



The Trend of Box Office Performance During 2021 National Day Holiday

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Abstract. Movies, a common form of entertainment, are one of the ways for people to escape the busy life for some short time, especially during the holidays. This paper focuses on analyzing the relationship between the box office and popular movie genres during the Chinese National Day Holiday Golden Week. We utilized visualization in R-Studio to demonstrate the box office situations during the Chinese National Day Holiday Golden Week from 2018 to 2021. We have also compiled a list of movies that have been determined to be still showing in 2021 based on the information cinemas and distributors offered to the public. In the visualization analysis, we also include most prevailing genres and make a prediction that *Changjin Lake*, which combines action, war, dramatic and history genres together, would rank the top for the box office. Moreover, as the last movie in the whole National Holiday movie series, *My Parents and I* will also enter the top three even with a lack of action genre. Based on past box office data, it is expected that during the Chinese National Day Holiday, children's movies would dominate the box office. Therefore, we believe that animation movies released during the National Day are more likely to gain a great result.

Keywords: Box Office · Predictive Model · Data Analysis

1 Introduction

The movie industry as we know it today originated in the early 19th century through a series of technological developments. From the Kinetoscope in 1880 to the brilliant technology blockbusters we watch in the cinema nowadays, movies help economic growth, inspire individuals, and expand basic knowledge of the world around us [1]. According to the paper which is written by *Qi He* and *Bin Hu*, the film industry combines humanities and arts with technological innovation. In most parts of the world, the film industry has always been the main means of cultural output [2]. The film is called the Eighth

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Art. A good film can reflect the current social situation, stimulate people to think, and spread positive social energy. At the same time, with the development of technology, film special effects have been significantly improved. The scenes in science fiction movies have always been the direction of people's future development. Therefore, the film is a model that combines cultural concepts and technological development. Now film has become a medium of mass entertainment and communication and has become a multi-billion-pound industry. Movie box office revenue is an important indicator to measure the realization of the consumer market value of the film industry. Studying the link between box office and movies will provide direction for film companies' investment.

Currently, the research on the prediction of movie box office can be divided into two stages. In the first phase of the prediction study, the most famous researcher was George Gallup, who introduced political polling to the film industry [3]. The research methods are limited to manual collection and analysis of data, and the factors that impact the box office are not enough. In the second phase of the study, Barry Littman and Scott Sukey developed a complete box-office forecasting model. They quantified and graded these impact factors, then, a mathematical model which can be directly used in calculation is constructed by testing the regression coefficient [4]. There is no doubt that this method is effective as the method incorporates modern mathematical theories. At this stage, another classification of film types was also widely accepted. Limited to the difficulty of collecting information, it is difficult to get accurate figures about the box office in the past [5]. But now the state-run movie data site collects both online and offline ticket sales and attendance, and these numbers are authoritative. Currently, investigations to forecast movie box office reached numerous achievements. For example, the famous Hollywood stock market used the term "Multiple effects" in the second stage of box-office forecasting to predict movie box-office receipts. The major contribution of the Hollywood stock market to box-office forecasting is in its ability to forecast first-week box-office receipts. Before the film is released, these participants will use a variety of information-gathering schemes. Ask their loved ones if they'd like to see a movie, watch a movie trailer, check out the actors or directors of a movie, or even ask a professional movie critic for help. Based on this information, they will continue to participate in the movie's stock trading every weekend for the year before the movie's release to help predict the movie's box office. The Hollywood Stock Exchange's first-week box-office forecast had an average Absolute Percentage Error of 30.96% [6]. However, it should be noted that previous researchers had generally tried to find a general solution to the box office prediction from a macro perspective [7]. Limited studies were going to focus on a given period. Besides, in many cases, the movies released during the Golden Week do not apply to the general box office forecasting method. Because of the special nature of this holiday season, movies with specific characteristics are more popular. So, we hope to predict the "Tipping point" for the next golden week, based on the popularity of films from the same period over the past four years.

The investigation process in this paper can be generalized as follows. First, as our purpose is to find out which movies are more popular and which ones might drop out of this acute movie market competition, we look at the movies released during the National Day holiday and divide them into two parts. Since some of the films were released before the Golden Week, and most of the movies will continue to be released in the cinema for

more than a month, the top 10 movies with the highest box office revenue in the 30 days before the holiday were listed, including box office revenue, scoring, and scheduling movies, etc.; second, we collected the data for the same period from the previous three years. The data is collected from China Movie Database, which is a Chinese platform for movies, and creates rankings for the movie industry. We import the three datasets and implement some visualization graphs to assist our analysis; Third, we analyzed the sum of the data and how the seven of the more popular genres have performed over the past three years. Then we looked at the data for films released during the first 30 days in September. Furthermore, we create the time series of three types of movies with high box offices and plot graphs to compare the box offices of some specific movies in the 2019 and 2020 National Day holiday period. The results show that movies with plot and action elements will be the winners of the Golden Week.

2 Data

To be able to analyze the box office of a movie during Golden Week, the first thing to be determined is which movies will be released during this period. Since movies are shown in cinemas for more than 30 days under no special circumstances, there must be some films released before the Golden Week that can still be seen during the holidays. In addition, some investors will choose to release movies during the Golden Week, usually between October 1st and 3rd. Therefore, the box office data needed to be collected is divided into two categories. Information about the films from Sept 1st to Sept 30th was gathered to assess the box office trends of the films that continue to be released, information about the week of the Golden Week over the past few years has been collected to assess the overall trend of box office activity during the week. Before finding the China Movie Database according to the news, the sources of the box office data collected are generally from the media, such as Yien Consulting, Cat's eye real-time data, and movie box office bars, but these sites will make up the movie's one day box office figures for their own commercial value.

Overall, the total box office for a single film may be close to the true value, but during the release period, the website may show a higher one day box office in order to create the illusion that the film is popular, then pull down the one-day box office after a certain date to find balance. This is unacceptable to researchers who are trying to figure out how movies work. Movie box office related data comes from China Movie Database, a box office data platform under the jurisdiction of the state administration of radio and television, which is mainly responsible for the statistics of real-time movie box office data across the country. National Film Data Network through the national integrated box office information system management platform to receive film box office, the number of viewers, average ticket prices and other data, so as to get more authoritative data. Therefore, China Movie Database data is currently the only accurate, there is no commercial purpose of the film box office data source platform.

Some simple Python programs have been used to capture the data, since the web pages (<https://www.zgdypw.cn/>) provided by the China Movie Database are messy and do not offer forms to download. The table data of the web page is mainly implemented in the `< table >`, and the Pandas `read_html()` method is used to read the content in

the tag. Therefore, after simply constructing the crawling URL, the single-day movie box office data in CSV cells can be gotten. Considering that there are probably more than 40 movies on this list, only the top 10 daily grossing films were included in the analysis. In addition to the box office, another important task is to assign labels to the movies that have been chosen for data analysis. The film is divided into different types according to different standards, so a relatively uniform distribution standard is needed. The most widely used film evaluation platform in China is Douban, which also has its own application software and community. On Douban.com, movie labels can be added by distributors and Douban.com executives, as well as by viewers who join the community after watching a movie to comment on it. Under the influence of this comprehensive factor, the movie labels are arranged from left to right under the name of the movie according to the level of relevance, so in the case of more labels to choose the top three labels as the type of film classification basis. Douban also offers movie favourites, which means that users can create their own watch lists. So, create a list of the movies we need to analyze, and crawl through the definition of what we need in the source code of the web page mentioned above, you can get the corresponding relationship between the movie name and the movie type.

Since the tabular form and the box office form are two different forms, a separate tabular merge is required. Using the tag as the last three columns of the box office table to match the name of the movie, a complete data table can be obtained. However, some refinements are required after obtaining the complete table. On the China Movie Database, pre-sold ticket prices will also be shown in the table, so you need to manually exclude the data, and add the correct movies and their box office numbers to the day's table. Only then the cleaned-up data sheet can be used for analysis.

3 Analysis

To begin with, we study the box office the first 30 days in September. The main method in this part is to use tableau to create the visualization. Data visualization is the presentation of data or information in graphs, charts, or other visual formats. It conveys the relationship between data and image. It can more easily see trends and patterns. A visual summary of information makes it easier to identify patterns and trends than looking at thousands of rows on a spreadsheet. Without visualization, it will be more difficult to convey meaning. Charts and graphs make it easier to communicate data discovery. Figure 1 is to show the trend of box office science in theatres during the first 30 days in September. We do the cluster analysis in this part and obtain a straightforward diagram. As shown in Fig. 1, we analyze the box office by cluster analysis. Clustering can provide us with a good starting point and help us find the main research objects. In the graph, it is obvious that science is at the top level while action and dramatic genres are at second level, meaning that science is the most popular genre, followed by dramatic and action. Therefore, our main research movie type will be action, science and dramatic.

Furthermore, we looked at the time series of some types of movies with high box offices. The data are plotted in Fig. 2, using a line chart to show the trend. We noticed that the box office of action movies and science movies has some float with the upcoming weekends. However, the box office of dramatic movies started to rise after Sept.17th,

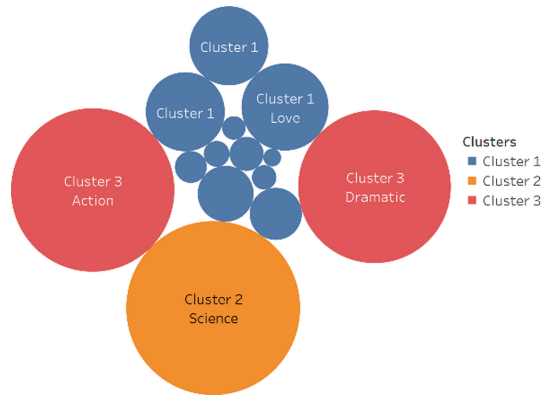


Fig. 1. The Cluster of Movie Type (photo credit: Original)

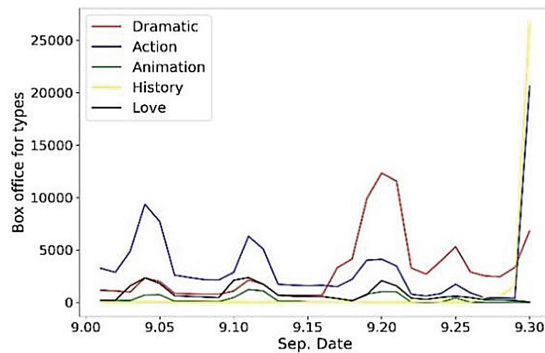


Fig. 2. The Box Office of Dramatic, Action, Animation, History and Love movies in September 2021 (photo credit: Original)

demonstrating that a popular dramatic movie was released. After we check the details of each movie in the week of Sept.17th, there are two new dramatic movies which are called *Everything About Mom* and *Firestorm*. This last dramatic film was in theatres on Sept.4th. The new movie in the first week will have a huge box office.

But Fig. 3 brings a different perspective. Considering that movies' box office is often affected by more factors, such as holidays or the COVID-19, we made another chart to observe the change trend of different types of movies' box office share.

As shown in Fig. 3, the broken line chart of the percentage of box office receipts for action and history movies has had a sharp jump since 9.29, which is consistent with the trend in Fig. 1. At the same time, Fig. 1 shows a small but steady increase in box office sales for movies with a dramatic tag, but due to a small increase, in Fig. 2 shows a relatively large downward trend.

Further collating the data, Fig. 4 shows that the sharp rise in the share of action, history and war films in the box office is the key to the mutation. Because the sudden change is caused by the release of new films, there is no doubt that these films will

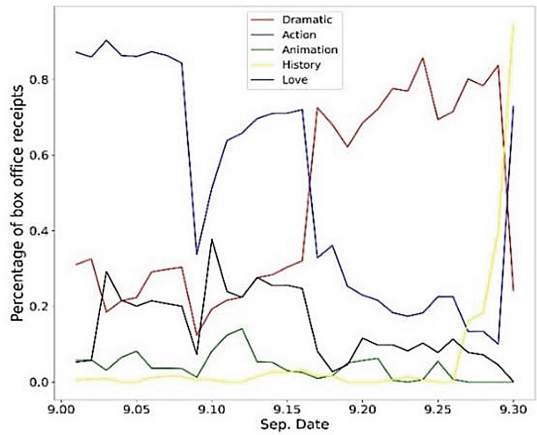


Fig. 3. Daily box Office share of Dramatic, Action, Animation, History and Love movies in September 2021 (photo credit: Original)

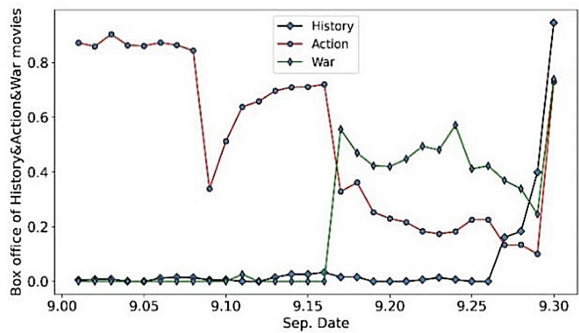


Fig. 4. Daily box Office share of History, Action and War movies in September 2021 (photo credit: Original)

continue to be released during the National Day holiday, and they will continue to exert a huge influence on the box office.

After identifying the most influential factors, we used some single linear regression models [8] to predict.

The mathematical representation of linear regression is given by Formula 1.

$$Y = \sum_n^1 \Theta^n X^n + \Theta^0 = \sum_n^0 \Theta^n X^n \tag{1}$$

Θ^0 is the intercept value.

The computation of polynomials requires a large space and a long operation time, so the formula is changed into the matrix product form (Formula 2).

$$\Theta = [\Theta^0, \dots, \Theta^n] \tag{2}$$

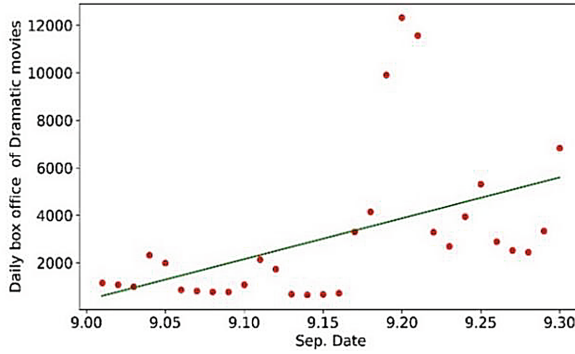


Fig. 5. Linear regression line chart of Dramatic movies' box office in September 2021 (photo credit: Original)

$$X = [X^0, \dots, X^n] \quad (3)$$

$$Y = \Theta X \quad (4)$$

After completing the transformation, we plug in the least squares model and set a function L to further represent the loss function (Formula 5).

$$Y = \Theta X \quad (5)$$

$$L = \frac{1}{2}(\Theta X - Y)^T(\Theta X - Y) \quad (6)$$

$$\Theta = (X^T X)^{-1} X^T Y \quad (7)$$

Finally, the gradient descent model (Formula 8) is used to add more reasonable results to the programming process.

$$\theta_i = \theta_i - \alpha \frac{\partial}{\partial \theta} J(\theta) = \theta_i - \alpha (h_{\theta}(x) - y) x^{(i)} \quad (8)$$

From Figs. 5, 6, 7, 8, 9, 10, 11 and 12, we can draw some conclusions about the box office of individual films. Drama films, for example, will earn more than 60 million a day, or more than 76% of the total. War films are expected to earn more than 50 million in a single day, rising to 60% of the box office. However, we also noticed that the action and history films were not favored before the national day, and the overall trend is flat or declining. Therefore, single linear regression is not the best data analysis tool for subsequent box office forecasts.

Another important point to consider is that national day week is a holiday, so the total box office can not be predicted according to the usual dates. So, we found some national day movie box office data from the past few years as a reference to predict more accurate box office.

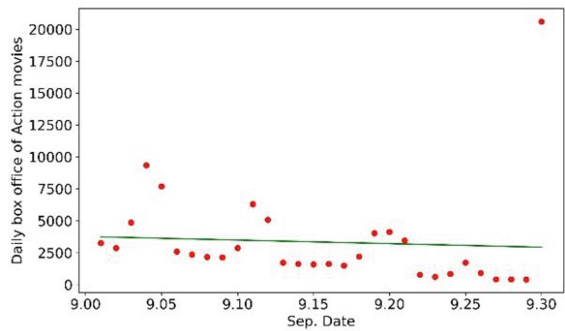


Fig. 6. Linear regression line chart of Action movies' box office in September 2021 (photo credit: Original)

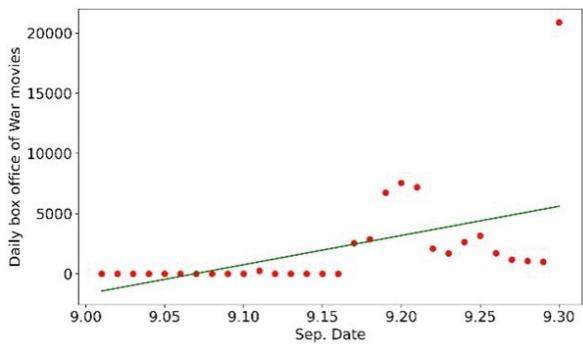


Fig. 7. Linear regression line chart of War movies' box office in September 2021 (photo credit: Original)

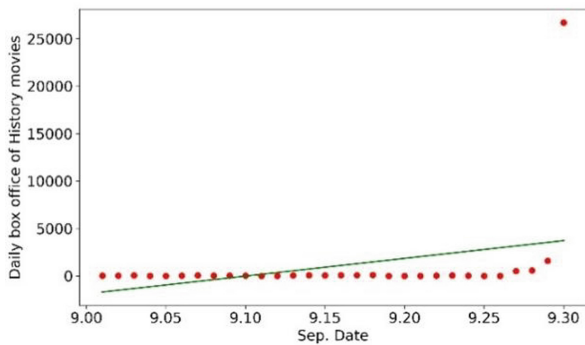


Fig. 8. Linear regression line chart of History movies' box office in September 2021 (photo credit: Original)

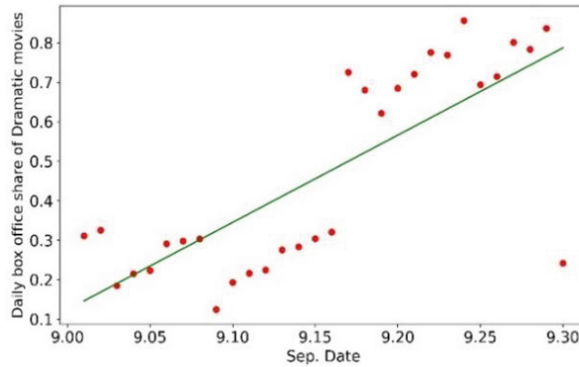


Fig. 9. Linear regression line chart of Dramatic movies' box office share in September 2021 (photo credit: Original)

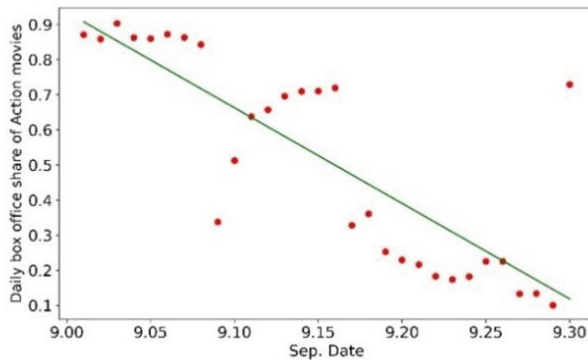


Fig. 10. Linear regression line chart of Action movies' box office share in September 2021 (photo credit: Original)

When analyzing the box office for movies during the National Holiday Week in the previous three years (2018, 2019 and 2020), we produced a data form, shown in Table 1, shows the box office receipts of the top 10 films of the past three years over the National Day holiday, indicating the sum of the data from the previous three years. It is noticeable that the movies tagged with the dramatic genre rank at the top of the box office, followed by the genre history, legend and action genres, accounting for a relatively average share of the box office.

We also analyzed the performance of seven more popular genres in the past three years during National Holiday (Fig. 13), including Action, Adventure, Animation, Comedy, Dramatic, History and Legend. To be more specific, from 2018 to 2019, the box office of movies with the dramatic genre rose sharply, while some other genres such as action or comedy demonstrated an obvious decline. Although the box office for 2019 and 2020 shrunk significantly, dramatic films still occupied a clear advantage.

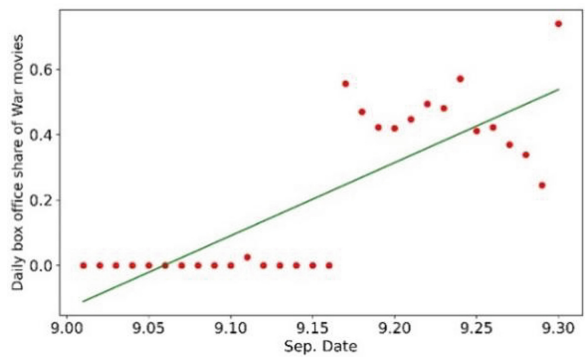


Fig. 11. Linear regression line chart of War movies' box office share in September 2021 (photo credit: Original)

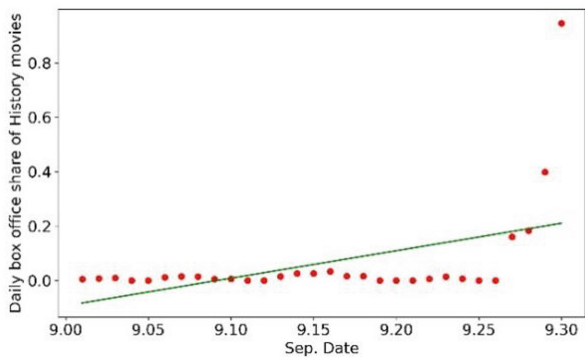


Fig. 12. Linear regression line chart of History movies' box office share in September 2021 (photo credit: Original)

It is true that we cannot ignore the impact of COVID-19 in 2019 and 2020, that most people are stuck at home because of the ongoing pandemic. As a result, we produce the proportional chart for each genre film and not surprisingly, the dramatic genre was still the most popular one in 2020. However, there has been some backlash between action movies and comedies. To find out why, we also looked at some more detailed data, and realized that they appeared in some movies along with the dramatic genre. In other words, most movies do not only have a single genre, but there could be several ones combining together. For instance, *Changjin Lake*, which occupies the top spot of the movie box office in 2021, is a film that integrates dramatic, action and war genres together.

Taking the movie box office during the National Day period as the analysis target, we analyzed the influence of the movie type on the movie box office in the Golden Week, the movie opening day box office, the highest one-day box office and the movie total box office (Table 2).

Table 1. The Box office of each movie type during the National Holiday in the last three year

TYPE	TYPE_BOX	PERCENT
Action	245985	12.03%
Adventure	32418.8	1.59%
Animation	127934.2	6.26%
Campus	447.94	0.02%
Comedy	199247.3	9.75%
Criminal	64066.36	3.13%
Documentary	1437.52	0.07%
Dramatic	649170.9	31.75%
Education	447.94	0.02%
Family	46434.38	2.27%
History	287360.1	14.05%
Legend	280276	13.71%
Magic	6825.86	0.33%
Myth	1800.76	0.09%
Romance	9528.75	0.47%
Science	828.9	0.04%
Sports	31375.14	1.53%
Suspense	44189.4	2.16%
Teen	9678.95	0.47%
War	5145.15	0.25%

The conclusion of correlation is generated in R based on multiple linear regression model.

Multivariate linear regression models are usually used to describe the stochastic linear relationship between variables y and x. That is:

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \cdots + \beta_p x_{ip} + \epsilon \quad (9)$$

where, for i = n observations:

y_i = dependent variable

x_i = explanatory variables

β_0 = y-intercept (constant term)

β_p = slope coefficients for each explanatory variable

ϵ = the model's error term (also known as the residuals)

The multiple regression model is based on the following assumptions:

- a) There is a linear relationship between the dependent variables and the independent variables

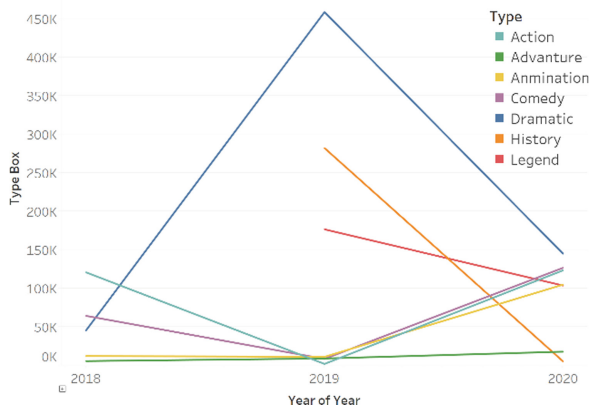


Fig. 13. The Box Office of each type of movie in the past three years during National Holiday (photo credit: Original)

- b) The independent variables are not too highly correlated with each other
- c) y_i observations are selected independently and randomly from the population
- d) Residuals should be normally distributed with a mean of 0 and variance σ

The coefficient of determination (R-squared) is a statistical metric that is used to measure how much of the variation in outcome can be explained by the variation in the independent variables. R^2 always increases as more predictors are added to the MLR model, even though the predictors may not be related to the outcome variable.

R^2 by itself can't thus be used to identify which predictors should be included in a model and which should be excluded. R^2 can only be between 0 and 1, where 0 indicates that the outcome cannot be predicted by any of the independent variables and 1 indicates that the outcome can be predicted without error from the independent variables.

When interpreting the results of multiple regression, beta coefficients are valid while holding all other variables constant ("all else equal"). The output from a multiple regression can be displayed horizontally as an equation, or vertically in table form. This is the theoretical basis of Tables 2 and 3.

The correlations in Tables 2 and 3 show a positive correlation between labels action, dramatic, history, legend and war and all of the movie's box office performance. Myth was only negatively correlated with the National Day weekend total, but positively correlated with other box office numbers.

For the National Day Box Office, the biggest positive impact is the legend and history of the two labels, while the label adventure brought a huge negative impact. This means that films with an adventure label will be less successful at the box office during National Day Week. And for September's box office, action, drama and science fiction films brought in the most revenue.

Moreover, we also plot graphs to compare the box offices of some specific movies in 2019 (Fig. 14), with similar types of movies as in 2021. It is noticeable that people preferred dramatic and action movies during the holiday week. We also can see that the box office increased a lot after the 11th day. This is because it is the first weekend after

Table 2. The correlation between film type and box office in National Day week

TYPE	Golden week	First day
Action	4425.24	4425.24
Adventure	-121072.83	-121072.83
Animation	-58003.39	-58003.39
Campus	-117008.47	-117008.47
Comedy	213883.49	213883.49
Criminal	-24701.66	-24701.66
Documentary	-119239.13	-119239.13
Dramatic	172204.07	172204.07
Educational	-117008.47	-117008.47
Family	-77568.33	-77568.33
History	121796.01	121796.01
Legend	105081.67	105081.67
Magic	-118351.19	-118351.19
Romance	-103071.85	-103071.85
Science	-96376.09	-96376.09
Sports	-77133.95	-77133.95
Suspense	-76368.33	-76368.33
Teen	-108947.23	-108947.23
War	320631.67	320631.67
Myth	381531.67	381531.67
TYPE	Highest	Total
Action	4425.24	4425.24
Adventure	-121072.83	-121072.83
Animation	-58003.39	-58003.39
Campus	-117008.47	-117008.47
Comedy	213883.49	213883.49
Criminal	-24701.66	-24701.66
Documentary	-119239.13	-119239.13
Dramatic	172204.07	172204.07
Educational	-117008.47	117008.47
Family	-77568.33	-77568.33
History	121796.01	121796.01
Legend	105081.67	105081.67
Magic	-118351.19	-118351.19

(continued)

Table 2. (continued)

TYPE	Highest	Total
Romance	−103071.85	−103071.85
Science	−96376.09	−96376.09
Sports	−77133.95	−77133.95
Suspense	−76368.33	−76368.33
Teen	−108947.23	−108947.23
War	320631.67	320631.67
Myth	381531.67	381531.67

Table 3. The correlation between film type and box office in September 2021

TYPE	Box office	Slice rate
Action	0.12275	0.12275
Adventure	0.05029	0.05029
Amination	0.03370	0.03370
Animation	0.04124	0.04124
Biographies	−0.00426	−0.00426
Comedy	0.11819	0.11819
Criminal	0.16699	0.16699
Documentary	0.00565	0.00565
Dramatic	0.09410	0.09410
Education	−0.00401	−0.00401
Family	0.10435	0.10435
History	0.02730	0.02730
Love	0.07870	0.07870
Magic	0.04004	0.04004
Science	0.15621	0.15621
Sports	0.01135	0.01135
Suspense	0.01194	0.01194
Suspense	0.02231	0.02231
Teen	0.03801	0.03801
Thrill	0.09388	0.09388
War	0.27926	0.27926

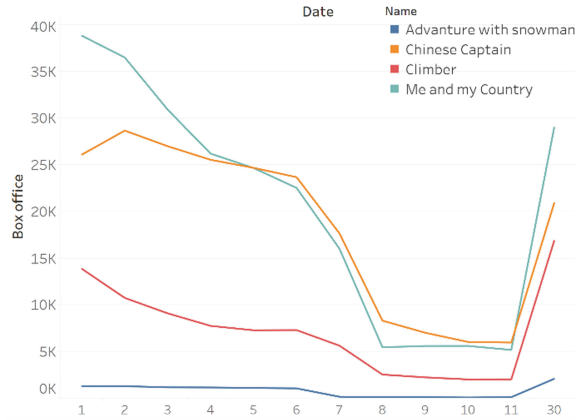


Fig. 14. The Box Office of Four dramatic and Action movies in 2019 National Holiday week (photo credit: Original)

the holiday. The people who do not see the movies on holiday will choose this weekend to go to the theatre. As this holiday is the Chinese National Holiday, more audiences may watch Chinese mainstream dramatic movies. Drama film is a film that mainly relies on in-depth character development, interaction, and highly emotional themes. In a good drama movie, the audience can empathize. The audience seems to enter the plot of the movie impressively. This is where the charm of drama and film lies.

In addition, we drew charts to compare the box office of certain specific movies in the National Week of 2020 (Fig. 15), which have extremely identical types of movies as in 2021. It is obvious that the trend in 2020 was not ideal, which is the reason for the lasting COVID-19 pandemic. It is worth noting that people prefer dramatic and action movies during the holiday weeks. Also, since this holiday is the Chinese National Day, more audiences prefer to watch mainstream Chinese dramatic movies.

Figures 10 and 11 illustrate the changes in the box office and the National Day Week over the past few years. As this year (2021) has not yet reached the end of the year, so the total box office has room to rise, but the final value is difficult to break 50 billion (Figs. 16 and 17).

As a result, we think 2021's national day box office will eventually be close to 4 billion in 2020, and given that people's lives are gradually returning to normal after the new crown epidemic, the final result should be between 4.2 bn and 4.4 billion.

Based on the percentage of box office receipts from each genre, we think that an action label means an average of 475 million per day, while a war label is about 425 million and the historical label is 375 million, dramatic label is 300 million. After each label is given a corresponding daily box office in proportion, the average daily box office for a single film during the National Day holiday can be calculated based on the percentage of the label in the film. *Changjin Lake*, for example, has about 30% action, 30% war, and the rest is history and drama. As a result, the average one-day box office in *Changjin Lake* over the National Day holiday will be more than 370 million.

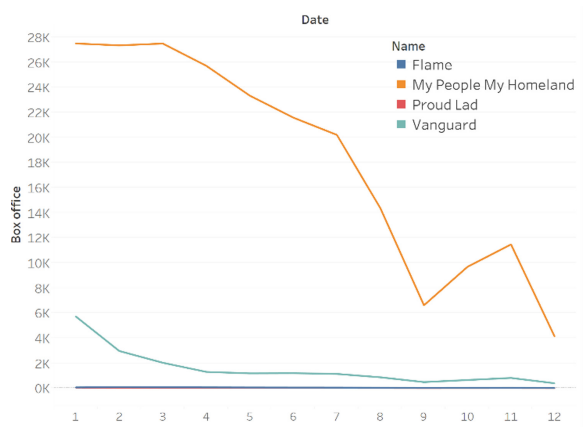


Fig. 15. The Box Office of Four dramatic and Action movies in 2020 National Holiday week (photo credit: Original)

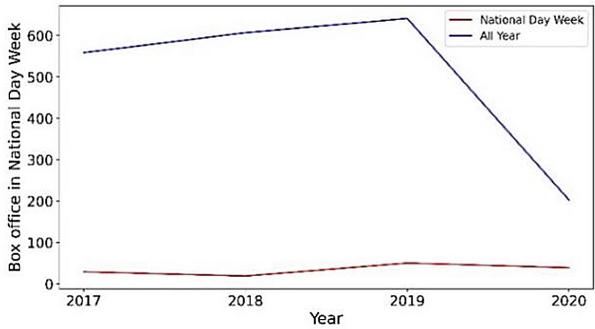


Fig. 16. The Box Office of National Day Week and Annual box office in 2017, 2018, 2019 and 2020 (photo credit: Original)

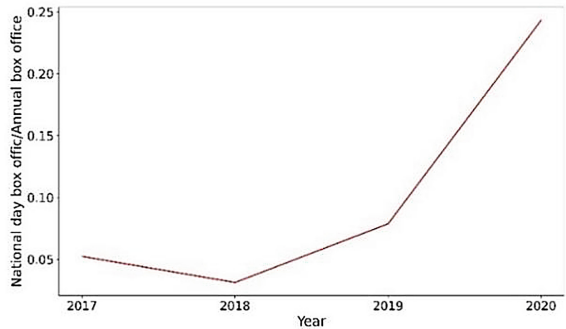


Fig. 17. National day box office as a percentage of annual box office (photo credit: Original)

4 Conclusion

This paper focuses on the relationship between the box office and the types of popular movies during the National Day holiday. We used two separate sets of data to predict Golden Week's box office ahead of 2021's National Day holiday. The first category is Golden Week's top 10 box office films of 2018, 2019 and 2020, and the total box office of films they produced in a single week. In addition, we have compiled a list of films that have been identified as still showing during the 2021, based on information that cinemas and distributors can make publicly available. Then, by comparing the box office figures of the same period over the past three years with the changes in this year's box office before the holiday, we can draw such a conclusion, that 2021 will finally welcome a film with both action and war elements.

Because of the special nature of the National Day, films with a certain national character will be more popular than other films during this holiday. As a result, we believe that *Changjin Lake*, with its mix of action, war, drama and history, will be the box office champ. The average box office in a single day will exceed 370 million. As the last film in a similar series, *My parents and I* will also be in the top three. This judgment comes from its lack of certain action elements. It ended up floating around 150 million a day.

According to past box office figures, one or two films aimed at children are expected to top the box office during the National Day holiday. Considering the limited popularity of children-oriented films, we tend to think that animated films released during the National Day holiday are more likely to earn a better income.

Our predictions have been well borne out by the box office figures for the films that have made it past the 2021 Golden Week holiday.

Similarly, combining the previous month and the past four years of box office data and film types to explore the method can be used to predict the future national day box office.

Since 2021 National Day holiday is over, we can assume that the 2022 National Day movie box office will start to approach its highest point which was in 2019.

This means that the 2022 national day box office will reach 4.7 billion the distribution of film types will return to normal. Action, war, history and drama are still the most popular genres, but their box office counterparts will fall back to 60% of normal one day box office receipts.

According to our findings, we think that the dramatic movie will be famous during the future Chinese National Holiday. The National Holiday always needs some movies to describe the country. The topic includes the heroes, history, and life in the country. The dramatic movies are the most suitable to display those topics. Therefore, we think the dramatic movie will still be famous during the future National Holidays.

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