction of the mainland annual series. Two mainland sources report city employment by sector, but neither spans the full panel. The economic and national censuses enumerate the full population of legal-person units, the definition used throughout this paper, but only in 2004, 2008, 2013, 2018, and 2023. The statistical yearbooks report employment annually, but only for urban non-private units, a narrower universe whose level is not comparable with the census count.

We therefore use the censuses as benchmarks and the yearbook series as interpolators. For each city and sector, employment in a census year equals the census value. Between two consecutive benchmarks, employment follows the growth path of the corresponding non-private series, scaled so that the interpolated path meets both benchmarks exactly. Yearbook figures are converted from the published unit of ten thousand persons. The constructed annual series uses the census definition in every year and coincides with the census panel, after aggregation to fifteen sectors, at each of the five benchmarks.

Two properties of this construction bear on the results. First, levels are identified by the censuses alone: the yearbook series contributes only the shape of the path between them, so any level bias in the narrower universe is removed by the

benchmarking. Second, and correspondingly, the yearbook series does affect the timing of movements within an inter-census interval. Where a result in Section 5 turns on timing, we report the corresponding value at the census benchmarks, which do not depend on it.

Hong Kong and Macao require no such step. Both jurisdictions publish employment by industry annually on a consistent basis, and their series enter the panel as published.

Construction of Harmonized Data. Three source classifications are mapped to the common framework: the mainland GB/T 4754 sections (19 categories), the Hong Kong Standard Industrial Classification (21 categories), and the Macao DSEC industry classification (14 categories). Table 9 reports all three mappings side by side. Two pooling decisions are forced by the Macao classification, which reports jointly what the other two report separately. Transport, storage and post are pooled with information and communication, because Macao publishes a single transport-and-communications line; and real estate is pooled with renting, business, professional, scientific and administrative services, because Macao publishes a single real-estate-and-business-activities line. Both poolings bind Hong Kong as well, which reports these activities in five separate categories. Two further decisions are ours rather than forced. The mainland section for water conservancy, environment and public facilities management is folded into utilities, matching Hong Kong's grouping of water supply with sewerage and waste management. And gaming is retained inside culture, sports and entertainment rather than separated: Macao does publish gaming separately, but neither of the other two sources isolates a comparable activity, so separating it would create a category defined for one city alone.

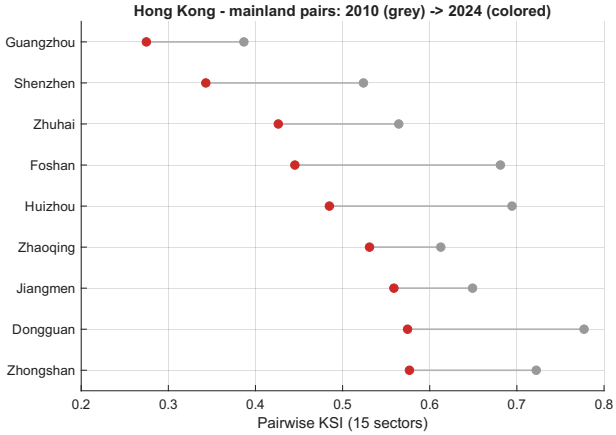
Table 9: The three source classifications mapped to the fifteen-sector frame

	Harmonized sector	Mainland	Hong Kong	Macao
1	Agriculture, Forestry & Fishing	1 Agriculture, forestry, livestock and fishery	1 Agriculture, forestry & fishing	0 no observation
2	Mining & Quarrying	2 Mining	2 Mining and quarrying	0 no observation
3	Manufacturing	3 Manufacturing	3 Manufacturing	1 Manufacturing
4	Electricity, Gas, Water & Environmental Services	4 Electricity, heat, gas and water production and supply; 5 Water conservancy, environment and public facilities management	4 Electricity & gas supply; 5 Water supply, sewerage & waste management	2 Electricity, gas and water supply
5	Construction	6 Construction	6 Construction	3 Construction
6	Wholesale & Retail Trade	7 Wholesale and retail trade	7 Import & export trade; 8 Wholesale; 9 Retail trade	4 Wholesale & retail
7	Transport, Storage, Post & ICT	8 Transport, storage and post; 9 Information transmission, software and IT services	10 Transport, storage, postal & courier; 11 Information & communication	5 Transport, storage and communications
8	Accommodation & Food Services	10 Accommodation and catering	12 Accommodation & food services	6 Hotels, restaurants and similar activities
9	Finance & Insurance	11 Finance	13 Financing & insurance	7 Financial activities
10	Real Estate, Renting & Business Services	12 Real estate; 13 Leasing and business services; 14 Scientific research and technical services	14 Real estate; 15 Professional, scientific & technical services; 16 Administrative & support services	8 Real estate, renting and business activities
11	Education	15 Education	17 Education	9 Education
12	Health & Social Work	16 Health and social work	18 Human health & social work	10 Health and social welfare
13	Culture, Sports, Entertainment & Gaming	17 Culture, sports and entertainment	19 Arts, entertainment & recreation	11 Recreational, cultural, gaming and other services
14	Public Administration & Social Security	18 Public administration, social security and social organizations	20 Public administration	12 Public administration and compulsory social security
15	Resident, Repair & Other Personal Services	19 Resident services, repair and other services	21 Other	13 Domestic work; 14 Others

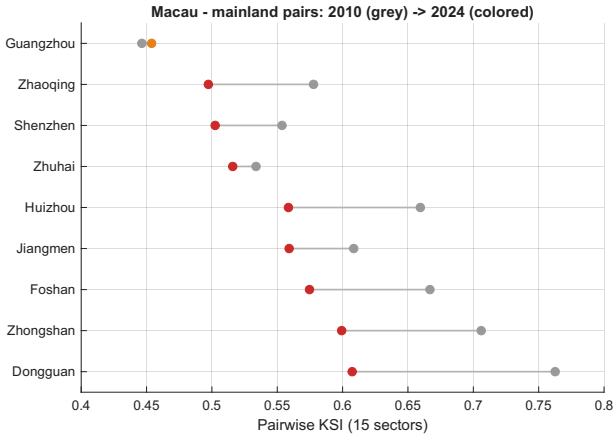
Notes. Each harmonized sector is the union of the source categories in its row; no source category is split across sectors. Source categories are numbered sequentially down each column as they appear in this table, not by the codes of the original classifications. The mainland section for international organizations reports no employment in Guangdong and is omitted. Macao publishes gaming separately within its recreational and cultural category; it is retained inside sector 13 because neither other source isolates a comparable activity. Hong Kong's residual "other" category, mapped to sector 15, includes foreign domestic helpers and is therefore larger relative to the economy than its mainland counterpart.

B Additional Figures

Figure 6: The eighteen SAR–mainland city pairs, 2010 and 2024



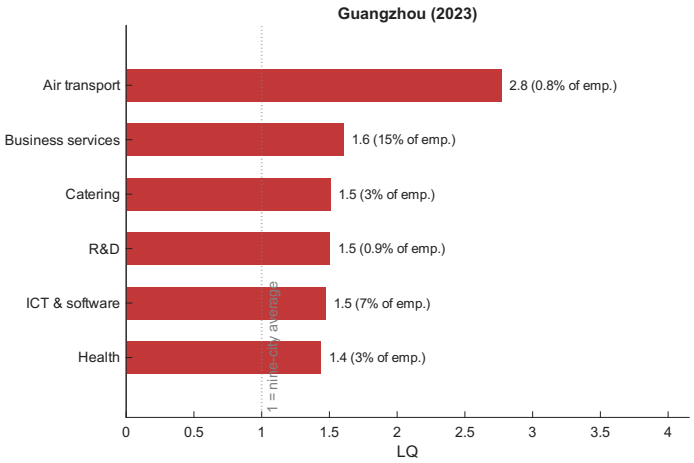
(a) Hong Kong with each mainland city



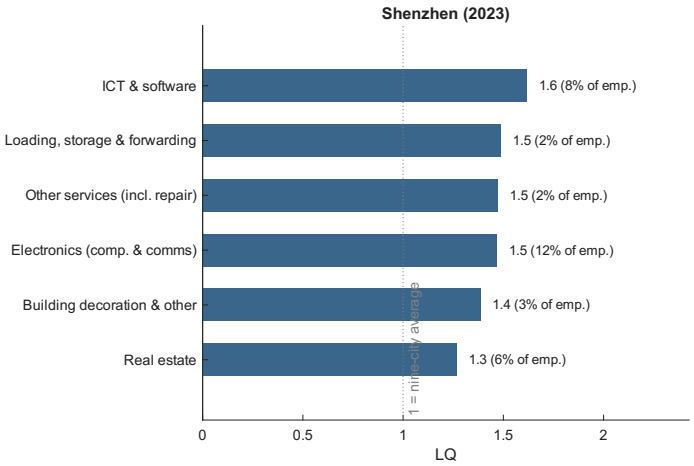
(b) Macao with each mainland city

Notes. Each row represents one city pair. The marker shows the structural distance between the two cities, defined as the share of employment that would have to change industry for their structures to coincide, in 2010 and 2024. Seventeen of the eighteen pairs are closer in 2024; the exception is Macao–Guangzhou. Annual panel, fifteen sectors.

Figure 7: Hub-function profiles of the two mainland core cities, 2023



(a) Guangzhou



(b) Shenzhen

Notes. Bars are location quotients: the activity's share of the city's employment divided by its share of regional employment, so that 1 marks the regional norm. Only activities at or above the specialization threshold are shown, with each activity's share of city employment given alongside.