Explore the Impact of Population Aging on E-Commerce Based on Grey Model

Yi-he LIU
International College of Beijing University of Post and Telecommunication, China

Keyword: Aging population, E-commerce development, Grey model, Aged education, Website design, Supervision mechanism.

Abstract. With the arrival of the aging of the population, it is bound to have a certain impact on the development of e-commerce. Based on the grey prediction model, this paper quantitatively analyses the influence of aging population on e-commerce, which obtains that the proportion of elderly people who participate in e-commerce is gradually increasing, and the concludes that e-commerce has a broad market in the field of the aged. And in terms of the current situation, it makes relevant suggestions on how to develop e-commerce markets for older people.

Introduction

According to data from World Population Prospects: Worldwide, there were 901 million people aged 60 years or over in 2015, an increase of 48 per cent over the 607 million older persons globally in 2000. Obviously, the number of older population aged 60 years or over has increased substantially in recent years in most countries and regions. [1] Meanwhile, with the rapid development of Internet, e-commerce began to infiltrate into everyone’s life. Take Taobao as an example, it reached in 2016 3 trillion yuan turnover, equivalent to 2015 China's total retail sales of social consumer goods about 10%. [2] However, the arrival of the aging population has inevitably influenced the development of e-commerce, therefore, it is necessary to find out the aging of the population to the impact of e-commerce.

Estimation of the Impact of Aging Population on E-Commerce Based on Grey Model

Conditional Setting

As of 2016, the proportion of China's elderly population has exceeded 10%, China has become a large population of aging population. At the same time, with the rise of Taobao, Jingdong and other enterprises, China's e-commerce industry is booming development. It can be seen that China is in rapid progress on aging population e-commerce, which is the representative to study the effects of aging population on e-commerce, so the grey model used by the data are selected from China for reference.

The deviation which is caused by population migration and age changes is not considered in this analysis.

Ignore the impact of some force majeure on population aging.

Reference Description

Y: the change of the year
S: serial number to identify the different data
P: the percentage that the elder are in the use of e-commerce

Model Introduction

GM(1,1)(Grey model with 1 variation and 1 equation) is a sequence prediction model which is based on superposition.

Model Establishment:
First step: according to the obtained data, [3][4][5][6][7][8][9][10] it can be organized into the following table
Table 1. The proportion for the elderly in e-commerce.

<table>
<thead>
<tr>
<th>S</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>2.5</td>
<td>3.7</td>
<td>4.3</td>
<td>6.3</td>
<td>7.9</td>
</tr>
</tbody>
</table>

Second step: Make the data sequence \( P(0)(i) = \{ P^{(0)}(1), P^{(0)}(2), P^{(0)}(3), \ldots, P^{(0)}(n) \} \) do a cumulative generation processing, obtain \( P^{(1)}(i) = \{ P^{(1)}(1), P^{(1)}(2), P^{(1)}(3), \ldots, P^{(1)}(n) \} \), and

\[
P(1)(t) = \sum_{k=1}^{t} P^{(0)}(k),
\]

(1)

In this section, via substituting specific data, it can be generalized as follow.

Table 2. The cumulative proportion for the elderly in e-commerce

<table>
<thead>
<tr>
<th>S</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>P(^{(0)})</td>
<td>2.5</td>
<td>3.7</td>
<td>4.3</td>
<td>6.3</td>
<td>7.9</td>
</tr>
<tr>
<td>P(^{(1)})</td>
<td>2.5</td>
<td>6.2</td>
<td>10.5</td>
<td>16.8</td>
<td>24.5</td>
</tr>
</tbody>
</table>

Third step: construct the cumulative matrix \( B \) and constant term vector \( Y \)

\[
B = \begin{bmatrix}
-1/2[P^{(1)}(1) + P^{(1)}(2)] & 1 \\
-1/2[P^{(1)}(2) + P^{(1)}(3)] & 1 \\
\vdots & \vdots \\
-1/2[P^{(1)}(n-1) + P^{(1)}(n)] & 1
\end{bmatrix}
= \begin{bmatrix}
-1/2(8.7) & 1 \\
-1/2(16.7) & 1 \\
-1/2(27.3) & 1 \\
-1/2(41.3) & 1
\end{bmatrix}
= \begin{bmatrix}
-4.35 & 1 \\
-8.35 & 1 \\
-13.75 & 1 \\
-20.15 & 1
\end{bmatrix}
\]

(2)

\[
Y = [P^{(0)}(2), P^{(0)}(3), P^{(0)}(4), \ldots, P^{(0)}(n)]^T = [3.7, 4.3, 6.3, 7.9]^T
\]

(3)

Forth step: the GM(1,1) differential equation is established as follow

\[
dP^{(1)}(t)/dt + aP^{(1)}(t) = u,
\]

(4)

The parameter column is obtained by least squares fitting:

\[
\hat{U} = (B^T B)^{-1} B^T Y = \begin{bmatrix} 0.27322 \\ 2.35273 \end{bmatrix}
\]

(5)

Fifth step: find out GM(1,1) prediction function

\[
^\wedge P(1)(k+1) = [P(1)(1) - u/a]e^{-ak} + u/a = 11.111112e0.27322k - 8.61112
\]

(6)

Sixth step: accuracy test and prediction

Table 4 can be used to test whether the prediction model meets the accuracy requirements.

Residuals:

\[
E(k) = P(0)(k) - \hat{P}(1)(k)
\]

(7)

Relative residuals:

\[
e(k) = E(k)/P(0)(k)
\]

(8)

The basic data is calculated into the following table according Eq.7 and Eq.8

Table 3. Residuals and Relative Residuals.

<table>
<thead>
<tr>
<th>( \hat{P}^{(0)}(k) )</th>
<th>( P^{(0)}(k) )</th>
<th>E(k)</th>
<th>e(k)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.491</td>
<td>3.7</td>
<td>0.05649</td>
<td>0.209</td>
</tr>
<tr>
<td>4.58782</td>
<td>4.3</td>
<td>0.06693</td>
<td>-0.28782</td>
</tr>
<tr>
<td>6.02928</td>
<td>6.3</td>
<td>0.04297</td>
<td>0.27072</td>
</tr>
<tr>
<td>7.92361</td>
<td>7.9</td>
<td>0.00299</td>
<td>-0.02361</td>
</tr>
</tbody>
</table>

Average of \( P(0) \):
\[
\bar{P} = \frac{1}{n} \sum_{k=1}^{n} P^{(0)}(k) = 1/5 \sum_{k=1}^{5} P^{(0)}(k) = 4.9
\]

Variance of \(P(0)\):

\[
S1 = \sqrt{\frac{1}{N} \sum_{k=1}^{N} [P^{(0)}(k) - \bar{P}]^2} = 1.93386
\]

Average of residuals:

\[
\bar{E} = \frac{1}{N-1} \sum_{k=2}^{N} E(k) = 0.04207
\]

Variance of residuals:

\[
S2 = \sqrt{\frac{1}{N-1} \sum_{k=2}^{N} [E(k - \bar{E})]^2} = 0.21982
\]

Posterior ratio:

\[
C = \frac{S2}{S1} = 0.11367
\]

Small probability of error:

\[
P = P\{|E(k) - \bar{E}| < 0.6745S1\} = 1
\]

Table 4. Grey prediction accuracy test grade standard.

<table>
<thead>
<tr>
<th>Prediction accuracy level</th>
<th>Good</th>
<th>Qualified</th>
<th>Inadequate</th>
<th>Unqualified</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>&gt;0.95</td>
<td>&gt;0.80</td>
<td>&gt;0.70</td>
<td>≤ 0.70</td>
</tr>
<tr>
<td>C</td>
<td>&lt;0.35</td>
<td>&lt;0.5</td>
<td>&lt;0.65</td>
<td>≥ 0.65</td>
</tr>
</tbody>
</table>

Due to \(P=1>0.95\) and \(C=0.11367<0.35\), which indicates that the prediction level is good, it can be seen that the prediction equation (6) is available.

\[
\hat{P}(0)(k+1) = \hat{P}(1)(k+1) - \hat{P}(1)(k)
\]

Through a derivative of Eq.15, it is proved that \(\hat{P}(0)(k)\) is a monotonically increasing function, which means that the proportion of the elderly in e-commerce will continue to grow. [8]

It means that the aging of the population does not mean that the development of electricity providers will be contained, but there is a huge market waiting to explore.

**Strategies to Promote Elderly E-Commerce Industry**

**Set up the Elderly Education**

Education is the foundation of development, which means that the development of anything requires education and learning. Therefore, the development of e-commerce in the elderly is inseparable from education. [9]The basic e-commerce operation course is set up through the establishment of the old university or the community service, so that the elderly have a fundamental understanding of e-commerce. [10] Meanwhile, due to the network is flooded with all sorts of information including the wrong mixed, how to avoid being deceived to the fullest extent, and choose the correct information that the people require become completely significant. The e-commerce information screening and identification course is designed to improve the ability of the aged to distinguish information.

**Perfecting the Supervisory System**

When enjoying that the Internet services bring great convenience, the problems including personal
information exposure and the problem of Internet fraud are increasingly serious. At the same time owing to the low threshold of e-commerce, the entire e-commerce industry is quite mixed and jumbly. Unscrupulous traders selling fake and shoddy products, poor service attitude, lack of protection after-sales service and other issues are still critical. Improving the ability of the elderly to identify online information does not fundamentally solve the problem. Therefore, it is requisite to formulate a stricter regulatory system, which aims at improving product quality and enhance the credibility of the product. First, all types of electricity business enterprises should establish a more stringent and practical access system and certification system and collaborating with quality control departments actively to be regularly investigated for credit and ensure that screening filter. Second, continue to improve the third Party payment platform construction, explore a more reasonable and legitimate claims protection, promote the construction of logistics support system which is completely related to the efficiency of e-commerce operations.

**Website Design for Target Crowd**

The design of the website should take into account the behavioral characteristics of the target population. Aged people with decreased eyesight, slow response ability, are not suitable for long time browsing online. Therefore, as designing the site, it should be as far as possible to highlight the theme, make modular division clear and apply the fonts and typesetting which are concise and reasonable. In addition, in planning and construction of the website, each product should be attached to the use of cases and methods of efficacy instructions to facilitate the learning and use for the elderly. [11]

**Summary**

In a conclusion, in the new era of rapid development of the global aging, e-commerce has capability to open up more markets to achieve greater economic, business and social value, it also create a convenient, open, diversified new lifestyle for the elderly.

**Reference**


