

The Impact of International Exchange and Cooperation on The Scientific Research Performance of Local Universities

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Abstract: In order to comprehensively analyze the impact of international exchange and cooperation on the scientific research performance of local universities, based on the provincial panel data from 2009 to 2020, the dynamic panel data model is used to empirically analyze the relationship between international exchange and cooperation and the scientific research performance of local universities. The results show that international education and cooperation have a positive impact on the scientific research performance of local universities, and this promotion effect has heterogeneity among universities in different regions. Knowledge exchange and interaction positively affect the relationship between international education and cooperation and scientific research performance of local universities. Therefore, local universities should further expand the scope of international science and technology and exchange and cooperation under the background of national innovation-driven, establish a new mechanism conducive to scientific research innovation and talent exchange and introduction, promote the circulation and sharing of innovative resources, and realize the high output of scientific research in universities.

Keywords: International exchange and cooperation, Local universities, Scientific research efficiency, Knowledge exchange and interaction.

1. Introduction

The 20th National Congress of the Communist Party of China clearly pointed out that it is necessary to promote the innovation ability of colleges and universities and better serve the society. The scientific research level of colleges and universities provides a steady stream of support for the development of national science and technology, and even contributes an important force to the growth of the country's high-tech strength. Under the background of the country's promotion of world-class universities and first-class discipline construction, China's higher education integrates into the wave of globalization with new ideas and attitudes, takes the cultivation of talents with international vision as its own responsibility, strengthens exchanges and cooperation with international universities, continuously improves the quality of school running, and strives to develop into the ranks of world-class universities. Throughout the country, a considerable number of universities have carried out international exchanges and cooperation. However, due to the constraints of geography, history and other factors, the level of scientific research input and output of local universities is uneven. Scientific research performance evaluation is an important booster for the orderly progress of scientific research and innovation in colleges and universities. Scientific and reasonable performance evaluation can not only effectively allocate scientific research resources, improve the overall strength of scientific research in colleges and universities, but also provide a basis for the establishment of a more sound and fair salary and incentive mechanism for personnel departments in colleges and universities. In the current situation of unbalanced educational resources, what is the effect of international exchange and cooperation on the scientific research performance of local universities? How to scientifically adopt the path of international exchange and cooperation to improve the scientific research performance of

local universities? It is an important theoretical basis for decision makers to carry out scientific research. Scientific research personnel and knowledge exchange are the key engines to promote the scientific research performance of local universities. Higher international exchange and cooperation can promote the transnational exchange of talents, enrich the human capital of colleges and universities, promote the knowledge exchange and interaction of colleges and universities, learn and absorb international knowledge and technology, and improve the scientific research output of colleges and universities.

Based on this, based on the relevant panel data of 31 provinces (autonomous regions and municipalities, except Hong Kong, Macao and Taiwan, the same below) in China from 2009 to 2020, this paper uses multiple regression analysis method to study the impact of international exchanges and cooperation on the scientific research performance of local universities, as well as the impact of scientific research human capital of local universities on the scientific research performance of local universities.

2. Literature Review

2.1. University research efficiency

The existing research on the efficiency of scientific research in colleges and universities mainly focuses on two aspects: the output index of scientific research efficiency in colleges and universities and the analysis of influencing factors. For the output index of scientific research efficiency in colleges and universities, one kind of research is based on DEA model (Yang Hongjin [1], 2011), Factor Analysis (Xiaoming Han [2], 2015), Reliability analysis method (Dandan Wu [3], 2016) and Analytic Hierarchy Process (Xichun Zhang [4], 2022) methods such as analysis of university science and technology innovation ability. The other is to directly use the number of papers, scientific

research project investment, works, patents, science and technology awards, achievement transformation and other indicators to measure the efficiency of scientific research in colleges and universities. Regarding the relevant factors that affect the scientific and technological innovation of colleges and universities, existing research shows that government support (Shuguang Liang[5],2019),Scientific research project funds and human resources(Siyu Yao[6],2021) have an impact on the ability of scientific and technological innovation in colleges and universities. Government support, investment in scientific research project funds and optimization and rational allocation of human resources are conducive to improving the ability of scientific and technological innovation in colleges and universities.

2.2. Research on the relationship between international exchange and cooperation and university scientific research performance

At present, the academic research on the relationship between international exchange and cooperation and the performance of scientific research in colleges and universities mainly stays at the theoretical research level that international exchange and cooperation is to improve the scientific research level of colleges and universities. Few scholars have introduced empirical research to reveal the impact mechanism of international exchange and cooperation on the performance of scientific research efficiency in colleges and universities. However, combing foreign literature, scholars have studied the level of scientific research cooperation at the national level. In 2005, Luijten-Lub A and other scholars studied the international cooperation model, and they found that international cooperation has geographical boundaries. moreover, countries with strong scientific research strength pay more attention to domestic cooperation, and international cooperation is relatively less. Here is also a higher proportion of international cooperation in basic disciplines among all disciplines. This shows that geographical location, language, culture and other factors have a great influence on international scientific research cooperation[7]. In 2006, Ki-Wan Kim et al. pointed out that multilateral international cooperation has increased significantly in international cooperation, while the proportion of international scientific research cooperation has remained stable, which indirectly proves that scientific research cooperation is changing from 'asymmetric' to 'symmetric' [8]. In 2014, H. M. Puuska et al., based on the published data of Finland from 1990 to 2008, compared the number of citations of international cooperation published papers, domestic cooperation published papers and non-cooperation published papers, and analyzed the impact of international cooperation and domestic cooperation on citations. Differences between disciplines[9]. In 2017, L. Aldieri et al. constructed a model to explore the impact of scientific research cooperation within and outside universities on scientific research output in several major European countries, such as Russia, the United Kingdom, Italy, France, and Germany[10]. However, in this research, most scholars only explored the relationship between scientific research cooperation and scientific research output, and did not specifically study the impact mechanism of scientific research cooperation on scientific research output. Only by revealing the specific impact mechanism can we put forward more targeted strategies to improve the performance of scientific research efficiency in colleges and universities.

Therefore, based on the existing literature, this paper attempts to innovate and further study in the following aspects:(1)Taking local universities as the research object, this paper examines whether their scientific research performance is affected by the intensity of international exchanges and cooperation.(2)Comprehensively examine the scientific research performance of local universities, including different indicators of papers and patents, taking into account the quantity and quality factors, and examining the scientific research efficiency of universities from the overall and sub-regional aspects. In addition, in terms of research methods, the dynamic panel regression model is used to overcome the shortcomings of mean regression and reduce the interference of data endogeneity, so as to more accurately and carefully analyze the impact of international exchanges and cooperation on the scientific research performance of local universities.

3. Theory and Research Hypothesis

3.1. The impact of international exchange and cooperation on the scientific research performance of local universities.

From the perspective of scientific research performance of local colleges and universities, R&D investment, R&D subjects and cross-regional knowledge flow are the core factors affecting the scientific research performance of local colleges and universities. Colleges and universities first enhance the international reputation of colleges and universities by strengthening international academic exchanges, enhance the in-depth cooperation between colleges and universities, enterprises and research institutions, and integrate innovative resources among multiple subjects, which will help promote the investment and construction of a series of innovative resources such as international joint laboratories and collaborative innovation platforms. Secondly, as one of the ways of international exchange and cooperation, participating in the construction of Sino-foreign cooperative education system and attracting foreign famous universities and educational institutions with high-quality educational resources as partners can help Chinese universities absorb and learn from international advanced teaching management methods and innovative talent training system, which is helpful for universities to cultivate innovative talents with international vision and improve the quality of human capital. Finally, international academic exchanges provide a platform for the knowledge exchange and collision of R & D groups. University scholars and student groups improve their scientific research ability and international publishing ability by participating in international academic conferences, studying and communicating in world-renowned universities, and participating in international cooperative research projects, so as to promote the expansion of human resources in universities and improve the efficiency of scientific research in universities. Therefore, this paper proposes the following hypothesis :

H1:International exchanges and cooperation have a positive impact on the scientific research performance of local universities.

3.2. The mediating effect of knowledge exchange and interaction

International exchanges and cooperation can create a more international learning and working environment for college

teachers and students, and attract foreign famous universities and educational institutions with high-quality educational resources as partners. It can help Chinese universities to absorb and learn from international advanced teaching management methods and innovative talent training systems, and help universities cultivate innovative talents with international vision and improve the quality of human capital. Secondly, in the process of international exchange and cooperation in colleges and universities, international education in China, as an important manifestation of the high mobility of international education, can enable international students with different cultural and educational backgrounds to enter Chinese universities for further study. These international talents with diversified backgrounds, as knowledge exchange and interaction, can help colleges and universities expand their knowledge boundaries and stimulate innovation potential; finally, international academic exchanges provide a platform for the knowledge exchange and collision of R&D groups. University scholars and student groups improve their scientific research ability and international publishing ability by participating in international academic conferences, studying and communicating in world-renowned universities, and participating in international cooperative research projects. Promote the expansion of human resources in universities and enhance the innovation ability of universities.

H2: Knowledge exchange and interaction have a positive impact on the scientific research performance of local universities.

H3: Knowledge exchange and interaction play an intermediary role in the impact of international exchange and cooperation on the scientific research performance of local universities.

4. Research Design

4.1. Variable selection

4.1.1. Explanatory variables: university research efficiency. on the basis of research Jiangjiang Guo[11], Ping Shi[12], Lindao Cha[13], in order to reflect the scientific research efficiency of local colleges and universities as comprehensively as possible, the number of scientific papers and the number of invention patents are selected as the evaluation system of scientific research efficiency indicators of colleges and universities, and the principal component analysis method is used to calculate the comprehensive score of scientific research output. In addition to scientific papers and patents, the scientific research efficiency of colleges and

universities is generally reflected in the number of scientific and technological works published. However, due to the poor timeliness of scientific and technological works, the innovation evaluation mechanism of scientific and technological works is not perfect, so this paper does not include the number of published scientific and technological works into the index of scientific research efficiency of colleges and universities. Relevant research literature shows that the average lag time between innovation input and patent output is about 1 year[14]. This article follows this lag period.

4.1.2. Explanatory variables: international exchange and cooperation. Referring to the practice of Haiping Xue[15] and other scholars, this paper constructs the degree of international exchange and cooperation of local colleges and universities from three perspectives: overseas education, cooperative research and international academic conference. The number of international students enrolled and the number of international students in school are selected as the indicators of education for international students in China; select the number of cooperative research dispatches and the number of cooperative research acceptances as cooperative research indicators; to select the attendance of international academic conferences; the number of papers exchanged in international academic conferences, the number of invited reports of international academic conferences, and the number of international academic conferences hosted are used as indicators of international academic exchanges.

4.1.3. Control variables: Comprehensively consider other factors that affect the efficiency of scientific research in colleges and universities except for international exchanges and cooperation[16][17] avoid missing individual variables, select scientific research funds in colleges and universities, the number of teachers in schools, the number of graduate students and the number of school sizes as the control variables that affect the efficiency of scientific research in colleges and universities into the model, and use the scale of scientific research funds in colleges and universities, the number of full-time teachers, the number of graduate students in schools, and the number of regional colleges and universities as proxy indicators, the scale of scientific research funds in colleges and universities, the number of full-time teachers, and the number of graduate students in schools. In the empirical study, dummy variables such as time and region are also controlled. In order to reduce the impact of extreme values on the regression results, all continuous variables were tailed at both ends by 1% before regression. The definition and calculation methods of variables are listed in Table 1.

Table 1. Main variables and measures

Variable	index	variable symbol	implication
variable being explained	Universit scientific research performance	LURE	The comprehensive score based on entropy-TOPSIS model
explanatory variables	international exchanges and cooperation	IRE	The comprehensive score based on entropy-TOPSIS model
control variable	scientific research funds	RFU	The total amount of scientific research funds in different provinces in that year
	mentor	TEA	The total number of full-time teachers in different provinces
	postgraduate	GRA	The total number of graduate students in different provinces in the year
	school scale	SCH	The number of schools in different provinces in the year
	particular year province	Year Province	Year dummy variable Provincial dummy variable

The panel data of 31 provinces(except Hong Kong, Macao and Taiwan, the same below)in China from 2009 to 2020 are selected as samples, with a total of 372 observation samples. The data come from the'Compilation of Science and Technology Statistics in Colleges and Universities 2009-2021'.

The explained variable is a continuous variable greater than 0, so the Tobit model is used for regression[17]. The data structure is balanced panel data. Mixed model, fixed effect model or random effect model can be used to process panel data. The three models of panel Tobit regression need to be selected by LR test and Hausman test to determine the applicability of LR test to compare mixed model and fixed effect model[18]. The results show that the P value is less than 0.01, indicating that the fixed effect model is better than the

$$LURE_{i,t+1} = \alpha_0 + \alpha_1 IRC_{it} + \alpha_2 SCH_{i,t} + \alpha_3 LnRFU_{it} + \alpha_4 TEA_{it} + \alpha_5 LnGRA_{it} + \nu_i + \mu_t + \varepsilon_{it} \quad (1)$$

Among them, LURE refers to the scientific research efficiency of local universities and uses the entropy method to calculate the final score ; iRE is the international exchange and cooperation level of colleges and universities and uses the entropy method to calculate the final score. SCH is the number of colleges and universities in different provinces in the same year. LnRFU is the total amount of scientific research funds in colleges and universities in different provinces in the same year and logarithmically processed. TEA is the number of full-time teachers in colleges and universities in different provinces in the same year. GRA is

mixed model. The Hausman test was used to estimate the fixed effect model and the random effect model. The results showed that the P value was greater than 0.1, which proved that the random effect model was superior to the fixed effect model, so the random effect model was finally selected. Data analysis was performed using software Stata14.0.

4.2. Model setting

This study uses the method of multiple regression analysis to verify the theory and research hypothesis. The basic model is shown in Formula (1). Formula (1) is used to analyze the relationship between international communication and cooperation and scientific research performance of local universities. Through data processing, a multivariate linear regression equation is initially established as follows :

the number of graduate students in different provinces in the same year and logarithmically processed. ν_t and μ_i represent the individual fixed effect and time fixed effect of universities, respectively. By controlling the fixed effects of the two dimensions, we can fully consider the observable and unobservable influencing factors related to the efficiency of scientific research in universities. ε_{it} is a random error term ; i and t represent universities and time respectively.

5. Empirical Analysis

Table 3. Baseline regression

	(1) scientific research performance	(2) scientific research performance	(3) scientific research performance	(4) scientific research performance	(5) scientific research performance
international exchanges and cooperation	0.858** (31.958)	0.287** (3.184)	0.209** (4.170)	0.204** (4.080)	0.192** (3.934)
university scale			0.001** (2.841)	0.001** (2.545)	0.001* (2.068)
university scientific research funds				0.003 (0.711)	-0.001 (-0.237)
college teachers' quantity					0.007* (2.334)
Number of postgraduate students					0.017 (1.808)
_cons	0.064** (7.605)	0.206** (6.063)	0.184** (5.451)	0.153*** (2.953)	-0.046 (-0.437)
two-way fixed effects	N0	Yes	Yes	Yes	Yes
N	372	372	372	372	372
R2 a	0.506	0.320	0.399	0.404	0.461

Note : t-test values in parentheses, * p < 0.1, ** p < 0.05, *** p < 0.01, the following table is the same.

Table 2 reports the regression results based on Model (1). Among them, columns (1) - (3) are panel data fixed effect estimation results. The data results show that after adding control variables and year fixed effects, international exchanges and cooperation in colleges and universities have a significant positive impact on the efficiency of scientific research in colleges and universities. This means that international exchanges and cooperation can help promote the output of scientific research achievements in local universities and improve the efficiency of scientific research in universities. On the one hand, international exchange and

cooperation can enhance their own talent training ability and scientific research ability by strengthening academic communication and R&D cooperation with foreign universities. On the other hand, it can also bring more international multidisciplinary talents with different knowledge reserves and cultural backgrounds to colleges and universities, which will help to better absorb international advanced science and technology and promote their own scientific research efficiency.

5.1. Robustness test

In order to test the robustness of the regression results, this

paper first uses the method of replacing the explained variables. Considering that the comprehensive index of university scientific research efficiency is used as the explained variable in the benchmark regression, this paper uses the number of university papers published and the number of university patent applications as the proxy variables of university scientific research efficiency for

regression estimation. The results are shown in columns (1) and (2) of Table 4. At the same time, in order to eliminate the influence of extreme values, this paper also carries out 1 % tail reduction processing on each variable, and the results are shown in column (3) of table 3. The estimation results show that the baseline estimation results of this study are robust.

Table 3. Robustness test

	(1) research paper	(2) patent for invention	(3) Tailing processing
international exchanges and cooperation	0.351** (2.595)	-1.164* (-2.370)	0.164** (3.333)
university scale	0.002* (2.304)	-1.164* (-2.370)	0.001 (1.589)
university scientific research funds	-0.012 (-0.515)	0.252* (2.010)	0.001 (0.161)
college teachers' quantity	0.019 (1.942)	-0.002 (-0.037)	0.007* (2.319)
Number of postgraduate students	0.332** (3.502)	0.878** (5.690)	0.007* (2.319)
_cons	5.680** (6.849)	-5.835** (-5.936)	-0.060 (-0.547)
two-way fixed effects	Yes	Yes	Yes
N	372	372	372
R2 a	0.513	0.432	0.451

5.2. Heterogeneity analysis

This study takes local universities as samples to study the overall effect of international exchange and cooperation on the efficiency of scientific research in universities. The open level and scientific research environment of colleges and universities in different regions are different, so the influence of international exchange and cooperation level on the level of scientific research efficiency of colleges and universities in different regions may be different.

Firstly, this paper makes a grouped regression comparison according to the geographical location of colleges and universities in the eastern, central and western regions. Among the 31 provinces in the study sample, 11 provinces belong to the east, 8 provinces belong to the middle, and 12 provinces belong to the west. The regression results are shown in table 5, column (1) (2). Through comparison, it can be found that the grouping regression results of the eastern, central and western regions are significantly positive, indicating that the impact of international exchanges and

cooperation on the efficiency of scientific research in colleges and universities is universal ; at the same time, in the ' western ' group, this effect is greater, which means that international exchanges and cooperation are more conducive to improving the scientific research efficiency of local universities in the western region. This may be because there is a certain gap between the basic research environment, scientific research human resources and R & D capital investment of local universities in the western region and those in the eastern and central regions. The overall R & D efficiency and innovation level are low, and there is a large room for improvement. International exchanges and cooperation can improve the scientific research investment and innovation environment of colleges and universities, improve the scientific research efficiency of these colleges and universities, help to narrow the gap in innovation level between local colleges and universities in the western region and other regional colleges and universities, and help such colleges and universities to achieve scientific research and innovation catch-up.

Table 4. Heterogeneity analysis

	(1) scientific research performance	(2) scientific research performance	(3) scientific research performance
international exchanges and cooperation	0.362** (3.357)	0.627** (6.627)	0.002 (0.410)
university scale	0.362** (3.357)	0.627** (6.627)	0.453** (7.315)
university scientific research funds	0.362** (3.357)	-0.066** (-4.425)	-0.000 (-0.356)
college teachers' quantity	0.015 (0.749)	0.007 (1.186)	-0.000 (-0.356)
Number of postgraduate students	0.015 (0.749)	-0.004 (-0.296)	0.002 (0.410)
_cons	0.015 (0.749)	0.773** (3.757)	0.002 (0.410)
two-way fixed effects	Yes	Yes	Yes
N	132	96	144
R2 a	0.593	0.551	0.646

5.3. Mechanism test

The previous article has verified the hypothesis that international exchanges and cooperation have a significant effect on the efficiency of scientific research in universities, but has not yet analyzed the impact mechanism. Therefore, this paper will further verify the theoretical mechanism of

$$KEI_{it} = \alpha_0 + \alpha_1 IRC_{it} + \alpha_2 SCH_{it} + \alpha_3 \ln RFU_{it} + \alpha_4 TEA_{it} + \alpha_5 \ln GRA_{it} + \nu_i + \mu_i + \varepsilon_{it} \quad (2)$$

$$LURE_{it+1} = \alpha_0 + \alpha_1 KEI_{it} + \alpha_2 IRE_{it} + \alpha_3 SCH_{it} + \alpha_4 \ln RFU_{it} + \alpha_5 TEA_{it} + \alpha_6 \ln GRA_{it} + \nu_i + \mu_i + \varepsilon_{it} \quad (3)$$

Among them, KEI represents knowledge exchange and interaction. International publication represents the 'voice' of Chinese scholars in the international academic community, which can reflect the knowledge exchange and interaction of China in the international academic community[21]. Therefore, the number of papers published by universities in

international exchange and cooperation affecting the efficiency of scientific research in universities, and test the intermediary path of knowledge exchange and interaction. Referring to the research on the mediating effect model of river boats[20], this paper uses the following models (2) and (3) to test the mechanism.

foreign academic journals is used as the proxy variable of knowledge exchange and interaction in universities. Other variables are defined as the same as Model (1), and the data are from the 'compilation'. The above mediating effect models are regressed separately, and the regression results are shown in Table 5.

Table 5. Influence mechanism test results

	(1) Knowledge exchange and interaction	(2) scientific research performance
international exchanges and cooperation	0.280** (2.3786)	0.075*** (2.8131)
Knowledge exchange and interaction		0.011*** (8.3528)
university scale		
university scientific research funds		
college teachers' quantity	0.000 (0.2988)	-0.000 (-1.4907)
Number of postgraduate students	0.069 (1.3247)	0.013 (0.6349)
_cons	0.489*** (3.3712)	-0.196 (-0.9735)
two-way fixed effects	2.881** (2.5763)	7.974*** (5.5867)
N	Yes	Yes
R2_a	372	372
university scale	0.632	0.663

International exchanges and cooperation can enable teachers and students of local universities to go out through various channels such as academic exchanges and personnel exchanges. The results of column (1) and column (2) in Table 5 show that international exchange and cooperation can significantly promote the exchange and interaction of knowledge, and then have a positive effect on university innovation. The results show that knowledge exchange and interaction effect is one of the important mechanisms for the improvement of international exchange and cooperation innovation. International exchange and cooperation can build an open communication platform for local universities, promote the flow, absorption and collision of knowledge, help universities to learn and absorb advanced international knowledge and technology, realize the cross-integration of subject knowledge, and improve their own level of scientific research and innovation.

6. Research Conclusions and Discussion

6.1. Research conclusions

Based on relevant data from local universities in China from 2009 to 2020, this article constructs an evaluation system for international exchange and cooperation indicators, including international cooperative education, international student mobility, and international academic exchange. The entropy weight method and TOPSIS are combined to calculate the level of international exchange and cooperation among local universities, and multiple measurement methods such as bidirectional fixed effect model and intermediary effect model are used. Analyzed the impact of international exchange and cooperation on the research performance of local universities, as well as the mediating role of knowledge exchange and interaction in international exchange and cooperation on the research performance of local universities. The main findings of the study are:

(1) International exchange and cooperation can improve the level of scientific research innovation in local universities through knowledge exchange and interactive effects.

(2) International exchange and cooperation can significantly promote the research performance of local universities, and this conclusion remains valid after robustness and endogeneity tests.

(3) The results of heterogeneity analysis indicate that this impact is more pronounced in local universities in the western region.

6.2. Conclusion and discussion

Given the above conclusions, local universities, as important bases for cultivating high-level talents and promoting scientific research in China, have played an important strategic role in accelerating the process of building an innovative country. Therefore, this article proposes the following suggestions:

Firstly, local universities follow a diversified and distinctive internationalization path in response to national strategies and regional development needs. Based on the objective needs of national and regional economic and social development, we aim to accurately position ourselves in coordinating and serving national strategies and regional economic and social development, fully leverage regional advantages, explore internationalization strategies that are suitable for our own development and have unique characteristics, and create an international brand.

Secondly, local universities will extend international exchanges from the administrative level to the fields of teaching and research, enhancing the internationalization effect. Local universities should focus on the goal of international talent cultivation, keep up with the development of the times and the needs of social reality, fully concentrate resources from all aspects, and carry out international exchanges and cooperation in academic exchanges, research projects, and achievement output, in order to promote the internationalization of talent cultivation through the internationalization of scientific research.

Third, colleges and universities in the west need to grasp the opportunity that the study abroad craze turns into the tide of returning home in the post epidemic era, implement curriculum co construction, credit exchange, degree mutual recognition, etc. with countries along the "the Belt and Road", relax the policy restrictions on students' participation in internships in places where they study abroad, and encourage quality mobility; At the same time, it is necessary to continuously improve the guarantee mechanism for international exchange and cooperation, ensure that various international cooperation projects can continue to deepen, and thus maximize the improvement of their scientific research performance within the scope of scientific and reasonable international exchange and cooperation levels.

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