Journal of Regional Economics

Homepage: https://anser.press/index.php/JRE

The realization path and effect measurement of ecological value transformation to promote the common prosperity of urban and rural areas

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ABSTRACT

On the basis of the background of the global green development wave, this paper studies the mechanism between ecological value transformation and urban-rural common prosperity as well as selects 24 data indicators in relation to ecological value transformation, i.e., green development level from 2008 to 2017, calculate the comprehensive score of China's green development level by entropy method, measures the gap between the rich and the poor between urban and rural areas by urban-rural income ratio, and using correlation analysis, she examines the relationship between green development level and the urban-rural income ratio. Moreover, through empirical analysis, there is a significant negative correlation between the level of green development and the ratio of urban to rural income, according to the findings. The improvement of the level of green development will assist narrow the income gap between urban and rural residents as well as achieve common prosperity.

KEYWORDS

Ecological value transformation; Green development; Common prosperity; Entropy method; Correlation analysis

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ISSN 2972-3434
doi: 10.58567/jre01010003

Received 28 November 2022; Accepted 27 December 2022; Available online 29 December 2022

1. Introduction

Kuznets's inverted U curve hypothesis is widely disputed Paukert and Syrqiun proved that the inverted U-shaped curve does exist, while John et al have made an investigation that in some countries, particularly developing countries, the gap between the wealthy and the poor has not shrunk as a result of economic growth, but has shown a tendency to widen. Western classical economists put forward that there is a dilemma between economic growth and limited resources, accordingly, economic growth is bound to bring the problem of ecological environment destruction. On the basis of this theory, since the reform and opening up in China, the environmental damage resulting from economic growth has become more tolerant, and the extensive economic growth model has impacted people's standard of living of the Chinese people(Hu and Zhou 2014). Additionally, the widening gap between the rich and the poor between urban and rural residents has affected social stability(Huang et al. 2015). In light of this, the China Municipal Government has recently put forth the "Lucid waters and lush mountains are invaluable assets" or "Two Mountains Theory" and argued that there is no absolute conflict between protecting the ecological environment, promoting economic growth, and promoting people's sustained income growth. The transformation of ecological value is conducive to promoting the adjustment and transformation of industrial structure(Zhang et al. 2016), not only increasing residents' income but also optimizing the ecological environment. Predicated on Marx and Engles' division of labor development theorem that accords with the law of Chinese-style modern economy, this paper proposes to investigate the comprehensive comparative advantage of ecological value using the Hunan Province of China as an illustration. It selects 24 indicators from the aspects of green economic growth, carrying capacity of resources, and government green policy, and studies the relationship between green development and common prosperity of urban and rural areas, which not only enhances the theoretical content of green development and common prosperity of urban and rural areas but also provides Hunan Province with specific development ideas to achieve the goal of common prosperity of urban and rural areas.

2. The Internal Mechanism and Realization Mechanism of Ecological Value Transformation Promoting Urban and Rural Common Prosperity

Essentially, ecological value transformation still falls under the category of green economic growth, and labor division is the source of economic growth. The inner mechanism of green development in urban and rural areas to promote commonwealth depends on the evolution of the division of the green, optimization the tax regulation, guiding the capital to the green technology innovation investment, letting the green technology promote production tools, greening of raw material, production process, reduce carbon dioxide, wastewater, waste gas and other emissions of pollutants, within the confines of environmental carrying capacity, efficiency and system optimization technology trading transaction efficiency, increase the reliance on trade between rural and urban areas assist the needy rural population especially to find your place in the vast system of division of labor, promote urban and rural integration to form, will eventually from black to green economic development. Its core concept is to fulfill General Secretary Xi Jinping's call that "green waters and green mountains are gold and silver mountains" so that advantageous green resources in rural areas can be transformed into green products using green technologies, and green products can have a positive external effect, thereby reducing the income gap between urban and rural areas, enhancing the ecological environment, and realizing a beautiful China.

Furthermore, corresponding to the internal mechanism, the green evolution of the division of labor promotes the common prosperity of urban and rural areas predominantly through the following five mechanisms: in the first place, through the specialization development of labor division, the endogenous comparative advantage is highlighted, such that innovation in green technology can enhance production efficiency and thereby expand the economy as a whole. Second, to promote the prosperity of green products through professional diversification of

the division of labor and develop green emerging industries for the purpose of meeting the diversified needs of consumers. Moreover, Green demand further drives green supply and forms a positive green cycle between the supply side and the demand side. Third, the circuitousness of the division of labor to expand the production chain, and stimulate the potential of green investment to become the growing power of the green economy. Fourth, through the organization of the division of labor, for the purpose of enhancing the degree of cooperation between enterprises, social groups, individual farmers, and other market entities, to expand the market scale. Fifth, the government, to establish a fair and equitable market order and a reasonable system of income distribution, finally, achieving the common prosperity of urban and rural areas(Xiang et al. 2022) .

3. Study design

3.1. Establishment of index system

This paper selected the rural-urban income ratio index to reflect the rural-urban wealth gap in Hunan Province . (Wu .2017)Intending to measure the green development level of Hunan Province, consequently, this paper selected 24 indicators from the aspects of green economic growth, resource carrying capacity, as well as government policies, as demonstrated in Table 1(Cai et al. 2017).

Table 1. The evaluation system of green development level indicators in Hunan Province.

One level index	Secondary index	Index name	Direction
Green economic growth A1	GDP per capita	X1	+
	Energy consumption per unit of GDP	X2	-
	Sulfur dioxide emissions per unit of GDP	X3	-
	Labor productivity in the primary industry	X4	+
	Per capita grain output	X5	+
	Labor productivity in the secondary industry	X6	+
	Proportion of employees in the secondary industry	X7	-
	Labor productivity in the tertiary industry	X8	+
	Proportion of employees in the tertiary industry	X9	+
	Proportion of added value of the tertiary industry	X10	+
Resource carrying capacity A2	Local water resources per capita	X11	+
	Park Green Area	X12	+
	Sulfur dioxide emissions per capita	X13	-
	Sulfur dioxide emissions per unit land area	X14	-
	Wastewater discharge per capita	X15	-
	Wastewater discharge per unit land area	X16	-
	Per capita domestic waste	X17	-
Government Policy A3	The proportion of spending on environmental protection in government spending	X18	+
	The proportion of spending on science, education, culture and health in government expenditures	X19	+
	Green coverage rate in built-up areas	X20	+
	Per capita number of public transport vehicles in operation	X21	+
	Investment in waste water treatment project completed	X22	+
	Investment in waste gas control project completed	X23	+
	Investment in solid waste treatment project completed	X24	+

3.2. Data Sources

This paper selected index data from the China Statistical Yearbook and Hunan Statistical Yearbook from 2008 to 2017 to illustrate the level of green development and the disparity between urban and rural wealth in Hunan Province, as indicated in Tables 2 and 3.

Table 2. Indicator data of green development level in Hunan Province.

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
X1	18140	20428	24719	29880	33280	36943	40271	42745	46382	49558
X2	1.23	1.20	1.17	0.89	0.83	0.79	0.74	0.69	0.65	0.62
X3	6.76	5.76	4.57	3.22	2.70	2.43	2.15	1.92	1.02	0.59
X4	0.27	0.27	0.30	0.35	0.37	0.36	0.37	0.38	0.40	0.41
X5	443.22	458.13	444.14	453.23	462.69	448.54	458.59	457.72	448.70	449.29
X6	0.74	0.83	1.05	1.33	1.48	1.64	1.76	1.80	1.82	1.94
X7	22.4	22.8	23.0	23.3	23.6	23.9	23.7	23.5	23.3	22.8
X8	0.68	0.79	0.90	1.06	1.21	1.42	1.59	1.77	2.00	2.30
X9	33.60	34.20	34.60	34.80	34.90	35.10	35.50	35.80	36.20	37.50
X10	40.26	41.61	40.02	38.70	39.44	41.39	42.70	44.76	47.37	49.43
X11	2512.76	2190.63	2938.70	1711.93	3005.68	2373.56	2680.11	2839.14	3229.11	2795.46
X12	0.55	0.61	0.68	0.74	0.93	0.90	0.96	1.01	1.20	1.26
X13	122.71	117.61	113.03	96.07	89.83	89.73	86.60	82.22	47.38	29.41
X14	3.97	3.83	3.78	3.24	3.05	3.03	2.94	2.81	1.64	1.01
X15	36.82	36.28	36.71	37.57	38.83	42.56	42.66	42.80	42.92	40.95
X16	1.19	1.18	1.23	1.27	1.32	1.44	1.45	1.46	1.48	1.41
X17	0.08	0.07	0.07	0.07	0.08	0.09	0.08	0.09	0.09	0.10
X18	2.36	3.33	3.36	2.42	2.66	2.74	2.74	2.60	2.70	2.52
X19	25.54	26.22	24.36	25.12	29.24	27.21	27.80	27.93	28.25	28.26
X20	35.8	36.6	36.6	36.8	37.0	37.6	38.6	39.7	40.6	41.2
X21	1.69	1.70	1.74	1.77	1.83	1.96	2.19	2.40	2.65	2.89
X22	58309	66315	59248	50215	48312	53022	23655	35689	31960	14036
X23	73366	58965	63845	31816	78513	143636	133227	126053	81056	66139
X24	6901	5375	11222	8853	4157	3764	3605	2056	93	212

Table 3. Indicator data of green development level in Hunan Province.

time	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Urban-rural income ratio	3.06	3.07	2.95	2.87	2.87	2.70	2.64	2.62	2.62	2.62

4. Empirical analysis

4.1. Evaluation of the green development level of Hunan Province

4.1.1. Data standardization

In this paper, the entropy method is employed to evaluate the green development level of Hunan Province and standardize the data(Qin and Hu 2017) , as indicated in Table 4.

Table 4. Data standardization results.

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
X1	0.00	0.07	0.21	0.37	0.48	0.60	0.70	0.78	0.90	1.00
X2	0.00	0.05	0.10	0.56	0.66	0.72	0.80	0.88	0.94	1.00
X3	0.00	0.16	0.36	0.58	0.66	0.70	0.75	0.78	0.93	1.00
X4	0.00	0.03	0.26	0.59	0.73	0.67	0.72	0.78	0.91	1.00
X5	0.00	0.77	0.05	0.51	1.00	0.27	0.79	0.74	0.28	0.31
X6	1.00	0.92	0.74	0.51	0.38	0.25	0.15	0.12	0.10	0.00

X7	1.00	0.73	0.60	0.40	0.20	0.00	0.13	0.27	0.40	0.73
X8	0.00	0.07	0.14	0.24	0.33	0.45	0.56	0.67	0.82	1.00
X9	0.00	0.15	0.26	0.31	0.33	0.38	0.49	0.56	0.67	1.00
X10	0.15	0.27	0.12	0.00	0.07	0.25	0.37	0.56	0.81	1.00
X11	0.53	0.32	0.81	0.00	0.85	0.44	0.64	0.74	1.00	0.71
X12	0.00	0.08	0.18	0.27	0.54	0.49	0.58	0.65	0.92	1.00
X13	0.00	0.05	0.10	0.29	0.35	0.35	0.39	0.43	0.81	1.00
X14	0.00	0.05	0.06	0.25	0.31	0.32	0.35	0.39	0.79	1.00
X15	0.92	1.00	0.93	0.80	0.62	0.05	0.04	0.02	0.00	0.30
X16	0.97	1.00	0.84	0.72	0.55	0.16	0.11	0.07	0.00	0.24
X17	0.76	0.91	1.00	0.90	0.78	0.55	0.64	0.50	0.35	0.00
X18	0.00	0.97	1.00	0.06	0.29	0.38	0.38	0.24	0.33	0.16
X19	0.24	0.38	0.00	0.16	1.00	0.58	0.71	0.73	0.80	0.80
X20	0.00	0.15	0.15	0.19	0.22	0.33	0.52	0.72	0.89	1.00
X21	0.00	0.01	0.04	0.06	0.12	0.23	0.42	0.59	0.80	1.00
X22	0.85	1.00	0.86	0.69	0.66	0.75	0.18	0.41	0.34	0.00
X23	0.37	0.24	0.29	0.00	0.42	1.00	0.91	0.84	0.44	0.31
X24	0.61	0.47	1.00	0.79	0.37	0.33	0.32	0.18	0.00	0.01

4.1.2. Calculation of index weight

Using the formula $P_{ij} = \frac{x'_{ij}}{\sum x'_{ij}}$ (j=1，2，...n) The proportion of sample i in index j is calculated to obtain P_{ij}. The results are demonstrated in Table 5.

Table 5. Index specific gravity P_{ij}.

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
X1	0.05	0.06	0.07	0.09	0.10	0.11	0.12	0.12	0.14	0.14
X2	0.14	0.14	0.13	0.10	0.09	0.09	0.08	0.08	0.07	0.07
X3	0.22	0.18	0.15	0.10	0.09	0.08	0.07	0.06	0.03	0.02
X4	0.08	0.08	0.09	0.10	0.11	0.10	0.11	0.11	0.11	0.12
X5	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
X6	0.05	0.06	0.07	0.09	0.10	0.11	0.12	0.13	0.13	0.13
X7	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
X8	0.05	0.06	0.07	0.08	0.09	0.10	0.12	0.13	0.15	0.17
X9	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.11
X10	0.09	0.10	0.09	0.09	0.09	0.10	0.10	0.11	0.11	0.12
X11	0.10	0.08	0.11	0.07	0.11	0.09	0.10	0.11	0.12	0.11
X12	0.06	0.07	0.08	0.08	0.11	0.10	0.11	0.11	0.14	0.14
X13	0.14	0.13	0.13	0.11	0.10	0.10	0.10	0.09	0.05	0.03
X14	0.14	0.13	0.13	0.11	0.10	0.10	0.10	0.10	0.06	0.03
X15	0.09	0.09	0.09	0.09	0.10	0.11	0.11	0.11	0.11	0.10
X16	0.09	0.09	0.09	0.09	0.10	0.11	0.11	0.11	0.11	0.11
X17	0.10	0.09	0.09	0.09	0.09	0.10	0.10	0.11	0.11	0.13
X18	0.09	0.12	0.12	0.09	0.10	0.10	0.10	0.09	0.10	0.09
X19	0.09	0.10	0.09	0.09	0.11	0.10	0.10	0.10	0.10	0.10
X20	0.09	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.11	0.11
X21	0.08	0.08	0.08	0.08	0.09	0.09	0.11	0.12	0.13	0.14
X22	0.13	0.15	0.13	0.11	0.11	0.12	0.05	0.08	0.07	0.03
X23	0.09	0.07	0.07	0.04	0.09	0.17	0.16	0.15	0.09	0.08
X24	0.15	0.12	0.24	0.19	0.09	0.08	0.08	0.04	0.00	0.00

4.1.3. Calculation of index entropy and weight

Employ the following formula to calculate the entropy value of the j index.

$$e_j = -k\sum_{i=1}^{m} P_{ij}\ln(P_{ij}) \tag{1}$$

Among them k>0,

$$k = \frac{1}{\ln(m)} \tag{2}$$

The result of calculating the difference coefficient of item j is indicated in Table 6.

$$g_j = 1 - e_j \tag{3}$$

Table 6. Indicator difference coefficient.

X1	X2	X3	X4	X5	X6	X7	X8
0.0205	0.0135	0.0813	0.0044	0.0000	0.0191	0.0001	0.0303
X9	X10	X11	X12	X13	X14	X15	X16
0.0002	0.0013	0.0059	0.0144	0.0259	0.0238	0.0010	0.0016
X17	X18	X19	X20	X21	X22	X23	X24
0.0028	0.0029	0.0007	0.0005	0.0080	0.0326	0.0353	0.1360

The following formula is adopted to calculate the weight of green development level indicators, and the results are displayed in Table7.

$$W_j = \frac{g_j}{\sum_{i=1}^{n} g_j} \tag{4}$$

Table 7. Index weights.

X1	X2	X3	X4	X5	X6	X7	X8
0.0443	0.0292	0.1758	0.0096	0.0001	0.0413	0.0002	0.0656
X9	X10	X11	X12	X13	X14	X15	X16
0.0004	0.0029	0.0128	0.0312	0.0560	0.0516	0.0022	0.0034
X9	X10	X11	X12	X13	X14	X15	X16
0.0004	0.0029	0.0128	0.0312	0.0560	0.0516	0.0022	0.0034

4.1.4. Calculate the comprehensive score

The green development level of Hunan Province from 2008 to 2017 is calculated in accordance with the following formula(Wang and Wu 2018), as indicated in Tables 8 and 9.

$$S_i = \sum_{j=1}^{n} P_{ij} \times W_j \tag{5}$$

Table 8. The score of the green development level index in Hunan Province.

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
X1	0.0000	0.0015	0.0043	0.0076	0.0099	0.0122	0.0144	0.0160	0.0184	0.0205
X2	0.0000	0.0007	0.0013	0.0075	0.0088	0.0097	0.0108	0.0119	0.0127	0.0135
X3	0.0000	0.0133	0.0289	0.0467	0.0535	0.0571	0.0608	0.0637	0.0756	0.0813
X4	0.0000	0.0001	0.0012	0.0026	0.0032	0.0030	0.0032	0.0035	0.0040	0.0044
X5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
X6	0.0191	0.0176	0.0142	0.0097	0.0073	0.0047	0.0028	0.0022	0.0018	0.0000
X7	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
X8	0.0000	0.0020	0.0042	0.0071	0.0099	0.0138	0.0170	0.0204	0.0247	0.0303
X9	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002
X10	0.0002	0.0004	0.0002	0.0000	0.0001	0.0003	0.0005	0.0008	0.0011	0.0013

X11	0.0031	0.0019	0.0048	0.0000	0.0050	0.0026	0.0038	0.0044	0.0059	0.0042
X12	0.0000	0.0012	0.0026	0.0039	0.0077	0.0071	0.0083	0.0093	0.0132	0.0144
X13	0.0000	0.0014	0.0027	0.0074	0.0091	0.0091	0.0100	0.0112	0.0209	0.0259
X14	0.0000	0.0011	0.0015	0.0059	0.0074	0.0076	0.0082	0.0093	0.0188	0.0238
X15	0.0009	0.0010	0.0009	0.0008	0.0006	0.0001	0.0000	0.0000	0.0000	0.0003
X16	0.0015	0.0016	0.0013	0.0011	0.0009	0.0002	0.0002	0.0001	0.0000	0.0004
X17	0.0022	0.0026	0.0028	0.0026	0.0022	0.0016	0.0018	0.0014	0.0010	0.0000
X18	0.0000	0.0029	0.0029	0.0002	0.0009	0.0011	0.0011	0.0007	0.0010	0.0005
X19	0.0002	0.0003	0.0000	0.0001	0.0007	0.0004	0.0005	0.0005	0.0006	0.0006
X20	0.0000	0.0001	0.0001	0.0001	0.0001	0.0002	0.0002	0.0003	0.0004	0.0005
X21	0.0000	0.0001	0.0003	0.0005	0.0010	0.0018	0.0033	0.0048	0.0064	0.0080
X22	0.0276	0.0326	0.0282	0.0226	0.0214	0.0243	0.0060	0.0135	0.0112	0.0000
X23	0.0131	0.0086	0.0101	0.0000	0.0148	0.0353	0.0320	0.0298	0.0156	0.0108
X24	0.0832	0.0645	0.1360	0.1070	0.0497	0.0449	0.0429	0.0240	0.0000	0.0015

Table 9. The comprehensive score of green development level in Hunan Province.

	A1	A2	A3	Composite scores
2008	0.0194	0.0077	0.1241	0.1512
2009	0.0357	0.0107	0.1090	0.1554
2010	0.0543	0.0167	0.1777	0.2486
2011	0.0815	0.0216	0.1305	0.2336
2012	0.0929	0.0330	0.0884	0.2143
2013	0.1010	0.0283	0.1080	0.2372
2014	0.1097	0.0324	0.0861	0.2282
2015	0.1187	0.0358	0.0736	0.2280
2016	0.1386	0.0598	0.0351	0.2335
2017	0.1516	0.0690	0.0218	0.2424

From 2008 to 2017, the comprehensive score of Hunan's green development level rose from 0.1512 to 0.2424, indicating that Hunan's green economy is on the rise. Nonetheless, the green development level of Hunan Province is not high, with the highest score of 0.2486 in 2010. The greening of economic growth in Hunan Province takes a large proportion in the comprehensive score and is in an expanding trend, whereas the proportion of carrying capacity to total resources is modest., the importance of resource carrying capacity is becoming increasingly prominent, as well as the proportion of government policies is in a declining trend, which requires improvement (Liu et al. 2018).

4.2. Correlation analysis

The correlation analysis between the level of green development and the rural-urban income ratio in Hunan Province from 2008 to 2017 was conducted(Xiong et al. 2019) . The results are demonstrated in Table 10.

Table 10. Correlation analysis.

	A1	A2	A3	Composite scores	Urban-rural income ratio
A1	1.000				
A2	0.935	1.000			
A3	-0.796	-0.874	1.000		
Composite scores	0.725	0.580	-0.172	1.000	
Urban-rural income ratio	-0.983	-0.967	0.886	-0.605	1.000

There is a -0.605 correlation between the rural-urban income ratio and the level of green development in Hunan Province, a -0.983 correlation between the rural-urban income ratio and the greening of economic growth, a 0.967 correlation between the rural-urban income ratio and the resource carrying capacity, and a 0.886 correlation between the rural-urban income ratio and the resource carrying capacity. The greening of economic

growth and the improvement of resource-carrying capacity can effectively reduce the rural-urban income ratio and promote the common prosperity of urban and rural areas.

5. Conclusion

In conclusion, developing a green economy through the transformation of ecological value can enhance the level of green development, provide assistance to narrow the gap between the rich and the poor in urban and rural areas, and achieve common prosperity in urban and rural areas. And conclude with the following policy recommendations:

(1) Preserving a fair and just market order is necessary for the realization of the green evolution of labor division. Specifically, it is to ensure the fair sharing of ecological resources and the fair distribution of the results of value transformation. For instance, the first, second, and third distributions' income distribution adjustment systems must be optimized.

(2) The government should create conditions for the green evolution of the division of labor, implement strict carbon tax regulations, give full play to the positive externalities of green products, increase investments in environmentally responsible innovation, actively cultivate new economic growth points characterized by low-carbon emissions, pay attention to adjusting and transforming traditional industries and developing new industries including new energy, energy conservation, and environmental protection, focus on encouraging the greening of production, circulation, distribution, and consumption, guide green investment and financing to green industries and assist traditional industries, namely, traditional agriculture upgrade and transform.

(3) Establish and enhance institutional mechanisms conducive to green development. For instance, indicators related to green development including resource utilization, environmental governance, as well as environmental quality should be added to the evaluation of government performance at all levels. Evaluate, influence, and restrict local government's policy choices with green performance.

(4) Whereas greening the supply side, we must develop the notion of ecological civilization., guide the greening of the demand side, incorporate simplicity and moderation and environmental ethics into the public order and good customs of social operation, consider the carrying capacity of resources and the capacity of the ecological environment as essential conditions for economic activities., guide the public to consciously choose green consumption behavior, as well as promote the green transformation of lifestyle.

Funding Statement

This research was funded by Scientific Research Project of Hunan Provincial Department of Education “Realization Path and Effect Measurement of Ecological Value Transformation to Promote Urban and Rural Common Prosperity", grant number 22B1102.

Acknowledgments

Thanks to the Hunan Provincial Department of Education and the Department of Economics and Management of Changsha Normal University for their scientific research support.

Conflict of interest

All authors promise that the manuscript is completely original, and that there is no actual or potential conflict of interest between the research results and any institution, organization or organ.

Author contributions

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