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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 Sichuan-Chongqing Economic Circle is a major national strategy to promote high-quality development in Western China. Based on panel data from 19 cities in the Sichuan and Chongqing region 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 on high-quality economic development in the region. The findings show that the development of the language service industry significantly promotes high-quality 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, the paper proposes building collaborative platforms that integrate industry, academia, research, and application; promoting gradient development of language service industry clusters; establishing a green language technology standards system; and improving the training mechanisms for interdisciplinary talents. These measures aim to drive high-quality development of the language service industry in the Chengdu-Chongqing Economic Circle, resolve regional coordination bottlenecks, balance ecological protection goals, and achieve sustainable industrial upgrading.

Keywords: language service industry; high-quality economic development; Sichuan-Chongqing region; empirical study

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1. Introduction

The shift Driven by China's Belt and Road Initiative and the ongoing development of the New Western Land-Sea Corridor, Western China, serving as a strategic hub for the national Western Development Strategy, is rapidly integrating into the global industrial division of labor. 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 (Wang & Wang, 2024). 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 (Li, 2020; Li, 2023).

This study aims to empirically examine the impact and underlying mechanisms of the language service industry on high-quality economic development in the Sichuan-Chongqing region. The study 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 under China's "dual circulation" strategy. Furthermore, the study offers a demand-driven perspective for foreign language universities seeking to align with the "New Liberal Arts" transformation, highlighting practical pathways for interdisciplinary and application-oriented development.

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 (Wang, 2020). 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 health care (Young et al., 2016; Chen, 2021; Zhuo et al., 2022; Shen & Gu, 2023; Wang, 2024), emergency response (Dreisbach & Mendoza-Dreisbach, 2021; Wang & Li, 2023; Wei & Qian, 2023; Guo et al., 2024; Wang et al., 2025), immigrant and minority support (Antonini, 2016; Graves, 2020; Lee, 2021), disability education (Sylvan, 2018; Kelly & Drasgow, 2020; Walters et al., 2021), and technological innovation (Wang & Sun, 2024; Deng et al., 2024; Wang, 2025).

As an emerging industry, China's language services sector has experienced rapid development and technological advancement, marked by its expanding scale, growing institutional collaborations, and increasing efforts toward self-regulation (Luo et al., 2018). In China, language services have extended into the macro-governance dimension of regional coordinated development (Wang & Cui, 2020; Wang et al., 2022; Xiao & Deng, 2024). 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 (Li, 2018; Li, 2023). Wang and Cui (2020) 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. Wang et al. (2022) 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. Xiao and Deng

(2024), based on panel data at the prefecture-city level 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.

In terms of mechanisms, language services contribute to regional economic development on multiple fronts by facilitating the flow of high-end factors and the efficient transformation of information (Wang, 2020). 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 (Jiang et al., 2023; Xu & Wang, 2021). Situated in the strategic heartland of national development, the Sichuan-Chongqing region continues to strengthen its innovation foundation. The high-tech zones in Chengdu and Chongqing have emerged as demonstration areas for scientific innovation and high-end industrial clustering in western China. The deep integration of language services with regional innovation resources helps to unleash local technological vitality and empower high-quality development (Wei et al., 2021).

Second, language services function as foundational infrastructure for removing barriers to regional external cooperation. They can effectively reduce the costs of cross-border communication and improve the efficiency and stickiness of institutional alignment and cooperation (Wang & Cui, 2020). As a strategic nexus where the Belt and Road Initiative intersects with the New Western Land-Sea Corridor, the Chengdu-Chongqing Economic Circle has significantly enhanced its openness and connectivity. As of 2023, the China-Europe Railway Express and other major international logistics channels have achieved high-frequency operation, while international cooperation platforms such as the China-Singapore (Chongqing) Demonstration Initiative on Strategic Connectivity and the China (Sichuan) Pilot Free Trade Zone have continuously deepened. The language service industry, by providing multilingual translation, localization, interpretation, and cross-cultural communication services, plays a critical role in supporting these opening-up efforts, helping the region to better integrate into global industrial and value chains.

Furthermore, language services provide critical support for international talent in language adaptation, cross-cultural communication, and policy navigation, increasingly becoming a key mechanism for attracting and retaining high-end talent. Jiang (2023) pointed out that the language industry has become a "new career promoter" service system, offering full lifecycle language support for overseas talent. In recent years, the Sichuan-Chongqing region has continuously improved its talent service ecosystem by leveraging international schools, expatriate communities, and entrepreneurial parks, strengthening support systems in language, living conditions, and policy, thereby significantly enhancing the region's talent attraction capacity and factor allocation efficiency (Yao & Fang, 2024).

In addition, regional studies have indicated that the policy performance of language services does not manifest equally across all areas but is significantly moderated by regional foundational conditions (Xiao & Deng, 2024). Areas rich in educational resources have more comprehensive language talent training systems and research infrastructure, which are conducive to the high-end development of language services (Wen & Tan, 2024; Cui & Zheng, 2021). Regions with a higher share of the service sector, due to strong demand for professional language services, can more effectively integrate into high value-added scenarios, achieving economies of scale and industrial synergy (Qu, 2018; Li, 2023). Spatial economic theory also reveals that the diffusion of regional language service capabilities presents a gradient effect, characterized by concentration in core cities and limited spillovers to peripheral areas, resulting in a polarized pattern (Fan, 2021).

However, current research primarily focuses on the more developed eastern coastal regions or the national level as a whole, with a lack of in-depth empirical assessments of western China, particularly the Sichuan-Chongqing region. To address this gap and 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 development of the language service industry has a significant positive impact on the high-quality economic development of the Sichuan-Chongqing region.

H2: The development of the language service industry promotes high-quality economic development in the Sichuan-Chongqing region by enhancing innovation capacity.
H3: The development of the language service industry promotes high-quality economic development in the Sichuan-Chongqing region by expanding trade scale.
H4: The development of the language service industry promotes high-quality economic development in the Sichuan-Chongqing region by attracting overseas talent.
H5: The impact of the language service industry development on high-quality economic development in the Sichuan-Chongqing region is moderated by regional conditions.

H5a: The level of education investment positively moderates the effect of the language service industry on high-quality economic development, with stronger effects in regions with higher education investment.
H5b: The level of service industry development positively moderates the effect of the language service industry on high-quality economic development, with stronger effects in regions with a more developed service sector.
H5c: The promoting effect of the language service industry on high-quality development exhibits a spatial gradient difference as follows: core areas (Chengdu, Chongqing) > radiation areas (Deyang, Meishan, Ziyang) > peripheral areas (Bazhong, Guangyuan, etc.).

3. Research Design

(1) Data and Sample

This study focuses on 19 prefecture-level cities in the Sichuan-Chongqing region during the period 2005–2022[1]. A systematic indicator system for the development of the language service industry and high-quality economic development is constructed to conduct empirical analysis. First, referring to the approach of Wang and Wang (2024), data on the number of language service enterprises, industry output value, practitioners, and talent demand as secondary indicators were collected based on the enterprise registration information database of the State Administration for Market Regulation, as well as major recruitment platforms such as 51Job (https://www.51job.com), BOSS Zhipin (https://www.zhipin.com), and Zhaopin (https://www.zhaopin.com). Following the industrial contribution measurement method outlined in the *Report on Language Service Development in China (2024)*, these secondary indicators were aggregated into a first-level composite indicator of language service industry development using the entropy weighting method (see Table 1).

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 Practitioners	+	0.270
	Language Service Talent Demand	+	0.258

[1] This study focuses on 19 prefecture-level cities in the Sichuan-Chongqing region, 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.

Second, following the approach of Liu et al. (2021), data were collected from the National Bureau of Statistics, China Urban Statistical Yearbook, Sichuan Statistical Yearbook, Chongqing Statistical Yearbook, and the CNRDS database. The data included four-level indicators such as research and development investment/government expenditure, financial deposit/loan balances, and utilization of foreign capital. Using the entropy weighting method, these were aggregated into tertiary indicators such as science and education investment and financial development, which were further consolidated into five secondary dimensions of high-quality development: innovation, coordination, openness, green development, and shared development. Ultimately, a comprehensive first-level composite index of high-quality development was constructed (see Table 2).

In addition, data on regional GDP, population, fixed asset investment, urbanization level, number of foreign-invested enterprises, and export scale were obtained from the Sichuan and Chongqing Statistical Yearbooks. Data on executives' overseas background were sourced from the CSMAR database, while patent application counts were retrieved from the China National Intellectual Property Administration.

Table 2. Indicator System for High-Quality Economic Development

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
		Financial Development	Financial Deposits / Financial Loans Balance	o	0.007
	Coordination Development	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
		Social Welfare	Number of Physicians / Population	+	0.024
			Wages of Employees on the Job	+	0.029
			Urban Greening Rate	+	0.003
	Shared Development	Consumption Level	Social Retail Goods Consumption / GDP	+	0.011
		Government Burden	Fiscal Expenditure / Fiscal Revenue	o	0.002

Note: "+" indicates a positive indicator, "-" indicates a negative indicator, and "o" indicates a moderate indicator.

(2) Empirical Model

This study adopts a two-way fixed effects model, following the approach of Xiao and Deng (2024), to examine the relationship between the development of the language service industry and regional high-quality economic development. The model is specified as follows:

$$TotalScore_t = \beta_0 + \beta_1 LangService_t + \beta_2 Controls_t + City + Year + \varepsilon_t$$

where:

- TotalScore is the composite index of high-quality economic development, including five dimensions: innovation development (InnoScore), coordinated development (CoorScore), openness development (OpenScore), green development (GreenScore), and shared 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 direct investment (Fcompany);
- City and Year represent city and year fixed effects, respectively;
- ε_t is the random error term.

Regarding the treatment of control variables, the urbanization rate (UrbanRate) is a percentage ratio variable with a stable value range and certain standardization characteristics; to avoid distortion and bias in interpretation, it is not log-transformed. Other continuous control variables are uniformly processed by taking the logarithm after adding one, to reduce heteroscedasticity and scale differences. The key coefficient of interest in this study is β_1, which reflects the marginal effect of language service industry development on high-quality economic development.

Table 3 Variable Definitions

Type	Variable	Indicator	Definition
Explanatory variables	LangService	Language service industry development	Constructed following the approach of Wang and Wang (2024)
	LangService_enterprise	Number of Language Service Enterprises	
	LangService_output	Language Service Output Value	

	LangService_practitioner	Number of language service practitioners	
	LangService_demand	Language Service Talent Demand	
Dependent variables	TotalScore	High-Quality Economic Development	Constructed following the approach of Liu et al. (2021)
	InnoScore	Innovation Development	
	CoorScore	Coordinated Development	
	OpenScore	Openness Development	
	GreenScore	Green Development	
	ShareScore	Shared Development	
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. Empirical Results

(1) Baseline Regression

According to the baseline regression results shown in Table 4, the development of the language service industry significantly promotes the high-quality economic development of the Sichuan-Chongqing region, with particularly prominent effects observed in the dimensions of openness, innovation, shared development, and coordinated development. All these results are significantly positive at the 1% statistical level. Specifically, for every one standard deviation increase in the language service industry development index, the ratio of the high-quality development index to its mean increases by 0.554, while the economic significance of openness, innovation, shared development, and coordinated development indices increases by 0.400, 0.146, 0.009, and 0.004, respectively. These findings indicate that language services are becoming a key driving force for the region's high-quality economic growth by activating technological innovation potential, optimizing regional resource allocation, enhancing external communication capabilities, and strengthening public service coverage.

Notably, the effect on the green development dimension is significantly negative (coefficient = -0.005, $p < 0.01$), suggesting that the language service industry in the Sichuan-Chongqing area still has shortcomings in constructing green discourse systems, promoting environmentally friendly communication capabilities, and enabling sustainable development. This may be attributed to the relatively low participation of some language service enterprises in green initiatives and the lack of corresponding standards and professional capacity in this regard.

Table 4 Baseline Regression Results

Variable	(1) High-Quality	(2) Innovation	(3) Coordinated	(4) Openness	(5) Green	(6) Shared

	Development	Development	Development	Development	Development	Development
Language Service	0.554***	0.146***	0.004***	0.400***	-0.005***	0.009***
	(0.024)	(0.007)	(0.001)	(0.019)	(0.002)	(0.001)
Citygdp	0.001	0.004	-0.008***	0.010	-0.001	-0.003***
	(0.021)	(0.006)	(0.001)	(0.016)	(0.001)	(0.001)
Population	0.111***	0.032***	0.004***	0.069***	0.002	0.003***
	(0.023)	(0.007)	(0.001)	(0.018)	(0.002)	(0.001)
FixAsset	-0.033***	-0.008***	-0.002***	-0.025***	0.001	0.001***
	(0.009)	(0.003)	(0.001)	(0.007)	(0.001)	(0.000)
UrbanRate	0.003**	0.001***	0.000	0.001	0.000*	0.000
	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Fcompany	0.018***	0.003	0.000	0.015***	-0.000	0.000
	(0.006)	(0.002)	(0.000)	(0.004)	(0.000)	(0.000)
Constant	-0.603***	-0.227***	0.045***	-0.422***	-0.002	0.003
	(0.133)	(0.041)	(0.008)	(0.104)	(0.009)	(0.006)
City Fixed Effects	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Year Fixed Effects	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Sample Size	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

(1) Lagged Variable Test

To examine the dynamic characteristics and time-lag effects of the language service industry on high-quality economic development in the Sichuan-Chongqing region, this study introduces the lagged one-period variable of the language service industry development index (LSt−1) and re-estimates the model using a fixed effects approach.

As shown in Table 5, the lagged language service industry index maintains a significant positive effect at the 1% level on overall high-quality development (coefficient = 0.568), innovation development (coefficient = 0.154), openness development (coefficient = 0.407), and shared development (coefficient = 0.009) dimensions. Moreover, these coefficients show a slight increase compared to the baseline model (Table 3), indicating that the driving effect of the language service industry in the Sichuan-Chongqing region is robust and strengthens over time, with a policy dividend release cycle of approximately 1–2 years.

Regarding coordinated development, the lagged effect remains significant (coefficient = 0.003, $p < 0.05$) but slightly decreases compared to the baseline regression (coefficient = 0.004, $p < 0.01$), revealing a marginal weakening in the language service industry's contribution to balanced regional development in Sichuan-Chongqing. This result reflects a “spatial decay” feature in the language service industry’s role in regional coordination, benefiting primarily from resource agglomeration in core cities (such as the main urban areas of Chengdu and Chongqing), while its spillover effect on peripheral cities (such as Bazhong and Guangyuan) remains limited, indicating that a comprehensive linkage mechanism for coordinated development across the entire region has yet to be established.

Additionally, the negative inhibitory effect in the green development dimension remains significant in the lag period (coefficient = -0.005, $p < 0.01$), suggesting that the language service industry in Sichuan-Chongqing still faces multiple challenges, including time lags in the implementation of environmental policies and insufficient green transformation capacity of language service enterprises. These intertwined factors create short-term tension between the expansion of the language service industry and ecological objectives.

Table 5. Lagged One-Period Variable Test

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

(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 constructs regression models based on the normal economic cycle from 2005 to 2019. As shown in Table 6, the results indicate that the development of the language service industry has a further strengthened positive effect on the high-quality economic development (coefficient = 0.633), openness development (coefficient = 0.486), and shared development (coefficient = 0.012) of the Sichuan-Chongqing region, all of which are significant at the 1% level. Notably, the coefficient for openness development increased by 21.5%, from 0.400 to 0.486, indicating that before the pandemic, language services empowered the open economy in the Sichuan-Chongqing region more significantly through international rule adaptation and cross-border resource integration.

In terms of innovation development, the regression coefficient remains significant but slightly decreased from 0.146 to 0.137, suggesting that the technology empowerment pathway was still in its infancy before the pandemic. The integration depth and synergy mechanisms between the language service industry and the regional innovation system in the Sichuan-Chongqing area remain to be improved. For coordinated development, the significance level declined from 1% to 5%, while the coefficient remained roughly unchanged, indicating a marginal decrease in the regional coordination effect of language services during normal periods. This confirms that the diffusion of language service capabilities across regions in Sichuan-Chongqing is still constrained by the dominance of core cities, with limited efficiency in resource sinking and difficulty in achieving balanced development across the whole region.

Additionally, the negative effect on green development slightly weakened, with significance level dropping from 1% to 5%, and the coefficient remaining at -0.005. This suggests that during the normal economic cycle, the energy consumption externalities triggered by the language service industry in the Sichuan-Chongqing region have been somewhat alleviated, possibly related to some enterprises' promotion of green certifications and the initial establishment of green translation standards. However, overall, a cohesive green empowerment system has yet to be formed.

Table 6. Sample Period Adjustment Test

Variable	(1) High-Quality Development	(2) Innovation Development	(3) Coordinated Development	(4) Openness Development	(5) Green Development	(6) Shared Development
Language Service	0.633***	0.137***	0.004**	0.486***	-0.005**	0.012***
	(0.033)	(0.008)	(0.002)	(0.026)	(0.002)	(0.002)
Citygdp	-0.021	-0.000	-0.008***	-0.006	0.000	-0.006***
	(0.028)	(0.007)	(0.001)	(0.022)	(0.002)	(0.001)
Population	0.178***	0.041***	0.006***	0.124***	0.001	0.006***
	(0.026)	(0.006)	(0.001)	(0.021)	(0.002)	(0.001)
FixAsset	-0.032***	-0.007***	-0.003***	-0.025***	0.001	0.002***
	(0.010)	(0.002)	(0.001)	(0.008)	(0.001)	(0.000)
UrbanRate	0.010***	0.002***	0.000	0.007***	0.000	0.000***
	(0.002)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Fcompany	0.018***	0.003*	0.000	0.015***	-0.000	0.000
	(0.006)	(0.002)	(0.000)	(0.005)	(0.000)	(0.000)
Constant	-1.111***	-0.291***	0.035***	-0.845***	-0.001	-0.010
	(0.174)	(0.043)	(0.009)	(0.138)	(0.012)	(0.008)
City Fixed Effects	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Year Fixed Effects	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Sample Size	285	285	285	285	285	285
Within R^2	0.841	0.765	0.975	0.770	0.720	0.982

(3) Winsorization Robustness Test

To prevent extreme values from distorting the empirical results, this study applies a 1% winsorization to the core explanatory variables and main control variables. As shown in Table 7, after winsorization, the positive effects of language service industry development on the Sichuan-Chongqing region's high-quality development (coefficient 0.639), innovation development (coefficient 0.169), openness development (coefficient 0.462), and shared development (coefficient 0.010) are all further strengthened compared to the baseline model (Table 3), with significance maintained at the 1% level. Notably, the coefficient for high-quality development increased from 0.554 to 0.639, a rise of 15.3%, indicating that the original estimates may have underestimated the true policy effect of the language service industry.

Regarding coordinated development, the winsorized regression coefficient remains positive but not statistically significant (0.003, $p > 0.1$), further confirming the spatial attenuation effect of language services in promoting regional coordination in the Sichuan-Chongqing area. The strong resource absorption effect of core cities has yet to effectively spill over to peripheral regions. Additionally, the negative effect on green development remains significant (coefficient -0.005, $p < 0.01$), indicating that the environmental resource competition associated with the language service industry in Sichuan-Chongqing is structurally widespread rather than driven by a few outlier samples.

Table 7 Winsorization Robustness Test

Variable	(1) High-Quality Development	(2) Innovation Development	(3) Coordinated Development	(4) Openness Development	(5) Green Development	(6) Shared Development
Language Service	0.639***	0.169***	0.003	0.462***	-0.005***	0.010***
	(0.027)	(0.009)	(0.002)	(0.021)	(0.002)	(0.001)
Citygdp	-0.025	-0.010	-0.006***	-0.004	-0.001	-0.004***
	(0.020)	(0.006)	(0.001)	(0.016)	(0.001)	(0.001)
Population	0.131***	0.042***	0.004***	0.079***	0.003*	0.004***
	(0.022)	(0.007)	(0.001)	(0.017)	(0.002)	(0.001)
FixAsset	-0.025***	-0.005*	-0.003***	-0.020***	0.001	0.001***
	(0.009)	(0.003)	(0.001)	(0.007)	(0.001)	(0.000)
UrbanRate	0.004***	0.002***	-0.000	0.002***	0.000*	0.000
	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Fcompany	0.014***	0.001	0.000	0.013***	-0.000	0.000
	(0.005)	(0.002)	(0.000)	(0.004)	(0.000)	(0.000)
Constant	-0.645***	-0.228***	0.041***	-0.456***	-0.003	0.001
	(0.129)	(0.041)	(0.008)	(0.100)	(0.009)	(0.006)
City Fixed Effects	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Year Fixed Effects	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Sample Size	342	342	342	342	342	342
Within R^2	0.890	0.811	0.981	0.822	0.700	0.986

In summary, the robustness tests demonstrate that the development of the language service industry consistently promotes high-quality economic development in the Sichuan-Chongqing region across multiple

model specifications. The regression coefficients remain highly consistent with the baseline model in terms of direction, consistency, and significance levels, thereby further enhancing the credibility and theoretical explanatory power of the study's findings. The empirical results strongly support the hypothesis H1 proposed in this paper.

6. Mechanism Analysis

To clarify the internal mechanisms through which the language service industry promotes high-quality economic development in the Sichuan-Chongqing region, this study conducts mechanism tests from three dimensions: innovation incentives, foreign trade, and talent attraction. Patent application counts, export trade volume, 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 constructed for empirical analysis, with results shown 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 US dollars.

(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 indicates that the current language service industry in the region still focuses mainly on traditional translation services and has not yet deeply integrated into high value-added areas such as intelligent language technology R&D. Moreover, the demand from research institutions for cross-lingual knowledge mining services has not been fully unleashed, resulting in insufficient synergy between language services and the regional innovation chain. Therefore, the hypothesis H2 proposed in this study is not fully supported, although the direction is consistent, reflecting potential in the innovation pathway that has not yet manifested significant effects.

(2) Foreign Trade Mechanism

The language service industry significantly increases the export scale of the Sichuan-Chongqing region (coefficient = 1.535, $p < 0.01$). This demonstrates that language services play a key role in reducing information barriers, enhancing transnational communication efficiency, and empowering enterprise brand internationalization, thereby effectively promoting the growth of foreign trade in the region. Hypothesis H3 is strongly supported by the results.

(3) Talent Attraction Mechanism

The development of the language service industry also has a significant positive effect on the number of overseas-background executives in listed companies in the Sichuan-Chongqing region (coefficient = 0.891, $p < 0.01$). This indicates that language services help create a favorable linguistic environment and international image, enhancing the attraction of high-quality international management talent and promoting the optimization of human capital structure and governance capabilities of enterprises in the region. Hypothesis H4 is strongly supported.

Table 9 Mechanism Analysis

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

7. Heterogeneity Analysis

(1) Education Investment

To examine the moderating effect of education investment on the relationship between the language service industry and high-quality economic development in the Sichuan-Chongqing region, this study divides the sample into high and low education investment groups based on the median of fiscal education expenditure at the prefecture-level cities in the region. The results in Column (1) of Table 10 show that the language service industry significantly promotes high-quality economic development in areas with high education investment (coefficient = 2.185, $p < 0.01$). Regions with higher education investment usually have more established systems for cultivating language talents, such as foreign language universities and translation training institutions continuously supplying professionals to the market. Meanwhile, the cultural openness and innovation foundation in these regions provide important support for the digital upgrading of language services. By contrast, in regions with relatively insufficient educational resources, the effectiveness of the language service industry is constrained, possibly facing structural bottlenecks like “low-end lock-in” and inadequate talent reserves. Hypothesis H5a is thus validated.

(2) Service Industry Level

Using the proportion of the service industry in GDP as a proxy for service industry development level, the sample is further divided into high and low service industry groups based on the median. This allows investigation of the moderating role of service industry structure on the economic effect of the language service

industry in the Sichuan-Chongqing region. The results in Column (2) of Table 10 indicate that the language service industry also significantly promotes high-quality economic development in areas with a high share of the service industry (coefficient = 9.774, $p < 0.05$). This synergy mainly derives from the strong dependence of producer services (such as finance, law, and consulting) on professional language services. For example, in contexts such as cross-border investment, trade, and arbitration, multilingual contract translation and localization of technical terminology are key to improving efficiency and compliance, thereby promoting the extension of language services toward higher value chains. Furthermore, developed service regions generally have relatively complete information infrastructure and policy support, providing a favorable operating environment for language service enterprises. Conversely, in regions where the service system is underdeveloped and market demand is unclear, language services lack sufficient scenario embedding and technological matching, which may lead to inefficient or redundant resource allocation and fail to effectively support high-quality development. Hypothesis H5b is validated.

(3) Regional Differences

Combining policy zoning and spatial economic characteristics, this study divides the Sichuan-Chongqing region into the core area (Chengdu, Chongqing), the radiation area (Deyang, Meishan, Ziyang), and the peripheral area (Bazhong, Guangyuan, etc.) to explore the spatial heterogeneity of the impact of the language service industry on high-quality development. Columns (3) to (5) of Table 10 show significant differences in the effects of the language service industry on high-quality development across these regions.

In the Sichuan-Chongqing core area, the language service industry exhibits a strong positive effect (coefficient = 1.646, $p < 0.01$), indicating that the industry significantly promotes high-quality development through economies of scale and institutional innovation. For example, Chengdu leverages the Free Trade Zone policy to develop technical advantages in cross-border data flows and AI translation, while Chongqing embeds multilingual logistics systems into international supply chain management via the Western Land-Sea New Corridor, enhancing global resource allocation capabilities.

By contrast, in the radiation area, the interaction term coefficient is negative but not statistically significant (-0.061, $p > 0.1$), reflecting that the spillover effects of the language service industry have not yet fully penetrated neighboring areas. This may be constrained by insufficient infrastructure coordination (e.g., incomplete interconnection of Chengdu-Deyang-Meishan-Ziyang railways), industrial chain discontinuities (e.g., Deyang's advanced equipment manufacturing lacks capacity to undertake high-end language service business), and weak policy adaptability (e.g., Meishan's cultural tourism industry has multilingual service demands but lacks a distinctive service ecosystem).

In the peripheral area, the interaction term coefficient is significantly negative (coefficient = -1.508, $p < 0.01$), indicating that the language service industry has yet to achieve effective industrial embedding in peripheral regions and may even exacerbate resource outflows and development imbalances. On one hand, the "siphon effect" of the core area attracts language talents, weakening the innovation capacity of peripheral areas; on the other hand, peripheral cities, without fully assessing local endowments and market demand, replicate core-area models leading to serious mismatches in resource input and development paths.

These results jointly confirm the "core-radiation-periphery" spatially uneven structure of the Sichuan-Chongqing region and reveal the dual role of the language service industry in regional coordination: it can strengthen the advantages of core areas through agglomeration effects but may also widen development gaps due to siphoning. Hypothesis H5c is thus validated.

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 Effects	Controlled	Controlled	Controlled	Controlled	Controlled
Year Fixed Effects	Controlled	Controlled	Controlled	Controlled	Controlled
Sample Size	342	342	342	342	342
Within R^2	0.894	0.883	0.887	0.881	0.886

8. Conclusion and Policy Recommendations

Based on panel data from the Sichuan-Chongqing region spanning 2005 to 2022, this study systematically examines the impact and underlying mechanisms of the language service industry on high-quality economic development in the region. Empirical findings indicate that the language service industry significantly promotes high-quality development in Chengdu and Chongqing, particularly in the dimensions of openness, innovation, sharing, and coordination, though structural tensions remain with regard to green development. The dual-driven mechanism of "international trade expansion – international talent aggregation" underpins the industry's role, while technology-driven innovation still relies on industrial upgrading and long-term ecosystem cultivation. Regional heterogeneity in Sichuan-Chongqing reflects a pattern of "core polarization – peripheral collapse", shaped by a triad of moderating factors: education investment, the development level of the service sector, and spatial gradient. Based on the above findings, this study proposes the following policy recommendations:

First, enhance collaborative innovation and build an industrial upgrading ecosystem. A Sichuan-Chongqing Language Service Industry Collaborative Innovation Center should be established, focusing on breakthroughs in core technologies such as intelligent translation engines and cross-lingual knowledge graphs. The traditional "technology transfer" model of industry-academia collaboration should shift toward joint R&D efforts. A "Language Services Plus" strategy should be implemented to integrate language service capabilities into

innovation hubs such as the Western (China) Science City and Mianyang Science and Technology City. This would promote synergy between the language industry and emerging sectors like artificial intelligence, biomedicine, and quantum computing.

Second, strengthen openness and accelerate international integration. Relying on platforms such as the China (Chongqing) Pilot Free Trade Zone, the New International Land-Sea Trade Corridor, and cross-border e-commerce demonstration zones, regional governments should promote the construction of multilingual service systems in trade, logistics, and digital governance. Supporting enterprises in "going global" requires building international communication capabilities, including multilingual websites, overseas market localization, and international brand discourse systems. Additionally, international talent introduction programs should be expanded, especially in attracting returnees and foreign experts in language technology and global operations.

Third, optimize human capital supply to break structural bottlenecks. Expand investment in applied language education by enhancing the supply of high-level professionals in translation, localization, and intercultural communication. Establish regional talent training alliances among universities, vocational colleges, and industry associations in Chengdu and Chongqing. Encourage foreign language colleges and business English programs to upgrade their curricula toward emerging fields such as AI-assisted translation, data annotation, and multilingual NLP. Meanwhile, promote lifelong learning pathways for language professionals to adapt to digital transformation.

Fourth, promote inclusive growth and reduce regional disparities. In peripheral and radiating areas with relatively weak foundations, targeted support should be provided for language service infrastructure, including multilingual public information systems, translation service centers, and SME translation subsidies. Encourage metropolitan areas like Chengdu and Chongqing to extend the industrial chain downstream through outsourcing and technological assistance, fostering the spillover of language service capabilities. Strengthen inter-city collaboration mechanisms—such as coordinated project funding and joint talent pools – to form a more integrated regional language service market.

Fifth, balance green transformation with language service expansion. Encourage the integration of green discourse and multilingual communication in ecological governance, environmental diplomacy, and green trade. Develop multilingual corpora for climate change, biodiversity, and sustainable development, and support green language services in ESG reporting and carbon disclosure translation. Promote energy-efficient and low-carbon practices in the language service industry, such as using green data centers and optimizing digital workflows.

In sum, the development of the language service industry in Chengdu and Chongqing should not only serve as a catalyst for high-quality regional development but also be positioned as a strategic node in China's broader efforts to enhance international discourse power and digital economic competitiveness. Future research could further explore cross-regional comparisons and policy impact evaluations to refine the theoretical framework and empirical evidence base for language service-driven development.

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