CHAIN INDEX CONSTRUCTED WITH SEASONAL ADJUSTMENT

DAN-HUI YI AND HONG-WEI XIAO
School of Statistics
Renmin University of China
Beijing, 100872, China
xiaohongwei2006@126.com

ABSTRACT. *This paper, based on time series seasonal adjustment, proposes the construction method of statistics chain index, firstly decomposes the time series structure, according to the proportion of each component in different periods, to determine the dynamic weight, then calculates statistical chain index of each component, finally synthesizes the statistical chain index. When adding a new monthly data, we do seasonally adjustment again, and adjust the chain of previous statistics index accordingly. We use this chain index construction method on China monthly exports data, result shows that statistical chain index is stabile and easy to compare between different months.*
Keywords: Seasonal Adjustment; X-12-ARIMA; Statistical Chain Index

1. Introduction. China announced economic time series data is divided into two categories: the amount of data, year-on-year data. In order to eliminate seasonal factors, China's monthly statistics mainly use year-on-year index, which compares the two periods' raw data directly, now the main announced data is the last year over the same month of the year index. The year-on-year index facilitates the calculation, but due to the interval of two comparisons is 12-month, as well as by the impact of "hikes", in economic time series change, as an indicator of turning points in response to economic change, year-on-year index responses more slowly than the chain index, and is not conducive to receive rapid feedback from changes, affecting the timeliness and accuracy of decision-making. Therefore, in order to improve the timeliness of statistics, it is necessary for the calculation of statistical chain index. When calculating the chain index, due to seasonal factors, not facilitate the comparison between the quarterly or monthly, hence need seasonal adjustments. When excluding the impact of external factors, such as seasonal factor etc, only reflecting the economic internal growth trends, statistical chain index can be very clear to reflect the internal operation of the basic trend of the economy and the effects of macro-control policy implementation, and also can capture the possible turning point and change trends about macroeconomy timely, even government policy makers can facilitate to seize the best opportunity of economic adjustment to improve the level and quality of the macroeconomic regulation and control. In the post-crisis era, on the basis of seasonally adjusted of China's macro-economic data, composing and estimating the statistical chain index can help improve the time accuracy of macroeconomic regulation, which has practical significance to promote rapid and healthy development of China's economy.

2. Data Seasonally Adjusted. In the calculation of chain speed, comparison between two calendar periods, due to the different calendar days, the impact of trading day effect, day

effect, moving holidays, fixed seasonal factors etc, results the uncomparability in different quarters or months, so the seasonal adjustment must be carried out prior to calculation of the chain index.

$$Y_t = T_t \times C_t \times S_t \times I_t, \quad A_t = T_t \times C_t \times I_t$$
$$Y_t = T_t + C_t + S_t + I_t, \quad A_t = T_t + C_t + I_t$$

Which Y_t represents the original sequence, A_t represents seasonally adjusted series. If the scale of seasonal factors is unchanged with the original sequence level increasment or decrease, then we use the additive model; if seasonal factors scale change in proportion to original sequence, we use the multiplicative model. As to the macroeconomic issues, we generally use the multiplicative model.

Fan et al. (2006) systematic comparatively study on the X-11 series, TRAMO / SEATS, structural time series models, SABL, BV4, DAINTIES and other types from the method, decomposition method, seasonal component, and point out X -12-ARIMA and TRAMO / SEATS are the most advanced two seasonal adjustment methods.

Since China announced economic time series data is divided into two categories: the amount of data, year-on-year data. As China's amount of imports and exports in June 2010 was 254.77 billion U.S. dollars, year-on-year increase 39.2%, exports was 137.4 billion U.S. dollars, year-on-year increase 43.9% and imports was 117.37 billion U.S. dollars, year-on-year increase 34.1%. Due to the time series seasonally adjustment is usually built on a period basis for the base period, and then this adjustment will has a significant effect. So for the amount of data, we directly select a monthly data as the base, find the appropriate ratio of fixed base. On year-on-year data, due to the exclusion of part seasonal factors itself, we use Xia Chun' (2002) method, selected a year as base year, and set up fixed base data, which received the data is very close to the real series after seasonal adjustment.

As to the fixed base data, we use X-12-ARIMA, TRAMO / SEATS method for seasonal adjustment. According to the time series features, we select the additive model, multiplicative model, the lognorm additive model, the proposed additive model, and make the fixed base data decompose into a trend component T, cycle components C, seasonal ingredients S and irregular ingredients I, After removing the seasonal component S, we can obtain seasonally adjusted fixed base data.

Using X-12-ARIMA model for seasonal adjustment, we can choose additive decomposition model or multiplicative decomposition model according to the characteristics of time series, then calculate AIC Criterion to determine whether or not to convert logarithmic transformation, and regress the constant and term trading day effects in the regARIMA module. Testing all the models of list and electing a model with minimum prediction error, X12 automatically selects ARIMA model from the collection which provides contains a series of default model ,a description of the file specified (X12A.MDL). After automatical detecting AO and LS outliers, it will test on the residuals of the regression, and revise history test on the seasonally adjusted. TRAMO and SEATS two procedures are often used together. Firstly, we pretreated the data with TRAMO, then use SEATS decompose time series into trend component T, cycle component C, seasonal ingredients S and irregular elements I four parts.

3. Chain Index Constructed Based on Seasonally Adjusted. Statistics seasonally adjusted chain index is divided into two categories: direct statistical chain index, indirect statistical chain index. For the direct statistical chain index, using close two months fixed base data to divided, the data can be obtained, and direct statistical chain index usually be used in the circumstances of trend component T, cycle component C, irregular component I are the same. However, in practice, the trend component T, cycle component C, irregular component I three parts of the component often inconsistent develop, and therefore we need to calculate the indirect statistical chain index. In this paper, we mainly introduce the indirect statistical chain index, and take the additive model, multiplicative model for example. Construction steps and methods are as follows:

(1) Fixed base data conversion. For the amount of data, we directly select a month as base period and then calculate fixed base data corresponding. For the year-on-year data, we select a year as the base year, and then calculate conversion data.

(2) Fixed base data decomposition. We use X-12-ARIMA, TRAMO / SEATS to decompose time series structure. The form of additive model is $Y_t = T_t + C_t + S_t + I_t$ and the form of multiplication model is $Y_t = T_t \times C_t \times S_t \times I_t$.

(3) Eliminate seasonal factors. On the basis of time series decomposition, we exclude seasonal factors, and then can get fixed base data after seasonally adjusted. The form after seasonally adjusted additive model is $A_t = T_t + C_t + I_t$ and the form after seasonally adjusted multiplicative model is $A_t = T_t \times C_t \times I_t$.

(4) Determine seasonal adjusted data of each period ratio of three components, trend component T, cycle component C, the irregular component I. For period t, the trend component T ratio denoted α_t^T, the cycle components C ratio denoted α_t^C, the irregular component I ratio denoted α_t^I. As for additive model, we directly use the proportion of each component. As for multiplicative model, we firstly logarithmic on both sides of the multiply model $A_t = T_t \times C_t \times I_t$, that is $\ln A_t = \ln T_t + \ln C_t + \ln I_t$, and then take $\ln T_t$、$\ln C_t$、$\ln I_t$ proportion to $\ln A_t$ as the each proportion of the components.

(5) Calculate the statistical chain index respectively after the data was decomposed to three components, trend component T, cycle component C, irregular component I. As for additive model, we directly calculate their statistical chain indexes T_t / T_{t-1}、C_t / C_{t-1}、I_t / I_{t-1} and denote T_t^*、C_t^*、I_t^*. As for multiplicative model, we calculate $\ln T_t / T_{t-1}$、$\ln C_t / C_{t-1}$、$\ln I_t / I_{t-1}$, and statistical chain indices are denoted $\ln T_t^*$、$\ln C_t^*$、$\ln I_t^*$.

(6) Synthesize indirect statistical chain index. We take seasonally adjusted of each period component as weight ratio, and then use three component statistical chain indexes to synthesize indirect statistical chain index. As for additive model, the seasonally adjusted index for the chain statistics is $A_t^* = 100 * (\alpha_t^T T^*{}_t + \alpha_t^C C_t^* + \alpha_t^I I_t^*)$. As for multiplicative model, the seasonally adjusted index for the chain statistics is

$$A_t^* = 100 * \exp(\alpha_t^T \ln T^*{}_t + \alpha_t^C \ln C_t^* + \alpha_t^I \ln I_t^*).$$

(7) When adding a new monthly data, we do seasonally adjustment again and repeat the above steps. According to new data, we adjust the previous statistical chain index accordingly.

4. Empirical Analysis. In this paper, we take China's export trade data and year-on-year data for example, and use the above chain index constructed method to calculate. The data comes from the Ministry of Commerce, "Import and Export countries (regions) value" and the Ministry of Commerce Website statistics / import and export statistics. For the seasonally adjusted monthly data, more than 8 years of the sample should be needed to obtain a better adjustment effect, and so we select the monthly data from January 1999 to June 2010. As for the amount of data, we select in January 1999 as the base period = 100, and calculate the fixed base index directly in the base of January 1999. As for the year-on-year data, due to the exclusion of part seasonal factors itself, seasonally adjusted time series are usually built on the basis of fixed base index, and this adjustment will have a significant effect, so in this paper, with using Xia Chun's (2002) method, we select 1999 as the base year, through the year-on-year conversion ratio, and thus the data be obtained is very close to the real series after seasonal adjustment. From the January 1999 based export fixed base and the 1999 based export fixed base curves, we can see that, in 1999-2007, China's exports fixed base index and export year-on-year fixed base shows a steady increase in trend. In 2008, owing to the international financial crisis, the exports declined, and under the role of national policies, the 2009's began to rise. Basical cyclel changes the same every year, with significant seasonal.

Since most economic time series meets the multiplicative model, and the additive model only be used in some fields, such as research students in employment etc. So this article based on exports fixed base data, we use X-12-ARIMA model for seasonal adjustment, and select the multiplicative decomposition model. In order to reflect the dynamic adjustment features of statistical chain index when adding new monthly data, We firstly use 1999.01-2010.05 amount of the monthly data and year-on-year data respectively to calculate statistical chain index, and then on the basis of adding June 2010 export trade data, use 1999.01-2010.06 amount of the monthly data and year-on-year data respectively to estimate statistical chain index again, and adjust previous statistical chain index accordingly.

4.1. Statistical Chain Index Measure of the Export Amount Data. As to the amount of export trade data, we select January 1999 as the base period = 100, and calculate fixed base index directly. We select the multiplicative model, using X-12-ARIMA method for time series decomposition, and obtain trend and cycle components TC, seasonal component S, the irregular component I three parts. On this basis, we eliminate seasonal ingredients, and as for the multiplicative model after seasonal adjusted, we first logarithmic both sides of the multiply model $A_t = TC_t \times I_t$, that is $\ln A_t = \ln TC_t + \ln I_t = \ln T_t + \ln C_t + \ln I_t$. As to the logarithmic trend and cycle components, we use HP filter method for trend decomposition, the trend component T is separated from the C cycle components. So we can obtain components without seasonal factor, the trend component T, the cycle component C, the irregular component I three logarithmic components. We take $\ln T_t$、$\ln C_t$、$\ln I_t$ proportion to $\ln A_t$, as the proportion of the components, and respectively denotes α_t^T、α_t^C、α_t^I. Then after calculating $\ln T_t / T_{t-1}$、$\ln C_t / C_{t-1}$、$\ln I_t / I_{t-1}$, we can obtain statistical chain indices which are denoted as $\ln T_t^*$、$\ln C_t^*$、$\ln I_t^*$. Finally, chain

statistics index after seasonally adjusted is

$$A_t^* = 100 * \exp(\alpha_t^T \ln T^*_t + \alpha_t^C \ln C_t^* + \alpha_t^I \ln I_t^*) .$$

We use 1999.01-2010.05 monthly amount data to calculate statistical chain index, and the calculation results are in Table 1.

TABLE 1. Statistical chain index measure of the export amount data 2009.01-2010.05

Period	α_t^T	α_t^C	α_t^I	$\ln T_t^*$	$\ln C_t^*$	$\ln I_t^*$	Statistics chain index A_t^*	Direct statistical chain index
2009-01	1.0183	-0.0142	-0.0040	0.0010	-0.0203	-0.0145	100.1395	92.5145
2009-02	1.0394	-0.0199	-0.0195	0.0010	-0.0155	-0.0443	100.2202	87.3344
2009-03	1.0207	-0.0233	0.0026	0.0010	-0.0109	0.0636	100.1417	113.1617
2009-04	1.0251	-0.0256	0.0006	0.0010	-0.0065	-0.0060	100.1182	97.3821
2009-05	1.0290	-0.0265	-0.0026	0.0010	-0.0021	-0.0091	100.1138	97.6720
2009-06	1.0256	-0.0257	0.0000	0.0011	0.0021	0.0076	100.1054	102.4968
2009-07	1.0210	-0.0234	0.0023	0.0011	0.0063	0.0068	100.1031	103.3438
2009-08	1.0247	-0.0200	-0.0047	0.0012	0.0100	-0.0205	100.1129	97.8882
2009-09	1.0127	-0.0151	0.0024	0.0013	0.0139	0.0206	100.1125	108.6007
2009-10	1.0083	-0.0096	0.0013	0.0013	0.0161	-0.0033	100.1183	103.3264
2009-11	1.0083	-0.0042	-0.0041	0.0014	0.0158	-0.0159	100.1394	100.3036
2009-12	0.9872	0.0005	0.0123	0.0014	0.0140	0.0496	100.2032	116.1700
2010-01	0.9949	0.0043	0.0007	0.0015	0.0116	-0.0353	100.1481	95.0110
2010-02	0.9886	0.0073	0.0041	0.0015	0.0092	0.0102	100.1581	104.9184
2010-03	0.9932	0.0099	-0.0031	0.0015	0.0077	-0.0219	100.1640	97.1310
2010-04	0.9908	0.0120	-0.0028	0.0015	0.0064	0.0010	100.1573	102.0800
2010-05	0.9775	0.0134	0.0091	0.0015	0.0049	0.0366	100.1881	110.3996

Adding June 2010 on the basis of the export trade data, we use the monthly amount data 1999.01-2010.06 for statistical estimation again, and the previous data is adjusted accordingly. The calculation results are in Table 2.

TABLE 2. Statistical chain index measure of the export amount data 2009.01-2010.06

Period	α_t^T	α_t^C	α_t^I	$\ln T_t^*$	$\ln C_t^*$	$\ln I_t^*$	Statistics chain index A_t^*	Direct statistical chain index
2009-01	1.0188	-0.0150	-0.0038	0.0013	-0.0206	-0.0142	100.1722	92.5848
2009-02	1.0400	-0.0208	-0.0192	0.0013	-0.0157	-0.0442	100.2550	87.3882
2009-03	1.0214	-0.0242	0.0028	0.0013	-0.0110	0.0635	100.1809	113.1824
2009-04	1.0260	-0.0265	0.0005	0.0014	-0.0066	-0.0066	100.1588	97.3124
2009-05	1.0305	-0.0274	-0.0031	0.0014	-0.0023	-0.0105	100.1582	97.4344
2009-06	1.0262	-0.0267	0.0005	0.0015	0.0018	0.0103	100.1521	103.1847
2009-07	1.0222	-0.0246	0.0024	0.0016	0.0057	0.0056	100.1520	103.0141
2009-08	1.0261	-0.0216	-0.0045	0.0017	0.0091	-0.0201	100.1644	97.8844
2009-09	1.0145	-0.0170	0.0025	0.0018	0.0129	0.0205	100.1658	108.4384
2009-10	1.0108	-0.0118	0.0010	0.0019	0.0151	-0.0044	100.1725	102.9260
2009-11	1.0109	-0.0069	-0.0040	0.0020	0.0147	-0.0150	100.1949	100.3847
2009-12	0.9895	-0.0024	0.0128	0.0020	0.0133	0.0510	100.2639	116.4931
2010-01	0.9974	0.0016	0.0010	0.0021	0.0119	-0.0359	100.2070	95.0851
2010-02	0.9912	0.0050	0.0038	0.0021	0.0105	0.0085	100.2205	104.9952
2010-03	0.9960	0.0084	-0.0045	0.0022	0.0102	-0.0251	100.2360	97.1259
2010-04	0.9939	0.0118	-0.0057	0.0022	0.0103	-0.0038	100.2321	102.0089
2010-05	0.9811	0.0150	0.0038	0.0022	0.0105	0.0291	100.2429	110.1002
2010-06	0.9811	0.0180	0.0009	0.0022	0.0091	-0.0089	100.2319	100.5612

4.2. Statistical Chain Index Measure of the Export Year-On-Year Data. As to the year-on-year of export trade data, we select 1999 as the base year, and through the fixed base conversion ratio. Specific steps to measure are the same as statistical chain index measure of the export amount data. We use 1999.01-2010.05 monthly year-on-year data for statistical calculations, and the calculation results are in Table 3.

TABLE 3. Statistical chain index measure of the export year-on-year date 2009.01-2010.05

Period	α_t^T	α_t^C	α_t^I	$\ln T_t^*$	$\ln C_t^*$	$\ln I_t^*$	Statistics chain index A_t^*	Direct statistical chain index
2009-01	1.0189	-0.0149	-0.0040	0.0011	-0.0206	-0.0139	100.1457	92.5977
2009-02	1.0412	-0.0210	-0.0202	0.0010	-0.0159	-0.0444	100.2315	87.2446
2009-03	1.0220	-0.0247	0.0027	0.0010	-0.0114	0.0632	100.1507	112.9414
2009-04	1.0264	-0.0273	0.0009	0.0011	-0.0070	-0.0051	100.1265	97.4916
2009-05	1.0311	-0.0283	-0.0029	0.0011	-0.0025	-0.0105	100.1226	97.3016
2009-06	1.0279	-0.0275	-0.0004	0.0011	0.0018	0.0069	100.1127	102.2793
2009-07	1.0223	-0.0252	0.0028	0.0012	0.0062	0.0091	100.1108	103.8746
2009-08	1.0264	-0.0216	-0.0048	0.0013	0.0102	-0.0214	100.1199	97.7443
2009-09	1.0137	-0.0163	0.0025	0.0014	0.0143	0.0206	100.1190	108.7260
2009-10	1.0095	-0.0103	0.0008	0.0014	0.0167	-0.0048	100.1255	103.1031
2009-11	1.0091	-0.0047	-0.0044	0.0015	0.0160	-0.0148	100.1479	100.6218
2009-12	0.9867	0.0002	0.0130	0.0015	0.0140	0.0505	100.2168	116.4192
2010-01	0.9948	0.0042	0.0009	0.0016	0.0116	-0.0354	100.1571	95.0176
2010-02	0.9884	0.0075	0.0042	0.0016	0.0095	0.0094	100.1682	104.8450
2010-03	0.9935	0.0105	-0.0040	0.0016	0.0088	-0.0237	100.1784	96.9812
2010-04	0.9909	0.0135	-0.0043	0.0016	0.0086	-0.0010	100.1723	102.1475
2010-05	0.9776	0.0162	0.0062	0.0016	0.0086	0.0309	100.1916	109.9440

Adding June 2010 on the basis of the export trade data, we use the monthly amount data 1999.01-2010.06 for statistical estimation again, and the previous data is adjusted accordingly. The calculation results are in Table 4.

TABLE 4. Statistical chain index measure of the export year-on-year data 2009.01-2010.06

Period	α_t^T	α_t^C	α_t^I	$\ln T_t^*$	$\ln C_t^*$	$\ln I_t^*$	Statistics chain index A_t^*	Direct statistical chain index
2009-01	1.0198	-0.0156	-0.0042	0.0013	-0.0208	-0.0149	100.1737	92.3977
2009-02	1.0418	-0.0217	-0.0201	0.0013	-0.0159	-0.0435	100.2586	87.4766
2009-03	1.0223	-0.0253	0.0030	0.0013	-0.0112	0.0636	100.1830	113.1610
2009-04	1.0272	-0.0279	0.0007	0.0014	-0.0068	-0.0065	100.1592	97.2855
2009-05	1.0320	-0.0289	-0.0031	0.0014	-0.0025	-0.0105	100.1583	97.3658
2009-06	1.0279	-0.0282	0.0003	0.0015	0.0016	0.0095	100.1511	102.9542
2009-07	1.0235	-0.0260	0.0025	0.0016	0.0058	0.0062	100.1504	103.1821
2009-08	1.0276	-0.0227	-0.0049	0.0017	0.0093	-0.0208	100.1631	97.7768
2009-09	1.0151	-0.0178	0.0027	0.0018	0.0131	0.0213	100.1638	108.6979
2009-10	1.0112	-0.0123	0.0012	0.0019	0.0153	-0.0043	100.1703	103.0252
2009-11	1.0112	-0.0071	-0.0041	0.0020	0.0148	-0.0150	100.1934	100.4184
2009-12	0.9888	-0.0024	0.0136	0.0020	0.0134	0.0513	100.2671	116.6131
2010-01	0.9974	0.0017	0.0008	0.0021	0.0119	-0.0372	100.2067	94.7992
2010-02	0.9907	0.0053	0.0040	0.0021	0.0105	0.0092	100.2201	105.1624
2010-03	0.9956	0.0089	-0.0045	0.0022	0.0102	-0.0247	100.2352	97.1836
2010-04	0.9936	0.0123	-0.0059	0.0022	0.0102	-0.0041	100.2316	101.9121
2010-05	0.9803	0.0157	0.0040	0.0022	0.0103	0.0290	100.2425	110.0217
2010-06	0.9806	0.0187	0.0007	0.0022	0.0089	-0.0096	100.2311	100.3411

From the statistical chain index based on seasonal adjustment of the export trade amount data and year-on-year data, using the multiplicative model and dynamic synthesize statistical chain index based on time series structure decomposition method ,we can be found, owing to the trend component T has a large percentage, cycle component C and irregular ingredients I is relatively small, so the indirect statistical chain index is more stable than the direct statistical chain index, indicating that in the post-crisis era China's exports have maintained a good momentum of development. Adding the June 2010 new information and adjusting the previous index correspondingly, the data more objectively reflect the actual changes.

5. Conclusions. This paper, based on time series seasonally adjusted, proposes the construction methods of statistical chain index. Firstly of all, decompose the seasonally adjusted time series into trend component T, cycle component C, irregular component I three parts, then according to the ratio of three components weight dynamically to determine the ratio of three components the weight of each component, and then calculate their statistical chain index, finally synthesize indirect statistical chain index. When adding a new monthly data, we did seasonally adjustment again, chain index of past statistics were adjusted accordingly. With China's export trade amount data and year-on-year data for statistical chain index measure, the specific composing process are discussed, results show that, the seasonally adjusted the indirect statistical chain index more stable than the direct statistical chain index, more full use of the information contained in the data, facilitates the comparisons between different months, and helps to improve the timeliness of statistics.

REFERENCES

[1] C. Xia (2002), The actual calculation of economic time series, seasonal adjustment and related economic implications, *Economic Research* , vol.3, pp. 36 - 43.

[2] H. Luan (2007), The consumer price index, real-time monitoring - based on seasonal adjustment methods, *Economic Science*,vol.2, pp. 59-67.

[3] M. Zhang (2009), Seasonal adjustment on the latest developments in international and Reflections on China, *Statistical Research*, vol.10, pp.14-18.

[4] M. Zhang, Y. Xiang and D. Qi (2004), Seasonally adjusted consumer price index for empirical research, *FINANCE*,vol.3, pp.133-144.

[5] L. Liu (2001), On the West seasonally adjusted time series understanding, *Statistical Research*, vol.12, pp. 60-61.

[6] Statistics Division of the People's Bank of China (2006), Time Series X-12-ARIMA seasonal adjustment, Principles and Methods, China Financial Publishing House.

[7] T. Gao (2006), *Econometric analysis and modeling*, Beijing: Tsinghua University Press.

[8] W. Fan, L. Zhang and G. Shi (2006). Review and compare seasonal adjustment method, *Statistical Research*, vol.2, pp.70 - 73.

[9] Y. Dong, Y. Shen and L. Dong (2008), CPI monthly chain index and the CPI seasonally adjusted annual rate of folding method, *Statistical Research*, vol.2, pp. 22-24.