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Research on Social Stability Early Warning Based on Social Stability Indicator System and Prediction Model

Boyang Li[1,*]

[1]*School of Accounting, Nanjing University of Finance & Economics, Nanjing, China*
[*]*Corresponding author: BoyangLi-nufe@outlook.com*

Abstract: *This paper focuses on the social stability index system, analyzes the reasons for the success or failure of color revolutions in history by establishing an early warning model of social stability, and finally puts forward suggestions for preventing color revolutions and maintaining social stability. Firstly, six social stability impact indicators of different natures are selected to analyze and construct the indicator system, and it is found that the per capita disposable income is highly correlated with the GDP growth, education investment and social security rate; secondly, a multiple linear regression model containing five indicators is established through the Regress function in the statistical toolbox of MATLAB, and a multiple linear regression model is constructed through the F-test, the correlation coefficient R^2, the P-value and the Estimated error variance S^2 and other five main criteria to assess the validity of the model; finally, based on the GM(1,1) prediction model, the social stability indicators were analyzed from 2010-2014, and it was concluded that the model was highly accurate and of high practical value, and trends were analyzed and recommendations were made accordingly [1].*

Keywords: *Social Stability Indicators, Early Warning Models, Multiple Linear Regression, GM (1,1) Prediction Models*

1. Introduction

The history of human development is a history of overcoming crises which constantly lurk in the future. In the context of social stability, it is crucial to identify factors that affect it, to accurately forecast potential social crises. Various elements, including subsistence security, economic support, social distribution, social control, social psychology, and the external environment, interplay to maintain societal balance. Fluctuation in any of these factors can lead to social unrest or even collapse. This paper aims to address several key questions: Firstly, it seeks to establish an indicator system for social stability, combining qualitative and quantitative aspects to reflect all facets of societal balance. Secondly, the development of an early warning model for social stability is proposed, focusing on the constructive collaboration and checks among different indicators. For instance, a society under economic strain might leverage human spirit to counterbalance economic shortcomings. Lastly, the paper will apply this model to a specific case study of a country or region where a 'color revolution' attempted to change the regime. This will include an evaluation of social stability, identification of the primary reasons behind the revolution's failure, an assessment of future trends in social stability, and suggestions for improvement.

2. Correlation Analysis of Social Stability Indicators

2.1 Pearson Model

In this study, the Pearson correlation coefficient is employed to assess the relationships between numerous factors impacting social stability. This coefficient, symbolized as γ, is calculated based on the covariance between two variables and their respective standard deviations. The value of γ ranges from -1 to 1, with negative values indicating a negative correlation, positive values indicating a positive correlation, and a value of 0 denoting no correlation. The strength of the correlation is determined by the proximity of γ to these extremes, with ranges classified as extremely correlated (0.8 to 1.0), strongly correlated (0.6 to 0.8), moderately correlated (0.4 to 0.6), weakly correlated (0.2 to 0.4), and very weakly correlated or not correlated (0.0 to 0.2). This quantitative analysis is crucial for understanding the intricate interrelations among variables that influence social stability [2].

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Six indicators of different natures.

Disposable income per capita: It is the most important determinant of consumer spending and is used to measure changes in a country's standard of living. Disposable income per capita is directly proportional to the standard of living, meaning that the higher the disposable income per capita, the higher the standard of living.

Unemployment rate: It is an important indicator for capital markets and falls under the category of lagging indicators. An increase in unemployment is a sign of economic weakness and can lead the government to ease monetary resources and stimulate economic growth; conversely a decrease in unemployment will create inflation and cause the central bank to tighten monetary resources and reduce monetary investment.

GDP growth: It is the core indicator of national economic accounting and an important indicator of the economic situation and development level of a country or region. A positive GDP growth figure indicates that the region's economy is in an expansionary phase; conversely, a negative one indicates a recession.

Inflation rate: Also known as the rate of change in prices, it is the ratio of the excess of money issued to the amount of money needed and reflects the extent of currency depreciation.

Investment in education: It is a fundamental and strategic investment to support the long-term development of the country, an important material basis for the development of education, and a priority for public financial protection.

Social security rate: A comprehensive index that measures the four basic aspects of what constitutes social security in a country or region. These include social security, traffic security, life security and production security.

2.2 Six indicators correlation and causality

The graph below shows the values of the correlation coefficients in the form of a heat map, with the magnitude of the values indicated by the shade of color in Figure 1.

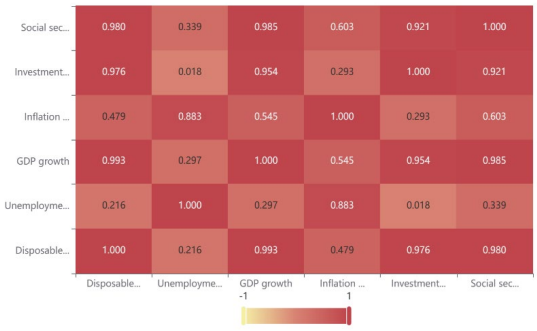

Figure 1: Correlation coefficients

Through the Pearson correlation coefficient model [3], it is concluded that:

Disposable income per capita is extremely correlated with GDP growth, investment in education, and social security rate; mildly correlated with the rate of inflation; weakly correlated with unemployment rate.

Unemployment rate is highly correlated with inflation rate, weakly correlated with GDP growth and social security rate, and very weakly correlated with education input.

GDP growth is extremely correlated with education investment, social security rate and moderately correlated with inflation rate.

Inflation rate is extremely correlated with the rate of social security and moderately correlated with education investment.

Education investment is significantly and positively correlated with the social security rate.

So that we can learn about the economic base determines the superstructure, and a good superstructure further promotes the economic base, thus maintaining social stability in a virtuous circle.

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3. Social Stability: A Multiple Linear Regression Model

3.1 Multiple linear regression

This paper argues that disposable income per capita, GDP growth, unemployment rate, inflation rate, and education input can determine the relationship with the social stability ratio and develop a multiple linear regression model [4].

$$[b, bint, r, rint, stats] = regress(Y, X, alpha) \quad (1)$$

Where b is the regression coefficient, $bint$ is the confidence interval for the regression coefficient, r is the residual, $rint$ is the confidence interval for the residual and alpha is the significance level. *Stats* contain four statistics, the correlation coefficient R^2, the F-value, the probability p corresponding to F, and the estimated error variance S^2.

The closer the correlation coefficient R^2 Is to 1, the more significant the regression equation is; H_0 Is rejected when $F > F_{1-\alpha}$(k,n-k-1) , and the larger F is, the more significant the regression equation is; H_0 Is rejected when the probability $p < \alpha$ corresponding to F, and the regression model holds. The smaller the variance of the estimation error, the more significant the regression equation.

Five-step approach to regression analysis in Figure 2.

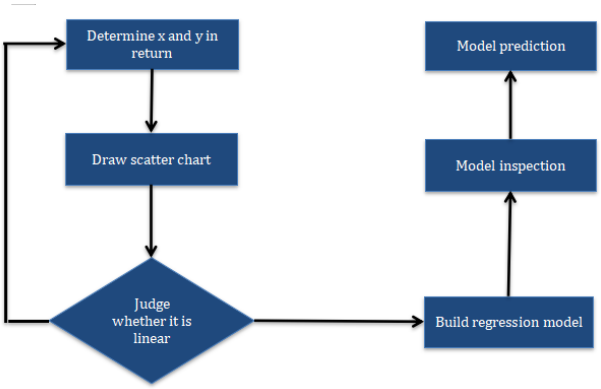

Figure 2: Analysis flowchart

Scatterplot of disposable income per capita and social security rate in Figure 3:

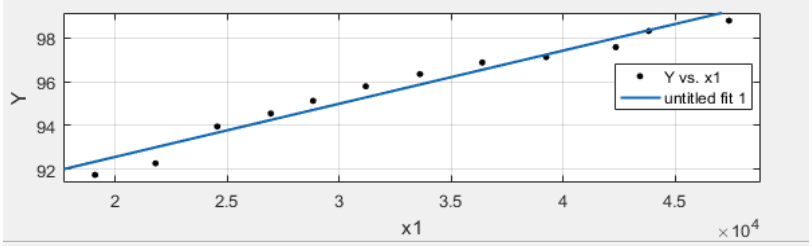

Figure 3: Disposable income per capita and social security rate

Scatterplot of unemployment rate and social security rate in Figure 4:

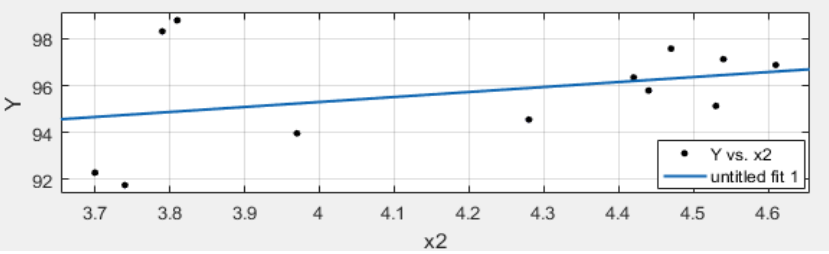

Figure 4: Unemployment rate and social security rate

Scatterplot of GDP growth and social security rate in Figure 5:

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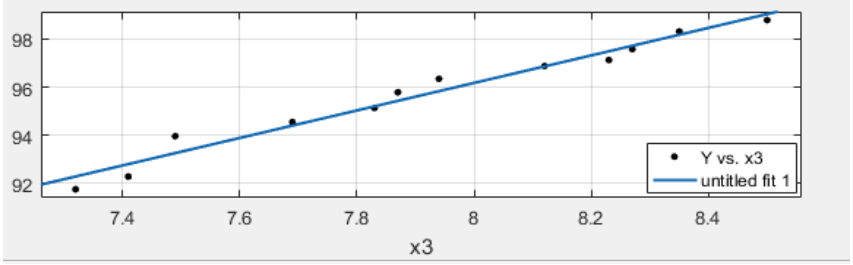

Figure 5: GDP growth and social security rate

Scatterplot of inflation rate and social security rate in Figure 6:

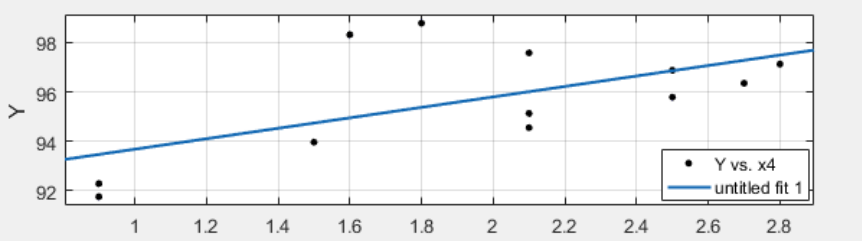

Figure 6: Inflation rate and social security rate

Scatterplot of education investment and social security rate in Figure 7:

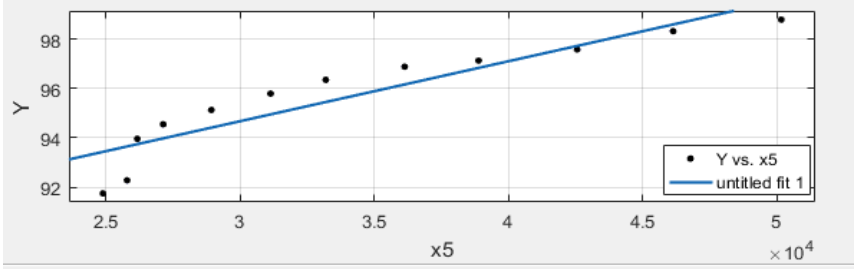

Figure 7: Education investment and social security rate

Through the scatter plot, the closer the absolute value of R-square to 1, the stronger the linear correlation, from which we retained R-square > 0.4, for which we extracted variables that were linearly correlated with the dependent variable Y to construct the multiple linear regression model.

3.2 Multiple linear regression model building

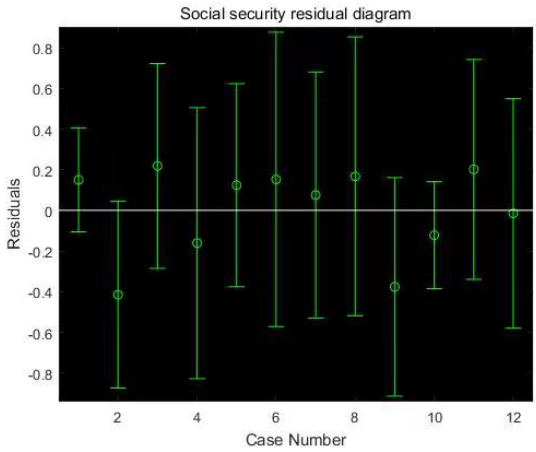

Figure 8: Residuals

The Regress function in the MATLAB statistical toolbox is used to find b and $bint$, and residual analysis is conducted to develop the final multiple linear regression models for the five indicators and the social security indicators. Based on the analysis of the model, five main criteria are used to assess the

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success of the model, namely the *F*-test, the correlation coefficient R^2 , the *p*-value, and the estimated error variance S^2.

Regression of social security rates and indicator residuals in Figure 8:

This paper presents findings where the correlation coefficient R^2 is calculated to be 0.9904, illustrating that the regression equation holds substantial significance. The null hypothesis (H_0) is rejected when the probability p is less than the chosen significance level α in relation to the F-value. Utilizing the F-test, it is determined that the multiple linear regression prediction model is valid. Consequently, the established linear relationship is deemed to be extremely statistically significant at the 0.01 significance level. This elevated level of significance underscores the robustness of the model in predicting and analyzing the factors influencing social stability.

We can therefore construct a multiple linear regression model for the five indicators and the dependent variable Y social stability.

$$Y = 77.784 - 1.156X_2 + 2.353X_3 + 0.275X_4 \quad (2)$$

4. Predicting Social Stability: The GM (1,1) Model

4.1 Multiple linear regression forecasting

In this study, data on the unemployment rate, inflation rate, GDP growth, and social pain index in Ukraine from 2010 to 2014 were collected in Figure 9. Utilizing the social stability early warning model developed earlier, this data was then analyzed to assess Ukraine's social stability during this period. The model, which incorporates multiple linear regression techniques as discussed in the previous sections, provides a framework for understanding how these economic and social indicators collectively impact the overall social stability of a nation. This approach allows for a nuanced analysis of Ukraine's socio-economic dynamics over the specified years [5].

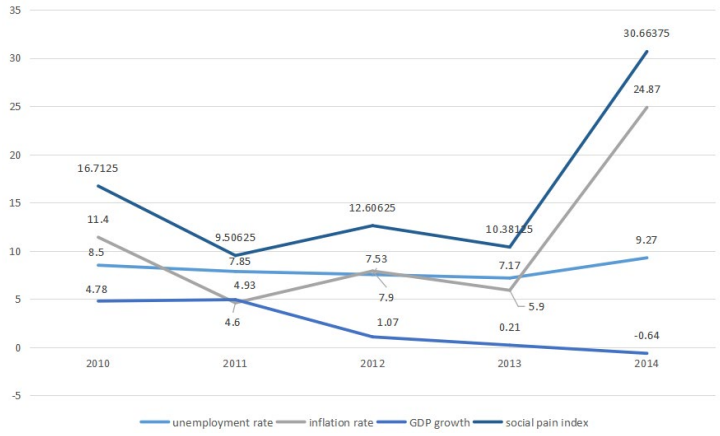

Figure 9: Data on Ukraine

The above indicators were brought into the multiple linear regression prediction model derived to obtain the level of social stability in Ukraine from 2010 to 2014.

The multiple linear regression model:

$$Y = 77.784 - 1.156X_2 + 2.353X_3 + 0.275X_4 \quad (3)$$

X_2, X_3, X_4 Represent the corresponding indicator values.

The results showed a declining trend in social stability over these years. In 2010, Ukraine exhibited an extremely elevated level of social stability with a score of 83.340, but this steadily decreased over the subsequent years, reaching a score of 41.737 by 2014, which indicates only weak stability. This analysis categorizes social stability into five levels: very weak (0-20), weak (20-40), moderate (40-60), high (60-80), and extremely stable (80-100). The observed downward trend in Ukraine's social stability underscores the dynamic nature of societal stability and the need for ongoing assessment and intervention strategies to mitigate potential risks.

The data from Ukraine reveals that the color revolution not only failed to stabilize the country but also

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intensified social unrest. Economic growth slowed, while unemployment and inflation surged, leading to a marked decline in social stability. This indicates that the color revolutions did not meet the needs of the people and lacked popular support, contributing to their failure. This case underscores the critical importance of aligning political initiatives with the genuine needs and support of the populace for effective governance.

4.2 Trend of social stability and suggestions

Assume $x^{(0)} = \left(x^{(0)}(1), x^{(0)}(2), \cdots, x^{(0)}(n)\right)$ Is the initial non-negative data column, which we add up once to get the new generated data column.

$$x^{(1)}(x^{(0)\prime}s \text{ 1-AGO}), \text{where } x^{(1)}(m) = \sum_{i=1}^{m} x^{(1)}(i), m = 1,2,\cdots,n.$$

Let $z^{(1)}$ Be the immediate neighborhood mean of the series $x^{(1)}$ Generating the series.

$z^{(0)} = \left(z^{(0)}(1), z^{(0)}(2), \cdots, z^{(0)}(n)\right)$, where $z^{(1)}(m) = \delta x^{(1)}(m) + (1-\delta)x^{(1)}(m-1), m = 2,3,\cdots, n, \delta = 0.5.$

We call $x^{(0)}(k) + az^{(1)}(k) = b$ the basic form of the GM (1,1) model, where *b* denotes the amount of grey action and *-a* denotes the development coefficient.

$$u = (a,b)^T, Y = \begin{bmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \vdots \\ x^{(0)}(n) \end{bmatrix}, \quad B = \begin{bmatrix} -z^{(1)}(2) & 1 \\ -z^{(1)}(3) & \vdots \\ \vdots & \vdots \\ \vdots & \vdots \\ -z^{(1)}(n) & 1 \end{bmatrix} \tag{4}$$

So $x^{(0)}(k) + az^{(1)}(k) = b$ can be shown as: *Y=Bu.*

We can use the least squares method to obtain estimates of the parameters a, b as

$$\hat{u} = \begin{pmatrix} \hat{a} \\ \hat{b} \end{pmatrix} = (B^T B)^{-1} B^T Y \tag{5}$$

$$x^{(0)}(k) = -az^{(1)}(k) + b \tag{6}$$

When making predictions on data:

$$\widehat{x^{(0)}}(m+1) = \widehat{x^{(1)}}(m+1) - \widehat{x^{(1)}}(m) = \left(1 - e^{\hat{a}}\right)\left[x^{(0)}(1) - \frac{\hat{b}}{\hat{a}}\right]e^{-m\hat{a}}, m = 1,2,\cdots,n-1 \tag{7}$$

After the construction of the GM (1,1) model, we make future forecasts of Ukrainian trends and obtain the following in Figure 10:

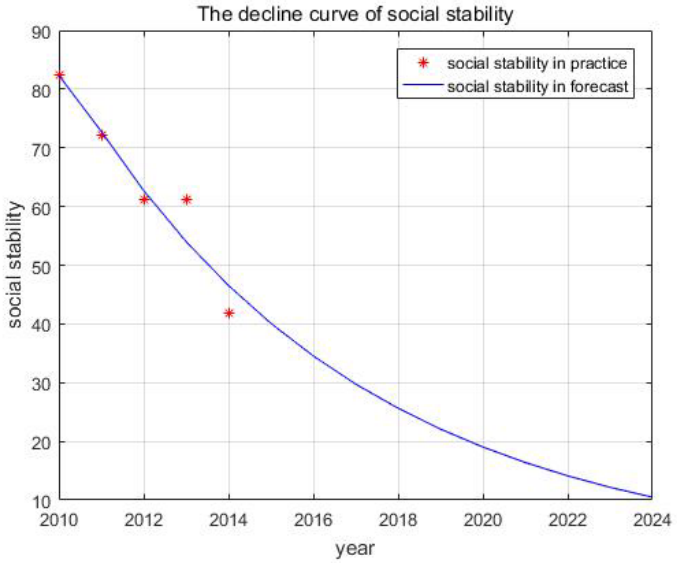

Figure 10: The decline curve of social stability

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The analysis includes a post-test difference ratio test, yielding values of C=0.29225, Q=0.13617, and P=1, indicating good model prediction accuracy. The model forecasts that Ukraine's social stability will continue to decline annually post-2014, accompanied by increasing social unrest. Based on these findings, it is recommended that in the aftermath of a color revolution, the government should closely monitor societal livelihood changes. Implementing monetary or fiscal measures to curb inflation, enhance employment, stimulate GDP growth, and reduce the social misery index is crucial. These steps are essential to prevent the emergence of another color revolution and potential regime overthrow. This approach highlights the importance of initiative-taking governance in stabilizing and improving societal conditions following significant political upheavals.

5. Conclusions

The conclusion of this research highlights the critical need for initiative-taking measures in addressing social contradictions that manifest psychological discontent, to prevent them from escalating into conflicts. A robust mechanism for collecting and analyzing public opinion is essential, coupled with targeted guidance and education to build public trust and preemptively resolve potential disputes. For businesses, establishing predictive, responsive, supervisory, and accountability mechanisms is crucial for maintaining stability. Individuals are encouraged to adhere to national security protocols, assisting in maintaining societal harmony. Collectively, these strategies are vital for fostering a stable and harmonious social environment.

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