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# Adjustment of Administrative Divisions and Upgrading of Industrial Structure in Hefei Metropolitan Area: Taking "Partitions of Chaohu" as a Quasi-natural Experiment

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**Abstract** Administrative regions are an important environment for the operation of China's market economy. The relevant economic subjects cannot predict the policy of adjustment of administrative divisions and carry out conscious migration behavior, adjustment of administrative divisions can be regarded as a quasi-natural experiment. The three cities of Hefei, Wuhu, and Ma'anshan, which are directly related to the adjustment of the administrative division of Chaohu, are taken as the treatment group, and the seven adjacent cities of Lu'an, Huainan, Chuzhou, Bengbu, Anqing, Chizhou, and Tongling are taken as the control group. Differences-in-Differences method and relevant control variables affecting the upgrading of industrial structure are used to test. The test results show that "Partitions of Chaohu" has a significant industrial structure upgrading effect by promoting the optimization of spatial layout, the cross-regional flow of production factors and the effective management of Chaohu Lake Basin. At the same time, the increase of total retail sales of consumer goods, urban fixed assets investment, public utility expenses in science, education, culture and health, and population plays a significant positive role in promoting the upgrading of industrial structure, while foreign direct investment plays a certain inhibition role in the upgrading of industrial structure. In order to meet the ever-developing space demands and enhance the impact on surrounding areas, the Hefei metropolitan area should be driven by technological innovation, strengthen the integration of industrial chains, improve the business environment and transportation network, and continuously promote the upgrading of industrial structure and the formation and development of new productive forces.

**Key words** Adjustment of administrative divisions, Upgrading of industrial structure, Hefei metropolitan area, Quasi-natural experiment

## 1 Introduction

Moderate adjustment of administrative divisions has different degrees of impact on regional economy, ecological environment and public services. In August 2011, the State Council announced the abolition of prefecture-level Chaohu City, and the original Chaohu City was divided into three parts for Hefei, Wuhu, and Ma'anshan. After "Partitions of Chaohu", the regional area and population of Hefei City have reached the level of first-tier cities in the country; the regional area, population and economic aggregate of Wuhu and Ma'anshan have been greatly improved, and the strategic concept of establishing industrial parks and logistics parks in area north of the Yangtze River has been successfully realized; Chaohu Lake has become an inner lake in Hefei City, and the main body of resource development, management and utilization of Chaohu Lake is much clearer. However, whether the adjustment of administrative divisions can promote the upgrading of the industrial structure of the Hefei metropolitan area is still a practical issue worthy of in-depth study.

## 2 Literature review of relevant adjustment of administrative divisions

The adjustment of administrative divisions at the provincial level mainly involves the establishment of Hainan as a province and the establishment of Chongqing as a municipality directly under the Central Government. Zhang Ersheng pointed out through horizontal and vertical comparative analysis that the adjustment of administrative divisions in Hainan Province has narrowed the economic gap between Guangdong and Hainan to a certain extent[1]. Wang Xianbin and Nie Haifeng found that the establishment of a municipality directly under the Central Government in Chongqing has unequal impact on the former Sichuan Province and the new Chongqing City, and has a greater role in promoting the economic development of Chongqing City, while the impact on Sichuan Province is not obvious[2]. When Chen Zhao studied the impact of adjustment of administrative divisions on regional economic development in Sichuan Province from 1993 to 1998, he found that adjustment of administrative divisions accelerated the regional economic growth rate, and this promotion effect was more obvious for new central cities[3].

The adjustment of administrative divisions makes the administrative region economy transition to the economic zone economy, which can reduce regional economic barriers and local protectionism to a certain extent, reduce transaction costs, and promote regional economic growth[4]. Bai Xiaohu conducted an empirical study on industrial spatial change and industrial upgrading from the perspective of adjustment of administrative divisions, and the research results showed a certain positive effect[5].

In terms of research methods, Jiang Ying and Zhong Changbiao used the panel data of 275 prefecture-level cities from 2000 to 2019, and used the difference-in-differences method to ex-

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plore the role of adjustment of administrative divisions in the equalization of basic public services. The study shows that the adjustment of administrative divisions through the reorganization of district boundaries can effectively improve the equalization of basic public services, and bridge the regional gap through the effect of fiscal expenditure and population mobility[6]. Gao Lingling and Sun Haiming used the difference-in-differences method to study the policy effects of 2 245 adjustments of administrative divisions above prefecture-level cities across the country from 1992 to 2012, and concluded the regional heterogeneity of the effect of adjustment of administrative divisions on regional economic growth. It has a significant positive correlation effect on the eastern region; however, the impact on the western region showed two stages of negative correlation (1992 – 2000) and positive correlation (2001 – 2012)[7].

In modern regional economic development, spatial agglomeration can better meet the needs of industrialization and urbanization by reducing the transaction costs of economic activities and improving the spatial efficiency of resource allocation[8]. Since 2000, Chaohu City has been the only case involving the transformation of cities into counties in China. "Partitions of Chaohu" is guided by economic development and regional economic integration, and generally conforms to the internal needs of regional space optimization. Sun Xueyu believes that in the management system of municipally affiliated county, the city economy must be developed enough to lead and drive the county economy to help it develop the economy and get out of poverty, rather than cause the siphon effect, which makes the county economy fall into greater poverty[9]. He Dan *et al.* pointed out from the perspective of spatial differentiation that the spatial differentiation caused by "weak cities and strong counties" is the main driving force for "Partitions of Chaohu"[10]. Liu Fen summarized the spatial impact of "Partitions of Chaohu" from three levels: from the perspective of a central city, Hefei's central position has been strengthened and consolidated; from the perspective of metropolitan area development, the spatial agglomeration of Hefei, Wuhu, and Ma'anshan has increased; from the perspective of regional economic integration, the trend of double-circle linkage and integration between the Hefei metropolitan area and the Nanjing metropolitan area is prominent[11].

Thus it can be seen that the adjustment of administrative divisions in China is carried out on different spatial scales, and its impact on the adjusted areas involves not only the total economic growth effect, but also the local spatial change and industrial upgrading effect.

## 3 Analysis of the upgrading effect of the industrial structure of "Partitions of Chaohu"

**3.1 Research scoping and data sources** The Hefei metropolitan area has gone through three development stages: "provincial capital economic circle", "Hefei economic circle" and the current "Hefei metropolitan area", and now covers Hefei, Lu'an, Huainan, Chuzhou, Wuhu, Ma'anshan, Bengbu and Tongcheng.

The research objects are divided into two groups: one group includes Hefei, Wuhu, and Ma'anshan, which are directly related to "Partitions of Chaohu", as the "treatment group"; the other group includes the adjacent cities: Lu'an, Huainan, Chuzhou, Bengbu, Anqing, Chizhou, Tongling, which are compared with the "treatment group", as the "control group". In view of the comparability of the data, Tongcheng City, a county-level city, is not taken as a direct research object. All data are from the 2003 – 2019 *Statistical Yearbook of Anhui Province*.

**3.2 Theoretical assumptions and model settings** According to the general law of industrial structure upgrading at the macro level, the transformation and upgrading of industrial structure is mainly reflected in the gradual increase in the proportion of tertiary industry added value, tertiary industry output value, and tertiary industry employment in the regional economy. Since the Hefei metropolitan area is still in the middle stage of industrialization, the secondary industry accounts for a relatively large proportion. Especially since the establishment of the demonstration zone for undertaking industrial transfer in the Wanjiang urban belt, the second and tertiary industries have achieved great development, the proportion of the primary industry has gradually declined, and the tertiary industry has a development trend of rising first and then falling. According to the characteristics of industrial structure changes in Hefei metropolitan area, the difference between the sum of the added value of the secondary and tertiary industries and the added value of the primary industry is used to comprehensively reflect the upgrading of the industrial structure (*is*) of Hefei metropolitan area, and is used as an explained variable. At the same time, there are many factors affecting the upgrading of industrial structure, industrial transformation and upgrading are realized under the comprehensive effect of various factors, so the following explanatory variables are selected as the control variables in the model:

(i) Consumption. The main purpose of modern economic development is to meet the social needs of human beings. According to Maslow's hierarchy of needs theory, social needs will continue to upgrade with economic development, and further promote the change of industrial structure. In the process of China's economic transformation from high-speed to high-quality development, consumption continues to upgrade, and consumption is still the leading force driving economic growth. This paper uses the total retail sales of consumer goods (*rc*) as an indicator to measure consumption and promote the continuous upgrading of industrial structure. (ii) Investment. Since 1996, the high-speed growth of China's economy has mainly been driven by high investment, which will directly affect the changes in industrial structure. This paper regards urban fixed assets investment (*fai*) as an important factor affecting the upgrading of industrial structure. (iii) Foreign direct investment. Foreign direct investment is characterized by transfer of a "package" of factors, which brings new external factors to the change of domestic industrial structure. At present, the mode of

international division of labor between China and developed countries has not changed substantially, and FDI still plays an important role in the adjustment of regional industrial structure. In this paper, foreign direct investment (*fdi*) is regarded as an important index affecting the upgrading of industrial structure. With the international industrial transfer, Hefei metropolitan area attracts foreign direct investment by undertaking industrial transfer from developed countries or regions, and brings external impetus to the transformation and upgrading of industrial structure.

In addition, the "Partitions of Chaohu" has brought great changes to the public services and total population of the Hefei metropolitan area. Therefore, this paper establishes the main explanatory variables affecting the upgrading of industrial structure as: total retail sales of consumer goods (*rc*), urban fixed asset investment (*fai*), foreign direct investment (*fdi*), science, education, culture and health expenses (*secs*) and population (*popu*). *fdi* is calculated by converting into RMB at the average exchange rate of the year; after taking the natural logarithm of the three variables of *rc*, *fdi*, and *fai*, they are set as *lrc*, *lfdi*, and *lfai*, respectively, and added to the model to eliminate the influence of heteroscedasticity.

Based on the above theoretical hypotheses, the following two models are set:

$$is_{it} = \alpha_0 + \alpha_1 c_{it} + \alpha_2 t_{it} + \alpha_3 c_{it} t_{it} + \varepsilon_{it} \quad (1)$$

$$is_{it} = \alpha_0 + \alpha_1 c_{it} + \alpha_2 t_{it} + \alpha_3 c_{it} t_{it} + \beta_1 \ln rc_{it} + \beta_2 \ln fdi_{it} + \beta_3 \ln fai_{it} + \beta_4 secs_{it} + \beta_5 popu_{it} + \varepsilon_{it} \quad (2)$$

In model (1) and (2): $c$ represents the city dummy variable, $t$ represents the time dummy variable, and $c_{it}$ is the cross-product term; $\varepsilon$ is a random error term, satisfying the hypothesis that the mean value is 0, the individuals are independent of each other and it is the same variance. For the relevant economic entities, it is impossible to carry out conscious enterprise migration behavior due to the unpredictability of the adjustment of administrative divisions policy of "Partitions of Chaohu" in advance, so "Partitions of Chaohu" is regarded as a quasi-natural experiment.

Formula (1) uses difference-in-difference model to verify the individual effect, time effect and cross-multiplication effect of "Partitions of Chaohu" on the upgrading of industrial structure in Hefei metropolitan area. Formula (2) adds control variables that affect the upgrading of industrial structure on the basis of formula (1): *lrc*, *lfdi*, *lfai*, *secs*, *popu*. On the basis of verifying the policy effect of "Partitions of Chaohu", the transmission mechanism of "Partitions of Chaohu" to industrial structure upgrading is further verified through control variables.

**Table 1 Treatment group and control group**

| City grouping | Time node | City | Time | C&T |
|---|---|---|---|---|
| Treatment group: Hefei, Wuhu, Ma'anshan | Prior to 2011 | 1 | 0 | 0 |
| | 2011 and beyond | 1 | 1 | 1 |
| Control group: Chuzhou, Huainan, Lu'an, Anqing, Chizhou, Tongling, Bengbu | Prior to 2011 | 0 | 0 | 0 |
| | 2011 and beyond | 0 | 1 | 0 |

**3.3 Test results** Based on formula (1), after the first difference within the group, the second difference between the groups is carried out to obtain the net change of the industrial structure upgrading of the treatment group after the "Partitions of Chaohu", that is, the difference-in-differences (DID) coefficient value. For the industrial structure upgrading index selected in this paper, the difference-in-differences coefficient is 1 428.884, and it is significant at the level of 1%. Based on formula (2), after adding control variables, the difference-in-differences coefficient is 864.714. Compared with formula (1) without adding control variables, the difference-in-differences coefficient becomes smaller, but it is still significant at the 1% level, and $R^2$ is significantly improved, indicating that the model's explanatory power has been enhanced. The control variables *lrc*, *lfai*, *secs*, *popu* have a positive promotion effect on the upgrading of industrial structure, among which l*rc*, *lfai*, secs are significant at the level of 1%, and *popu* is significant at the level of 5%, but *lfdi* plays a certain inhibitory role in the upgrading of industrial structure, and it is significant at the level of 1%, which shows that the use of foreign direct investment FDI is low and does not play a role in promoting the upgrading of industrial structure.

**3.4 Analysis of the reasons for the test results**

**3.4.1** "Partitions of Chaohu" makes the spatial layout of the Hefei metropolitan area more optimized. The adjustment of administrative divisions—"Partitions of Chaohu" occurred one year after the central government established the Wanjiang Urban Belt Demonstration Zone to undertake industrial transfer. In order to better undertake the industrial transfer in the eastern coastal areas, Ma'anshan, Wuhu, Tongling, Chizhou, and Anqing, located in the Yangtze River urban belt of Anhui, urgently need to develop across the river, and Hefei, one of the 27 member cities of the Central Cities Economic Coordination Committee along the Yangtze River, also needs to be connected to the river and the sea. The direct effect of "Partitions of Chaohu" is that the three regional central cities of "Hefei – Wuhu – Ma'anshan" are adjacent to each other and are located in the Yangtze River urban belt of Anhui, and the spatial superposition effect of "One Belt, One Circle" is prominent. From the perspective of urban spatial structure, Hefei has become a very modern lakeside and riverside city. The state has established a lakeside new area and a national science and technology innovation center in Hefei. Chaohu City will continue to use the economic agglomeration function of the original prefecture-level city and at the same time, it will be continuously and directly driven by the central city Hefei.

"Partitions of Chaohu" has basically formed the spatial strategic layout of the Hefei metropolitan area, and the Hefei metropoli-

tan area will connect with the core circle of the Yangtze River Delta urban agglomeration with a more open attitude. Hefei has become an important national scientific research base linked with the Shanghai Science and Technology Innovation Center. As the core growth pole of Anhui's economic development, it has a greater driving effect on relatively backward areas such as northern and western Anhui. At the same time, it helps to deepen the "double-circle linkage" of Hefei metropolitan area and Nanjing metropolitan area, and strengthen the joint force in innovation drive, industrial cooperation, public service sharing and so on.

**Table 2 Test of effect of difference-in-differences and related control variables on industrial structure upgrading**

| Time node | City grouping | Explained variable *is* |
|---|---|---|
| 2003 – 2010 | Control group | 203.650 |
| | Treatment group | 668.524 |
| 2011 – 2019 | Treatment group | 620.356 |
| | Treatment group | 2 514. 114 |
| Difference-in-differences (DID) coefficient | | 1 428.884 (0.000***) $R^2$: 0.58 |
| Control variable coefficient | *lrc* | 180.187 (0.001***) |
| | *lfai* | 103.877 (0.007**) |
| | *lfdi* | -36.719 (0.069*) |
| | *secs* | 20.110 (0.000***) |
| | *popu* | 0.286 (0.030**) |
| 2003 – 2010 (add control variables) | Difference between treatment group and control group | 126.775 (0.006***) |
| 2011 – 2019 (add control variables) | Difference between treatment group and control group | 991.489 (0.000***) |
| Difference-in-differences (DID) coefficient | | 864.714 (0.000***) $R^2$: 0.91 |

**3.4.2** "Partitions of Chaohu" makes the industrial characteristics of the Hefei metropolitan area more distinctive. After the "Partitions of Chaohu", the mobility of factors in Hefei, Wuhu, Ma'anshan and the 1 district and 4 counties under the jurisdiction of the former Chaohu City has increased. From the perspective of development stage, the Hefei metropolitan area is still in the stage of agglomeration function, and the central city continues to attract surrounding economic factors to enhance its own strength.

Hefei is a regional central city along the lake and the river, Hefei's shipping industry will develop rapidly, and the "Project of Diverting Water from Yangtze River to Huaihe River" will further improve the waterway transportation system. The Binhu New Area on the northeast shore of Chaohu Lake will be further developed. The current county-level Chaohu City will develop into a satellite city of Greater Hefei and a sub-center of leisure and entertainment in Hefei; Lujiang County is rich in iron, copper and other mineral resources, as well as the human resources brought by good education, which will make the industrial system of New Hefei more complete. The Shanghai Huayi Super Petrochemical Project introduced by Wuwei Erba and the Gaogou cable industry cluster will form a new beneficial supplement to the industrial structure of Wuhu City. At the same time, the addition of Wuhu to the Jiangbei concentration area will help Wuhu make full use of the shoreline resources of the golden waterway of the Yangtze River and expand the port scale and handling capacity. Hanshan's foundry industry, ceramic industry and wine brewing industry will further promote the industrial diversification transformation of Ma'anshan. Known as the "Hometown of Foundry", Hanshan County have nearly 300 foundry enterprises, forming a strong support for Ma'anshan City to undertake industrial transfer.

After "Partitions of Chaohu", the three cities of "Hefei – Wuhu – Ma'anshan" have expanded their economic volume, population and land area. At the same time, resources have also continued to flow to the 1 district and 4 counties under the jurisdiction of the original Chaohu City. Hefei, Wuhu and Ma'anshan have become the direct support of 1 district and 4 counties. The original 1 district and 4 counties of Chaohu City have received more resources and financial support, and their industrial advantages have been enhanced to a certain extent. However, it is obvious that the economic burden of the three cities has increased compared with before, which has a certain negative impact on the upgrading of industrial structure.

**3.4.3** "Partitions of Chaohu" makes the governance subject of Chaohu Lake Basin clearer. After the "Partitions of Chaohu", Chaohu Lake became the inner lake of Hefei City, which will change the phenomenon that the Chaohu Lake basin was artificially divided into the eastern half of the lake and the western half of the lake to be governed by the original Chaohu City and Hefei City, respectively. Chaohu Lake is connected to the Yangtze River by the Yuxi River. Before Chaohu Lake built a sluice gate in the mid-1960s, the water body of Chaohu Lake was naturally connected with the water body of the Yangtze River, and the amount of water flowing into Chaohu Lake was about 45% of the runoff for Chaohu Lake. This natural environment has made Chaohu Lake known as "the land of fish and rice". After the mid-1960s, in order to improve the flood control capacity of the Chaohu Lake Basin, Yuxi Gate, Chaohu Gate, and Yuxi Second Reservoir were built one after another, and the amount of water flowing from the Yangtze River into Chaohu Lake was reduced to 5% of the runoff for Chaohu Lake. Chaohu Lake has become an artificially controlled semi-enclosed water area, which has completely lost the self-purification ability of the water body, causing ecological and environmental problems such as cyanobacteria outbreaks, turbid water bodies, vegetation decline, sharp decline of biological species, and river pollution[12].

At present, in the construction of the ecological civilization demonstration zone around Chaohu Lake, Chaohu Lake will surely

become a characteristic business card of the "Great Lake City". Therefore, the ecological role of Chaohu Lake cannot be ignored. Hefei City will use the loan from Anhui Provincial Development Bank to provide greater support for the ecological protection and restoration of Chaohu Lake, control the outbreak of cyanobacteria in Chaohu Lake from the source, strengthen the management of polluting industries, carry out clean production transformation of key polluting enterprises, develop ecological and sightseeing agriculture around Chaohu Lake, and continuously enhance the self-purification ability of lake water by "Project of Diverting the Water of Yangtze River to Chaohu Lake".

The coordinated management of Chaohu Lake in terms of flood control, flood prevention, irrigation, and ecological construction of road around the lake is conducive to building the Chaohu Lake Ecological Protection Demonstration Zone and the Dabie Mountain Ecological Conservation Zone into an ecological barrier for the Hefei metropolitan area, and continuously improving the ecology of the Hefei metropolitan area, constantly promoting carrying capacity of the Hefei metropolitan area, promoting the establishment of an environment-friendly society, and promoting the transformation of ecological advantages into development opportunities. The area surrounding heart-shaped road around Chaohu Lake will become a much denser urban area, integrating ecological protection and restoration, tourism, transportation, fishery, and modern agriculture, thereby changing the spatial and industrial layout within the Hefei metropolitan area.

## 4 Conclusions and recommendations

**4.1 Conclusions** This paper regards the adjustment of administrative divisions—"Partitions of Chaohu" within the Hefei metropolitan area as a quasi-natural experiment, taking the three cities of Hefei, Wuhu, and Ma'anshan as the treatment group, and Lu'an, Huainan, Chuzhou, Bengbu, Anqing, Chizhou, and Tongling as the "control group". The difference between the sum of the added value of the secondary and tertiary industries and the added value of the primary industry (*is*) is used as the industrial structure upgrading index of the Hefei metropolitan area, and the data from the 2003 – 2019 *Statistical Yearbook of Anhui Province* are used to perform difference-in-differences test on the treatment group and the control group respectively. The test results show that the difference-in-differences coefficient of "Partitions of Chaohu" on the upgrading of industrial structure is 1 428.884, and it is significant at the level of 1%. After adding the relevant control variables that affect the upgrading of industrial structure, further test is conducted. The difference-in-differences coefficient decreases to 864.714, and $R^2$ significantly increases from 0.58 to 0.91, and is significant at the level of 1%. The control variables *lrc* (natural logarithm of total retail sales of consumer goods), *lfai* (natural logarithm of urban fixed asset investment), secs (science, education, culture and health expenses), *popu* (population) have a positive role in promoting the upgrading of industrial structure. *lrc*, *lfai*, secs are significant at 1% level, *popu* is significant at 5% level, but the control variable *lfdi* (natural logarithm of foreign direct investment) plays a certain inhibitory role in the upgrading of industrial structure, and is significant at 1% level. Overall, "Partitions of Chaohu" has produced a significant industrial structure upgrading effect.

**4.2 Recommendations** Therefore, "Hefei – Wuhu – Ma'anshan" should break the economic thinking of the administrative region, be driven by technological innovation, strengthen the integration of the industrial chain, and improve the business environment and transportation network. Hefei is the city with the densest layout of major national science and technology projects in China in addition to Beijing. In accordance with General Secretary Xi Jinping's instructions of "put innovation first", it is necessary to use the Yangtze River Delta G60 Science and Technology Corridor, Hefei – Wuhu – Bengbu Independent Innovation Demonstration Zone and other scientific and educational resources to enrich advantages, focus on key areas such as artificial intelligence, big health, and new energy, focus on conquering core technologies of specific industries, strive to solve some bottlenecks and difficulties in the industrial chain and innovation chain, and create a scientific and technological innovation source with international influence. For industries such as new energy vehicles, white household appliances, and smart homes that have formed a large scale, a win-win cooperation mode between enterprises should be adopted to achieve sharing in terms of product raw material supply, related supporting facilities, and market demand information, and reduce transaction costs within industrial clusters.

It is necessary to make full use of factor endowment, strive to become an advanced manufacturing base for production, processing and assembly in the domestic value chain of the Yangtze River Delta, refine the division of labor in the industrial chain, focus on the development of high-end equipment manufacturing industry, expand the share of high-tech industries, improve the proportion of high-tech, finishing and high value-added industries, and especially expand independent research and development in leading industries, improve industrial innovation ability and expand brand influence. It is necessary to develop strategic emerging industries in the form of industrial technology innovation strategic alliances, and enhance the initiative and voices in industrial cooperation with developed countries or regions with technological leadership.

It is necessary to speed up the construction and opening of the Chaohu – Ma'anshan intercity high-speed railway, accelerate the construction of the Nanjing – Hefei section of the high-speed railway along the river, the Chizhou – Jiujiang high-speed railway, the Hefei – Wenzhou high-speed railway, and the Nanjing – Hexian Expressway, so that the cities along the road can quickly integrate into the Hefei metropolitan area. It is necessary to actively make use of the "lakeside and riverside" business environment brought about by the spatial superposition of the Hefei metropolitan area and the Anhui Yangtze River urban belt, improve the ecological compensation mechanism for water environment, and jointly promote the joint protection and joint governance of the ecological environment so that the Yangtze River can become the cultural and geographical indication of Hefei metropolitan area, and constantly promote the upgrading of industrial structure and the formation and development of new productive forces.

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