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An Empirical Study on the Impact of Language Service Industry Development on High-Quality Economic Growth in the Sichuan-Chongqing Region

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ABSTRACT

The construction of the Chengdu-Chongqing Economic Circle is a major national strategy to promote high-quality development in Western China. Based on panel data from 19 cities in Sichuan and Chongqing covering the years 2005 to 2022, this study employs a two-way fixed effects model to systematically examine the impact and underlying mechanisms of the language service industry development on high-quality economic growth in the region. The findings show that the development of the language service industry significantly promotes high-quality economic growth, particularly in the dimensions of openness, innovation, sharing, and coordination. Its effect is mainly realized through expanding foreign trade and attracting international talent. However, the industry's driving force is significantly stronger in the core areas of Chengdu and Chongqing than in the peripheral cities, showing a pattern of "core polarization-peripheral collapse" and indicating regional development imbalance. Based on these findings, this study recommends: (1) establishing collaborative innovation hubs that integrate industry, academia, research, and application; (2) promoting tiered development of language service clusters to support spatial spillovers; (3) aligning industrial expansion with green development through the creation of multilingual environmental corpora and certification systems; and (4) strengthening interdisciplinary talent pipelines via adaptive training and lifelong learning programs. These measures aim to position the language service industry as a strategic engine for innovation, global engagement, and sustainable development within the Chengdu-Chongqing Economic

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Circle, while addressing coordination bottlenecks and enabling inclusive regional transformation.
Keywords: Language Service Industry; High-Quality Economic Growth; Sichuan-Chongqing Region; Empirical Study

1. Introduction

Under the impetus of the Belt and Road Initiative and the ongoing development of the New Land-Sea Trade Corridor, Western China, positioned as a strategic hub of the national Western Development Strategy, is rapidly integrating into global production networks and value chains. According to 2024 data, the total import and export volume of the western region reached RMB 4,283.959 billion, with Sichuan Province leading at RMB 1,045.72 billion, marking a year-on-year growth of 9.4%. In 2020, the CPC Central Committee and the State Council released the Master Plan for the Construction of the Chengdu-Chongqing Economic Circle, aiming to promote integrated and coordinated development and build a new engine for high-quality growth and regional cooperation in Western China. In 2023, the gross regional product of the Sichuan and Chongqing region reached RMB 8.7 trillion, accounting for 30.30% of the western region's total, underscoring the strong momentum of the twin-city economic circle. Amid global value chain restructuring and regional economic coordination, the language service industry is transforming from a medium of cultural communication into a new form of infrastructure essential for high-quality regional development[1]. Regional language planning must be tailored to local characteristics and development needs, integrating resources such as language policies, talent cultivation, and the language industry to establish a language service system adapted to regional economic development[2].

This study empirically investigates the impact and underlying mechanisms of the language service industry on high-quality economic development in the Sichuan-Chongqing region. It contributes to the understanding of how language services can facilitate regional economic upgrading by dismantling linguistic barriers, particularly in the context of the Chengdu-Chongqing Economic Circle. It also provides policy insights for optimizing language governance in the context of China's "dual circulation" strategy, which aims to balance domestic economic growth with international engagement. Furthermore, the study offers a demand-driven perspective for universities specializing in foreign languages and international studies seeking to align with the "New Liberal Arts" reform, an initiative to modernize traditional disciplines by promoting interdisciplinary and practice-oriented education.

2. Theoretical Analysis and Research Hypotheses

Language services, centered on cross-linguistic competence, constitute a modern service industry aimed at achieving goals such as information transformation, knowledge transfer, cultural dissemination, and language training[3]. These services provide professional solutions, including translation, technological R&D, tool application, asset management, marketing and trade, investment and mergers, research consulting, and training and assessment, for high-tech sectors, international business, foreign-related legal affairs, international communication, government diplomacy, and foreign language education. In recent years, research on language services has gradually transcended the traditional boundaries of translation studies, expanding into more specialized areas of social services such as health care[4–8], emergency response[9–13], immigrant and minority support[14–16], disability education[17–19], and technological innovation[20–22].

As an emerging industry, China's language services industry has experienced rapid development and technological advancement, marked by its expanding scale, growing institutional collaborations, and increasing efforts toward self-regulation[23]. In China, language services have extended into the macro-governance dimension of regional coordinated development[24–26]. Existing studies generally agree that language services play a key role in promoting high-quality regional economic development, facilitating cultural exchange, and achieving social integration[27]. Wang and Cui measured the convenience of language services between China and countries along the Belt and Road Initiative, finding that language services have a significant positive effect on bilateral trade and investment[24]. Wang et al. further

developed an evaluation index system for language service competitiveness and conducted an empirical assessment of the three major national strategic regions – Beijing-Tianjin-Hebei, the Yangtze River Delta, and the Guangdong-Hong Kong-Macao Greater Bay Area – verifying the positive role of language services in promoting coordinated regional economic development [25]. Xiao and Deng, based on panel data nationwide, empirically demonstrated a significant positive correlation between the development of the language service industry and high-quality economic development, further confirming the driving effect of language services [26].

In terms of mechanisms, language services contribute to regional economic development through multiple channels, such as facilitating the mobility of high-end resources (e.g., talent, capital, and technology) and enhancing the efficient conversion of information into actionable knowledge [3]. First, as a knowledge- and technology-intensive industry, language services exhibit significant innovation spillover effects. Driven by the deep integration of technologies such as artificial intelligence, big data, and blockchain, the language service industry is rapidly evolving toward greater intelligentization and platformization, fostering a technology-driven growth model centered on innovation [28, 29]. Situated in the strategic heartland of national development, the Sichuan-Chongqing region continues to strengthen its innovation capacity. The high-tech zones in Chengdu and Chongqing have become key demonstration areas for scientific innovation and high-end industrial agglomeration in western China [30]. In this context, the integration of language services with regional innovation ecosystems contributes to enhanced knowledge transfer, improved cross-border collaboration, and the promotion of high-quality economic development.

Second, language services serve as essential infrastructure for facilitating regional external cooperation. They help lower the costs of cross-border communication and enhance the efficiency and sustainability of institutional alignment and collaboration [24]. As a strategic nexus where the Belt and Road Initiative converges with the New Land-Sea Trade Corridor, the Chengdu-Chongqing Economic Circle has substantially improved its openness and connectivity. By 2023, key international logistics routes, such as the China-Europe Railway Express, had achieved high-frequency operations, while international cooperation platforms, including the China-Singapore (Chongqing) Demonstration Initiative on Strategic Connectivity and the China (Sichuan) Pilot Free Trade Zone, continued to expand in scope and depth [31]. The language service industry plays a vital role in supporting this regional opening-up by providing multilingual translation, localization, interpretation, and cross-cultural communication services, thereby facilitating deeper integration into global industrial and value chains.

Third, language services provide critical support for international talent by facilitating language adaptation, cross-cultural communication, and policy navigation, thereby becoming an increasingly important mechanism for attracting and retaining high-end talent. According to Jiang et al. (2023), the language service industry has evolved into a "new career enabler", offering full lifecycle language support for globally mobile talent [28]. In recent years, the Sichuan-Chongqing region has continuously improved its talent service ecosystem by leveraging international schools, expatriate communities, and entrepreneurship parks [32]. These efforts have strengthened support systems in language, living conditions, and regulatory compliance, significantly boosting the region's capacity to attract talent and optimize factor allocation.

Furthermore, regional studies suggest that the effectiveness of language services is unevenly distributed and significantly moderated by local foundational conditions [26]. Areas rich in educational resources tend to possess more robust language talent development systems and research infrastructure, thereby supporting the high-end advancement of the language service industry [33, 34]. Areas with a higher proportion of service-oriented economic activity demonstrate stronger demand for professional language services and are better positioned to integrate into high value-added segments, enabling economies of scale and fostering industrial synergy [35]. Spatial economic theory further indicates that the diffusion of regional language service capabilities exhibits a gradient effect, with concentrations in core cities and limited spillovers to peripheral areas – resulting in a polarized spatial pattern [36].

However, existing research has primarily focused on the more developed eastern coastal regions or the nation as a whole, with limited empirical assessment of western China, particularly the Sichuan-Chongqing region. To address this gap and systematically examine the impact and underlying mechanisms of the language service industry on high-quality

economic development in this region, the present study proposes the following hypotheses:

H1. *The language service industry development has a significantly positive impact on the high-quality economic growth in the Sichuan-Chongqing region.*

H2. *The language service industry development promotes high-quality economic growth in the Sichuan-Chongqing region by enhancing innovation capacity.*

H3. *The language service industry development promotes high-quality economic growth in the Sichuan-Chongqing region by expanding foreign trade scale.*

H4. *The language service industry development promotes high-quality economic growth in the Sichuan-Chongqing region by attracting overseas talent.*

H5. *The impact of the language service industry development on high-quality economic growth in the Sichuan-Chongqing region is moderated by regional conditions.*

H5a. *The level of education investment positively moderates this relationship, with stronger effects observed in regions with higher education investment.*

H5b. *The level of service industry development positively moderates this relationship, with stronger effects observed in regions with a more developed service industry.*

H5c. *The positive effect exhibits a spatial gradient difference as follows: core areas (Chengdu, Chongqing) > radiation areas (Deyang, Meishan, Ziyang) > peripheral areas (Bazhong, Guangyuan, etc.).*

3. Research Design

3.1. Data and Sample

This study focuses on 19 cities in the Sichuan-Chongqing region over the period 2005-2022, including Chongqing, Chengdu, Zigong, Panzhihua, Luzhou, Deyang, Mianyang, Guangyuan, Suining, Neijiang, Leshan, Nanchong, Meishan, Yibin, Guang'an, Dazhou, Ya'an, Bazhong, and Ziyang. Due to data limitations, the Tibetan and Qiang Autonomous Prefecture of Aba, Ganzi, and Liangshan are not included in the analysis. Systematic indicator systems are developed to empirically examine the relationship between the language service industry development and high-quality economic growth.

Following the approach of Wang and Wang (2024), four secondary indicators were compiled: the number of language service enterprises, industry output value, number of employees, and talent demand[1]. Data on language service enterprises were obtained through keyword-based filtering and manual verification of the State Administration for Market Regulation (SAMR) database of active enterprises as of December 31, 2022. The keywords include *translation services* (e.g., written translation, interpretation), *localization services*, *language technology development and application* (e.g., machine translation, speech recognition), *language resource services* (e.g., multilingual and parallel corpora, terminology management), *language education and training* (e.g., training institutions, instructional methods), *other value-added services* (e.g., project management, desktop publishing). Identified enterprises were subsequently categorized by type, registered capital, and core business. Industry output value was estimated using the median value method based on reported revenue intervals, in accordance with the methodology outlined in the *Report on Language Service Development in China* (2024), yielding a high internal consistency coefficient (ICC = 0.989). To estimate the number of employees, a regression model was constructed using data from 128 enterprises surveyed:

$$\begin{aligned}\text{Number of Employees} &= 4.580 \\ &\times \text{Number of Insured Employees} \\ &-11.879 \ (p < 0.001)\end{aligned}$$

These secondary indicators were then aggregated into a composite first-level index reflecting the development level of the language service industry, using the entropy weighting method, as shown in **Table 1**.

Liu et al. proposed an evaluation framework for high-quality economic growth, measuring 282 Chinese cities from 2005 to 2016 across five dimensions: innovation, coordination, openness, green development, and sharing[37]. Building on this framework, the present study collects data from the National Bureau of Statistics, the *China Urban Statistical Yearbook*, the *Sichuan Statistical Yearbook*, the *Chongqing Statistical Yearbook*, and the CNRDS database. Based on these sources, a four-level indicator system is constructed (e.g., the balance of deposits and loans, proportion of service industry). These indicators are weighted using the entropy method to generate third-level indicators (e.g., Science & Education

Investment, Financial Development), which are subsequently aggregated into five second-level dimensions corresponding to the key pillars of high-quality economic development. Finally, a composite first-level index is constructed to capture the multidimensional characteristics of regional high-quality economic development, as seen in **Table 2**.

In addition, data on regional GDP, population, fixed asset investment, urbanization level, number of foreign-invested enterprises, and export volume are obtained from the *Sichuan Statistical Yearbook* and the *Chongqing Statistical Yearbook*. Information on executives with overseas backgrounds is retrieved from the CSMAR database, while patent application data is collected from the China National Intellectual Property Administration (CNIPA).

Table 1. Indicator system for language service industry development.

Primary Indicator	Secondary Indicator	Attribute	Weight
Language Services Industry Development	Language Service Enterprises	+	0.238
	Language Service Output Value	+	0.235
	Language Service Employees	+	0.270
	Language Service Talent Demand	+	0.258

Table 2. Indicator system for high-quality economic growth.

Primary Indicator	Secondary Indicator	Tertiary Indicator	Quaternary Indicator	Attribute	Weight
High-Quality Economic Development	Innovation Development	Science & Education Investment	Research Investment/Fiscal Expenditure	o	0.002
			Education Investment/Fiscal Expenditure	o	0.001
		Patent Level	Patent Authorization	+	0.200
	Coordination Development	Financial Development	Financial Deposits/Financial Loans Balance	o	0.007
		People's Livelihood	Per Capita Income	+	0.031
			Non-real Estate Investment/Fixed Asset Investment	o	0.004
		Industrial Structure	Proportion of Service Industry	+	0.024
	Openness Development	Foreign Investment	Utilization of Foreign Capital	+	0.245
			Total Output Value of Foreign-invested Enterprises	+	0.244
			Number of Foreign-invested Enterprises	+	0.149
	Green Development	Wastes Emissions	Industrial Wastewater Emission/Industrial Output Value	−	0.002
			Industrial Sulfur Dioxide Emission/Industrial Output Value	−	0.001
			Industrial Smoke (Dust) Emission/Industrial Output Value	−	0.001
		Pollution Treatment	Comprehensive Utilization Rate of General Industrial Solid Waste	+	0.009
			Centralized Treatment Rate of Sewage Treatment Plants	+	0.009
			Harmless Treatment Rate of Domestic Waste	+	0.003

Table 2. *Cont.*

Primary Indicator	Secondary Indicator	Tertiary Indicator	Quaternary Indicator	Attribute	Weight
High-Quality Economic Development	Sharing Development	Social Welfare	Number of Physicians/Population	+	0.024
			Wages of Employees on the Job	+	0.029
			Urban Greening Rate	+	0.003
		Consumption Level	Social Retail Goods Consumption/GDP	+	0.011
		Government Burden	Fiscal Expenditure/Fiscal Revenue	o	0.002

Note: "+" indicates a positively associated indicator, "−" indicates a negatively associated indicator, and "o" indicates a moderately weighted or neutral indicator.

3.2. Empirical Model

This study adopts a two-way fixed effects model, following the approach of Xiao and Deng[26], to examine the relationship between the regional language service industry development and high-quality economic growth. The model is specified as follows:

$$TotalScore_{i,t} = \beta_0 + \beta_1 LangService_{i,t} + \eta' Controls_{i,t} + City_i + Year_t + \varepsilon_{i,t}$$

Where:

TotalScore is the composite index of high-quality economic development, including five sub-dimensions: innovation development (*InnoScore*), coordination development (*CoorScore*), openness development (*OpenScore*), green development (*GreenScore*), and sharing development (*ShareScore*);

LangService is the core explanatory variable, representing the language service industry development index;

Controls includes major control variables: regional economic level (*Citygdp*), population size (*Population*), fixed asset investment (*FixAsset*), urbanization rate (*UrbanRate*), and foreign investment (*Fcompany*);

City and **Year** represent city and year fixed effects, respectively;

$\varepsilon_{i,t}$ is the random error term.

Detailed descriptions of the variables are provided in **Table 3**. Regarding the treatment of control variables, *UrbanRate* is a percentage-based ratio variable with a relatively stable range and inherent standardization; therefore, it is not log-transformed to avoid interpretive bias. All other continuous control variables are log-transformed (after adding one) to mitigate heteroscedasticity and reduce scale differences. More detailed information of variables can be seen in **Table 3**. The primary coefficient of interest is β_1, which captures the marginal effect of language service industry development on high-quality economic growth.

Table 3. Variable definitions.

Type	Variable	Indicator	Definition
Explanatory variables	LangService	Language service industry development	Constructed following the approach of Wang and Wang[1]
	LangService_enterprise	Number of Language Service Enterprises	
	LangService_output	Language Service Output Value	
	LangService_employees	Number of language service employees	
	LangService_demand	Language Service Talent Demand	
Dependent variables	TotalScore	High-Quality Economic Development	Constructed following the approach of Liu et al.[37]
	InnoScore	Innovation Development	
	CoorScore	Coordination Development	
	OpenScore	Openness Development	
	GreenScore	Green Development	
	ShareScore	Sharing Development	

Table 3. *Cont.*

Type	Variable	Indicator	Definition
Control variables	CityGDP	Regional economic level	City GDP (billion RMB)
	Population	Population size	City year-end total population (ten thousand)
	FixAsset	Fixed asset investment	Total fixed asset investment in the city (billion RMB)
	UrbanRate	Urbanization level	Urbanization rate of the city (ratio)
	Fcompany	Foreign-invested enterprises	Number of foreign-invested enterprises in the city

4. Baseline Regression

As shown in **Table 4**, the baseline regression results indicate that the development of the language service industry significantly promotes high-quality economic growth in the Sichuan-Chongqing region, with particularly strong effects observed in the dimensions of openness, innovation, sharing, and coordination development. All results are statistically significant at the 1% level. Specifically, a one standard deviation increase in the language service industry development index corresponds to a 0.554 increase in the ratio of the high-quality growth index to its mean. The economic effects on the openness, innovation, sharing, and coordination development dimensions are 0.400, 0.146, 0.009, and 0.004, respectively. These findings suggest that language services are emerging as a key driver of high-quality growth in the region by unlocking technological innovation potential, optimizing regional resource allocation, enhancing external communication capacity, and expanding public service coverage.

Notably, the effect on the green development dimension is significantly negative (coefficient = −0.005, $p < 0.01$), indicating that the language service industry in the Sichuan-Chongqing region continues to face limitations in constructing green discourse systems, fostering environmentally conscious communication practices, and supporting sustainable development. This may be due to the relatively low involvement of language service enterprises in green initiatives, as well as the absence of relevant standards and specialized professional capacity in this area.

Table 4. Baseline regression results.

Variable	(1) High-Quality Development	(2) Innovation Development	(3) Coordination Development	(4) Openness Development	(5) Green Development	(6) Sharing Development
Language Service	0.554*** (0.024)	0.146*** (0.007)	0.004*** (0.001)	0.400*** (0.019)	−0.005*** (0.002)	0.009*** (0.001)
CityGDP	0.001 (0.021)	0.004 (0.006)	−0.008*** (0.001)	0.010 (0.016)	−0.001 (0.001)	−0.003*** (0.001)
Population	0.111*** (0.023)	0.032*** (0.007)	0.004*** (0.001)	0.069*** (0.018)	0.002 (0.002)	0.003*** (0.001)
FixAsset	−0.033*** (0.009)	−0.008*** (0.003)	−0.002*** (0.001)	−0.025*** (0.007)	0.001 (0.001)	0.001*** (0.000)
UrbanRate	0.003** (0.001)	0.001*** (0.000)	0.000 (0.000)	0.001 (0.001)	0.000* (0.000)	0.000 (0.000)
Fcompany	0.018*** (0.006)	0.003 (0.002)	0.000 (0.000)	0.015*** (0.004)	−0.000 (0.000)	0.000 (0.000)
Constant	−0.603*** (0.133)	−0.227*** (0.041)	0.045*** (0.008)	−0.422*** (0.104)	−0.002 (0.009)	0.003 (0.006)
City Fixed	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled

Table 4. *Cont.*

Variable	(1) High-Quality Development	(2) Innovation Development	(3) Coordination Development	(4) Openness Development	(5) Green Development	(6) Sharing Development
Year Fixed	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Sample	342	342	342	342	342	342
Within R^2	0.881	0.808	0.982	0.805	0.700	0.986

Note: *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

5. Robustness Tests

5.1. Lagged Variable Test

To assess the dynamic characteristics and potential lagged effects of the language service industry on high-quality economic development in the Sichuan-Chongqing region, this study incorporates a one-period lag of the language service industry development index (LS_{t-1}) and re-estimates the model using a fixed effects approach.

As shown in **Table 5**, the lagged index remains significantly and positively associated with overall high-quality development (coefficient = 0.568), as well as with the dimensions of innovation development (coefficient = 0.154), openness development (coefficient = 0.407), and sharing development (coefficient = 0.009), all at the 1% significance level. These coefficients slightly exceed those in the baseline model (**Table 3**), suggesting that the positive impact of the language service industry is both robust and gradually intensifying over time, with a policy effect diffusion cycle of approximately 1–2 years.

Table 5. Lagged one-period variable test.

Variable	(1) High-Quality Development	(2) Innovation Development	(3) Coordination Development	(4) Openness Development	(5) Green Development	(6) Sharing Development
Language Service	0.568*** (0.027)	0.154*** (0.008)	0.003** (0.002)	0.407*** (0.021)	−0.005*** (0.002)	0.009*** (0.001)
CityGDP	0.018 (0.021)	0.008 (0.007)	−0.008*** (0.001)	0.023 (0.017)	−0.001 (0.001)	−0.003*** (0.001)
Population	0.099*** (0.025)	0.028*** (0.008)	0.005*** (0.001)	0.059*** (0.020)	0.003* (0.002)	0.004*** (0.001)
FixAsset	−0.037*** (0.009)	−0.009*** (0.003)	−0.002*** (0.001)	−0.027*** (0.007)	0.001 (0.001)	0.001** (0.000)
UrbanRate	0.002 (0.001)	0.001** (0.000)	0.000 (0.000)	0.000 (0.001)	0.000 (0.000)	0.000 (0.000)
Fcompany	0.020*** (0.006)	0.004* (0.002)	0.000 (0.000)	0.017*** (0.004)	−0.000 (0.000)	0.000 (0.000)
Constant	−0.557*** (0.139)	−0.218*** (0.044)	0.045*** (0.008)	−0.386*** (0.109)	−0.001 (0.009)	0.004 (0.007)
City Fixed	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Year Fixed	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Sample	342	342	342	342	342	342
Within R^2	0.874	0.799	0.983	0.788	0.636	0.985

For the dimension of coordination development, the lagged effect remains statistically significant (coefficient = 0.003, $p < 0.05$), though slightly diminished compared to the baseline result (coefficient = 0.004, $p < 0.01$). This suggests a marginal weakening of the industry's role in promoting balanced regional development. The result also reflects a

spatial decay effect, whereby the benefits of language service development are concentrated in core areas such as Chengdu and Chongqing, with limited spillover to peripheral cities such as Bazhong and Guangyuan. This indicates that a fully integrated mechanism for region-wide coordinated development has yet to be established. In addition, the inhibitory effect in the green development dimension persists in the lagged model (coefficient = −0.005, $p < 0.01$), highlighting ongoing challenges such as time lags in the implementation of environmental policies and the insufficient green transformation capacity of language service enterprises. These interrelated factors reveal a short-term tension between the industry's expansion and ecological sustainability goals.

5.2. Sample Period Adjustment Test

To avoid abnormal disturbances to the economic system caused by exogenous shocks such as the COVID-19 pandemic, this study excludes sample data from 2020 to 2022 and re-estimates the model based on a normal economic cycle spanning 2005–2019. As presented in **Table 6**, the results show that the development of the language service industry exerts an even stronger positive effect on overall high-quality economic development (coefficient = 0.633), openness development (coefficient = 0.486), and sharing development (coefficient = 0.012), all significant at the 1% level. Notably, the coefficient for openness development increased by 21.5%, from 0.400 to 0.486, indicating that prior to the pandemic, language services played a more pronounced role in facilitating regional openness through international rule adaptation and cross-border resource integration.

For innovation development, the regression coefficient remains significant but slightly declines from 0.146 to 0.137, suggesting that the technology empowerment pathway was still in its formative stage before the pandemic. The integration depth and coordination mechanisms between the language service industry and the regional innovation system in the Sichuan-Chongqing region require further strengthening. Regarding coordination development, the level of statistical significance decreases from 1% to 5%, while the coefficient remains essentially unchanged. This implies a slight weakening in the regional coordination effect of language services during stable economic periods, reaffirming that the diffusion of language service capabilities remains constrained by the dominance of core cities. The limited effectiveness of downward resource transmission continues to hinder balanced development across the region.

Table 6. Sample period adjustment test.

Variable	(1) High-Quality Development	(2) Innovation Development	(3) Coordination Development	(4) Openness Development	(5) Green Development	(6) Sharing Development
Language Service	0.633*** (0.033)	0.137*** (0.008)	0.004** (0.002)	0.486*** (0.026)	−0.005** (0.002)	0.012*** (0.002)
CityGDP	−0.021 (0.028)	−0.000 (0.007)	−0.008*** (0.001)	−0.006 (0.022)	0.000 (0.002)	−0.006*** (0.001)
Population	0.178*** (0.026)	0.041*** (0.006)	0.006*** (0.001)	0.124*** (0.021)	0.001 (0.002)	0.006*** (0.001)
FixAsset	−0.032*** (0.010)	−0.007*** (0.002)	−0.003*** (0.001)	−0.025*** (0.008)	0.001 (0.001)	0.002*** (0.000)
UrbanRate	0.010*** (0.002)	0.002*** (0.000)	0.000 (0.000)	0.007*** (0.001)	0.000 (0.000)	0.000*** (0.000)
Fcompany	0.018*** (0.006)	0.003* (0.002)	0.000 (0.000)	0.015*** (0.005)	−0.000 (0.000)	0.000 (0.000)
Constant	−1.111*** (0.174)	−0.291*** (0.043)	0.035*** (0.009)	−0.845*** (0.138)	−0.001 (0.012)	−0.010 (0.008)
City Fixed	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Year Fixed	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled

Table 6. *Cont.*

Variable	(1) High-Quality Development	(2) Innovation Development	(3) Coordination Development	(4) Openness Development	(5) Green Development	(6) Sharing Development
Sample	285	285	285	285	285	285
Within R^2	0.841	0.765	0.975	0.770	0.720	0.982

In the green development dimension, the negative effect slightly weakens, with the significance level dropping from 1% to 5%, and the coefficient remaining at −0.005. This suggests that during the normal economic cycle, some of the negative externalities – such as energy consumption – associated with language service expansion have been partially mitigated, possibly due to the adoption of green certifications by some enterprises and the initial establishment of green translation standards. Nonetheless, a comprehensive green empowerment framework has yet to be fully established.

5.3. Winsorization Robustness Test

To minimize the influence of extreme values on the empirical results, a 1% winsorization is applied to the core explanatory variable and key control variables. As shown in **Table 7**, after winsorization, the positive effects of language service industry development on overall high-quality development (coefficient = 0.639), innovation development (coefficient = 0.169), openness development (coefficient = 0.462), and sharing development (coefficient = 0.010) in the Sichuan-Chongqing region are all further strengthened relative to the baseline model (**Table 3**), with all results remaining statistically significant at the 1% level. Notably, the coefficient for overall high-quality development increased from 0.554 to 0.639 – a 15.3% rise – suggesting that the original estimates may have understated the true policy effect of the language service industry.

With respect to coordination development, the winsorized coefficient remains positive (coefficient = 0.003) but is not statistically significant ($p > 0.1$), providing additional evidence of the spatial attenuation effect of language services in fostering regional coordination within the Sichuan-Chongqing area. The strong resource absorption capacity of core cities has yet to generate meaningful spillovers to peripheral regions. In the case of green development, the negative effect remains statistically significant (coefficient = −0.005, $p < 0.01$), indicating that the environmental resource competition associated with language service industry expansion is structurally embedded rather than merely driven by a few outlier observations.

In summary, the robustness tests confirm that the language service industry development consistently promotes high-quality economic growth in the Sichuan-Chongqing region across various model specifications. The estimated coefficients remain highly consistent with the baseline results in terms of sign, magnitude, and statistical significance, thereby reinforcing the credibility and theoretical validity of the study's findings. These empirical results provide strong support for Hypothesis 1 (H1) proposed in this paper.

Table 7. Winsorization robustness test.

Variable	(1) High-Quality Development	(2) Innovation Development	(3) Coordination Development	(4) Openness Development	(5) Green Development	(6) Sharing Development
Language Service	0.639*** (0.027)	0.169*** (0.009)	0.003 (0.002)	0.462*** (0.021)	−0.005*** (0.002)	0.010*** (0.001)
CityGDP	−0.025 (0.020)	−0.010 (0.006)	−0.006*** (0.001)	−0.004 (0.016)	−0.001 (0.001)	−0.004*** (0.001)
Population	0.131*** (0.022)	0.042*** (0.007)	0.004*** (0.001)	0.079*** (0.017)	0.003* (0.002)	0.004*** (0.001)
FixAsset	−0.025*** (0.009)	−0.005* (0.003)	−0.003*** (0.001)	−0.020*** (0.007)	0.001 (0.001)	0.001*** (0.000)

Table 7. *Cont.*

Variable	(1) High-Quality Development	(2) Innovation Development	(3) Coordination Development	(4) Openness Development	(5) Green Development	(6) Sharing Development
UrbanRate	0.004*** (0.001)	0.002*** (0.000)	−0.000 (0.000)	0.002*** (0.001)	0.000* (0.000)	0.000 (0.000)
Fcompany	0.014*** (0.005)	0.001 (0.002)	0.000 (0.000)	0.013*** (0.004)	−0.000 (0.000)	0.000 (0.000)
Constant	−0.645*** (0.129)	−0.228*** (0.041)	0.041*** (0.008)	−0.456*** (0.100)	−0.003 (0.009)	0.001 (0.006)
City Fixed	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Year Fixed	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Sample	342	342	342	342	342	342
Within R^2	0.890	0.811	0.981	0.822	0.700	0.986

6. Mechanism Analysis

To uncover the underlying mechanisms through which the language service industry promotes high-quality economic development in the Sichuan-Chongqing region, this study conducts a series of mediation tests across three key dimensions: innovation incentives, foreign trade, and talent attraction. Specifically, the number of patent applications, the volume of export trade, and the number of listed company executives with overseas backgrounds in the Sichuan-Chongqing region are selected as mediating variables (see **Table 8**). Fixed effects regression models are employed for the empirical analysis, and the results are presented in Table 9.

Table 8. Descriptive statistics of mechanism variables.

Variable	(1) Sample Size	(2) Mean	(3) Std. Dev.	(4) Min	(5) Median	(6) Max
Patent Applications	342	2070.7602	6488.8142	3.0000	241.000	48622.0000
Export Scale	342	39.1781	128.5906	0.0875	2.7784	800.0637
Overseas Executives	342	3.4620	9.6698	0.0000	0.5000	63.0000

Note: Export scale is measured in billions of U.S. dollars.

6.1. Innovation Incentive Mechanism

The impact of language service industry development on the number of patent applications in the Sichuan-Chongqing region is positive but not statistically significant (coefficient = 0.187, $p > 0.1$). This suggests that the current language service industry in the region remains largely concentrated in traditional translation services and has yet to become deeply integrated into high value-added areas such as intelligent language technology research and development. Furthermore, the demand from research institutions for cross-lingual knowledge mining services has not been fully activated, resulting in limited synergy between language services and the regional innovation chain. Therefore, although the direction of the effect is consistent with expectations, Hypothesis 2 (H2) is not fully supported, indicating untapped potential in the innovation pathway that has yet to yield significant empirical effects.

6.2. Foreign Trade Mechanism

Language service industry development significantly increases the export scale of the Sichuan-Chongqing region (coefficient = 1.535, $p < 0.01$). This result demonstrates that language services play a crucial role in reducing information barriers, enhancing transnational communication efficiency, and facilitating the internationalization of enterprise branding, thereby effectively promoting regional foreign trade growth. These findings provide strong empirical support for Hypothesis 3 (H3).

6.3. Talent Attraction Mechanism

As seen in **Table 9**, the development of the language service industry also has a significant positive impact on the number of executives with overseas backgrounds in listed companies in the Sichuan-Chongqing region (coefficient = 0.891, $p < 0.01$). This indicates that language services contribute to building a favorable linguistic environment and international image, enhancing the region's ability to attract high-quality global managerial talent. Consequently, this supports the optimization of the human capital structure and corporate governance capacity. These results provide strong empirical support for Hypothesis 4 (H4).

Table 9. Mechanism analysis.

Variable	(1) Patent Applications	(2) Export Scale	(3) Overseas Executives
Language Service	0.187 (0.294)	1.535*** (0.486)	0.891*** (0.330)
CityGDP	0.025 (0.251)	0.456 (0.416)	−0.092 (0.282)
Population	−0.097 (0.282)	−0.016 (0.467)	1.503*** (0.317)
FixAsset	0.292*** (0.108)	0.344* (0.179)	−0.274** (0.122)
UrbanRate	0.008 (0.015)	0.110*** (0.025)	−0.006 (0.017)
Fcompany	−0.040 (0.068)	0.008 (0.112)	0.004 (0.076)
Constant	2.281 (1.617)	1.768 (2.675)	−6.935*** (1.816)
City Fixed	Controlled	Controlled	Controlled
Year Fixed	Controlled	Controlled	Controlled
Sample	342	342	342
Within R^2	0.936	0.580	0.539

7. Heterogeneity Analysis

7.1. Education Investment

To assess the moderating effect of education investment on the relationship between the language service industry and high-quality economic development in the Sichuan-Chongqing region, the sample is divided into high and low education investment groups based on the median value of fiscal expenditure on education. As shown in Column (1) of **Table 10**, the language service industry significantly promotes high-quality economic development in areas with higher levels of education investment (coefficient = 2.185, $p < 0.01$). These regions typically possess more established systems for cultivating language talent, such as foreign language universities and translation training institutions that continuously supply professionals to the market. In addition, their strong cultural openness and innovation foundations provide critical support for the digital upgrading of the language service industry. By contrast, in areas with relatively limited educational resources, the effectiveness of the language service industry is constrained – possibly due to structural bottlenecks such as "low-end lock-in" and inadequate talent reserves. These findings provide empirical support for Hypothesis 5a (H5a).

7.2. Service Industry Level

Using the proportion of the service industry in GDP as a proxy for the level of service industry development, the sample is further divided into high and low service industry groups based on the median. This facilitates an examination of the moderating role of service industry structure in shaping the economic impact of the language service industry in the Sichuan-Chongqing region. As shown in Column (2) of **Table 10**, the language service industry significantly promotes high-quality economic growth in areas with a more developed service industry (coefficient = 9.774, $p < 0.05$). This synergy primarily arises from the strong dependence of producer services – such as finance, law, and consulting – on professional language services. For instance, in contexts involving cross-border investment, trade, and arbitration, multilingual contract translation and localization of technical terminology are essential for enhancing efficiency and regulatory compliance, thereby enabling language services to move up the value chain. Moreover, regions with a mature service industry typically possess well-developed information infrastructure and favorable policy environments, offering strong operational support for language service enterprises. Conversely, in regions where the service system is underdeveloped and

market demand is vague, language services tend to lack sufficient scenario embedding and technological integration. This may result in inefficient or redundant resource allocation and limit the industry's ability to contribute to high-quality development. These results support Hypothesis 5b (H5b).

7.3. Regional Differences

Based on policy zoning and spatial economic characteristics, this study divides the 19 cities of Sichuan-Chongqing region into three subregions: the core area (Chengdu, Chongqing), the radiation area (Deyang, Meishan, Ziyang), and the peripheral area (Bazhong, Guangyuan, etc.), in order to examine the spatial heterogeneity in the effects of the language service industry on high-quality development. Columns (3) to (5) in **Table 10** reveal substantial variation across these regional tiers.

In the core area, the language service industry exerts a strong and statistically significant positive impact on high-quality development (coefficient = 1.646, $p < 0.01$). This suggests that the industry fosters regional growth through economies of scale and institutional innovation. For instance, Chengdu leverages Free Trade Zone policies to advance technical capabilities in cross-border data flows and AI-driven translation, while Chongqing embeds multilingual logistics systems into international supply chain management via the New Land-Sea Trade Corridor, thereby enhancing global resource allocation capacity.

Table 10. Heterogeneity analysis.

Variable	(1) High-Quality Development	(2) High-Quality Development	(3) High-Quality Development	(4) High-Quality Development	(5) High-Quality Development
Language Services × Education Level	2.185*** (0.408)				
Language Services × Service Industry		9.774** (4.915)			
Language Services × Core Area			1.646*** (0.439)		
Language Services × Radiation Area				−0.061 (1.568)	
Language Services × Peripheral Area					−1.508*** (0.422)
Language Service	−1.668*** (0.413)	−9.233* (4.917)	−1.117** (0.447)	0.554*** (0.024)	0.534*** (0.024)
CityGDP	0.003 (0.020)	−0.011 (0.021)	0.015 (0.021)	0.001 (0.021)	0.018 (0.021)
Population	0.112*** (0.022)	0.119*** (0.024)	0.116*** (0.023)	0.111*** (0.023)	0.113*** (0.023)
FixAsset	−0.033*** (0.009)	−0.034*** (0.009)	−0.042*** (0.009)	−0.033*** (0.009)	−0.040*** (0.009)
UrbanRate	0.005*** (0.001)	0.003** (0.001)	0.003*** (0.001)	0.003** (0.001)	0.003** (0.001)
Fcompany	0.019*** (0.005)	0.019*** (0.006)	0.018*** (0.005)	0.018*** (0.006)	0.019*** (0.005)
Constant	−0.674*** (0.127)	−0.584*** (0.133)	−0.681*** (0.132)	−0.603*** (0.134)	−0.688*** (0.133)
City Fixed	Controlled	Controlled	Controlled	Controlled	Controlled
Year Fixed	Controlled	Controlled	Controlled	Controlled	Controlled
Sample	342	342	342	342	342
Within R^2	0.894	0.883	0.887	0.881	0.886

In contrast, the radiation area shows a negative but statistically insignificant interaction term (coefficient = −0.061, $p > 0.1$), indicating that the spillover effects from the core have not yet fully materialized. This may be due to several constraints, including insufficient infrastructure coordination (e.g., incomplete integration of the Chengdu-Deyang-Meishan-Ziyang rail system), discontinuities in industrial chains (e.g., Deyang's advanced equipment manufacturing lacks the capacity to absorb high-end language service business), and limited policy adaptability (e.g., Meishan's cultural tourism sector has multilingual service demand but lacks a mature service ecosystem).

In the peripheral area, the interaction term is significantly negative (coefficient = −1.508, $p < 0.01$), suggesting that the language service industry has not yet achieved meaningful industrial embedding and may even exacerbate regional disparities. On one hand, the "siphon effect" of the core area draws language talent away from peripheral regions, weakening their innovation capacity. On the other hand, peripheral cities often replicate models from the core without sufficient consideration of local resource endowments and market conditions, leading to mismatches between resource inputs and development strategies.

These results collectively confirm the "core-radiation-periphery" spatial asymmetry in the Sichuan-Chongqing region and highlight the dual role of the language service industry in regional coordination: while it reinforces the strengths of core areas through agglomeration effects, it may also widen development gaps due to resource siphoning. Therefore, Hypothesis 5c (H5c) is supported.

8. Conclusions

Drawing on panel data from the Sichuan-Chongqing region spanning 2005 to 2022, this study systematically investigates the impact and underlying mechanisms of the language service industry on regional high-quality economic development. The empirical results demonstrate that the language service industry significantly contributes to high-quality development in Sichuan and Chongqing, especially in the dimensions of openness, innovation, sharing, and coordination development, although structural tensions persist in the area of green development. The industry's influence is primarily driven by a dual mechanism of international trade expansion and international talent aggregation, while technology-enabled innovation remains contingent upon long-term industrial upgrading and ecosystem cultivation. The observed regional heterogeneity follows a pattern of core polarization and peripheral stagnation, shaped by three key moderating factors: education investment, service industry development, and spatial gradient effects. Based on these findings, the following policy recommendations are proposed:

To foster collaborative innovation and advance industrial upgrading, the Chengdu-Chongqing region should establish a dedicated Language Technology Innovation Hub within the Western (China) Science City. This hub would focus on the co-development of AI-powered translation engines and cross-lingual knowledge graph tools tailored to regional governance and Belt and Road communication needs. Moving beyond conventional models of technology transfer, the region should encourage the establishment of joint laboratories between institutions such as Sichuan International Studies University and emerging startups in Chongqing's Yubei District. These labs could pilot multilingual chatbots and speech recognition tools for public services. In parallel, Mianyang Science and Technology City may launch a "Language Services + Biomedicine" initiative to provide specialized translation platforms for the pharmaceutical industry.

To enhance openness and global integration, the Chongqing Pilot Free Trade Zone should host a Multilingual Trade Facilitation Center, offering real-time translation and localization services for logistics, customs clearance, and SME exporters. Chengdu-based e-commerce firms, such as the local branches of Anker, should receive support in developing localized platforms in Portuguese and Arabic to strengthen engagement with Lusophone and Middle Eastern markets. Furthermore, the New Land-Sea Trade Corridor can be leveraged to convene an annual Multilingual Digital Governance Forum, focusing on language policy and compliance in cross-border digital transactions. Existing overseas talent programs, such as the Yuzhong Overseas Talent Initiative, should be scaled up to attract returnees and international experts with backgrounds in language AI and global operations.

To address structural bottlenecks in talent supply, the region should launch a Chengdu-Chongqing Applied Language Talent Consortium, integrating local universities, vocational

colleges, and industry associations. This consortium could offer industry-aligned programs in AI-assisted translation, multilingual NLP, and content moderation. For instance, Chongqing Technology and Business University could pilot micro-credential or dual-degree programs tailored to emerging language service roles. In parallel, a Digital Language Skills Lifelong Learning Center should be established in Chengdu's High-Tech Zone to provide upskilling pathways for mid-career translators and interpreters, enhancing workforce adaptability amid ongoing digital transformation.

To promote inclusive growth, targeted investments are needed in underdeveloped areas such as Guang'an (Sichuan) and Wanzhou (Chongqing). These localities should receive funding to build multilingual public information systems and modernize translation infrastructure. SMEs located in industrial parks, particularly in cities like Nanchong and Luzhou, could benefit from translation subsidies for product manuals and international client communications. Moreover, metropolitan centers like Chengdu can facilitate capability spillovers by subcontracting or mentoring local language teams in areas such as Aba and Qianjiang District. To coordinate these efforts, a Chengdu-Chongqing Language Industry Coordination Platform should be established to oversee project funding, harmonize pricing standards, and share translator and interpreter pools.

Finally, language service expansion should align with the region's green development goals. The Chengdu Environmental Protection Bureau could lead the development of a Southwest China Multilingual Green Corpus, covering key terminology related to ESG, biodiversity, and climate governance. Local enterprises should be encouraged to adopt energy-efficient digital workflows and utilize green-certified data centers for subtitling, localization, and content delivery. A "Green Translation Innovation Award" could be launched at the Western China Language Service Expo in Chongqing to incentivize eco-conscious practices and embed environmental values into service provision.

In sum, the language service industry in Chengdu and Chongqing should not merely serve as a supporting sector, but be positioned as a strategic engine for regional innovation, international engagement, and sustainable growth. Effective local implementation and coordinated cross-city collaboration will be vital to unlocking its full potential and establishing replicable models for inland regions across China.

Author Contributions

L.W. contributed to conceptualization, methodology, and supervision. Z.Z. was responsible for data collection, validation, and drafting the manuscript. Both authors participated in reviewing and editing the manuscript and approved the final version.

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The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflict of interest.

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