

# *The Influence of Mobile Phone Parameters on the Price of Domestic Mobile Phones*

*Taking Huawei, Xiaomi, OPPO and vivo as Examples*

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**Abstract**—with the sustained and steady growth of China's economy and the development of mobile communication services, mobile phones are becoming more and more popular. Domestic mobile phones have developed rapidly this year. But at the same time, mobile phones are trapped in increasing intense competition. How do manufacturers price mobile phones become one of the key factors for enterprises, and it is also the focus of consumers. This paper focuses on major parameters and price of four domestic mobile phone brands, Huawei, Xiaomi, OPPO and vivo. This paper analyzes and organizes the data by Equal Part Linear Regression Model, studies the influence of mobile phone parameters on mobile phone price, and finally gives some suggestions on the reasonable price of mobile phone.

**Keywords**—domestic smart phones, major parameter, selling price, Equal Part Linear Regression Model

## **I. Introduction**

With the continuous advancement of communication technology, mobile phones have gradually had a profound impact on people's lifestyles. More and more people are paying attention to different parameters of mobile phones when purchasing mobile phones in order to get a good user experience. Studying the impact of different parameters on mobile phone prices plays an important role in consumers' choice of mobile phones.

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## **II. Research Framework**

### **A. Basic Information of Samples**

#### **1) Source and Quantification of data**

This article selects the mobile phone parameters and selling prices of four domestic mobile phone brands Huawei, Xiaomi, OPPO and vivo as sample data. The research data was captured by WebCrawler from official information published by online mobile phone manufacturers. The official mobile phone parameter data includes the actual transaction price and detailed phone parameter characteristics. Mobile phone release date spans from August 2016 to June 2018. The total number of samples is 116.

#### **2) Selected parameters and Its Quantitation**

This paper selects 10 mobile phone parameter, they are Random Access Memory (RAM), Read-Only Memory (ROM), screen size, full screen, CPU score, weight, thickness, fast charging technology, fingerprint identification technology and sale time. Details are in Table 1. Table 2 is a sample narrative of the phone parameters.

### **B. Methodology**

In the study, most scholars use multiple linear regression analysis as the data analysis method. Extreme value data is the focus of social research institutes. However, using linear regression models to analyze these data can lead to errors in the results. Currently among the models for processing extreme value data, most researchers used Quantile Regression Model [1].

But this model is too complex to be understood. As a result, in order to minimize the errors and process data with a more understandable model, this paper uses the Equal Part Linear Regression model proposed by Professor Pan [2].

TABLE I. PARAMETERS AND ITS QUANTIFICATION

Number	Independent Variable	Quantitation
X1	RAM	G
X2	ROM	G
X3	Screen Size	inch
X4	Full Screen	full screen or not (0=no, 1=yes)
X5	CPU Score	point
X6	Weight	Gram (g)
X7	Thickness	millimeter (mm)
X8	Fast Charging Technology	support fast charging technology or not (0=no, 1=yes)
X9	Fingerprint Identification Technology	support fingerprint identification technology or not (0=no, 1=yes)
X10	Sale Time	month

TABLE II. SAMPLE NARRATIVE

Variable (unit)	Average	Standard Deviation	Minimum	Maximum
RAM (G)	4.4052	1.2997	2	8
ROM (G)	69.6558	39.5982	16	256
Screen Size (Inch)	5.7978	0.3600	5	6.44
Full Screen	0.7069	0.4552	0	1
CPU Score (point)	39.9798	10.1688	20	53
Weight(g)	163.1857	15.9062	137	211
Thickness (mm)	7.6674	0.4034	6.79	9.25
Fast Charging Technology	0.5259	0.4993	0	1
Fingerprint Identification Technology	0.8966	0.3045	0	1
Sale Time (m)	6.2672	5.3051	0	22

Equal Part linear regression allows researchers to use distance bisector linear regression or sample point bisector linear regression for analysis based on actual research needs. Similar to Quantile Regression Model, this method can effectively avoid the situation of data distortion due to the existence of extreme values. More importantly, Equal Part linear regression is simpler and more understandable for researchers.

According to EPLRM theory, linear data is cut into " $\tau$ " aliquots, each of which is processed by the Linear

Regression Model. In the paper, linear data are divided in three aliquots. Fig. 1 shows the relevant image.

In Fig. 1, 9 linear data points are divided into three aliquots and each division has three data points. In different parts, trend of three data points are different. So using standard linear regression to analyze samples may cause large error and incorrect conclusion.

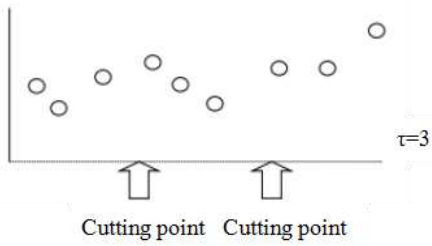


Figure 1. Three Equal Part Linear Regression Models

Therefore, Linear Regression Model can be applied in each parts in minimize errors. The three formula of EQLRM can be written as:

$$y_i^\tau = \beta_0^\tau + \beta_1^\tau x_i^\tau + \varepsilon_i^\tau$$

Least square formula:

$$\hat{\beta}_0^\tau = \frac{\sum_{i=1}^n (x_i^\tau - \bar{x}^\tau)(y_i^\tau - \bar{y}^\tau)}{\sum_{i=1}^n (x_i^\tau - \bar{x}^\tau)^2}$$

$$\hat{\beta}_1^\tau = \bar{y}^\tau - \hat{\beta}_0^\tau \bar{x}^\tau$$

Coefficient of determination and confidence interval:

$$\hat{\beta}_i^\tau - t_{\alpha/2} \times s_{\hat{\beta}_i^\tau}, \hat{\beta}_i^\tau + t_{\alpha/2} \times s_{\hat{\beta}_i^\tau}, i = 0,1$$

The "τ" symbol can be added to a specific position in the formula.

By using the R Language to perform Equal Part Linear Regression Model, the regression equation can be obtained. By statistically testing the regression coefficients, the insignificant factors are eliminated, and finally the optimal regression equation is obtained.

### III. Empirical analysis

#### A. Statistical and correlation analysis of variables

Mobile phone price (Y) is the dependent variable, RAM (X1), ROM (X2), screen size (X3), full screen (X4), CPU score (X5), weight (X6), thickness (X7), fast charging technology (X8), fingerprint identification technology (X9), and sale time (X10) are independent variables. The coefficients of the sample data are separately counted and showed in Table 3.

TABLE III. LEAST SQUARES REGRESSION COEFFICIENT AND CONSTANT

	Coefficient
Constant	-573.306123283901
X1	195.482560611148
X2	6.33824091456418
X3	-262.39556657991
X4	620.870620542893
X5	26.5813598792409
X6	-0.413239422818492
X7	119.124427206644
X8	531.55715371369
X9	1.87000580638643
X10	50.348474433388

From Table 2, it can be seen that RAM (X1), ROM (X2), full screen (X4), CPU score (X5), thickness (X7), fast charging technology (X8), fingerprint identification technology (X9) and the sale time (X10) are positively correlated with mobile phone price (Y). Screen size (X3) and weight (X6) are negatively correlated with mobile phone price (Y).

#### B. Result of the operation

From Table 4, it can be seen that at the first aliquot level the RAM (X1) and the thickness (X7) enjoy 10% significant level. The fast charging technology (X8) is significant in high degree, and other variables are not significant.

At the second aliquot level ROM (X2), CPU score (X5) and sale time (X10) are significant, and other variables are not significant.

At the second aliquot level ROM (X2), CPU score (X5) and sale time (X10) are significant, and other variables are not significant.

At the third aliquot level, the screen size (X3) and weight (X6) are significant in high degree. RAM (X1), full screen (X4), fast charging technology (X8) and sale time (X10) are significant at the third level, and other variables are not significant.

TABLE IV. EQUAL PART LINEAR REGRESSION SAMPLE NARRATIVE STATISTICS<sup>2</sup>

Variable <sup>1</sup>	Standard Linear Regression R <sup>2</sup> =0.77240464553159			The First Aliquot R <sup>2</sup> =0.829409769623324			The Second Aliquot R <sup>2</sup> =0.819419765384264			The Third Aliquot R <sup>2</sup> =0.969012448704471		
	Coefficient	T value	Significance	Coefficient	T value	Significance	Coefficient	T value	Significance	Coefficient	T value	Significance
X1	195.48	2.87	***	290.74	1.97	*	11.58	0.10	-	207.49	4.26	***
X2	6.34	3.79	***	3.63	1.07	-	8.72	3.01	***	6.02	4.93	-
X3	-262.40	-1.41	-	-816.82	-0.73	-	192.90	0.21	-	-405.81	-2.57	**
X4	620.87	3.19	***	385.60	0.51	-	422.78	0.87	-	492.11	3.23	***
X5	26.58	2.59	**	17.09	0.67	-	75.38	2.93	***	5.22	0.73	-
X6	-0.41	-0.08	-	19.44	1.06	-	-7.48	-0.38	-	11.01	2.39	**
X7	119.12	1.06	-	950.40	2.02	*	488.25	1.59	-	93.66	0.90	-
X8	531.56	2.47	**	904.21	2.11	**	-255.07	-0.50	-	717.74	4.21	***
X9	1.87	0.01	-	-68.39	-0.11	-	182.47	0.41	-	88.33	0.86	-
X10	50.35	3.72	***	33.45	0.76	-	112.06	3.19	***	27.56	3.48	***

1 X1: RAM; X2: ROM; X3: screen size; X4: full screen; X5: CPU score; X6: weight; X7: thickness; X8: Fast charging technology; X9: fingerprint identification technology; X10: sale time

2 \*: significant at 10% significant level; \*\*: significant at 10% significant level; \*\*\*: significant at 10% significant level

### C. Analysis of the result

#### 3) Analysis of the X1 (RAM)

Figure 2 shows the trajectory graph of the equal part linear regression coefficient and the confidence interval. The red dotted line in the figure is the standard linear regression line, the upper and lower two horizontal lines are the confidence intervals of the standard linear regression, and the irregular thick lines are the equal part linear regression lines (EPLRLs). The upper and lower gray areas are the confidence intervals for the equal part linear regression.

From Figure 2 it can be seen the equal part linear regression lines of the RAM (X1) at the lower aliquot is located above or within the confidence interval of the standard linear regression, where there is an underestimation; In the middle and low divisions, the EPLRL is below the confidence interval and there is an overestimation; At higher aliquots, the EPLRL is within the confidence interval, but below the red line, the price is slightly overestimated.

This paper believes that with the rapid development of the information age, low-traffic mobile phones are increasingly unable to meet people's needs, so people are reluctant to choose low-running mobile phones, even if the low-run memory phone is relatively more cost-effective. People are reluctant to use a few mobile phones to handle different things, while mobile phones with medium-run memory are not willing to pay extra value for them, but people are willing to pay extra value for them. As for high-end memory phones, the price of mobile phones is higher because of higher cost. It is also higher, but people feel value for money and are willing to pay this price.

#### 4) Analysis of the X2 (ROM)

It can be seen from Figure 3 that the EPLRL of the storage memory (X2) at the lower aliquot is located under the confidence interval of the standard linear regression, and the EPLRL at the middle and low aliquots is below the red line, and the presence is high. The situation is estimated, and EPLRL at the middle and high divisions is above the red line and there is an underestimation.

This article believes that some middle-aged and older people do not need to use mobile phones with higher storage memory because of knowledge restrictions and

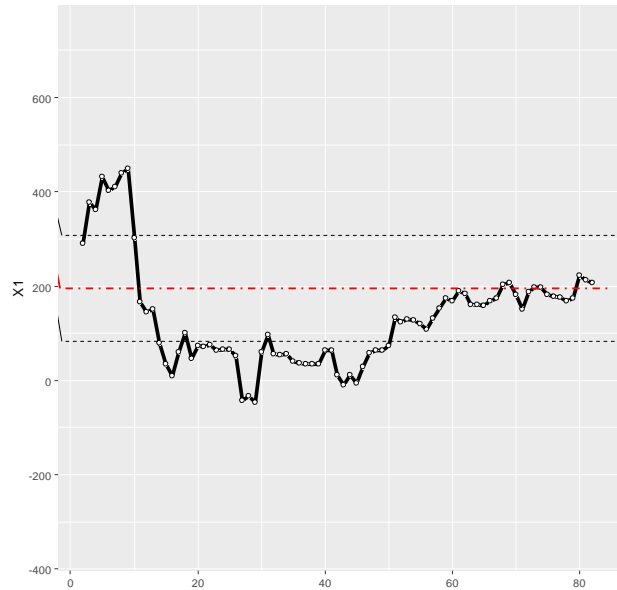


Figure 2. Equal part linear regression trend graph of X1

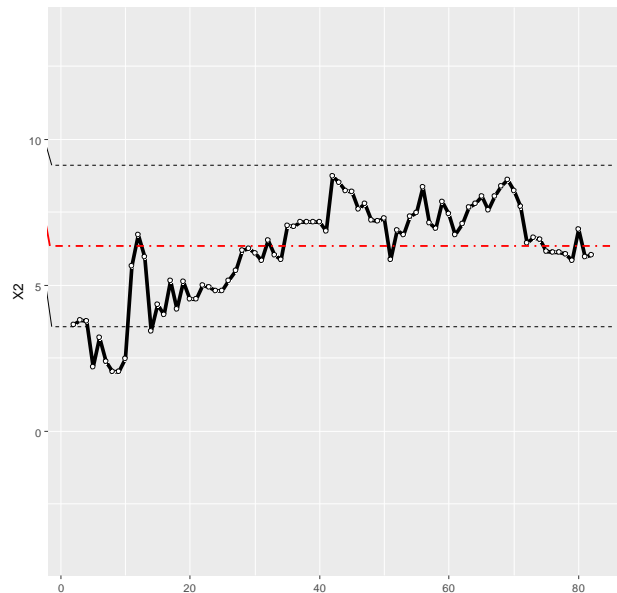


Figure 3. Equal part linear regression trend graph of X2

limitations of information acquisition, but many children will change their smartphones for parents due to holidays or mobile phone promotions, and children will give gifts to parents. Time is often not too much consideration of the price, only considers the applicability, so some mobile phones with small memory can also sell a good price; In addition, some mobile phones with relatively small memory and mobile phones are only bought by migrant workers or wage earners. They pay attention to price/performance ratio and are not willing to spend too much money on mobile phones, but because they do not understand mobile phone market, they are very May use this point to make this part of the phone also sell well. In the middle and high price mobile

phones, in order to save more things in the mobile phone, people often do not have a card machine or will clean up the mobile phone soon, they will often be willing to pay a higher price than the actual value of the mobile phone, resulting in the price of the mobile phone may be Underestimated situation.

**5) Analysis of the X3 (Screen size)**

As can be seen from Figure 4, most of the aliquot linear regression lines of the mobile phone screen size (X3) are located in the confidence interval of the standard linear regression. By comparing the data analysis effects of the aliquot linear regression and the least squares regression, we find that two The difference in the regression model is large, that is, the degree of significance is high and there is an underestimation.

This article believes that with the fragmentation of people's entertainment time, the people's entertainment requirements for mobile phones are getting higher and higher. The bigger the screen of a mobile phone, the more people play the game, the easier it is to operate, the more enjoyable it is to watch movies or TV shows, etc. The larger the screen of a mobile phone, the more attractive it is to people with high entertainment requirements, which leads to the underestimation of the impact of the screen size of the mobile phone on the price of the mobile phone.

**6) Analysis of the X4 (full screen)**

It can be seen from Figure 5 that in the low aliquot, most of the EPLRL are below the confidence interval of the standard linear regression, and there are overestimated cases; and the EPLRL at the middle and low aliquots are mostly Both are above the confidence interval of the standard linear regression, and there are underestimated cases; most of the EPLRL at the high and low equal parts are below the confidence interval of the standard linear regression, and there is an overestimation.

This paper believes that even if the mobile phones with lower price are full-screen mobile phones, people's recognition of these brands is not high. I feel that these full-screen mobile phones are very easy to break, but some people with low incomes want to catch up with the trend and are willing to buy. The price of this part of the full-screen mobile phone has been overestimated. In low- and medium-priced mobile phones, people generally recognize brands, but because they have limited economic

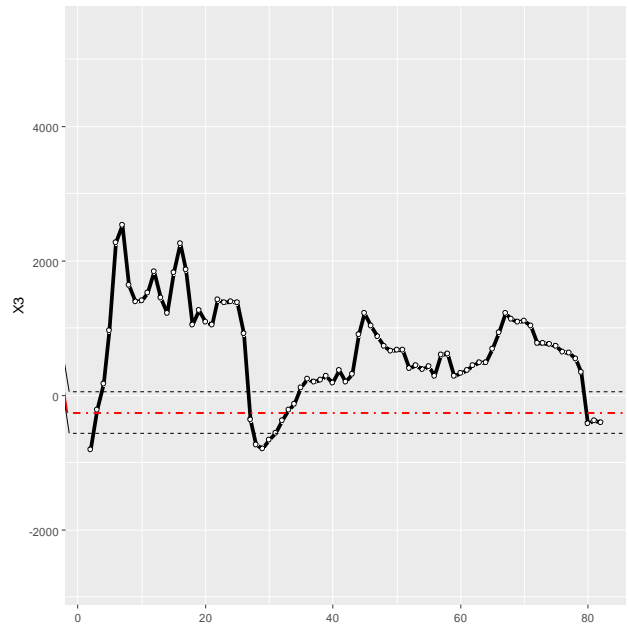


Figure 4. Equal part linear regression trend graph of X3

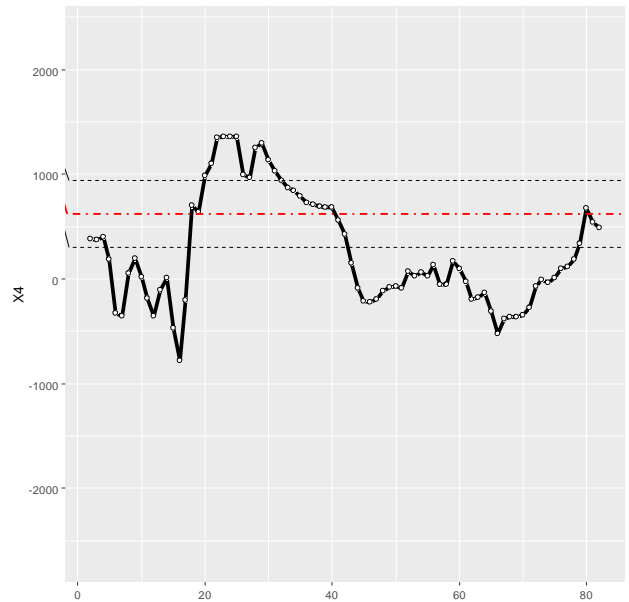


Figure 5. Equal part linear regression trend graph of X4

resources, they cannot buy higher-priced mobile phones, and are not willing to pay more prices to buy high-priced full-screen mobile phones. The price of this part of the full-screen mobile phone is underestimated. High-priced full-screen phones often have high brand prices due to good branding, and people are willing to pay high prices to get high quality, which has led to an overestimation of the price of this full-screen mobile phone.

**7) Analysis of the X5 (CPU score)**

It can be seen from Fig. 6 that most of the EPLRLs are located in the confidence interval of the standard linear

regression, and there are underestimation cases; A small fraction of the aliquots of the low and equal divisions are located below the line of the standard linear regression and are overestimated.

The manufacturer believes that the CPU is very important, so the price increases accordingly. But for users who buy low-cost mobile phones, some customers do not need high-performance mobile phone CPU configuration. They are reluctant to pay for the mobile phone experience, so the impact of low- and sub-base CPU scores on mobile phone prices is overestimated.

The high CPU score may be more popular with users, and consumers have greater willingness to purchase, resulting in the underestimation of the impact of most CPU ratings on mobile phone prices.

This paper believes that the CPU as the core of a mobile phone affects the ability of the mobile phone to run multiple programs at the same time, and plays an important role in the operation speed and image processing functions of the mobile phone. Therefore, the CPU score becomes an important parameter that users pay attention to when purchasing mobile phones.

8) **Analysis of the X6 (weigh)**

It can be seen from Fig. 7 that most of the EPLRLs are located under the confidence interval of the standard linear regression, and there are cases of overestimation; the aliquots of the low-central and high-allocation are in a standard linear Above the line of regression, there is an underestimation.

This article believes that for most users, the weight of the mobile phone does not affect the purchase intention without affecting the operation, but many mobile phone brands use mobile phones as an important selling point for mobile phones. The manufacturer believes that users will pay attention to the weight of the mobile phone, so the price of this part of the mobile phone is overestimated. Lighter mobile phones will give users a better experience. At similar price levels, consumers tend to prefer mobile phones, which will make the price of this part of the phone overvalued. If consumers buy high-priced mobile phones, people will consider the impact of weight on the sense of use. Mobile phones with higher than average weight will affect users' use to a certain extent, and are not welcomed

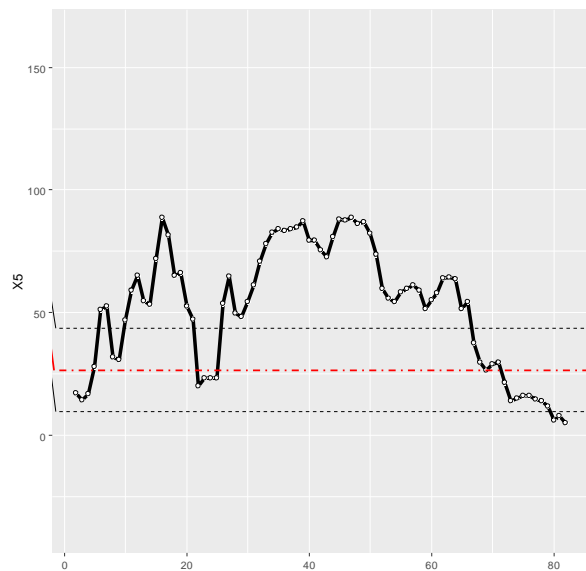


Figure 6. Equal part linear regression trend graph of X5

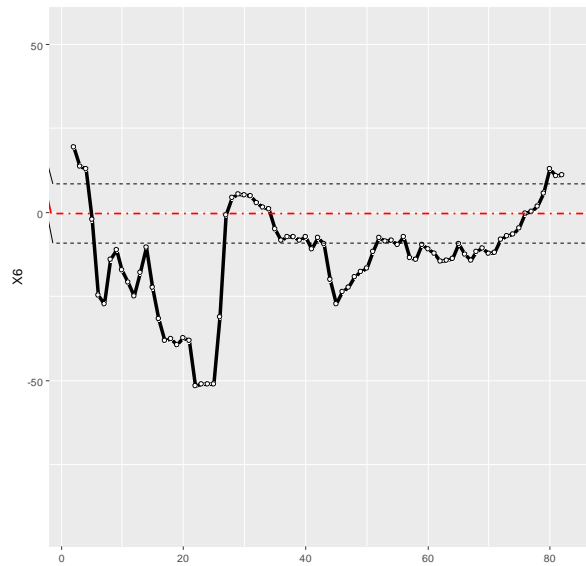


Figure 7. Equal part linear regression trend graph of X6

by consumers, underestimating the impact of weight on mobile phone prices.

9) **Analysis of the X7 (thickness)**

It can be seen from Figure 8 that the EPLRLs of X7 are basically located in the confidence interval of the standard linear regression, and there are cases where the estimation is underestimated.

The main reason is that the thickness of the mobile phone can be visually observed by the user, and is closely related to the shape design. The thinner mobile phone is designed to be more fashionable and personalized, and the user has greater willingness to purchase. When the price level is similar, the average user will choose a thinner and lighter mobile phone. For the moment, people's

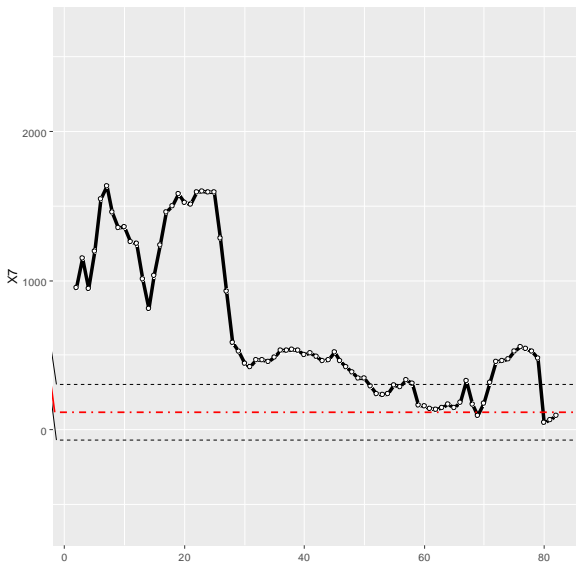


Figure 8. Equal part linear regression trend graph of X7

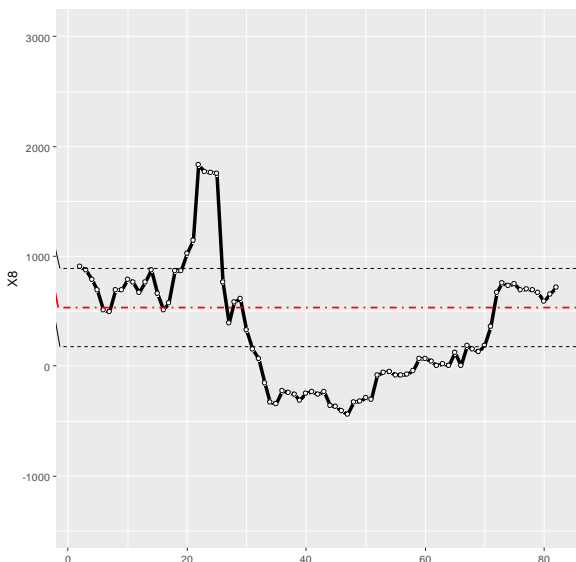


Figure 9. Equal part linear regression trend graph of X8

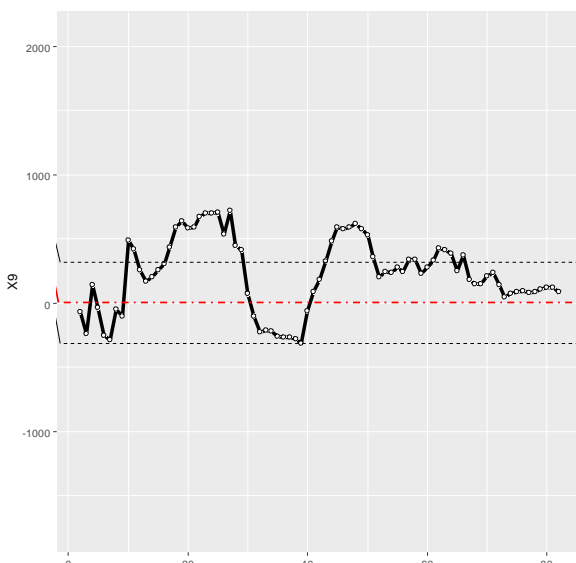


Figure 10. Equal part linear regression trend graph of X9

consumption levels have increased, and the better-looking mobile phones are still acceptable even if the price is slightly higher. For those who are pursuing the shape design of mobile phones, the thinner mobile phones are more attractive, resulting in the thickness of mobile phones. The impact of the impact is underestimated.

### 10) Analysis of the X8 (fast charging technology)

It can be seen from Fig. 9 that at the low aliquot the EPLRL is located within the confidence interval of the standard linear regression, and there is a case where it is slightly underestimated; the part is located above the confidence interval of the standard linear regression, and there is an underestimation. Most of the EPLRLs in the middle and high aliquots are located below the confidence interval of the standard linear regression, and there is an overestimation; the small part of the EPLRL at the high and low aliquots is above the confidence interval of the standard linear regression. There is a situation of underestimation.

The main reason for this phenomenon is that the fast charging technology of mobile phones is very popular among consumers and is an advantage of mobile phone performance. Especially for users who need to go out for a long time, it is inconvenient to charge the mobile phone outside, and fast charging can solve this problem very well. Therefore, mobile phone manufacturers believe that consumers prefer mobile phones that support fast charging.

However, the function of fast charging of mobile phones makes the mobile phone have a big security problem. Users have to consider this factor when purchasing mobile phones, so for mobile phones with lower prices, users usually think that their security is not in place. It will reduce the user's willingness to buy.

### 11) Analysis of the X9 (fingerprint identification technology)

As can be seen from Figure 10, most of the EPLRLs are located in the confidence interval of the standard linear regression, and there are cases of underestimation. In the middle and lower part, the partial EPLRL is located under the confidence interval of the standard linear regression, and there is an overestimation.

The reason for this situation is that the fingerprint recognition function increases the security of the mobile phone and reduces the risk of the privacy of the mobile phone being sneaked. Even if the mobile phone is lost, the



privacy of the user can be protected from being easily leaked, which makes many users have the willingness to purchase such a mobile phone.

The technology of fingerprint identification has been newly developed in recent years and has not been popularized to all mobile phone brands. This has also attracted some users who are pursuing high-tech, which has led to the underestimation of the impact of fingerprint unlocking on the price of mobile phones. For consumers with limited consumption levels, fingerprint identification is not a must. They are not willing to spend much on fingerprint identification function.

Other consumers viewed that mobile digital passwords have been satisfied their privacy security needs, with no need to purchase fingerprint-locked mobile phones.

### 12) Analysis of the X10 (sale time)

As can be seen from Figure 11, most EPLRLs are located in the confidence interval of the standard linear regression, and there are cases of underestimation.

The sale time of mobile phones is an important factor affecting the current price of mobile phones. With the development of technology, mobile phone replacement has changed rapidly; the life cycle of a new mobile phone product has been shortened. As a result, the price of the same mobile phone product has changed rapidly.

For most consumers who like to catch up with the trend, the latest phones are often the most attractive. The longer the mobile phone is on sale, the lower the consumer's sense of freshness on the mobile phone, leading to an overestimation. However, in order to compete with other brands in the market and gain market share, more brand owners have the fastest price cuts in the stage of new mobile phones. This has caused some mobile phone prices to be undervalued.

### 13) F test results of sample data

From Table 5, it can be seen that at the first and second aliquot level X4 (full screen or not) is slightly significant. X3(screen size), X8(fast charging technology) and X10 (sale time) have a 5% significant level while X9 (fingerprint identification technology) has a 1% significant level. At the first and third aliquot level X2 (ROM) and X9 (fingerprint identification technology) are slightly significant while X1 (RAM) is more significant.

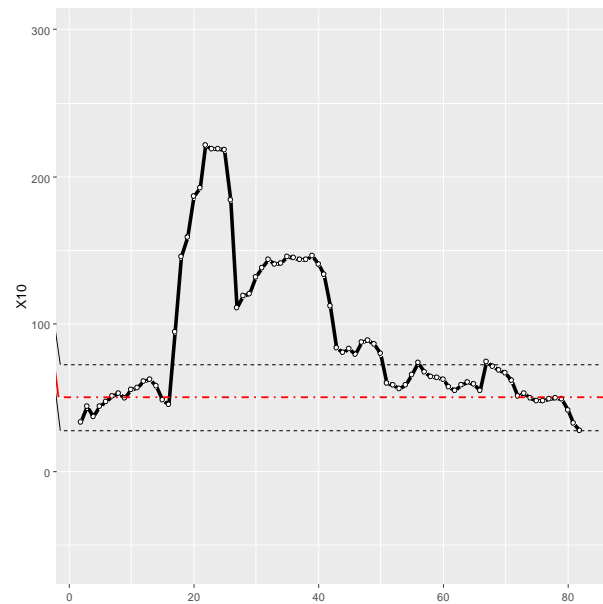


Figure 11. Equal part linear regression trend graph of X10

TABLE I. F TEST RESULTS OF SAMPLE DATA

Variable	c1-c2		c1-c3		c2-c3	
	F Value	Significance	F Value	Significance	F Value	Significance
X1	1.3916	-	5.3834	**	3.8684	*
X2	3.1333	-	4.9252	*	1.5719	-
X3	5.1832	**	189.6410	-	36.5878	***
X4	4.2084	*	15.2530	***	3.6244	-
X5	1.3097	-	30.3382	***	23.1636	***
X6	2.5829	-	96.4938	-	37.3592	***
X7	0.7034	-	37.9013	-	53.8801	-
X8	0.1550	**	16.9134	***	109.1013	-
X9	0.0920	***	4.7772	*	51.9039	-
X10	0.1631	**	2.4410	-	14.9663	***

The significant level of performance of the remaining independent variables is also listed in Table 5.

## IV. Conclusion and Suggestion

Studying the impact of mobile phone parameters on mobile phone prices is of great significance to mobile phone manufacturers' specified production and sales plans. The Equal Part Linear Regression Model used in this paper is a newly proposed research method, which can effectively avoid data distortion. The purpose of this paper is to study the influence of the least squares regression and the Equal Part Linear Regression method on the mobile phone price, and to explore the accuracy of the mobile phone valuation by the Equal Part Linear Regression.

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The research data was captured by WebCrawler from official information published by online mobile phone manufacturers. The least square regression model and the Equal Part Linear Regression established in the paper are the basis for empirical analysis and valuation accuracy analysis. The empirical analysis found that when the mobile phone price is in the middle and high grades, the storage memory, screen size, CPU score, fingerprint identification technology and the sale time have an underestimation effect on the mobile phone price; When the price is in a low grade, the memory, the thickness, CPU score, and whether fast charging is supported have an underestimation effect.

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