Empirical Research on Connectedness for International Trade and Investment between Guangzhou and Countries along B&R Based on PVAR Test

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Abstract Guangzhou, an international trading hub, plays an important role in the development of Belt and Road Initiative (B&R Initiative). We select the Export Similarity Index and Trade Intensity Index (ESI and TII) for trade and investment, and analyse the interconnectedness between trade and investment in the aspect of capacity cooperation between Guangzhou and countries along B&R, basing on the PVAR model. The result shows that the increase of investment and trade of Guangzhou has remarkably positive influence on the future ones of the countries along the B&R. We suggest that Guangzhou insist on attracting foreign investment and opening to the outside world, and consider carefully about the complementary relationship between trade and investment for capacity when establishing the related policy.

1. Introduction

Guangzhou, where the first customs in China was set up, has long been one of the most important ports for international trade. Over the last 2000 years, Guangzhou, as an international trade hub, has obvious outward-oriented economic characteristics, with its urban development closely related to global development. As B&R Initiative become widely accepted, Guangzhou is in an increasingly pivotal status, and as a result, it is significant for Guangzhou to participate in B&R construction at a deeper level and enforce cooperation with other countries in the aspect of manufacture capacity, for manufacture transformation and upgrading. With the purpose of analysing the counterinfluence for trade and investment of Guangzhou with countries along B&R, we measure and calculate ESI and TII, then construct a PVAR model. After the research, we acquire a deeper understanding about the development of trade and investment between Guangzhou and countries along B&R, which is significant to discover the priorities for cooperation.

2. Connectedness Analysis for Trade Capacity and Investment

2.1 Model Construction
PVAR was first used by Holtz-Eakin in 1988 [1] and consecutively developed by Arellano and Bover (1995) [2], Blundell (1998) [3] and Love (2006) [4]. The first step consists of GMM estimation and regression fitting. PVAR has the advantage of Vector Autoregression and Panel Data Model. It helps not only to control the individual effect and time effect, but also to analyse the dynamic response to connectedness for capacity cooperation among countries along B&R. Every variable in the model is influential to the trade and investment capacity, and the process of dynamic effect outlines transmission mechanism for impulse response of every variable, in a relative better way. Here is the model:

$$K_{abt} = \beta_0 + \sum_{j=0}^{n} \beta_j K_{abt-j} + \sum_{j=1}^{n} \beta_j K_{abt-j}^F + \beta_j D_{abt} + \epsilon_{abt}$$

(1)

$$K_{abt}^F = \gamma_0 + \sum_{j=0}^{n} \gamma_j K_{abt-j}^F + \sum_{j=1}^{n} \gamma_j K_{abt-j}^F + \gamma_j D_{abt} + \epsilon_{abt}$$

(2)

$K_{abt}$ is the ESI or TII for trade and investment between region a to region b in the t period. $K_{abt-j}$ is the j level legged variable of $K_{abt}$. D is the distance between two places. $\beta, \beta', \gamma, \gamma'$ are intended for measurement of orientation for connectedness between Guangzhou and countries along B&R. ESI reflects on the similarity for trade and investment. It is the connectedness degree for capacity trade and investment between Guangzhou and countries along B&R. It reflects on the capacity competition degree between regions including capacity competition degree for trade (ESI_T) and capacity competition degree for investment (ESI_F). During a given period of stable external environment, ESI_T and ESI_F of the last period may impact the current ones. TII is the interdependence degree for capacity between Guangzhou and countries along B&R. By analyzing the capacity connectedness degree enables us to know about the capacity complementarity including trade connectedness degree (TII_T) and investment connectedness degree (TII_F). Generally, current capacity interdependence rate is influenced by trade interdependence degree and investment interdependence degree of the last period, and trade connectedness degree and investment connectedness degree may motivate current trade and investment.

2.2 Data Resource and Analysis

We calculate the ESI and TII for capacity cooperation between Guangzhou and countries along B&R, and clarify the connectedness of trade and investment, based on which we construct a PVAR model.

2.2.1 Export Similarity Index (ESI)

The change of ESI reflects on the characteristics of development of regional economy, the advancement of industrial structure, and the process of industrialization. In order to research on Guangzhou capacity status worldwide, we design the ESI for trade and investment between Guangzhou and countries in reference to Glick and Rose (1999) [5]. Our source comes from Guangzhou Statistical Yearbook, Guangdong Statistical Year book, Guangdong Customs Database and etc. Statistics of countries along B&R are from World Trade Database and United Nations Comrade Database. 65 countries and regions along The Silk Road Economic Belt are selected and divided into six groups as ASEAN, Western Asia (WA), Central Asia (CA), Southern Asia (SA), CIS and Central and Eastern Europe (CEE) according to the China Foreign Direct Investment Statistics.

The calculation result is shown in the Table 1.1 and 1.2.

| Year | ESI_T Total | ESI_T ASEAN | ESI_T WA | ESI_T CA | ESI_T SA | ESI_T CIS | ESI_T CEE |
|------|-------------|-------------|--------|--------|--------|---------|---------|
| 1995 | 47.03       | 76.19       | 33.73  | 35.56  | 63.73  | 34.97   | 59.95   |
| 1996 | 48.11       | 77.22       | 34.54  | 34.45  | 64.54  | 43.19   | 63.81   |
| 1997 | 51.96       | 74.79       | 38.84  | 35.71  | 68.84  | 33.38   | 58.62   |
| 1998 | 51.31       | 77.97       | 36.34  | 43.66  | 66.34  | 43.19   | 63.81   |
| 1999 | 51.75       | 76.64       | 29.18  | 41.11  | 59.18  | 36.82   | 58.79   |

Table 1.1. ESI for Trade between Guangzhou and Other Countries along B&R
### Table 1.2: ESI for Investment between Guangzhou and Other Countries along B&R

| Year | ESI_F |
|------|-------|
|      | Total | ASEAN | WA | CA | SA | CIS | CEE |
| 1995 | 53.10 | 73.86 | 44.67 | 34.76 | 63.19 | 77.98 | 65.84 |
| 1996 | 52.25 | 74.41 | 43.48 | 30.80 | 63.40 | 77.33 | 65.57 |
| 1997 | 51.96 | 75.16 | 42.44 | 31.22 | 62.96 | 76.23 | 65.64 |
| 1998 | 52.09 | 75.53 | 42.63 | 31.86 | 62.88 | 76.06 | 65.68 |
| 1999 | 51.71 | 75.94 | 42.25 | 31.74 | 62.64 | 76.93 | 64.09 |
| 2000 | 51.37 | 70.70 | 41.93 | 34.34 | 62.63 | 70.70 | 63.80 |
| 2001 | 51.65 | 74.88 | 42.58 | 35.51 | 62.09 | 72.94 | 64.11 |
| 2002 | 51.39 | 76.70 | 42.35 | 34.26 | 62.70 | 72.71 | 63.30 |
| 2003 | 51.57 | 71.46 | 42.37 | 34.83 | 62.53 | 71.46 | 63.23 |
| 2004 | 51.60 | 77.09 | 42.13 | 35.20 | 62.66 | 74.06 | 63.33 |
| 2005 | 51.33 | 76.75 | 41.93 | 34.40 | 62.93 | 72.80 | 63.42 |
| 2006 | 51.14 | 76.64 | 41.72 | 33.56 | 62.97 | 72.34 | 63.45 |
| 2007 | 53.78 | 66.84 | 41.66 | 31.82 | 61.84 | 66.84 | 62.96 |
| 2008 | 53.35 | 65.20 | 45.20 | 29.43 | 60.20 | 65.20 | 62.24 |
| 2009 | 52.79 | 66.64 | 42.64 | 29.38 | 57.64 | 62.64 | 61.34 |
| 2010 | 52.81 | 61.91 | 41.91 | 30.13 | 56.91 | 61.91 | 61.91 |
| 2011 | 52.96 | 63.15 | 43.15 | 29.23 | 58.15 | 63.15 | 62.74 |
| 2012 | 52.73 | 68.91 | 41.91 | 27.87 | 56.91 | 61.91 | 61.91 |
| 2013 | 50.20 | 75.20 | 37.20 | 28.96 | 59.20 | 57.20 | 64.20 |
| 2014 | 51.04 | 71.34 | 38.04 | 28.83 | 61.31 | 54.04 | 64.08 |

Source: Calculated the data from the UN Comrade Database, the Foreign Economic Database, the World Trade Database, the Guangzhou Customs Database, the Guangzhou Statistical Yearbook and the relevant statistical bulletins from 1995-2014.

### Table 2.1. TII for Trade between Guangzhou and Other Countries along B&R

| Year | TII_T |
|------|-------|
|      | Total | ASEAN | WA | CA | SA | CIS | CEE |
| 1995 | 51.10 | 73.86 | 44.67 | 34.76 | 63.19 | 77.98 | 65.84 |
| 1996 | 52.25 | 74.41 | 43.48 | 30.80 | 63.40 | 77.33 | 65.57 |
| 1997 | 51.96 | 75.16 | 42.44 | 31.22 | 62.96 | 76.23 | 65.64 |
| 1998 | 52.09 | 75.53 | 42.63 | 31.86 | 62.88 | 76.06 | 65.68 |
| 1999 | 51.71 | 75.94 | 42.25 | 31.74 | 62.64 | 76.93 | 64.09 |
| 2000 | 51.37 | 70.70 | 41.93 | 34.34 | 62.63 | 70.70 | 63.80 |
| 2001 | 51.65 | 74.88 | 42.58 | 35.51 | 62.09 | 72.94 | 64.11 |
| 2002 | 51.39 | 76.70 | 42.35 | 34.26 | 62.70 | 72.71 | 63.30 |
| 2003 | 51.57 | 71.46 | 42.37 | 34.83 | 62.53 | 71.46 | 63.23 |
| 2004 | 51.60 | 77.09 | 42.13 | 35.20 | 62.66 | 74.06 | 63.33 |
| 2005 | 51.33 | 76.75 | 41.93 | 34.40 | 62.93 | 72.80 | 63.42 |
| 2006 | 51.14 | 76.64 | 41.72 | 33.56 | 62.97 | 72.34 | 63.45 |
| 2007 | 53.78 | 66.84 | 41.66 | 31.82 | 61.84 | 66.84 | 62.96 |
| 2008 | 53.35 | 65.20 | 45.20 | 29.43 | 60.20 | 65.20 | 62.24 |
| 2009 | 52.79 | 66.64 | 42.64 | 29.38 | 57.64 | 62.64 | 61.34 |
| 2010 | 52.81 | 61.91 | 41.91 | 30.13 | 56.91 | 61.91 | 61.91 |
| 2011 | 52.96 | 63.15 | 43.15 | 29.23 | 58.15 | 63.15 | 62.74 |
| 2012 | 52.73 | 68.91 | 41.91 | 27.87 | 56.91 | 61.91 | 61.91 |
| 2013 | 50.20 | 75.20 | 37.20 | 28.96 | 59.20 | 57.20 | 64.20 |
| 2014 | 51.04 | 71.34 | 38.04 | 28.83 | 61.31 | 54.04 | 64.08 |

Source: Calculated the data from the UN Comrade Database, the Foreign Economic Database, the World Trade Database, the Guangzhou Customs Database, the Guangzhou Statistical Yearbook and the relevant statistical bulletins from 1995-2014.

#### 2.2.2 Trade Intensity Index (TII)

Trade Intensity Index (TII), first advanced by economist A.J.Brown in 1947[6], is an integrated index intended for measuring the connectedness of trade between two places. TII is positively correlated to the connectedness. Here is the TII for trade and investment between Guangzhou and other countries along B&R.
| Year  | TII_F |
|-------|-------|
|       | Total | ASEAN | WA    | CA    | SA    | CIS   | CEE   |
| 1995  | 0.486 | 0.485 | 0.383 | 0.458 | 0.482 | 0.594 | 0.516 |
| 1996  | 0.539 | 0.411 | 0.358 | 0.543 | 0.485 | 0.747 | 0.687 |
| 1997  | 0.511 | 0.410 | 0.531 | 0.499 | 0.384 | 0.740 | 0.499 |
| 1998  | 0.525 | 0.472 | 0.590 | 0.518 | 0.461 | 0.741 | 0.368 |
| 1999  | 0.578 | 0.559 | 0.509 | 0.656 | 0.620 | 0.756 | 0.368 |
| 2000  | 0.590 | 0.524 | 0.506 | 0.602 | 0.640 | 0.777 | 0.492 |
| 2001  | 0.598 | 0.659 | 0.642 | 0.659 | 0.488 | 0.669 | 0.468 |
| 2002  | 0.666 | 0.545 | 0.588 | 0.852 | 0.689 | 0.740 | 0.580 |
| 2003  | 0.666 | 0.423 | 0.656 | 0.915 | 0.574 | 0.795 | 0.632 |
| 2004  | 0.724 | 0.642 | 0.632 | 1.034 | 0.685 | 0.870 | 0.478 |
| 2005  | 0.789 | 0.693 | 0.660 | 1.243 | 0.727 | 0.789 | 0.623 |
| 2006  | 0.752 | 0.705 | 0.603 | 0.985 | 0.725 | 0.833 | 0.660 |
| 2007  | 0.854 | 0.693 | 0.868 | 1.133 | 0.827 | 0.850 | 0.750 |
| 2008  | 0.869 | 0.681 | 1.043 | 1.114 | 0.617 | 0.860 | 0.898 |
| 2009  | 0.959 | 0.816 | 1.136 | 1.114 | 0.905 | 0.874 | 0.910 |
| 2010  | 1.028 | 0.847 | 1.311 | 1.080 | 0.947 | 0.976 | 1.005 |
| 2011  | 1.021 | 0.949 | 1.165 | 1.035 | 0.984 | 1.096 | 0.899 |
| 2012  | 1.123 | 1.029 | 1.200 | 1.289 | 1.053 | 1.060 | 1.106 |
| 2013  | 1.134 | 0.915 | 1.293 | 1.269 | 1.136 | 1.049 | 1.142 |
| 2014  | 1.198 | 1.059 | 1.303 | 1.271 | 1.138 | 1.167 | 1.247 |

Source: Calculated the data from the UN Comrade Database, the Foreign Economic Database, the World Trade Database, the Guangzhou Customs Database, the Guangzhou Statistical Yearbook and the relevant statistical bulletins from 1995-2014.

2.3 Model Test for Connectedness for Trade and Investment
The statistics involved is in a relatively long span of time, and we found it necessary to apply Unit Root Test and Lag Intervals for Endogenous Test in order to avoid Spurious Regression.
2.3.1 Unit Root Test and Test for Lag Order

The most commonly used way for Unit Root Test can be divided into two groups. One is the test with different unit roots involved, such as IPS Test and Fisher-ADF Test. Another one is the test with the same unit root involved, such as LLC Test, Breitung Test and Hadri Test. Exceptionally, null hypothesis of Hadri Test is not involved with unit root. The result is shown in Table 3. Among the three kinds of test, InESI_T, InESI_F, InTII_T, InTII_F are have unstable average level. In IPS Test and Fisher-ADF Test, InESI_T, InESI_F, InTII_T, InTII_F reject to null hypothesis in the first difference but accept to null hypothesis in Hadri Test without unit root, which means that their first difference are stable. In conclusion, the result of unit root test shows that InESI_T, InESI_F, InTII_T, InTII_F are integrated of order 1.

| Variables | IPS Test | Fisher-ADF Test | Hadri Test | IPS Test | Fisher-ADF Test | Hadri Test |
|-----------|----------|-----------------|------------|----------|-----------------|------------|
| InESI_T   | -1.860   | 68.509          | 3.059***   | -6.678***| -6.053***       | 0.004      |
|           | (0.971)  | (1.000)         | (0.000)    | (0.000)  | (0.000)         | (0.498)    |
| InESI_F   | 0.964    | 10.814          | 5.462***   | -3.869***| -3.874***       | -0.057     |
|           | (0.992)  | (1.000)         | (0.000)    | (0.000)  | (0.000)         | (0.223)    |
| InTII_T   | 2.465    | 4.335           | 6.382***   | -4.723***| -4.645***       | 1.345      |
|           | (0.991)  | (1.000)         | (0.000)    | (0.000)  | (0.000)         | (0.489)    |
| InTII_F   | 2.547    | 2.645           | 6.915***   | -7.587***| -6.646***       | -0.555     |
|           | (0.993)  | (0.996)         | (0.000)    | (0.000)  | (0.000)         | (0.711)    |

Note: *** shows that it is obvious in 0.01 level, ** shows that it is obvious in 0.05 level,* shows that it is obvious in 0.1 level, and the numbers in parentheses are the probabilities.

Suitable lag order is essential when it comes to PVAR model construction. Shorter lag order leads to unstable result, while longer one leads to loss of some samples. As a consequence, when choosing lag order we follow two rules. The first one is to choose according to AIC, SIC and HQIC this three principles. And the second one is to choose according to the time span of variables so that we can avoid the influence on sample quantity from a lag order which is too long. In addition, the lag order is usually under 3. The result of AIC, HQIC and SIC is shown in Table 4.

| Variables | InESI_T and InESI_F | InTII_T and InTII_F |
|-----------|---------------------|---------------------|
| Countries | Lag Order           |         |         |
|           | Lag Order           | -3.21984 | -2.30532|
|           | AIC                 | -3.21400 | -2.30038|
|           | HQIC                | -3.12237 | -2.20875|
| ASEAN     | Lag Order           |         |         |
|           | Lag Order           | -2.67129 | 0.891552|
|           | AIC                 | -2.66634 | 0.896497|
|           | HQIC                | -2.57472 | 0.988125|
| Southern  | Lag Order           |         |         |
| Asia      | Lag Order           | -2.07155 | -0.89552|
|           | AIC                 | -2.06660 | -0.89058|
|           | HQIC                | -1.97498 | -0.79895|

5
2.3.2 Panel co-integration Test

Kao Test, Fisher Test and Pedroni Test are of the most commonly used panel co-integration tests and Pedroni Test has the largest range of application (Pedroni 1, 1999) [7]. We chose Pedroni Test to test the co-integration relationship between variables. Then, on the basis of regression residual, we constructed Panel V, Panel rho, Panel PP and Panel ADF for tests within groups and Group rho, Group PP and Group for tests between groups. The result is shown in the Table 5. It shows that InESI_T and InESI_F, InTII_T and InTII_F are not obvious in Panel V. It also shows that InESI and InESI_F are obvious in Panel PP, while InTII_T and InTII_F are obvious in Group PP 0.05 level. All the other statistics are obvious in 0.01 level. We conclude that InESI_T with InESI_F and InTII_T with InTII_F have co-integration relationship with each other.

| Statistics | Western Asia | Central and Eastern Europe | CIS |
|------------|--------------|-----------------------------|-----|
| AIC        | Lag 1        | Order 1                     | Lag 1 |
| HQIC       | -2.34924     | -2.78487                    | -3.73927 |
| SBIC       | -2.25762     | -2.77992                    | -1.20084 |
| AIC        | -2.22538     | -0.83492                    | -1.19589 |
| HQIC       | -2.08794     | -0.82997                    | -1.10426 |
| SBIC       | -2.68829     | -0.73835                    | -1.49777 |
| AIC        | -2.08794     | -0.82997                    |        |
| HQIC       | -2.22538     | -0.73835                    |        |
| SBIC       | -2.34924     | -0.83492                    |        |
|            |              |                             |      |

Table 5. Result for Panel Co-integration Test

| Statistics | InESI_T and InESI_F | p  | InTII_T and InTII_F | p  |
|------------|---------------------|----|---------------------|----|
| Panel V    | -1.171              | 0.48| -1.563              | 0.351|
| Panel rho  | -3.591***           | 0.000| -3.409***           | 0.000|
| Panel PP   | -5.065**            | 0.003| -4.266**            | 0.001|
| Panel ADF  | -2.933***           | 0.000| -3.574***           | 0.000|
| Group rho  | -1.729***           | 0.000| -2.114**            | 0.002|
| Group PP   | -3.522***           | 0.001| -2.213***           | 0.000|
| Croup ADF  | -3.658***           | 0.000| -2.685***           | 0.000|

Note: ***shows that it is obvious in 0.01 level,** shows that it is obvious in 0.05 level,* shows that it is obvious in 0.1 level.

3. Conclusion:

1 Pedroni indicates that when time span of panel data is longer than 100 (T>100), 7 statistics show bias error but high performance, however, when the time span is short, Panel V has relatively poor performance. The time span in our research is 20 years, so Panel V is not a major consideration. When the last 6 statistics are obvious, InESI_T and InESI_F, InTII_T and InTII_F are integrated of order 1 and have co-integration relationship, so we are able to construct a PVAR.
Form 6 is the estimation result for GMM based on PVAR model. It supports the following two results for the relationship between trade and investment for Guangzhou and the countries along the “One Belt One Road”. The first one is that delayed trade and investment significantly have positive effect on the current trade, which is consistent with the one from Zhang (2004) [8]. The second one is that delayed trade and investment has positive influence on the current investment, which is consistent with the one from Chen (2014) [9]. We can tell from the Table 9, that when the explained variable is ESI for trade capacity, coefficient on InESI_T and InESI_F are obviously positive in lag order 1 and 2, showing that current ESI_T for capacity changes in the same direction, with trade and investment for capacity cooperation between Guangzhou and countries along B&R. What’s more, trade and investment from lag order 1 and 2 increases the connectedness digress of current trade. When the explained variable is TII_F for capacity, coefficient on InTII_T and InTII_F are obviously positive in lag order 1 and 2, showing that trade and investment from lag order 1 and 2 increases the current trade connectedness degree. So, the first result is stable and we can conclude that trade and investment between Guangzhou and countries along B&R will promote the future ones. In the analytic equation for ESI for investment capacity, coefficients on InESI_T and InESI_F are obviously positive in lag order. In the analytic equation for TII for investment capacity, coefficients on InTII_T and InTII_F are obviously positive. So, the second result is stable and we can conclude that investment and trade between Guangzhou and countries along B&R increase connectedness degree of current investment. InDis is negative in the two quotations, which is an evidence for that trade and investment between Guangzhou and countries along B&R are negatively influenced by the distance.

As a result, two conclusions show co-relationship between trade and investment between Guangzhou and countries along B&R, and the current trade and investment significantly increase the future ones. One reason for the phenomena is that countries along B&R make progress in the aspect of policy, market structure and infrastructure and create a better environment, which becomes a motivation for investment. Another reason may be that companies in Guangzhou need trade and investment opportunities to integrate various resources and global strategy implementation. If Guangzhou increases investment along B&R, small companies will have a greater profit margin and they will be encouraged to trade and investment in the future. Additionally, the result of GMM shows connectedness between trade and investment for capacity cooperation between Guangzhou and countries along B&R. Trade and investment for capacity have positive impact on each other. It is evident that Guangzhou is striving for trade and investment integration with countries along B&R. In the new stage of B&R construction, Guangzhou is highly recommended that it should keep supporting policies on opening to the outside and encouraging foreign investment, and consider the complementary relationship between trade capacity and trade while putting them into a unified framework and system. In order to provide policy support on Guangzhou economy integration into B&R development, Guangzhou should attach importance to policy coordination.

| Explained Variables | InESI | variables | coefficient | Explained Variables | InTII | variables | coefficient |
|---------------------|-------|-----------|-------------|---------------------|-------|-----------|-------------|
| InESI_T             |       | InESI_T (1) | 0.449***    | (3.64)              |       | InTII_T (1) | 0.606***    | (5.61) |
|                     |       | InESI_T (2) | 0.317**     | (1.98)              |       | InTII_T (2) | 0.212**     | (2.01) |
|                     |       | InESI_F (1) | 0.332***    | (3.80)              |       | InTII_F (1) | 0.389***    | (3.69) |
|                     |       | InESI_F (2) | 0.228**     | (2.23)              |       | InTII_F (2) | 0.159**     | (2.08) |
|                     |       | InDis      | -0.281**    |                     |       | InDis      | -0.313**    |         |
| Explained Variables | variables | coefficient | Explained Variables | variables | coefficient |
|---------------------|-----------|-------------|---------------------|-----------|-------------|
| InESI_F             | InESI_T (-1) | 0.538*** (4.54) | InTII_F             | InTII_T (-1) | 0.272* (1.79) |
|                    | InESI_T (-2) | 0.148 (0.67) |                    | InTII_T (-2) | -0.002 (-0.01) |
|                    | InESI_F (-1) | 0.275* (1.73) |                    | InTII_F (-1) | 0.561*** (4.58) |
|                    | InESI_F (-2) | 0.091 (1.03) |                    | InTII_F (-2) | 0.099 (0.89) |
|                    | InDis      | -0.303*** (-3.81) |                    | InDis      | -0.185*** (-2.72) |

Note: *** shows that it is obvious in 0.01 level, ** shows that it is obvious in 0.05 level, * shows that it is obvious in 0.1 level, and the numbers in parentheses represent statistics Z.

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