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Analysis of influencing factors of foreign trade in Sichuan Province

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Abstract. This research uses a combination of principal component analysis and multiple linear regression analysis for the analysis of the influencing factors and the degree of influence on the foreign trade of Sichuan Province, China. Firstly, a visual analysis of the current situation of foreign trade in Sichuan province is conducted, which includes the structure of foreign trade mode, foreign trade commodity structure, and foreign trade partner structure of Sichuan province. Second-ly, the indicators that may affect the foreign trade of Sichuan province are selected and the empirical model is constructed using these indicators. Principal component analysis was used to extract principal components, and then regression analysis was conducted on the extracted principal components. Finally, the empirical results show that the gross regional product, consumer price index, foreign direct investment, average disposable income of residents, and investment in research and experimentation have a positive impact on Sichuan's foreign trade, and the RMB harms foreign trade.

Keywords: Foreign Trade, Influencing Factors, Principal component analysis.

1 Introduction

Since China proposed the "One Belt, One Road" initiative, China has developed a series of close trade cooperation with countries along the route, which has greatly promoted the economic development of the trading countries. Now that China's coastal areas are relatively mature for foreign trade, a new round of growth will occur mainly in the western region. Sichuan Province is a major economic province in the southwest, combining resources, population and culture, and is at the center of the "Belt and Road". See Figure 1. However, its location in the interior of western China, its basin topography, the absence of natural seaports and a series of other unfavorable factors have limited the development of foreign trade. Therefore,, an in-depth study of the factors affecting Sichuan's foreign trade is of practical importance to promote the development of Sichuan's foreign trade and make policy recommendations.

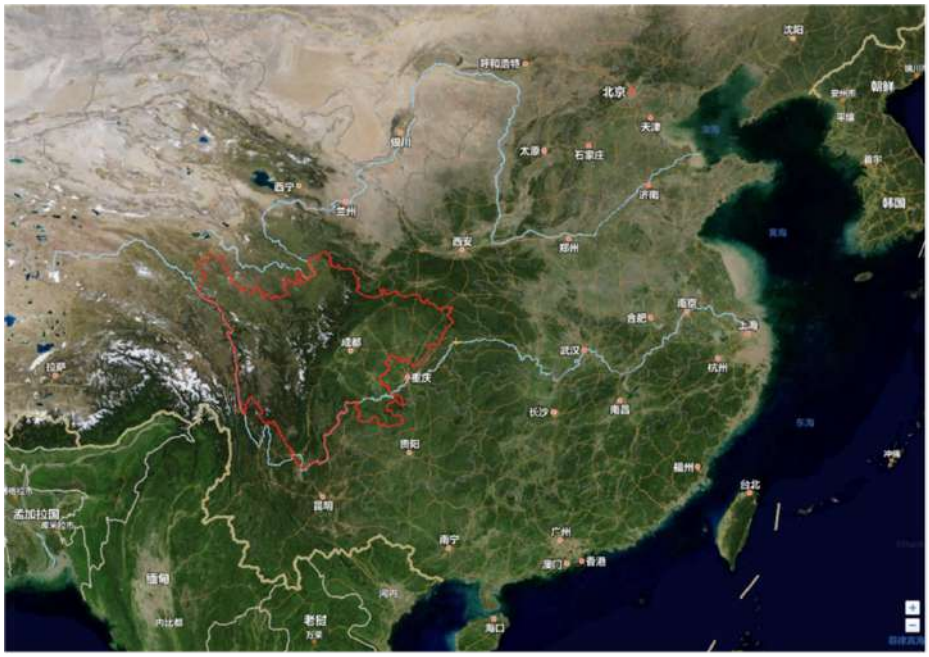

Fig. 1. Gross Domestic Product (GDP) growth by region since 2000-2020.

From Table 1, from 1999 to 2020, the total import and export of Sichuan Province grew from 2470.69 million U.S. dollars to 117172.640 million U.S. dollars. Among them, the growth was faster in 2008 and 2011, with an annual growth rate of 53.21% and 46.11%, an increase of 417.75 million U.S. dollars and 1036.90 million U.S. dollars respectively over the previous year. Total exports, total imports increased from 1140.73 million dollars and 1329.96 million dollars in 1999 to 67477.09 million U.S. dollars and 4969.55 million U.S. dollars in 2020, with an average annual growth rate of 22.28% and 21.49% respectively. In 2015, the external economy of Sichuan Province was affected by a few factors, including the general weakness of the global economy, low external demand, and the overall decline in commodity prices, resulting in a relatively large double drop in total imports and total exports. total imports and total exports rebounded rapidly after 2016, reaching a new high in 2019.

Table 1. The foreign trade volume of Sichuan Province 1999-2020 (USD10000)

Year	Total Foreign Trade of Sichuan	Total Export	Total Import	Annual growth rate
1999	247,069	114,073	132,996	18.19%
2000	254,517	139,435	115,082	3.01%
2001	309,916	158,272	151,644	21.77%
2002	446,919	271,145	175,774	44.21%
2003	563,862	321,291	242,571	26.17%
2004	687,162	398,371	288,791	21.87%
2005	790,476	470,089	320,387	15.03%

2006	1,102,097	662,406	439,691	39.42%
2007	1,438,461	860,826	577,635	30.52%
2008	2,203,828	1,310,789	893,039	53.21%
2009	2,422,728	1,415,167	1,007,561	9.93%
2010	3,270,396	1,884,064	1,386,332	34.99%
2011	4,778,444	2,904,567	1,873,877	46.11%
2012	5,912,538	3,846,147	2,066,391	23.73%
2013	6,457,884	4,194,906	2,262,978	9.22%
2014	7,020,297	4,483,913	2,536,384	8.71%
2015	5,118,856	3,309,290	1,809,566	-27.08%
2016	4,934,941	2,795,498	2,139,443	-3.59%
2017	68,106,77	3,755,394	3,055,283	38.01%
2018	8,993,788	5,039,827	3,953,961	32.05%
2019	9,805,150	5,638,075	4,167,075	9.02%
2020	11,717,264	6,747,709	4,969,555	19.50%

2 Literature Review

2.1 Empirical models are commonly used to analyze the relationship between influencing factors

Li Yan.[1] used RCA as the dependent variable of service trade competitiveness and Porter's "Diamond Model" as the independent variable of service trade competitiveness, we empirically analyzed the factors affecting the service trade competitiveness of Yangtze Delta. The analysis results show that the level of talent pool has little influence on the service trade competitiveness of the Yangtze River Delta region; GDP can gradually promote the service trade competitiveness; while the quantity of goods import and export and FDI can hinder the service trade competitiveness.

Patel, Krunal, and Sankalpa.[2] used Granger causality to analyze annual data from 1992-2013, using India as the main study, to find the causal relationship between its economic growth and various factors such as foreign trade, exchange rate, and foreign direct investment.

Cixun Wang. [3] using a time series model, selected five factors affecting China's foreign trade for empirical analysis and confirmed that GDP, exchange rate, actual utilization of foreign investment, and level of resident consumption have significant effects on China's foreign trade.

Hu.[4] using the gravity model, conducted a combination of case-by-case and overall regressions on the panel data of China and ten ASEAN countries. Taken together, both simple case-by-case regression analysis and general overall linear regression analysis show that the causal GDP and GDP per capita of each country are still important factors affecting bilateral trade flows. China and the ten ASEAN countries still need to vigorously develop their domestic economies and increase their national economic aggregates.

2.2 Foreign trade influence factors research

Stilianos Fountas and Don Brendin.[5] used quarterly data for the UK from 1978 to 1998, with exports as the explanatory variable and relative prices, real income and exchange rates as explanatory variables, it is concluded that exchange rates do not affect exports in the short run, but have a significant effect in the long run.

Ferrell and Gaston. [6] In their analysis of the industrial flows of FDI between Japan between 1984 and 1988, they conclude that FDI can stimulate the optimization of the export trade structure.

Yang Zitong. [7] systematically analyzed the changes in China's foreign trade structure from three aspects and concluded that four factors, mainly technology, industrial structure, foreign investment, and exchange rate, affect China's foreign trade structure.

Napshin S. and Brouthers L. E. [8] find a strong link between foreign trade and FDI in developed countries by first assuming that improving the use of intermediate goods in developed countries will change the economic decisions of multinational companies.

Patel, Krunal, and Sankalpa.[9] used Granger causality to analyze annual data from 1992-2013, using India as the main study, to find the causal relationship between its economic growth and various factors such as foreign trade, exchange rate, and foreign direct investment.

Ran Min and Yang Gang.[10] firstly analyzed the current situation of foreign trade development in Sichuan Province, based on which, annual data from 2006-2015 were collected and the impact of FDI on foreign trade in Sichuan Province was examined by using gray correlation analysis, Granger causality analysis, and cointegration analysis, respectively. The results show that there is a relatively strong gray correlation effect of FDI on foreign trade import and export in Sichuan province, and the relationship between FDI and foreign trade export is Granger causality.

Hu.[11] A combination of case-by-case regressions and overall regressions are conducted for panel data for China and ten ASEAN countries using the gravity model. Taken together, the causal GDP and GDP per capita of each country remain important factors affecting bilateral trade flows.

Yang Menglei.[12] using panel data from 2011-2016, a stochastic frontier gravity model was used to analyze the bilateral trade efficiency between Gansu Province and several countries along the "Belt and Road". It was found that the GDP of a country or region is positively proportional to the total bilateral import and export trade, and the spatial linear geographic distance between Lanzhou City, Gansu Province and the capitals of the countries along the route is inversely proportional to the total bilateral import and export trade.

3 Data and Methodology

3.1 Data

Relevant annual data from 1999 to 2020 were used. The data used are from the Sichuan Statistical Yearbook, the Sichuan National Economic and Social Development Statistical Bulletin, the National Bureau of Statistics and the Sichuan Provincial Department of Commerce.

1) Explained variable: Y: Total Foreign Trade of Sichuan Province (unit: USD billion).

2) Explanatory variable: X1: Gross regional product (Unit: USD billion); X2: Consumer Price Index; X3: Foreign direct investment (Unit: USD billion); X4: Per capita disposable income (in RMB); X5: Investment in Research and Experimental Development (R&D) (Unit: USD billion); X6: Exchange rate. The exchange rate of RMB to USD ($1=100 RMB).

Table 2. Statistics of each influencing factor

Year	Y	X1	X2	X3	X4	X5	X6
1999	24.71	440.81	98.5	5.93	5,784	4.68	827.83
2000	25.45	474.51	100.1	6.05	5,984	5.42	827.84
2001	30.99	518.73	102.1	9.92	6,360	6.94	827.70
2002	44.69	570.86	99.7	10.36	6,611	7.48	827.70
2003	56.39	644.33	101.7	11.47	7,042	9.60	827.70
2004	68.72	770.78	104.9	13.08	7,710	9.42	827.68
2005	79.048	901.53	101.7	20.03	8,386	11.75	819.17
2006	110.21	1,090.12	102.3	27.12	9,350	13.49	797.18
2007	143.85	1,389.06	105.9	45.46	12,633	18.29	760.40
2008	220.38	1,814.41	105.1	62.52	12,633	23.36	694.51
2009	242.27	2,071.63	100.8	24.25	13,839	31.39	683.10
2010	327.04	2,538.66	103.2	61.17	15,462	39.98	676.95
2011	477.84	3,255.51	105.3	62.59	17,899	45.53	645.88
2012	591.25	3,781.83	102.5	53.63	20,307	55.58	631.25
2013	645.79	4,261.46	102.8	40.42	22,368	64.58	619.32
2014	702.03	4,645.55	101.6	29.47	24,234	73.15	614.28
2015	511.89	4,825.17	101.5	35.66	26,205	80.74	622.84
2016	493.49	4,958.30	101.9	42.51	28,335	84.52	664.23
2017	681.07	5,477.09	101.4	61.78	30,727	94.47	675.18
2018	899.38	6,147.15	102.1	63.10	33,216	111.38	661.74
2019	980.52	6,757.38	103.2	103.37	36,154	118.43	689.85
2020	1,171.73	7,045.76	106.5	100.60	38,253	153.00	689.76

3.2 Methodology

In practical research, variables (or factors) related to the subject of study are often involved to be able to analyze the problem comprehensively. However, in most cases, there may be some correlation between the variables, leading to different degrees of overlap of variable information, thus increasing the complexity of the problem analysis. To overcome this correlation, overlap, it is usually chosen to use fewer variables in place of the original larger number of variables. Such substitution variables can reflect most of the information of the original multiple variables, and the principal component analysis method is the processing method of high-latitude data produced under this idea of dimensionality reduction.

1) Correlation of independent variables and analysis of the applicability of the principal component method.

The presence of multicollinearity among the independent variables may be caused by many in-dependent variables data, which affects the explanatory power of the econometric model. The principal component analysis is based on reducing the correlation between variables to achieve the purpose of reducing the number of variables. However, if the original variables are independent of each other or have low correlation, then the principal component analysis will be meaningless. Therefore, before performing principal component analysis, correlation tests should be performed on the independent variables.

Table 3. Correlation Matrix

Correlation	Z(X1)	Z(X2)	Z(X3)	Z(X4)	Z(X5)	Z(X6)
Z(X1)	1.000	.122	.809	.996	.986	-.788
Z(X2)	.122	1.000	.453	.135	.099	-.251
Z(X3)	.809	.453	1.000	.820	.811	-.625
Z(X4)	.996	.135	.820	1.000	.990	-.754
Z(X5)	.986	.099	.811	.990	1.000	-.701
Z(X6)	-.788	-.251	-.625	-.754	-.701	1.000

The correlation matrix is a square matrix of the magnitude of the correlation coefficient between two. The correlation coefficient shows whether the variables are correlated with each other, and thus the relationship between the variables. From the correlation matrix in Table 3, the six explanatory variables do have some correlation with each other and there is an overlap of information between the variables, which is especially important to eliminate the covariance between the variables by using principal component analysis.

Table 4 shows that KOM takes a value of 0.746, which is greater than 0.5. Bartlett's value is 225.498, and the above data indicate that the independent variables can be dimensionally reduced using principal component analysis.

Table 4. KMO and Bartlett's spherical test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.746**
Bartlett's Test of Sphericity	Approx. Chi-Square	225.498
	df	15
	Sig.	.000

In Table 5, variables such as regional GDP (X1), consumer price index (X2), actual utilization of foreign direct investment (X3), per capita disposable income (X4), investment in research and experimental development (X5), and RMB exchange rate (X6) all depend on the public factor to a degree above 60%, which is greater than the benchmark 0.4. Therefore, the variables are retained in the study analysis.

Table 5. Communalities

	Initial	Extraction
Z(X1)	1.000	.990
Z(X2)	1.000	.982
Z(X3)	1.000	.855
Z(X4)	1.000	.982
Z(X5)	1.000	.962
Z(X6)	1.000	.686

2) Selection of principal components

Combining the results of the eigenvalues and factor contributions for each factor in Table 6 and the Scree Plot of the eigenvalues in Figure 2. The first two components have eigenvalues greater than 1 and cumulative eigenvalues of more than 85%, which explain almost most of the information in the sample. In addition, the second component number in the scree plot shows the first inflection point. Therefore, it was decided to select these two principal components as the comprehensive evaluation indexes, denoted by F1 and F2.

Table 6. Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	4.395	73.244	73.244	4.395	73.244	73.244
2	1.062	17.704	90.949	1.062	17.704	90.949
3	.399	6.651	97.600			
4	.134	2.229	99.829			
5	.008	.138	99.967			
6	.002	.033	100.000			

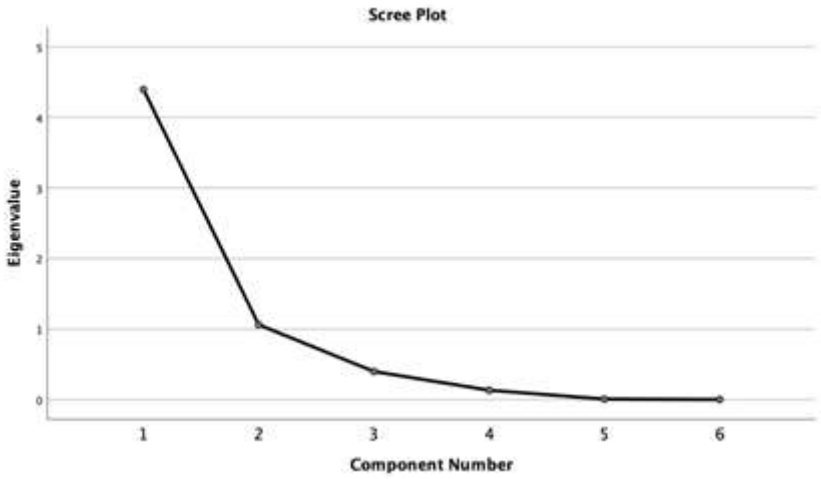

Fig. 2. Scree Plot

3) Expression of principal component function

The matrix of principal component score coefficients is used to illustrate the loadings of each principal component on each variable, which in turn leads to the expressions for each principal component. Because each variable is standardized, the variables in the expressions are standardized. According to Table 7, the expressions of principal components F1 and F2 are obtained as：

$$F_1 = 0.98Z(X_1) + 0.282Z(X_2) + 0.889Z(X_3) + 0.978Z(X_4) + 0.961Z(X_5) - 0.828Z(X_6) \quad (1)$$

$$F_2 = -0.174Z(X_1) + 0.95(X_2) + 0.254Z(X_3) - 0.161Z(X_4) - 0.195(X_5) - 0.026Z(X_6) \quad (2)$$

Table 7. Component Score Coefficient Matrix

	Component	
	1	2
Z(X1)	.980	-.174
Z(X2)	.282	.950
Z(X3)	.889	.254
Z(X4)	.978	-.161
Z(X5)	.961	-.195
Z(X6)	-.828	-.026

4) Principal component regression

The model performance is evaluated using the statistical metrics, consisting of the Mean Absolute Error (MAE) and Root Mean Square Error (RMSE) to measure the minimize error in the training dataset, testing dataset, and unseen dataset.

Based on the above analysis, the explanatory variable is standardized to ZY and the explanatory variable is the composite indicator F. The following one-select linear regression model is established.

$$ZY = \beta_0 + \beta_1 * F_1 + \beta * F_2 + \varepsilon \quad (3)$$

Regression of the model yields the following results:

Table 8. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.976	.952	.947	.23052662

Because F_1 and F_2 are two principal components extracted by principal component analysis, they do not correlate with each other and can-do linear regression. the R-square and adjusted R-square are used to identify the goodness of fit of the linear equation, and the closer the R-square is to 1, the better the fit is. In Table 8, the R-square is 0.952 and the adjusted R-square is 0.947, indicating that the independent variables can explain about 95% of the variation in the dependent variable and the model fits well.

Table 9. Coefficients

Model	Unstandardized Coef		Standardized Coef	t	Sig
	B	Std.Error	Beta		
(Constant)	-8.460E-17	.049		.000	1.000
REGR factor score 1 for analysis 1	.967	.050	.967	19.229	.000
REGR factor score 2 for analysis 1	-.127	.050	-.123	-2.530	.020

In the regression coefficient table, the t-test is used to test whether the regression coefficient is significant, that is, whether a particular independent variable can significantly affect the dependent variable. In Table 9, the p-values of the regression coefficients of the explanatory variables F1 and F2 are 0 and 0.02 respectively are less than 0.05, indicating that the t-test is passed at the 0.05 significance level and the regression coefficients β1, β2 exist. The variables of the regression equation derived from the combined results of the above tests are the variables after standardizing the data. To obtain the coefficients before the standardized variables must be done as follows.

$$\begin{bmatrix} \mathbf{0.980} & \mathbf{-0.174} \\ \mathbf{0.282} & \mathbf{0.950} \\ \mathbf{0.889} & \mathbf{0.254} \\ \mathbf{0.978} & \mathbf{-0.161} \\ \mathbf{0.961} & \mathbf{-0.195} \\ \mathbf{-0.828} & \mathbf{-0.026} \end{bmatrix} \begin{bmatrix} \mathbf{0.967} \\ \mathbf{-0.127} \end{bmatrix} = \begin{bmatrix} \mathbf{0.970} \\ \mathbf{0.152} \\ \mathbf{0.827} \\ \mathbf{0.966} \\ \mathbf{0.954} \\ \mathbf{-0.797} \end{bmatrix}$$

5) Results

In summary, the regression equation between Sichuan's foreign trade and each influencing factor is

$$Y = 0.970X_1 + 0.152X_2 + 0.827X_3 + 0.966X_4 + 0.954X_5 - 0.797X_6 \quad (4)$$

From the results of the regression analysis, it seems that the regional GDP, consumer price index, foreign direct investment, per capita disposable income of residents, and research and experimental development expenditure are positively correlated with foreign trade in Sichuan Province, and the exchange rate is negatively correlated with them. According to the regression equation, for every USD 1 billion increase in Sichuan's regional GDP, foreign trade increased by USD 0.97 billion. For each increase of 1 index in the consumer price index, foreign trade increased by USD 0.152 billion. For each increase of USD 1 billion in foreign direct investment, foreign trade increased by USD 0.827 billion. For every 1 RMB increase in the average disposable income of the residents, the foreign trade volume increases by USD 0.966 billion. For every USD 1 billion increase in R&D, the foreign trade volume increases by USD 0.954 billion. For every 1 under the exchange rate, the foreign trade volume decreases by USD 0.797 billion. Among the six factors, Sichuan's regional GDP has the greatest degree of influence on foreign trade. To promote the sustainable development of foreign trade in Sichuan Province, the government, enterprises and even consumers should make better use of the relevant national policies to improve the overall development of foreign trade.

4 Policy Recommendation

4.1 Actively integrate into the "One Belt, One Road" construction and expand trade markets

The "One Belt and One Road" involves 65 countries and regions along the route, and the trade market is very broad. Actively integrating into the "Belt and Road" construction can increase the opportunities for foreign trade cooperation in Sichuan Province, which is conducive to broadening the foreign trade market in Sichuan. To this end, the government should formulate relevant guiding policies to encourage enterprises, private organizations, and other subjects to actively participate in the construction of "One Belt, One Road". This requires the government to build a strong integration platform to provide comprehensive support for the construction of "One Belt, One Road" in terms of system, information, facilities, and funds. Encourage enterprises to

carry out various forms of regional cooperation directly with countries along the route and participate in each other's economic construction with their respective comparative advantages.

4.2 Enhance the awareness and ability to deal with exchange rate risks

The RMB exchange rate also has a very significant impact on Sichuan Province's foreign trade. For every 1 point increase in RMB exchange rate, the foreign trade volume of Sichuan Province decreases by USD 0.797 billion. Therefore, foreign trade enterprises should clarify the foreign trade development strategy formulated by the government and actively implement it. At the same time, they should increase technological innovation in product production and actively develop brands and other products with intellectual property rights, which will help increase the added value and profitability of imported and exported products. In addition, foreign trade enterprises can negotiate with their customers and agree on a fixed exchange rate to control the risk, which can also reduce the loss caused by the fluctuation of RMB exchange rate.

4.3 Improving the income structure of the population.

The widening income distribution gap is an important cause of internal ecological and economic im-balance, while Sichuan Province's persistent trade surplus manifests itself as an external economic imbalance. The key to solving the trade surplus problem is to solve the internal imbalance, which requires the government to establish a more equitable and reasonable distribution mechanism to narrow the income distribution gap. Therefore, the government should increase the business income and property income of urban residents, and increase the property income and wage income of rural residents to ensure the stable growth of residents' income.

4.4 Increase and optimize R&D funding

In many enterprises in Sichuan Province, core technologies are imported from abroad and lack of independent intellectual property rights of core technologies. Through empirical analysis, for every unit increase in R&D investment in Sichuan Province, the foreign trade volume of Sichuan Province will increase by USD 0.945 billion.The government should effectively increase R&D funds and invest more in basic and applied research to continuously improve the competitiveness of foreign trade enterprises.

4.5 Encourage the inflow of high-quality foreign investment

For every USD 1 billion increase in FDI in Sichuan, the foreign trade volume in Sichuan increases by USD 0.827 billion. The government should take active and effective measures to encourage the introduction of quality foreign investment. For example, expand the sources of FDI, improve the industrial environment, and attract some large

multinational companies with advanced technology and management experience to invest in Sichuan. Pay attention to the quality of introduced foreign investment and strengthen the supervision and use of foreign investment.

4.6 Active use of cross-border e-commerce platform

With the development of the Internet, the transparency of information resources has greatly increased. The government should increase publicity and give them certain preferential policies. The government and enterprises should strengthen the effective training of talents. Relevant personnel of the cross-border e-commerce platform should both fully understand the development of foreign trade in Sichuan Province and be familiar with the operation of the platform and related risks.

4.7 Improve the ability to resist international trade risks

To give full play to the agglomeration and diffusion capacity of Sichuan Province as a western province, take advantage of the regional advantages of the Chengdu Plain City Cluster in Sichuan, strengthen trade and commerce cooperation with Deyang, Mianyang, Meishan and Ziyang, form the Chengdu Economic Zone, and then bring together the advantageous resources of the Chengdu-Chongqing City Cluster to fully realize the optimal allocation of resources. Gradually build Sichuan Province into a longitudinal western, facing the whole country, radiation of the world of China's western trade center, accelerate the integration process of trade within and outside Sichuan Province, and enhance the ability to resist international.

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