

Economic chromatography analysis method: innovative theory and method of Interdisciplinary Research——based on the reference of statistics to chemistry

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Abstract

Inspired by the chromatography in chemistry, this paper tries to set up a new method of statistical analysis, with the complex economic phenomena as the subject of study. This paper also studies how to combine statistics with chromatography in chemistry including the theoretical background and feasibility analysis. Based on the case of economic chromatography analysis, this paper explores the specific patterns and models of interdisciplinary research. Using the consumer behavior analysis as example, the paper has illustrated the substitution of the concepts, theories and methods of chemical chromatography. It also has demonstrated how to apply the plate theory to analyzing consumer behaviors. In general, the paper has tested and validated preliminarily the theoretical framework of economic chromatography analysis; thus, has laid a theoretical foundation for further study.

Keywords: Statistics combing chemistry; economic chromatography analysis; interdisciplinary research; consumer analysis

1. Introduction

As an academic behavior, the interdisciplinary research, especially the mutual learning from related theory and method among subjects, should be advocated, because it is a good means to transform the academic development direction and improve the academic levels. As an interdisciplinary, the statistics is so. Based on the chemistry chromatography technology, the paper tries to introduce the chromatographic analysis method into statistics under an innovative thinking mode of interdisciplinary research. Furthermore, it also tries to explore the mutual learning among subjects in order to establish a set of new theories and methods of statistical analysis.

2. The brief introduction of the referenced subject Chemical Chromatography

Chromatography, as one important branch of the referenced subject Chemistry, is a physical and chemical separation and analysis method, mainly based on the small differences of solubility, pressure, adsorption capacity, structure, ion exchange and other physicochemical properties. Since components have different partition coefficients in mobile phase and stationary phase, they will go through multiple distributions continuously between the two phases, and finally be separated.

The main features of chromatography are: Excellent Selectivity; high separation efficiency and fast analysis speed; reliable detection ability and high sensitivity; less samples are needed. The main theories and methods include balance theory, plate theory, rate theory, resolution theory, signal detection method, qualitative and quantitative analysis method, etc.

3. The feasibility analysis that Statistics reference Chemical Chromatography

Chromatography is a method exploring internal system according to the object system response. Compared with other methods, it has many advantages which include wider application field and more effective classification, and it is also more scientific and practical. While subjective evaluation is the main feature of existing methods analyzing complex economical phenomenon, which analyzes the essence of the object

according to its peripheral subjective understanding, while the chromatography determines the scientific basis as well as the evaluation standard, which is the expected standard of truth, by the interior signal detection inside the natural object. In the present study, low-resolution analysis and measurement problem resulting from the multidimensional performance of complex economic phenomenon, together with the information omission are vital bottlenecks. Contrarily, chromatography can both greatly improve the resolution of the analysis and reduce information omission since the separated components will go through multiple distributions between stationary phase and mobile phase. Besides, single method and selective application field are also restrictive defects of existing analysis methods. However, chromatography can detect the longitudinal and diffusion signals of components using the analysis function of its column system, and therefore to a large extent broaden the field of analysis and application scope. Chromatography is based on reductionism, seeking explanations of economic phenomenon from local system and microstructure. It also takes holism as theoretical guidance and stresses the interrelation and interaction between each internal part of the system to determine the essence of phenomenon. Moreover, because of its unique column system, chromatography can quickly satisfy the requirements of both qualitative and quantitative analysis on components at the same time, which cannot be accomplished by other existing analysis methods.

4. Empirical simulation of chromatography economic analysis method

4.1 Simulation purposes, basic assumptions and replacement of the concepts

4.1.1 Simulation purposes

This paper intends to make an empirical simulation of consumer behavior classification, solely for the purpose to learn the feasibility of the reference model, with which we stimulate and prove this interdisciplinary research. It's mainly about the research on methodology and demonstration.

4.1.2 Basic assumptions

We assume that consumer groups are composed of two different types of consumers with different consumption propensity ---class A and class B. These two types of consumers can only choose between saving and consumption for their disposable income, and the ratio of consumption and saving is different. The ratio of class A is 1:1 and the ratio of class B is 1:4. Each partition coefficient (K) of two kinds of consumers is constant on each column plate, and don't change with the number of component on diverse column plates;

4.1.3 The key concepts and theories replacement

Due to space limitations, this paper will not analyze chromatography of chemistry in detail, only the basic concepts and theories are chosen for general description and replacement.

Stationary phase: in chemical chromatography, stationary phase is characterized by "adsorption", in chromatography economic analysis especially in this case, the stationary phase stands for the value. If consumers choose to save, which means he chose to hold his money, then money is said to be "absorbed" by stationary phase in the form of savings.

Mobile phase: in chemical chromatography, stationary phase is characterized by "elution" or "push", in chromatography economic analysis, the mobile phase is set to the value in use. If consumers choose consumption, which means he choose to use his money, then money is said to be "eluted" or "pushed" by mobile phase in the form of consumption.

Plate theory: plate theory is the basic theory of chromatographic analysis, in which a continuous chromatographic process is regarded as many repeated small pieces of the equilibrium process. Chromatographic column is compared to a distillation tower, and consists of many imaginary column plates. When the components to be separated get into the chromatographic column with the carrier gas, they begin to be allocated

between the two phases. For mobile phase keeps moving, the components in these intervals of plates constantly achieve continuous distribution equilibrium between two phases. Then we can obtain the mathematical expression of chromatographic elution curves according to the plate theory, and calculate the theoretical plates as given column length. In the classification of consumers' behavior, the macro environment the consumers facing is abstractly seen as a chromatographic column. The classification process of the components of consumers in the column consists of many imaginary column plates. In the chromatographic column of each plate area, a part of space is occupied by consumers choosing saving and the other part of space is occupied by consumers choosing consumption. When components of consumers to be separated get into the column, with the increase in disposable income as carrier gas, consumers begin to choose between mobile phase and stationary phase. At this time, distinguishing different types of consumers is based on different distribution ratios. Because of the constant changes in disposable income of consumers, the components of consumers to be separated constantly achieve continuous distribution equilibrium between saving and consumption.

Rate theory: As a semi-empirical theory, plate theory has many insufficient aspects: First, consumers do not make the instant decision. Usually, there was some time to think before they make choice of consumption. As the time of making decision has been extended, when we use plate theory to describe such kind of economic action, we will not get a satisfied result as we expected; Second, in view of the influence of economics factors and the interrelationship between consumers, part of consumers will choose the consumption space which has less people to avoid the consumption crowd. And then they observe and study to make more careful choice. This diffusing function lengthen the time of the separating component' s outflow; Third, the plate height H is also influenced by the total deviation of unit column length, which is influenced by the factor such as the rate of economic growth and the change of market. The plate theory can' t explain this too. Therefore the rate theory is an improvement of the plate theory. Through the study of how the movement of component in the chromatographic column influenced by eddy diffusion, molecular diffusion, and mass transfer resistance and so on, the rate theory has exactly perfected the system of chromatographic column, including some appropriate descriptions to some problems, like the time of component' outflow and the chromatographic peak' s wide.

Resolution theory: Resolution, also called distinguish ability, is the separated degree of the adjoining chromatographic peak between the components in the mixture, which can distinguish the separated situation of the substance in the chromatographic column. It is an index of measure the chromatographic column' s efficacy. When we use chromatographic economic analytic method to classify the complex economic phenomenon, we need to detect the resolution of different economic phenomenon, as it is the key factor to measure the separated degree of the targeted economic phenomenon and the chromatographic column' s efficacy. In this theory, the basic expressed indexes include the relative surplus, the chromatographic column' s efficacy, and the resolution ratio. The main factors needed to consider include the column efficacy factor, the volume factor and the alternative factor and so on.

The detection method of signal: After separated by the chromatographic column, the complex substance is divided into several components. The components outflow, and will be changed to measurable signal by detecting instrument. We can use the signal to make qualitative and quantitative analysis. During the chromatographic economic analysis, the awaiting parted components will signal relatively after parted by the chromatographic column. As different components have different signals, it will make an outflow curve in the exit of the chromatographic economic column system. The curve will be the base of qualitative and quantitative analysis.

Qualitative and quantitative analytic method: When we do the chromatographic analysis, our targets are not only parting complex substance but make the qualitative

and quantitative analysis to its components. In the chromatographic economic analytic methods, the qualitative analytic methods include the standardizing qualitative method, the literature qualitative method, the alternative detecting qualitative method, and the economic reactive qualitative method and so on. The quantitative analytic methods usually use special technique to analyze each component. The techniques include the measurement of the chromatographic economic peak's height, the measurement of the chromatographic economic peak's area, and quantitative corrective factor and so on. The qualitative and quantitative analysis is a crucial step in the study of the chromatographic economic analytic methods. By handling sample, choosing appropriate method, controlling the condition, and analyzing the parting process, we can select valid information and data to make qualitative and quantitative analysis towards the awaiting parted components. This method is helpful to study the characteristic, structure, and function of each component and then to part them from complex economic phenomenon.

4.2 Simulation process

As the main content of this paper is to elaborate the overall research idea of the innovative theory and methods of chromatography economic analysis method, and the research purpose is methodology, due to the space constraint, we only select the plate theory to simulate so as to play the role of demonstration.

4.2.1 The allocation process of similar components

First of all, this paper simulates the consumer behavior of homogeneous groups as the chromatographic process according to the hypotheses. At the beginning, 100 units of type A consumers (i.e. components), each of whom has M units of initial income, are added to the number zero tower plate. As the distribution ratio K1 is 1, the propensities to consume and to save are both 0.5; hence $m_m = m_s = 50$. The distribution of components in the chromatographic column can be shown in Table 1:

Table 1 The component distribution condition in the distribution process

| the plate number r | component distribution | 0 | 1 | 2 | 3 |
|--------------------|------------------------|------|-----------|----------|-----|
| access | m_m | 50 | | | |
| | m_s | 50 | | | |
| add constraint v1 | m_m | 25 | 25 | | |
| | m_s | 25 | 25 | | |
| add constraint v2 | m_m | 12.5 | 12.5+12.5 | 12.5 | |
| | m_s | 12.5 | 12.5+12.5 | 12.5 | |
| add constraint v3 | m_m | 6.3 | 6.3+12.5 | 12.5+6.3 | 6.3 |
| | m_s | 6.3 | 6.3+12.5 | 12.5+6.3 | 6.3 |

When the disposable income constraint increases, that is, when adding M units to every consumer's income at one time, the consumers continue to make choices and distribution between consumption and savings. Half of the consumers on plate number 0 choose consumption and go to the plate 1, as the previous process, due to select consumption, half of the consumers on plate 1 get into plate 2. When the same constraints increase, this process will be repeated. It is shown in table 1.

According to above distribution process, as for the system of plate number $n=5$, distribution ratio $k=1$ and component $m=100$, with the constraint pulse increased, the total number of component distribute on each plate is shown in table 2.

Table 2 the distribution of components in each tower plate when $n=5, k=1$

| the number of constraint added | the number of plate | | | | | exit |
|--------------------------------|---------------------|----|----|---|---|------|
| | 0 | 1 | 2 | 3 | 4 | |
| 0 | 100 | 0 | 0 | 0 | 0 | 0 |
| 1 | 50 | 50 | 0 | 0 | 0 | 0 |
| 2 | 25 | 50 | 25 | 0 | 0 | 0 |

| | | | | | | |
|----|------|------|------|------|------|------|
| 3 | 12.5 | 37.5 | 37.5 | 12.5 | 0 | 0 |
| 4 | 6.3 | 25 | 37.5 | 25 | 6.3 | 0 |
| 5 | 3.2 | 15.7 | 31.3 | 31.3 | 15.7 | 3.2 |
| 6 | 1.6 | 9.5 | 23.5 | 31.3 | 23.5 | 7.9 |
| 7 | 0.8 | 5.6 | 11.6 | 27.4 | 27.4 | 11.8 |
| 8 | 0.4 | 3.2 | 8.6 | 19.6 | 27.4 | 13.3 |
| 9 | 0.2 | 1.8 | 5.9 | 14.1 | 23.6 | 13.8 |
| 10 | 0.1 | 1 | 3.8 | 10 | 18.9 | 11.8 |
| 11 | 0 | 0.5 | 2.4 | 6.9 | 14.5 | 9.5 |
| 12 | 0 | 0.2 | 1.6 | 4.6 | 10.7 | 7.3 |
| 13 | 0 | 0.1 | 0.8 | 3 | 7.6 | 5.4 |
| 14 | 0 | 0 | 0.4 | 1.9 | 5.3 | 3.8 |
| 15 | 0 | 0 | 0.2 | 1.2 | 3.6 | 2.8 |
| 16 | 0 | 0 | 0.1 | 0.8 | 2.4 | 1.8 |

The Fig.1 shows the outflow curve draws according to table 2,the vertical axis shows the number of components in the outlet, while the horizontal axis indicates the number of increased constraints.

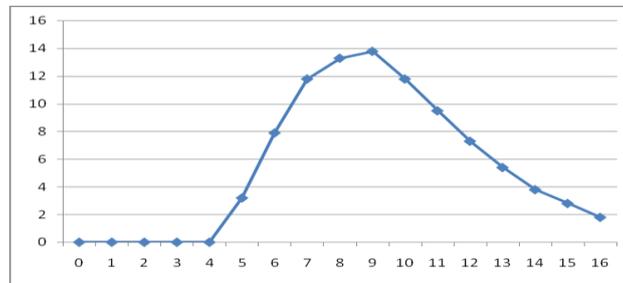


Fig. 1 the outflow curve when n=5, k=1

As the figure shows, the outflow curve is not symmetrical. However, according to the nature of the chromatography outflow curve and the plate theory, we can prove that: if the number of theoretical plate $n=100$, the outflow curve will approximate symmetrical and reaching the normal distribution as the number of constraints increase tends to infinity.

4.2.2 The separation of mixed components

When the consumer group is expanded to the mix of A and B, components A and B are distributed between different plates respectively according to the allocation process. The propensities to consume (hence, the distribution ratio) of class A and B consumers are different, Therefore, after several distributing equilibrium the maximum outflows of the two types of consumers are different. By hypothesis, the distribution ratio of class A and B consumers are $K1=1:1$ and $K2=1:4$. Using above simulation, the separation results obtained is shown in figure 2.

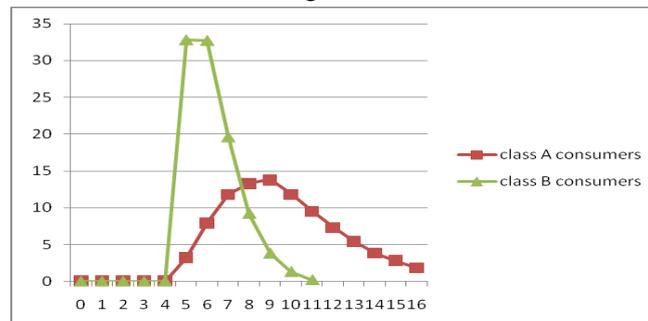


Fig.2 the outflow curve of the two mixed components when n=5

The figure shows that proportions of customers choosing consumption and saving are

different in two consumer groups due to the different distribution ratios. Two groups of consumers are separated by chromatographic separation system and their outflows formed two peaks.

5. Conclusion

For many scholars, the interdisciplinary research has many risks that they may cost considerable time but cannot be admired. Despite all that, the ideas and model analysis mentioned above is a proper academic try. Based on the foregoing research, we considered that for statistics, as a methodological branch, there are many expanding space to explore by learning some theories and methods from other subjects, meanwhile the corresponding theory and methods will improve. Of course, compared with other sophisticated statistic methods, the research in the paper is at the primary stage. Some assumptions and modes are unreasonable in form and content. Therefore, there are many problems which involved in the interdisciplinary research. According to the previous study, the theoretical and practical significance is worth expecting in the future.

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