Predicting Changes in Civil Litigation Representation Cases Based on Nonlinear Regression Models and Analysing the Intervention Muscles

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Abstract: This paper analyses the trend in the number of civil litigation representation cases in China and explores the impact of legal practices, such as the implementation of the Civil Code and the development of cyber courts, on this trend. First, case data from 2017 to 2021 are analyzed and predicted using a non-linear regression model, which reveals that factors such as restriction policies, epidemics, and judicial reforms have had a significant impact on the number of cases. Then, the detailed analyses of the implementation of the Civil Code and the improvement of cyber courts in 2021 found that this factor did not increase the growth rate of the number of civil litigation representation cases, but rather showed signs of decline. The causes of this phenomenon were further analyzed through normality tests and independent samples t-tests, pointing out that factors such as the adaptation period of the new law, the impact of epidemics and the popularity of alternative dispute resolution mechanisms may be the main reasons for the decline in the growth rate of cases. The research in this paper provides data support and theoretical basis for future judicial policy formulation.

1. Introduction

A study of trends in the number of civil litigation agents can reflect social legal awareness and demand, promote the rational allocation of judicial resources and provide a basis for the formulation of legal policy. In addition, this trend analysis can help to improve the quality of legal services and serve as an indicator of socio-economic development, providing support for legal practice and policy reform.

Susskind Richard observed the number of cases accumulated in civil courts in Brazil and India [1], combined with the rise and development of new ways of trial such as cyber courts in recent years, and found the role of cyber courts in improving the efficiency of litigation. Ulen, through his research [2], concluded that legal innovations and new ways of administering justice have a greater impact on the market for representation in civil litigation cases. Subhash Chand used a nonlinear regression method to study the trend of the stock market[3], meanwhile, Jones and Antonia J. solved the practical problem of water level and flow prediction in Thames River Basin through nonlinear regression equations[4], which shows that nonlinear regression method has a greater advantage in the problem of time series prediction. Marc Galanter pointed out through his research[5], that United States from 1962 to 2002, the number of tort cases decreased, and compared the changes in the growth rate of the number of domestic civil litigation cases. However, few scholars have used non-linear regression methods to analyze the impact of cyber court and major law amendment events on the trend of the number of civil litigation representation cases. Therefore, the purpose of this paper is to explore the specific impact of cyber court and major law amendment events on the change of the number of civil litigation representation cases based on the non-linear regression analysis model, so as to provide data support and theoretical basis for future judicial practice.

In this paper, Chapter 2 analyses the trend of the number of civil litigation representation cases in China, and predicts the trend based on a non-linear regression model. The content of Chapter 3 analyses the reasons for the decline in the growth rate of civil cases in 2021 and analyses the muscles produced by the impact.

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2. Analysis of changes in the number of civil litigation agents based on a non-linear regression model

2.1 Analysis of trends in the number of civil litigation agents

Civil litigation agent refers to the system whereby the parties or other litigation participants entrust others to conduct litigation activities on their behalf in civil litigation. Within the scope of the party's authorization, the agent carries out litigation activities in the party's name, and the legal consequences of his or her actions are borne by the party. China's civil litigation agency system in the "People's Republic of China Civil Procedure Law" has detailed provisions, aiming to protect the legitimate rights and interests of the parties, and promote judicial justice and efficiency. Its types include legal representation, appointed representation, entrusted representation and so on. Agency in the commercial field is dominated by entrusted agencies, and thus the connection between market fluctuation and civil agency is an important object for analyzing the number of civil litigation agency cases.

The demand for civil litigation is influenced by a number of factors, including population size, economic growth and the emergence of innovative industries, which have led to an increase in the variety and number of social relationships. At the same time, legal entities balance the costs of litigation against the costs of litigation and choose between litigation and non-litigation methods of dealing with social relationships. Changes in the content of civil law, the increase in the number of ways to seek judicial remedies, and the continuous improvement of the public interest litigation system are all key factors affecting the cost of litigation.

Specific trends in the number of civil litigation representations are shown in Figure 1.

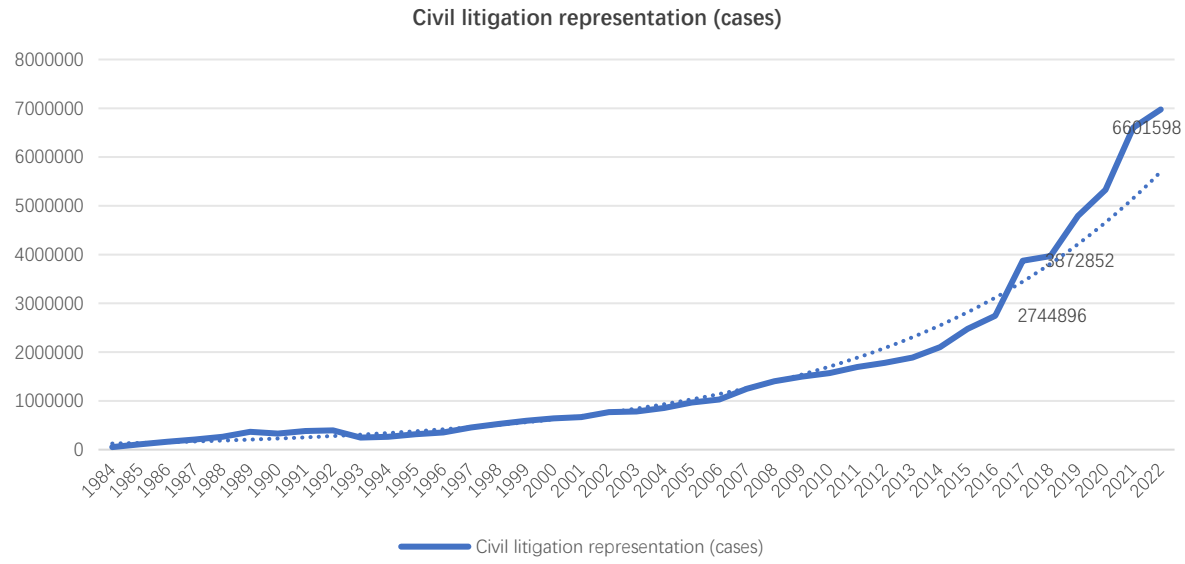

Figure 1 Trends in the number of civil litigation agents

The dashed part of Figure 1 shows the image of the exponential function of the most recent discrete image. There is a clear trend of slowing down in the growth of the number of cases from 2017 to 2018 compared to the previous year.

Among them, in 2017, China's real estate market experienced a series of purchase restriction policies, and the number of civil litigation cases related to real estate decreased based on the purchase restriction policies of each city. Firstly, the implementation of the purchase restriction policies has directly affected the homebuyers' purchasing behavior. In 2017, a number of first-tier cities such as Beijing, Shanghai, Guangzhou and Shenzhen introduced strict purchase restrictions that tightly control the eligibility to purchase a home. These policies required foreign homebuyers to provide a record of social security or personal income tax payments for several consecutive years in order to purchase a home and also imposed restrictions on local homebuyers, such as raising the limit on the number of units to be purchased and the percentage of down payment. Through these measures, the government has effectively curbed speculative purchases and short-term property speculation. The

stability of the market has been improved, and overheating in the property market has been effectively curbed, which in turn has reduced the number of civil disputes arising from drastic fluctuations in property prices. The introduction of the purchase restriction policy has indirectly reduced the pressure on the courts to handle litigation cases arising from property market problems.

The significant increase in the number of civil litigation cases from 2020 to 2021 was influenced by a combination of factors, including the impact of the New Crown epidemic, adjustments in judicial reform, legal disputes during the economic recovery period, changes in policies and laws, and the accumulation of social tensions. First, difficulties in contract performance, stagnant business operations and strained labor relations caused by the New Crown outbreak led to a surge in the number of civil litigation cases. Businesses and individuals were unable to fulfill their contractual obligations during the outbreak, and large-scale contractual disputes arose, particularly over leases, supply chain disruptions and service contracts. At the same time, there was a surge in labor disputes as companies shut down or laid off workers, who faced problems with pay and termination indemnities. A large number of disputes also arose between consumers and merchants over refunds and returns, further fuelling the growth in civil cases.

Second, the judicial reform and the restructuring of the case-handling mechanism between 2020 and 2021 had a significant impact on the number of civil litigation cases. In response to the surge in caseload, the court system adopted measures to centralize and prioritize cases, while promoting cyber courts to maximize the impact of online trials. While these reforms have improved the efficiency of case processing, the ability for cases to be filed quickly has allowed online trials to lower the threshold for litigation, and the use of smart courts has led to a short-term surge in the number of cases being litigated.

The Civil Code, which came into force on 1 January 2021, is widely regarded by the public as having made important adjustments to the civil litigation system, including the unification and refinement of legal norms in the areas of contracts, marriage and family, and inheritance. In response to judicial demand, a large number of legal interpretations and related implementing regulations have been generated, affecting the number of litigation cases in the relevant areas. In addition, changes in financial regulatory policies, in particular the consolidation of P2P lending platforms, have led to a large number of investor rights lawsuits, further increasing the number of civil cases.

2.2 Prediction of the number of civil litigation agents based on a non-linear regression model

A non-linear regression model is fitted. The functional relationship can be expressed as:

$$y_i = f(x_1^i, x_2^i, \ldots, x_j^i, \theta_1, \theta_2, \ldots, \theta_p) + \varepsilon_i (i = 1,2, \ldots, n)$$

where y is the true value; i denotes the ith set of data;$y_i = f(x_1^i, x_2^i, \ldots, x_j^i, \theta_1, \theta_2, \ldots, \theta_p)$ is the multivariate linear (nonlinear) function and denotes the deterministic part; $x_1^i, x_2^i, \ldots, x_j^i$ is the independent variable; $\theta_1, \theta_2, \ldots, \theta_p$ is the unknown model parameters of the multivariate linear (nonlinear) function;ε_i is the stochastic part.

Plotting a scatter plot observes the general direction of the data and then determines the multivariate function to be used:

$$y = \theta_1 * e^{(\theta_2 * x + \theta_3 * x^{\frac{1}{2}})} + \theta_4 * x$$

The solution is solved using a differential evolutionary algorithm for the$\theta_1, \theta_2, \theta_3, \theta_4$ optimisation.

Population initialisation:

The population size M is chosen to be 100, and M individuals are randomly and uniformly generated in the solution space, each consisting of n-dimensional vectors

$$X_i(0) = (X_{i,1}(0), X_{i,2}(0), X_{i,3}(0), \ldots, X_{i,n}(0))$$

i=1,2,3,... ,M

where before the first iteration the

$$X_{i,j}(0) = L_{jmin} + rand(0,1)(L_{jmax} - L_{jmin})$$

$$i=1,2,3,\ldots,M;\ j=1,2,3,\ldots,n$$

In the gth iteration, the

Three individuals were randomly selected from the population$X_{p1}(g)$, the$X_{p2}(g)$,$X_{p3}(g)$ and $p1 \neq p2 \neq p3 \neq i$. The vector of variation generated is:

$$H_i(g)=X_{p1}(g) +F*(X_{p2}(g) -X_{p3}(g))$$

where$\Delta_{p2,p3}(g) = X_{p2}(g) - X_{p3}(g)$ is the checkpointing vector and F is the scaling factor.

The three randomly selected individuals in the variation operator are ranked from best to worst to obtain theX_b, X_m, X_w Corresponding fitness $f_b, f_m, f_w,$ The variance operator reads:

$$V_i = X_b + F_i(X_m - X_w)$$

At the same time, the value of F varies adaptively according to the two individuals generating the difference vector:

$$F_i = F_I + (F_u - F_i)\frac{f_m - f_b}{f_w - f_b}, F_I = 0.1, F_u 0.9$$

The mutation strategy is:

$$DE/rand/1: V_i(g) = X_{p1}(g) + F(X_{p2}(g) - X_{p3}(g))$$

cross-cutting

$$V_{i,j=}\begin{cases} h_{i,j}(g), rand(0,1) \leq cr \\ X_{i,j}(g), else \end{cases}$$

where $cr \in [0,1]$ is the crossover probability, taken as cr = 0.7.

option

$$X_i(g+1) = \begin{cases} V_i(g), f(V_i(g)) < f(X_i(g)) \\ X_i(g), else \end{cases}$$

When the iteration is finished, the betterθ_1, θ_2 ,... ,θ_p combinations.

The method is repeated twice, respectively, resulting in Model I with sample data containing the number of civil cases in 2021 and Model II with sample data not containing the number of civil cases in 2021, and the prediction results can be obtained through simulation as shown in Figure 2.

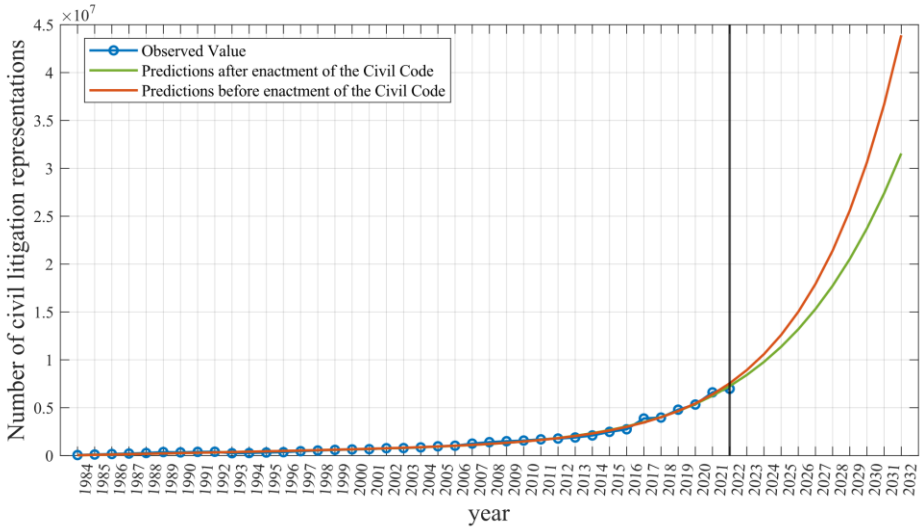

Figure 2 Predicted results

The performance of model I and model II obtained is shown in Table 1.

Table 1 Prediction results of the two models

norm	Modelling (excluding 2021 data)	Modelling (with 2021 data)
The root of Mean Square Error (RMSE)	144561.070611723	125998.291308521
The sum of Square Error (SSE)	815018222319.896	587396068268.68
Correlation Coef. (R)	0.99667588686096	0.995465474985966
R-Square	0.993362823450081	0.990951511889034

A comparative simulation analysis shows that the model's prediction of the future number of civil cases fluctuates slightly and the growth rate decreases after excluding the sample data of civil cases in 2021. In 2021, the impact of the COVID-19 outbreak and the implementation of the digital economy and data privacy laws, coupled with the official entry into force of the Civil Code as of 1 January 2021, led to a significant increase in the number of cases with different differences between data models. Particularly for the prediction of the number of civil litigation cases, the changes in the substantive law have triggered an increase in the double pressure in the trial and enforcement process. This change in the legal environment not only affects the trial of cases but also has an impact on the allocation of judicial resources and the efficiency of enforcement.

3. Analysis of the effectiveness of legislative interventions based on independent samples t-tests

3.1 Normality test and independent samples t-test

The distribution of the data needs to be tested before the correlation test can be performed.

The Kolmogorov-Smirnov distribution test model can be described as follows:

The original hypothesis (H0): the data follow a normal distribution;

Alternative hypothesis (H1): The data do not follow a normal distribution.

Let the overall X distribution function be $F(x)$ and $F(x)$ be the continuous function of $X_1, X_2, \ldots, X_n$ is the distribution function from X of the samples. Then its cumulative distribution function can be written as:

$$F_n(x) = \frac{1}{n}\sum_{i=1}^{n} I_{[-\infty,x]}(X_i)$$

where$I_{[-inf,x]}$ is the indicator function which takes the value:

$$I_{[-inf,x]}(X_i) = \begin{cases} 1, X_i \le x \\ 0, X_i > x \end{cases}$$

At this point, the Kolmogorov-Smirnov statistic can be formulated as:

$$D_n = \sup_x |F_n(x) - F(x)|$$

where $F_n(x)$ is the cumulative distribution function, and $F(x)$ is a hypothetical theoretical distribution. In that paper, we assume that it obeys normal distribution. $\sup$ is an upper definite bound on the distance, based on the Glivenko-Cantell quantification, if X_i obeys the theoretical distribution $F(x)$, then when n tends to infinity whenD_n tends to zero.

In general, significance was chosen to be 0.05 or 0.01.

The results of the normality test are shown in Table 2:

Table 2 Results of the normality test

norm	significance
Number of non-litigation representations	0.001

As can be seen from the table, the test *P* value is close to 0.001, and it can be assumed that the data approximately obey a normal distribution.

The t-test results are shown in Table 3:

Table 3 T-test results

norm	Sig.	Sig. (2-tailed)
Significance (P value)	0.004	0.079

As can be seen from the table, the test *P* value is greater than 0.05, and it can be assumed that there is no significant difference between the means of the two groups.

3.2 Analyses of the intervening texture of civil legislation

The growth rate of civil cases in 2021 shows a downward trend. According to the general logical analysis, the implementation of the Civil Code and the gradual improvement of cyber courts in 2021, the diversification of civil relations and the gradual reduction of litigation costs will lead to a further increase in the growth rate of civil litigation cases. However, the data shows that the growth rate has been suppressed to a certain extent, although the difference between the two sets of predicted data cannot be considered significant when compared. The reasons for this may be as follows:

One, 2021 is the first year of implementation of the Civil Code. The implementation of a new law usually requires a period of time for the public, legal practitioners, and the court system to gradually adapt. This adaptation period may result in some parties taking a wait-and-see attitude towards the application of the new law and thus delaying or avoiding litigation. The Civil Code provides clearer legal rules, which reduces uncertainty in the application of the law. The fact that it is easier for parties to predict the outcome of litigation may prompt them to choose to resolve their disputes through settlement and mediation rather than litigation, which indirectly inhibits the growth of cases.

Secondly, the world is still dealing with the COVID-19 epidemic in 2021, which has led to a decrease in economic activities and a corresponding decrease in commercial disputes, which may have affected the number of civil cases. Moreover, in recent years, alternative dispute resolution mechanisms such as mediation and arbitration have been further developed in China, particularly in the areas of grassroots communities, labor disputes and consumer disputes, and the widespread use of these mechanisms may have reduced the number of litigation cases. With the popularity of cyber courts and online mediation platforms, parties can resolve disputes more easily, reducing the need to resort to traditional courts. These factors may make parties more inclined to resolve disputes through non-litigious means.

Thirdly, with the deepening of legal education, the public has become more aware of the law and has a clearer understanding of the time, cost and uncertainty of litigation, and may choose more carefully whether or not to enter into litigation. This increased awareness has prompted more people to resolve their disputes through mediation and arbitration as provided for in the law, rather than resorting directly to the courts.

4. Summary

This paper examines the trend in the number of civil litigation representation cases in China, focusing on the impact of the implementation of the Civil Code and the development of cyber courts on this trend. The significance of the study is that by analyzing this trend, it provides a basis for the formulation of legal policies and the rational allocation of judicial resources, provides a guarantee for the improvement of the quality of legal services, and also reflects the changes in society's legal awareness and needs.

In Chapter 2, the article analyses data on civil litigation representation cases between 2017 and 2021 using a non-linear regression model, revealing the significant impact of restrictive policies, epidemics, and judicial reforms on caseloads. The model predictions show that although the implementation of the Civil Code and the improvement of cyber courts in 2021 should have further boosted caseload growth, a decline in growth rates actually occurred.

Chapter 3 analyses the causes of this phenomenon in depth, using tests of normality and independent samples t-tests, and points out that the period of adaptation to the new law, the impact of the epidemic and the spread of ADR mechanisms may be the main reasons for the decline in the rate of growth of cases. These factors have inhibited further increases in the number of cases.

In future research, this paper will further study the possible long-term impact of different legal events on the number of lawsuits, especially the validated statistical analyses of the medium- and long-term impact after the implementation of the new law. Attention will also be paid to the requirements of the traditional judicial system arising from the extensive application of ADR mechanisms in order to better adapt and improve the legal system and promote judicial reform.

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