The input-output analysis for the wholesale and retail trade industry of the Kazakhstan statistics

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Abstract. In this paper has been studied a two-sector input-output model between Wholesale and retail trade industry and Rest of economics. Here, the distribution of the total Input transactions between supply agents of Produce / selling, Gross value added and Import and the distribution of the total Output transactions between Purchase / buying, Final demand and Export consumer agents of the wholesale and retail trade industry create overheating and cooling uncertainty problems of national economy and problems of moderate and critical management of national economy. Particularly identified, – the convergence phase for Produce / selling transactions from 0.577 (or 14.89%) in 1995 to 3.849 U.S. billion dollars (or 14.29%) in 2011 to the state of Equilibrium growth and the divergence phase from 3.779 (or 14.11%) in 2012 to 0.569 U.S. billion dollars (or 3.10%) in 2018 from the state of Equilibrium growth, and also in accordance with the rules of "three sigma" from 24 years of observation in 20 years they were in the cooling zone of the economy beyond the level of critical manageability for flows and for the structure Produce / selling transactions of wholesale and retail trade industry of Kazakhstan economy. Keywords: Wholesale and retail trade, produce / selling, purchase / buying, gross value added, final demand, imports, exports, transactions, input-output analysis.

1 Introduction

The problems of input-output analysis have been studied by many scientists from all over the world for many years [1,2], the most recent work is given in the following literature review.

In today, it is known to forest industry participants that Canada, Brazil, Indonesia and other countries of hardwood forests are the main producers, and the USA, China, Germany and other developed countries are the main consumer countries. Within this trade network, deforestation has become a global issue today, and global initiatives and national policies to reduce deforestation are widespread. However, it is clear to all market participants that existing measures ignore the different roles countries play in the trade chain and pay little attention to indirect deforestation and consumer responsibility. Therefore, in order to determine the deforestation responsibilities of the above producers and consumers and to determine the role and interrelationships of these countries in the trade system, this study

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uses input-output analysis and a complex network approach to find the main producers and consumers of deforestation was studied in the article [3]. As a result, these studies show that these countries have the highest degree of dominance, power and centrality in online trading activities. Also, the network exhibits a small-world nature and heterogeneity that reflects the network's close connectivity and key roles of key nodes. This analysis provides findings that can help policymakers more effectively address deforestation around the world by showing resource flows to and from key economies that have previously been overlooked.

In this article [4] using input-output tables, the features of industrial sectors of Kazakhstan in 2012-2017 within the framework of the Total Factor Productivity (TFP) are considered. Indeed, the interrelationship of industries reflects the demand for input and supply as the level of production in the economy. In particular, the change in the total volume of industrial production is divided into two parts: it is implemented by the change in the technical coefficients of intermediate incomes and by the change in the added value, respectively. That is, the main conclusions of the article were developed by determining the pattern of changes in inter-industry indicators. In addition, the results showed that the productivity of various sectors, such as oil, manufacturing, construction and food processing sectors, is increasing. The economic development of the country is highly dependent on the manufacturing industries, the main reason for which is still good indicators of added value in production. It was also shown that development can achieve sustainable economic growth in the long term through diversification of the national economy and innovative measures. If there are barriers to this, it can only come from challenges like COVID-19 and climate change, and these challenges can be met by developing human capital and diversity.

2 Methods, models, data

To promotion of input-output analysis of wholesale and retail trade industry of the Kazakhstan statistics, we use the following methods, models and data:

Let we have the following notation systems to purchase/buying transactions, which are taken from [2]:

– $Z_1 \stackrel{\text{def}}{=} \begin{bmatrix} z_{11} & 0 \\ z_{r1} & 0 \end{bmatrix}$ is a value of purchases by the Wholesale and retail trade $(\cdot)_1$ of products from all industries of the economy $(\cdot)_1$-$(\cdot)_r$, in particular $Z_1 = \begin{bmatrix} 1.10 & 0 \\ 6.31 & 0 \end{bmatrix}$, U.S. billion dollars (see Table 1, column Z_1);

– $Z_r \stackrel{\text{def}}{=} \begin{bmatrix} 0 & z_{1r} \\ 0 & z_{rr} \end{bmatrix}$ is a value of purchases by the Rest of economics $(\cdot)_r$ of products from all industries of the economy $(\cdot)_1$-$(\cdot)_r$, in particular $Z_r = \begin{bmatrix} 0 & 9.95 \\ 0 & 55.00 \end{bmatrix}$, U.S. billion dollars (see Table 1, column Z_r);

– $Z \stackrel{\text{def}}{=} Z_1 + Z_r = \begin{bmatrix} z_{11} & z_{1r} \\ z_{r1} & z_{rr} \end{bmatrix}$ is a 2×2 matrix of value of sum purchases by the Wholesale and retail trade $(\cdot)_1$ and the Rest of economics $(\cdot)_r$ of products from all industries of the economy $(\cdot)_1$-$(\cdot)_r$, in particular $Z = \begin{bmatrix} 1.10 & 9.95 \\ 6.31 & 55.00 \end{bmatrix}$, U.S. billion dollars (see Table 1, matrix Z);

– $f_d \stackrel{\text{def}}{=} \begin{bmatrix} f_{1d} & 0 \\ f_{rd} & 0 \end{bmatrix}$ is value of Final demand to products from all industries of the economy $(\cdot)_1$-$(\cdot)_r$, in particular $f_d = \begin{bmatrix} 9.27 & 0 \\ 76.95 & 0 \end{bmatrix}$, U.S. billion dollars (see Table 1, column f_d);

– $f_e \overset{\text{def}}{=} \begin{bmatrix} 0 & f_{1e} \\ 0 & f_{re} \end{bmatrix}$ is a value of Export purchases by the rest of world products to products from all industries of the economy $(\cdot)_1$-$(\cdot)_r$, in particular $f_e = \begin{bmatrix} 0 & 5.55 \\ 0 & 37.35 \end{bmatrix}$, U.S. billion dollars (see Table 1, column f_e);

– $f \overset{\text{def}}{=} f_d + f_e = \begin{bmatrix} f_{1d} & f_{1e} \\ f_{rd} & f_{re} \end{bmatrix}$ is a sum purchases by the Final demand and Exports to products from all industries of the economy $(\cdot)_1$-$(\cdot)_r$, in particular $f = \begin{bmatrix} 9.27 & 5.55 \\ 76.95 & 37.35 \end{bmatrix}$, U.S. billion dollars (see Table 1, matrix f);

– $x \overset{\text{def}}{=} \begin{bmatrix} x_1 \\ x_r \end{bmatrix}$ is a value of Output to products from all industries of the economy $(\cdot)_1$-$(\cdot)_r$, in particular $x = \begin{bmatrix} 25.87 \\ 175.62 \end{bmatrix}$, U.S. billion dollars (see Table 1, column x);

– i $\overset{\text{def}}{=} \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ is a vector 2×1 column consisting of elements 1.

Then there is a system of flows identities between purchase / buying transactions according to the input-output table [2]:

$$\begin{aligned} x_1 &= z_{11} + z_{1r} + f_{1d} + f_{1e}, \\ x_r &= z_{r1} + z_{rr} + f_{rd} + f_{re}, \end{aligned} \tag{1}$$

or in matrix form

$$x = Z\mathrm{i} + f\mathrm{i}. \tag{2}$$

Also let we have the following notation systems to produce / selling transactions, which are taken from [2]:

– $Z'_1 \overset{\text{def}}{=} \begin{bmatrix} z'_{11} & z'_{1r} \\ 0 & 0 \end{bmatrix}$ is a value of produces by the Wholesale and retail trade $(\cdot)_1$ products selling to all industries of the economy $(\cdot)_1$-$(\cdot)_r$, in particular $Z'_1 = \begin{bmatrix} 1.10 & 9.95 \\ 0 & 0 \end{bmatrix}$, U.S. billion dollars (see Table 1, row Z'_1);

– $Z'_r \overset{\text{def}}{=} \begin{bmatrix} 0 & 0 \\ z'_{r1} & z'_{rr} \end{bmatrix}$ is a value of produces by the Rest of economics $(\cdot)_r$ products selling to all industries of the economy $(\cdot)_1$-$(\cdot)_r$, in particular $Z'_r = \begin{bmatrix} 0 & 0 \\ 6.31 & 55.00 \end{bmatrix}$, U.S. billion dollars (see Table 1, row Z'_r);

– $Z' \overset{\text{def}}{=} Z'_1 + Z'_r = \begin{bmatrix} z'_{11} & z'_{1r} \\ z'_{r1} & z'_{rr} \end{bmatrix}$ is a sum produces by the Wholesale and retail trade $(\cdot)_1$ and the Rest of economics $(\cdot)_r$ products selling to all industries of the economy $(\cdot)_1$-$(\cdot)_r$, in particular $Z' = \begin{bmatrix} 1.10 & 9.95 \\ 6.31 & 55.00 \end{bmatrix}$, U.S. billion dollars (see Table 1, matrix Z');

– $\varepsilon'_v \overset{\text{def}}{=} \begin{bmatrix} \varepsilon'_{v1} & \varepsilon'_{vr} \\ 0 & 0 \end{bmatrix}$ is a Gross value added of produces by the Wholesale and retail trade $(\cdot)_1$ and the Rest of economics $(\cdot)_r$ products selling to all industries of the economy $(\cdot)_1$-$(\cdot)_r$, in particular $\varepsilon'_v = \begin{bmatrix} 15.05 & 82.57 \\ 0 & 0 \end{bmatrix}$, U.S. billion dollars (see Table 1, row ε'_v);

– $\varepsilon'_m \overset{\text{def}}{=} \begin{bmatrix} 0 & 0 \\ \varepsilon'_{m1} & \varepsilon'_{mr} \end{bmatrix}$ is Imports of produces by the rest of world products selling to all industries of the economy $(\cdot)_1$-$(\cdot)_r$, in particular $\varepsilon'_m = \begin{bmatrix} 0 & 0 \\ 3.41 & 28.10 \end{bmatrix}$, U.S. billion dollars (see Table 1, row ε'_m);

– $\varepsilon' \stackrel{\text{def}}{=} \varepsilon'_v + \varepsilon'_m = \begin{bmatrix} \varepsilon'_{v1} & \varepsilon'_{vr} \\ \varepsilon'_{m1} & \varepsilon'_{mr} \end{bmatrix}$ is a sum of Gross value added and Imports of produces by the rest of world products selling to all industries of the economy $(\cdot)_1$-$(\cdot)_r$, in particular $\varepsilon' = \begin{bmatrix} 15.05 & 82.57 \\ 3.41 & 28.10 \end{bmatrix}$, U.S. billion dollars (see Table 1, matrix ε');

– $x' \stackrel{\text{def}}{=} [x'_1\ x'_r]$ is a value of Input products selling to all industries of the economy $(\cdot)_1$-$(\cdot)_r$, in particular $x' = [25.87\ 175.62]$, U.S. billion dollars (see Table 1, row x');

– $\mathrm{i}' = [1\ 1]$ is a vector 1×2 row consisting of elements 1.

Then there is a system of flows identities between the produce / selling transactions according to the input-output table [2]:

$$\begin{aligned} x'_1 &= z_{11} + z_{r1} + \varepsilon'_{v1} + \varepsilon'_{m1}, \\ x'_r &= z_{1r} + z_{rr} + \varepsilon'_{vr} + \varepsilon'_{mr}, \end{aligned} \tag{3}$$

or in matrix form

$$x' = \mathrm{i}'Z' + \mathrm{i}'\varepsilon', \tag{4}$$

and the corresponding input-output table with numerical values is placed in Table 1.

Table 1. The input-output table of mean transactions at 1995-2018 for Wholesale and retail trade $(\cdot)_1$ and Rest of economics $(\cdot)_r$ of Kazakhstan statistics, U.S. billion dollars, compiled from source OECD report [5].

	Z_1	Z_r	Σz	f_d	f_e	Σf	x
Z'_1	1.10	9.95	11.05	9.27	5.55	14.82	25.87
Z'_r	6.31	55.00	61.31	76.95	37.35	114.30	175.62
$\Sigma z'$	7.41	64.95	72.36	86.22	42.90	129.13	201.48
ε'_v	15.05	82.57	97.62				
ε'_m	3.41	28.10	31.51				
$\Sigma\varepsilon'$	18.46	110.67	129.13				
x'	25.87	175.62	201.48				

3 Results

It is known that according to the model of W. Leontiev [1], the total Input transactions will be distributed among supply agents: Produce / selling, Gross value added and Import transactions, as well as the total Output transactions will be distributed among consumer agents: Purchase / buying, Final demand and Export transactions. Then, to ensure the equilibrium, balance and optimality of these transactions, the following results are obtained.

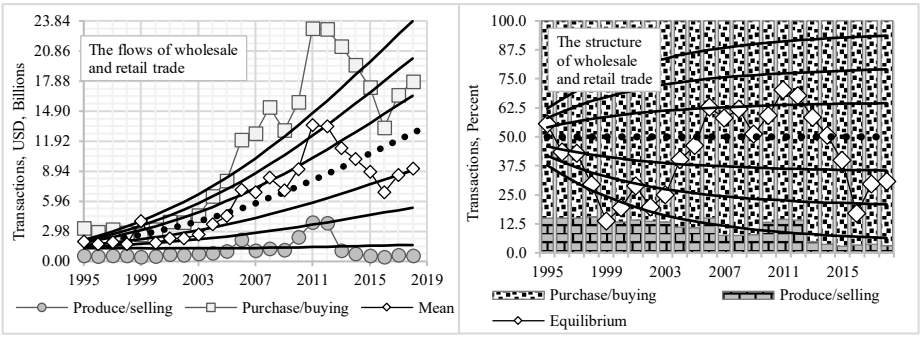
3.1 The Produce / selling and Purchase / buying transactions analysis

The behavioral characteristics of Produce / selling and Purchase / buying transactions have the following features, in particular:

– the convergence phase for Produce / selling transactions from 0.577 (or 14.89%) in 1995 to 3.849 U.S. billion dollars (or 14.29%) in 2011 to the state of Equilibrium growth and the divergence phase from 3.779 (or 14.11%) in 2012 to 0.569 U.S. billion dollars (or 3.10%) in 2018 from the state of Equilibrium growth, and also in accordance with the rules of "three sigma" from 24 years of observation in 20 years they were in the cooling zone of the economy beyond the level of critical manageability for flows (see Fig. 1. (a), graph with round markers)

and for the structure Produce / selling transactions of wholesale and retail trade industry (see Fig. 1. (b), histogram with accumulated sum);

– the divergence phase for Purchase / buying transactions from 3.299 (or 85.11%) in 1995 to 23.090 U.S. billion dollars (or 85.71%) in 2011 from the state of Equilibrium growth and convergence phase from 23.003 (or 85.89%) in 2012 to 17.807 U.S. billion dollars (or 96.90%) in 2018 to the state of Equilibrium growth, and in accordance with the rules of "three sigma" from 24 years of observation in 12 years, they were in the zone of overheating of the economy beyond the level of critical manageability for flows (see Fig. 1. (a), graph with square markers) and for the structure Purchase / buying transactions of wholesale and retail trade industry Kazakhstan economy (see Fig. 1. (b), histogram with accumulated sum).



(a) (b)

Fig. 1. The Produce / selling and Purchase / buying transactions for flows (a) and structures (b) of wholesale and retail trade industry.

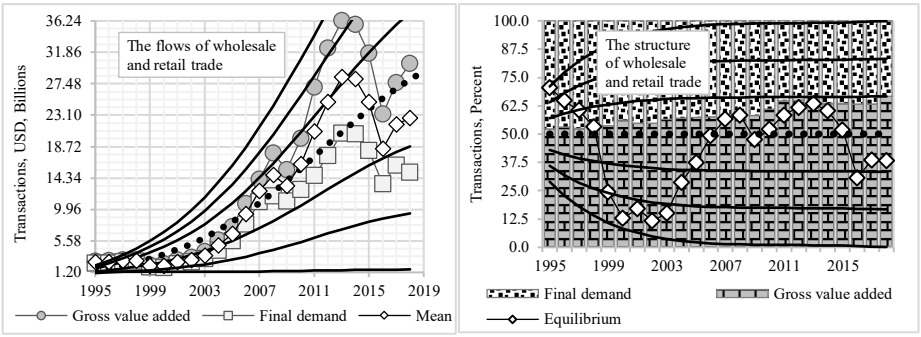
3.2 The Gross value added and Final demand transactions analysis

The behavioral characteristics of Gross value added and Final demand transactions have the following features, in particular:

– the 1st phase of the convergence for Gross value added transactions from 2.704 (or 52.14%) in 1995 to 2.213 U.S. billion dollars (or 53.71%) in 1999 to the state of Equilibrium growth and the 1st phase of the divergence from 2.387 (or 56.19%) in 2000 to 19.839 U.S. billion dollars (or 60.98%) in 2010 from the state of Equilibrium growth, then the 2nd phase of convergence for flows of Gross value added transactions from 26.986 (or 64.79%) in 2011 to 31.707 U.S. billion dollars in 2015 to the state of Equilibrium growth and the 2nd phase of the divergence from 23.237 (or 63.24%) in 2016 to 30.304 U.S. billion dollars (or 66.72%) in 2018 from the state of Equilibrium growth, as well as in accordance with the rules of "three sigma" from 24 years of observation in 4 years they were in the overheating zone at the level of critical controllability and 4 years in the cooling zone economy at the level of moderate manageability, and the rest of the years both for flows (see Fig. 2. (a), graph with round markers) and for the Gross value added transactions structure (see Fig. 2. (b), histogram with accumulated sum) were in the Equilibrium growth zone of the wholesale and retail trade industry of Kazakhstan economy;

– the 1st phase of convergence for flows of Final demand transactions from 2.482 (or 47.86%) in 1995 to 2.712 U.S. billion dollars (or 48.42%) in 1998 to the state of Equilibrium growth and the 1st phase of the divergence from 1.907 (or 46.29%) in 1999 to 4.253 U.S. billion dollars (or 42.83%) in 2004 from the state of Equilibrium growth, then the 2nd phase of convergence for flows of Final demand transactions from 5.611 (or 42.72%) in 2005 to 18.136 U.S. billion dollars (or 36.39%) in 2015 to the state of Equilibrium growth and the 2nd phase of the divergence from 13.508 (or 36.76%) in 2016 to 15.119 U.S. billion dollars

(or 33.28%) in 2018 from the state of Equilibrium growth, as well as in accordance with the rules of "three sigma" from 24 years of observation in 2 years they were in the overheating zone at the level of moderate manageability and 9 years in the cooling zone economy at the level of moderate manageability, and the remaining 13 years both for flows (see Fig. 2. (a), graph with square markers) and for the structure of Final demand transactions (see Fig. 2. (b), histogram with accumulated sum) were in the Equilibrium growth zone of the wholesale and retail trade industry of Kazakhstan economy.



(a) (b)

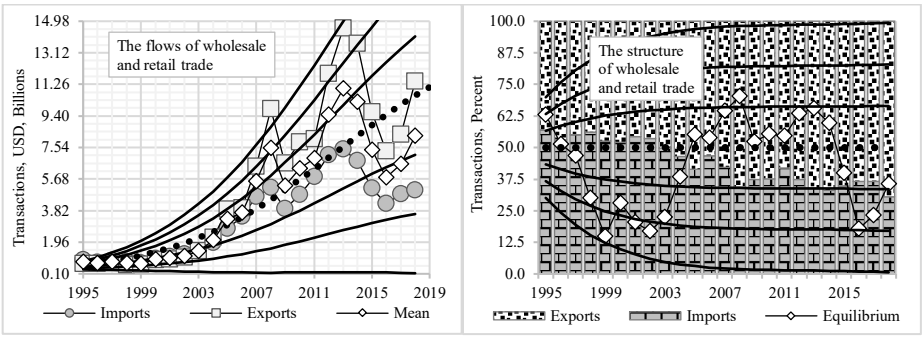
Fig. 2. The Gross value added and Final demand transactions for flows (a) and structures (b) of wholesale and retail trade industry.

3.3 The Import and Export transactions analysis

The behavioral characteristics of Import and Export transactions have the following features, in particular:

– the 1st phase of convergence for flows of Import transactions from 0.912 (or 56.84%) in 1995 to 0.865 U.S. billion dollars (or 55.00%) in 1997 to the state of Equilibrium growth and the 1st phase of the divergence from 0.793 (or 56.01%) in 1998 to 1.427 U.S. billion dollars (or 49.91%) in 2003 from the state of Equilibrium growth, then the 2nd phase of convergence for flows of Import transactions from 1.938 (or 46.41%) in 2004 to 6.758 U.S. billion dollars (or 33.11%) in 2014 to the state of Equilibrium growth and the 2nd phase of the divergence from 5.136 (or 34.82%) in 2015 to 5.011 U.S. billion dollars (or 30.49%) in 2018 to the state of Equilibrium growth, as well as in accordance with the rules of "three sigma" out of 24 years of observation, in 2 years they were in the overheating zone at the level of critical controllability and 7 years in the cooling zone economy at the level of moderate manageability, and the remaining 15 years both for flows (see Fig. 3. (a), graph with round markers) and for the structure of Import transactions (see Fig. 3. (b), histogram with accumulated sum) were in the Equilibrium growth zone of the wholesale and retail trade industry of Kazakhstan economy;

– the phase of divergence for flows of Export transactions from 0.693 (or 43.16%) in 1995 to 14.564 U.S. billion dollars (or 14.29%) in 2013 from the state of Equilibrium growth and phase of convergence from 13.652 (or 66.89%) in 2014 to 11.425 U.S. billion dollars (or 69.51%) in 2018 to the state of Equilibrium growth, as well as in accordance with the rules of "three sigma" from 24 years of observation in 6 years they were in the overheating zone at the level of critical and 3 years of moderate manageability, then and 4 years in the cooling zone of the economy at the level of moderate manageability, and the remaining 11 years both for flows (see Fig. 3. (a), graph with square markers) and for the structure of Export transactions (see Fig. 3. (b), histogram with accumulated sum) were in the Equilibrium growth zone of the wholesale and retail trade industry of Kazakhstan economy.



(a) (b)

Fig. 3. The Import and Export transactions for flows (a) and structures (b) of wholesale and retail trade industry.

4 Discussions

Today, in many different areas of business and society development, there is an active implementation of the results of intelligent information technologies obtained through the implementation of system solutions on input-output analysis models. As a subject of discussion, we present a few of them in the following.

Recently, there has been an increase in global economic costs due to cyber-attacks. However, research on the economic damage caused by cyber-attacks has mainly focused on the companies that have been attacked, and the spillover damage to other sectors has not been sufficiently explored in the scientific literature. In this context, [6] study analyzed economic costs from cyber-attacks in Japan using production function and input-output model to improve damage prediction accuracy and various national measures. First, the article developed a method for estimating annual direct losses by industry using a production function. That is, a key revenue data set loses uptime due to cyber incidents. Second, a model was developed to estimate the amount of damage spread across the country using the input-output model. Third, although the data on cyber damage was limited to interview data from the Japan Network Security Association (JNSA) and the Information Technology Promotion Agency (IPA), the study was able to demonstrate the process of direct and spillover damage assessment in all sectors of Japan as an activity. As a result, the evaluation methodology within the concept of the article assumes that the balance will simply occur at the level of the national economy and the system will develop effectively. It is certain that this study will contribute to future research on cyber resilience by analyzing the damage caused by cyber-attacks from a macroeconomic perspective using the production function and input-output model.

Today, green buildings are an important vehicle for making the construction industry greener, more efficient and more energy-efficient and an important part of the national sustainable development strategy. For example, the development of green construction in China is still in the initial stage, construction enterprises are not ready to develop green construction, and the promotion of green construction is facing the problem of insufficient capacity. The main reason is that the additional cost of green construction is too high. Therefore, this [7] paper takes green construction as a research object and investigates the quantification and evaluation of its additional cost-benefit. First, the composition of additional costs of green buildings is analyzed from the point of view of the whole life cycle, and the additional benefits are divided into economic benefits, environmental benefits and social benefits. Second, the additional cost and benefit evaluation model of the green building is constructed by combining the entropy weight method and the Data Envelopment Analysis

(DEA) method. Finally, the feasibility of this estimation method is tested by analyzing practical engineering cases. Through cost-benefit analysis of additional costs, projects with DEA efficiency and DEA inefficiency are identified and concrete proposals are made for them accordingly. The research results not only provide theoretical support for quantifying and evaluating additional costs and benefits of green buildings, but also provide guidance for formulating appropriate cost control measures and lay the foundation for green buildings to realize cost reduction and benefit maximization.

5 Conclusion

In conclusion, we note that in this paper, a two-sector input-output model between Wholesale and retail trade industry and Rest of economics has been studied. Here, the distribution of the total Input transactions between supply agents of Produce / selling, Gross value added and Import and the distribution of the total Output transactions between Purchase / buying, Final demand and Export consumer agents of the wholesale and retail trade industry create overheating and cooling uncertainty problems of national economy and problems of moderate and critical management of national economy. Particularly identified, – the convergence phase for Produce / selling transactions from 0.577 (or 14.89%) in 1995 to 3.849 U.S. billion dollars (or 14.29%) in 2011 to the state of Equilibrium growth and the divergence phase from 3.779 (or 14.11%) in 2012 to 0.569 U.S. billion dollars (or 3.10%) in 2018 from the state of Equilibrium growth, and also in accordance with the rules of "three sigma" from 24 years of observation in 20 years they were in the cooling zone of the economy beyond the level of critical manageability for flows and for the structure Produce / selling transactions of wholesale and retail trade industry of Kazakhstan economy.

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References

1. W. Leontief, The Review of Economics and Statistics **18(3)**, 105-125 (1936)
2. R.E. Miller, P.D. Blair, *Input-Output Analysis: Foundations and Extensions, Second Edition* (Cambridge University Press, 2009)
3. L. Sun, W. Zhou, X. Zhu, X. Xia, Journal of Environmental Management **325**, 116479 (2023)
4. T. Yasmin, G.A. Refae, S. Eletter, A. Kaba, Journal of Eastern European and Central Asian Research **9(6)**, 938-950 (2022)
5. *OECD Homepage. Input-Output tables for the wholesale and retail trade industry of Kazakhstan economy*, URL: https://stats.oecd.org
6. A. Kokaji, A. Goto, Journal of Economic Structures **11(1)**, 34 (2022)
7. W. Liu, X. Huang, Z. He, Y. Wang, L. Han, W. Qiu, Buildings **12(12)**, 2239 (2022)