The estimate of innovative development of construction industry in the Kazakhstan

Seyit Kerimkhulle[1*], *Ainur* Saliyeva[1], *Ulzhan* Makhazhanova[1], *Zhandos* Kerimkulov[1], *Alibek* Adalbek[1], and *Roman* Taberkhan[1]

[1]L.N. Gumilyov Eurasian National University, 2, Building, 11, Pushkin Str., 010008, Astana, Republic of Kazakhstan

Abstract. In this paper, based on OECD statistical data for 1995-2018 and the Input-Output model, a systematic study of the industrial and innovative development of the construction sector of the Republic of Kazakhstan was carried out. As, for the Produce / selling and Purchase / buying, the Gross value added and Final demand, the Import and Export transactions of structural agents, estimates are given and the bands of the left-hand critical, the left-sided moderate, the equilibrium, the right-sided moderate, the right-sided critical are confidence intervals constructed. Further, based on the erogeneity of the value of the standard deviation, the distributions of the absolute frequencies of the flows of transactions along the bands of confidence intervals are estimated, which, in turn, allow us to assess the state and condition of equilibrium of the industrial and innovative development of the construction industry of the Republic of Kazakhstan.

1 Introduction

It is known that on the basis of industrial and innovative development, the state can ensure economic growth, competitiveness, security, a decent quality of life for the population, maintain the status of a regional, and perhaps a world leader. In this regard, in this paper, an attempt was made to conduct a systematic analysis based on the Input-Output model [1-2] of the industrial and innovative development of the construction sector of the Republic of Kazakhstan on the OECD statistical data for 1995-2018 [3]. In particular, a systematic study of modern conditions, using the example of the construction industry of the Republic of Kazakhstan, makes it possible to obtain solutions to many applied problems of analysis, forecasting and diagnostics, as well as to consider promising areas for improving the system mechanisms of industrial and innovative development of the country within the framework of the State program of industrial and innovative development of the Republic of Kazakhstan for 2020-2025 [4].

To achieve the goal of this study, on the basis of a literary and technological review and generalizations of the results of the review, such studies as [4-11] in this paper, the specifics of the current situation in Kazakhstan in the context of industrial and innovative development of the production sectors of the national economy can be characterized by the following features:

---

[*] Corresponding author: kerimkhulle@gmail.com

– the state, business and society are afflicted with a disease called "indifference to development", as a result, the functions of the state prescribed in the National Innovation System turn out to be only declared, but unrealized due to the dominance of the interests of persons of corrupt centres of power, a block of financing and a system of functional structures;

– the country actually carried out de-industrialization and de-innovation, resulting in a low readiness of industries to introduce innovative technologies – a block of production;

– the system of branch applied sciences and applied research institutes was actually destroyed;

– in the country, the collapse of fundamental science and education is being consistently carried out, in particular, this is the transfer of the National Academy of Sciences of the Republic of Kazakhstan from state to public structures in the 90s, as well as the transition of training from a specialist to a bachelor's degree at the country's universities in the 2000s, from full to incomplete systems of higher education, – a creative block and a block of personnel training;

– low efficiency of the state in stimulating industrial and innovative activity in the business sphere, – blocks of financing, technology transfer, production, training.

As a result, we note that a systematic analysis of the prevailing Kazakhstani realities of the functioning of both individual blocks and the entire structure using the "Input-Output" model on statistical data for 1995-2018 using the example of the construction industry of the Republic of Kazakhstan makes it possible to generalize to answer the following questions [5]:

– what should be done to organize innovative development;

– who, why and for what purpose will carry out innovative development;

– who are the subjects of innovative development;

– who, how and why will cooperate in the aggregate subjects;

– what identification mechanisms will allow to form integral subjects of innovative development;

– who and how will create spaces of communication and trust;

– who and how will evaluate the social consequences of innovative development.

2 Methods, models, data

We will use an estimate of the μ mean population with a significance level $0 < \alpha < 1$:

– left-sided confidence interval estimate:

$$\frac{1}{n}\sum x - \frac{u_{1-\alpha}}{\sqrt{n}} \cdot \sigma_0 \leq \mu, \tag{1}$$

– right-sided confidence interval estimate:

$$\mu \leq \frac{1}{n}\sum x + \frac{u_{1-\alpha}}{\sqrt{n}} \cdot \sigma_0, \tag{2}$$

where x – the sample; n – the sample size; $u_{1-\alpha}$ – the quantile of standard normal distribution; σ_0 – the given standard deviation.

The work will use an information database obtained from the official website of the OECD for the construction industry of the national economy of the Republic of Kazakhstan for 1995-2018 [3] (see Table 1).

Table 1. The Input-Output table of mean transactions at 1995-2018 for construction and rest of economics of Kazakhstan statistics, U.S. billion dollars, compiled from source OECD report [3].

	Z_1	Z_r	Σz	f_d	f_e	Σf	x
Z'_1	1.06	3.01	4.07	9.37	0.02	9.39	13.46
Z'_r	5.56	62.73	68.28	76.85	42.89	119.74	188.02
$\Sigma z'$	6.62	65.74	72.36	86.22	42.90	129.13	201.48
ε'_v	6.78	90.84	97.62				
ε'_m	0.06	31.44	31.51				
$\Sigma z'$	6.84	122.29	129.13				
x'	13.46	188.02	201.48				

where Z'_1, Z_1 – the Produce / selling, respectively, the Purchase / buying transactions for the construction industry; Z'_r, Z_r – the Produce / selling, respectively, the Purchase / buying transactions for the rest of economics; ε'_v – the Gross value added transactions; ε'_m – the Import transactions; x' – the Input transactions; f_d – the Final demand transactions; f_e – the Export transactions; x – the Output transactions.

3 Results

3.1 The Estimate of Produce / selling and Purchase / buying transactions

In this section, the structures consisting of channels of confidence intervals are built, an estimate is given of the frequency distribution of Produce / selling and Purchase / buying transactions along these channels, and an analysis of the phases of the state of innovative development of the country's construction industry is given:

– Co-Band, – the cooling state with the boundary of the left-sided confidence interval (1) with a confidence probability of 1-α = 0.99 (see Fig. 1, half-space below the solid line), here the given standard deviation σ_0 = 6.78 USD Billions is chosen so that the cooling state was not in the Co-Band;

– Cr-Band, – the critical state is bounded with a border consisting of two left-sided confidence intervals (1), respectively, with a confidence probability of 1-α = 0.99 and 1-α = 0.95 (see Fig. 1, the band between the solid and large dotted lines) , here the critical state in the Cr-Band the Produce / selling transactions band has been for two years, which exceeds by one year the relation to the agent with behavior according to the normal distribution law, that is, there is (+) a overestimation of the critical state (see Fig. 2, the difference between the histogram with pattern fills of large confetti (2 years) and horizontal bricks (1 year));

– M-Band, – the moderate state is bounded with a boundary consisting of two left-sided confidence intervals (1), respectively, with a confidence probability of 1-α = 0.95 and 1-α = 0.90 (see Fig. 1, the band between the large and small dotted lines) , here the moderate state in the M-Band the Produce / selling transactions band was not found during all the years of observation, that is, there is a (–) underestimation of the moderate state (see Fig. 2, the difference between the histogram with patterned fills of large confetti and horizontal bricks (3 years));

– Eq-Band, – the equilibrium state is bounded from below with a boundary consisting of a left-right confidence interval with a confidence probability of 1-α = 0.90 (see Fig. 1, the half-space above with a solid line), here the equilibrium state is the Produce / selling and Purchase / buying transactions lasted 22 years, which is (+) overestimated by 6 years relative to the agent with normal distribution behavior (see Fig. 2, the difference between a histogram with large confetti pattern fills and horizontal bricks (6 years));

– M-Band, – the moderate state is bounded with a boundary consisting of two right-sided confidence intervals (2), respectively, with a confidence probability of 1-α = 0.90 and 1-α = 0.95 (see Fig. 1, the band between the small and large dotted line) , here the moderate state in the M-Band the Purchase / buying transactions band was not found during all the years of observation, that is, there is (–) an underestimation of the moderate state (see Fig. 2, the difference between the histogram with pattern fills with horizontal strokes and bricks (3 years));

– Cr-Band, – the critical state is bounded with a border consisting of two right-sided confidence intervals (2), respectively, with a confidence probability of 1-α = 0.95 and 1-α = 0.99 (see Fig. 1, the band between the large dotted line and the solid line) , here the critical state in the Cr-Band the Purchase / buying transactions band was observed for three years, that is, there is a (+) overestimation of the critical state (see Fig. 2, the difference between the histogram with pattern fills with horizontal strokes and bricks (2 years));

– Oh-Band, – the overheat state with the boundary of the right-handed confidence interval (2) with a confidence probability of 1-α = 0.99 (see Fig. 1, the half-space above with a solid line), here the given standard deviation σ_0 = 5.12 USD Billions is fitted so that the overheat state was not in the Oh-Band.

3.2 The Estimate of Gross value added and Final demand transactions

In this section, the structures consisting of channels of confidence intervals are built, an estimate is given of the distribution of frequencies of Gross value added and Final demand transactions along these channels, and an analysis of the phases of the state of innovative development of the country's construction industry is given:

– Co-Band, – the cooling state with the boundary of the left-sided confidence interval (1) with confidence probability = 0.99 (see Fig. 3, half-space below the solid line), here the given standard deviation σ_0 = 8.732 USD Billions is chosen so that the cooling state is not in the Co Band;

– Cr-Band, – the critical state is bounded with a border consisting of two left-sided confidence intervals (1), respectively, with a confidence probability of 1-α = 0.99 and 1-α = 0.95 (see Fig. 3, the band between the solid and large dotted lines) , here the critical state in the Cr-Band the Gross value added transactions band was for three years, which exceeds by two years the relation of the agent with behavior according to the normal distribution law, that is, there is a (+) overestimation of the critical state (see Fig. 4 , the difference between the histogram with pattern fills large confetti (3 years) and horizontal bricks (1 year));

– M-Band, – the moderate state is bounded with a boundary consisting of two left-sided confidence intervals (1), respectively, with a confidence probability of 1-α = 0.95 and 1-α = 0.90 (see Fig. 3, the band between the large and small dotted lines) , here the moderate state in the band M-Band the Gross value added and Final demand transactions was not found during all the years of observation, that is, there is a (–) underestimation of the moderate state (see Fig. 4, the difference between the histogram with pattern fills of large confetti and horizontal bricks (3 years));

– Eq-Band, – the equilibrium state is bounded from below with a boundary consisting of a left-right confidence interval with a confidence probability of 1-α = 0.90 (see Fig. 3, the half-space above and below the solid line), here the Gross value added and Final demand transactions lasted for 22 years, which is (+) overestimated by 9 years in relation to the agent with normal distribution behavior (see Fig. 4, difference between a histogram with large confetti pattern fills and horizontal bricks (9 years));

– M-Band, – the moderate state is bounded with a boundary consisting of two right-sided confidence intervals (2), respectively, with a confidence probability of 1-α = 0.90 and 1-α = 0.95 (see Fig. 3, the band between the small and large dotted line), here the moderate state in

the M-Band the Final demand transactions band was within one year of observation, that is, there is a (–) underestimation of the moderate state (see Fig. 4, the difference between the histogram with pattern fills with horizontal strokes and bricks (2 years));

– Cr-Band, – the critical state is bounded with a border consisting of two right-handed confidence intervals (2), respectively, with a confidence probability of 1-α = 0.95 and 1-α = 0.99 (see Fig. 3, the band between the large dotted line and the solid line) , here the critical state in the Cr-Band the Final demand transactions band was observed for three years, that is, there is a (+) overestimation of the critical state (see Fig. 4, the difference between the histogram with pattern fills with horizontal strokes and bricks (2 years));

– Oh-Band, – the overheat state with the border of the right-handed confidence interval (2) with a confidence probability of 1-α = 0.99 (see Fig. 3, the half-space above with a solid line), here the given standard deviation σ_0 = 6.502 USD Billions is chosen so that the overheat state does not was in the Oh-Band.

3.3 The Estimate of Import and Export transactions

In this section, the structures consisting of channels of confidence intervals are built, an assessment is given of the frequency distribution of Import and Export transactions along these channels, and an analysis of the phases of the state of innovative development of the country's construction industry is given:

– Co-Band, – the cooling state with the boundary of the left-sided confidence interval (1) with confidence probability = 0.99 (see Fig. 5, half-space below the solid line), here the given standard deviation σ_0 = 0.050 USD Billions is chosen so that the cooling state is not in the Co-Band;

– Cr-Band, – the critical state is bounded with a border consisting of two left-sided confidence intervals (1), respectively, with a confidence probability of 1-α = 0.99 and 1-α = 0.95 (see Fig. 5, the band between the solid and large dotted lines) , here the critical state in the Cr-Band the Export transactions band was for four years, which exceeds by three years the relation of the agent with behavior according to the normal distribution law, that is, there is (+) a overestimation of the critical state (see Fig. 6, difference between large confetti (4 years) and horizontal bricks histogram with pattern fills (1 year);

– M-Band, – the moderate state is bounded with a boundary consisting of two left-sided confidence intervals (1), respectively, with a confidence probability of 1-α = 0.95 and 1-α = 0.90 (see Fig. 5, the band between the large and small dotted line) , here the moderate state in the M-Band the Export and Import transactions band was not found during all the years of observation, that is, there is a (–) underestimation of the moderate state (see Fig. 6, the difference between the histogram with pattern fills of large confetti and horizontal bricks (3 years));

– Eq-Band, – the equilibrium state is bounded from below with a boundary consisting of a left-right confidence interval with a confidence probability of 1-α = 0.90 (see Fig. 5, the half-space above and below the solid line), here the equilibrium state is the Export and Import transactions was for 22 years, which is (+) overestimated by 9 years to the ratio of the agent with the behavior according to the normal distribution law (see Fig. 6, the difference between the histogram with pattern fills of large confetti and horizontal bricks (9 years));

– M-Band, – the moderate state is bounded with a boundary consisting of two right-sided confidence intervals (2), respectively, with a confidence probability of 1-α = 0.90 and 1-α = 0.95 (see Fig. 5, the band between the small and large dotted line) , here the moderate state in the M-Band the Import transactions band was within one year of observation, that is, there is a (–) underestimation of the moderate state (see Fig. 6, the difference between the histogram with pattern fills with horizontal strokes and bricks (2 years));

– Cr-Band, – the critical state is bounded with a boundary consisting of two right-sided confidence intervals (3), respectively, with a confidence probability of 1-α = 0.95 and 1-α = 0.99 (see Fig. 5, the band between the large dotted line and the solid line) , here the critical state in the Cr-Band the Import transactions band was within one year of observation, that is, there is a zero assessment of the critical state (see Fig. 6, there is no difference between the histogram with pattern fills with horizontal strokes and bricks);

– Oh-Band, – the overheat state with the border of the right-handed confidence interval (2) with a confidence probability of 1-α = 0.99 (see Fig. 5, the half-space above with a solid line), here the given standard deviation σ_0 = 0.127 USD Billions is chosen so that the overheat state does not was in the Oh-Band.

4 Discussions

Thus, based on the system analysis of the Input-Output model in the previous sections, it was possible to form the main characteristics and features of the industrial and innovative development of the construction sector of the Republic of Kazakhstan.

Then, in order to determine the potential opportunities for the development of industrial-innovative infrastructures at the level of the national economy as a whole, it is necessary to use the most significant developments of research and engineering works of research centers from all over the world, in particular, the work of:

– An innovative approach to the construction of compacted soil for the sustainable development of rural areas in southwest China [12];

– Digitalization of the economy as a tool for the development of innovative activities in construction [13];

– A system-functional approach in management of innovative development of construction enterprises in Ukraine [14];

– Innovative building materials, between sustainable development and technology, a promising approach towards sustainable construction [15];

– Construction of an innovative development model of intelligent media under the coverage of a wireless sensor network [16];

– Mathematical modeling of innovative development of enterprises in the construction industry [17];

– Innovative mesosystems algorithm for sustainable development priority areas identification in industry based on decision trees construction [18];

– Human capital as a factor of development of innovative activity of construction industry enterprises [19];

– Innovative technologies in the Russian construction industry as a factor of economic development [20];

– Research on the impact of innovative city construction on financial development: evidence from China [21].

5 Conclusion

Thus, in this paper, based on OECD statistical data for 1995-2018 and the Input-Output model, a systematic study of the industrial and innovative development of the construction sector of the Republic of Kazakhstan was carried out. As, for the Produce / selling and Purchase / buying, the Gross value added and Final demand, the Import and Export transactions of structural agents, estimates are given and the bands of the left-hand critical, the left-sided moderate, the equilibrium, the right-sided moderate, the right-sided critical are confidence intervals constructed. Further, based on the erogeneity of the value of the standard

deviation, the distributions of the absolute frequencies of the flows of transactions along the bands of confidence intervals are estimated, which, in turn, allow us to assess the state and condition of equilibrium of the industrial and innovative development of the construction industry of the Republic of Kazakhstan.
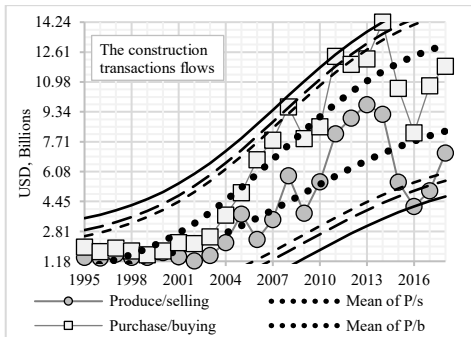
Acknowledgment

Appendix

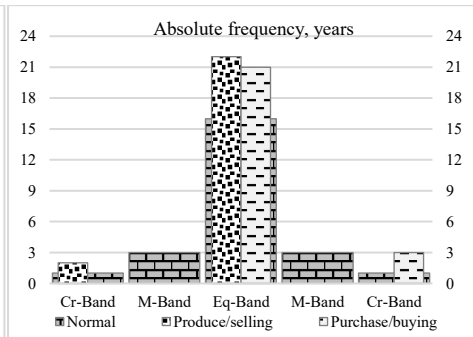**Fig. 1.** The Produce / selling and Purchase / buying transactions for flows of construction industry

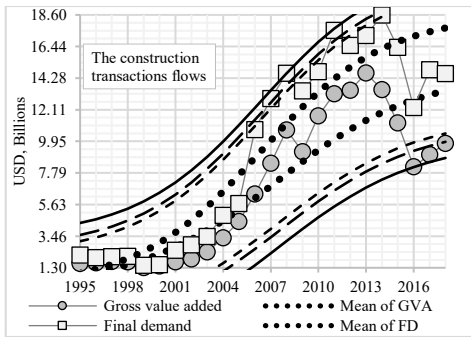**Fig. 2.** The Produce / selling and Purchase / buying transactions absolute frequencies at bands

Fig. 3. The Gross value added and Final demand transactions for flows of construction industry
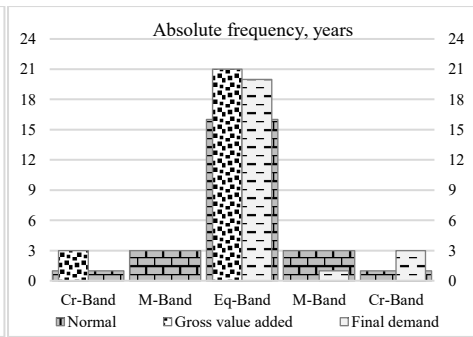

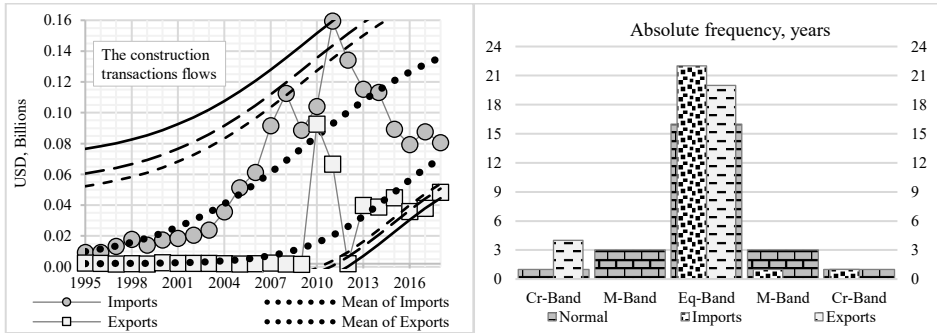**Fig. 4.** The Gross value added and Final demand transactions absolute frequencies at bands

Fig. 5. The Import and Export transactions for flows of construction industry

Fig. 6. The Import and Export transactions absolute frequencies at bands

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. Input-Output tables for the construction industry of Kazakhstan economy. OECD Homepage, URL: https://stats.oecd.org

4. *The State program of industrial and innovative development of the Republic of Kazakhstan for 2020-2025*, URL: https://adilet.zan.kz/kaz/docs/P1900001050

5. V.I. Arshinov, I.E. Zadorozhnyuk, and V.E. Lepsky, Voprosy Filosofii **6**, 164-168 (2008)

6. Y. Sun, H. Liu, J. Liu, M. Sun, and Q. Li, Sustainability **15**(2), 923 (2023)

7. N. Khezami, N. Gharbi, B. Neji, and N.B. Braiek, Sustainability **14**(23), 15826 (2022)

8. D. Bazaras, M. Išoraitė, and K. Vaičiūtė, Sustainability **14**(19), 12927 (2022)

9. M.K. Khalilova, V.A. Davydov, and S.U. Niyazbekova, Studies in Big Data **110**, 101-107 (2022)

10. E. Endri, B.T. Hania, and A. Ma'ruf, Environmental Economics **13**(1), 38-49 (2022)

11. A. Nurpeisova, A. Shaushenova, Z. Mutalova, Z. Zulpykhar, M. Ongarbayeva, and S. Niyazbekova, A. Semenov, L. and Maisigova, Computation **10**(8), 136 (2022)

12. L. Wan, E. Ng, X. Liu, L. Zhou, F. Tian, and X. Chi, Sustainability **14**(24), 16461 (2022)

13. G.I. Khokhlova, V.F. Nikulsheeva, V.Y. Burov, and A.Y. Khokhlova, AIP Conference Proceedings **2434**, 060003 (2022)

14. I. Gontareva, M.M. Kurt, O. Dorokhov, R. Rusin-Grinik, and N. Galayko, TEM Journal **11**(1), 125-137 (2022)

15. M. Kadri, M.Y. Telli, and A. Kaihoul, 2022 Engineering and Technology for Sustainable Architectural and Interior Design Environments, ETSAIDE, 1-7 (2022)

16. X. Yu, Mathematical Problems in Engineering, 9073067 (2022)

17. V. Onyshchenko, N. Ichanska, V. Skryl, and O. Furmanchuk, Lecture Notes in Civil Engineering **181**, 697-709 (2022)

18. A.I. Shinkevich, I.G. Ershova, F.F. Galimulina, and A.A. Yarlychenko, Mathematics **9**(23), 3055 (2021)

19. V.F. Nikulsheeva, G.I. Khokhlova, N.V. Kretova, and A.S. Borisova, IOP Conference Series: Earth and Environmental Science **751**(1), 012163 (2021)

20. O.G. Timchuk, and I.I. Kazantseva, IOP Conference Series: Earth and Environmental Science **751**(1), 012180 (2021)

21. Z. Zhao, Y. Zheng, Y. Chen, C. Ye, and Z. He, Discrete Dynamics in Nature and Society, 7541690 (2021)