The Second Hand Market of iPhone in PTT Macshop Board

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Outline

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3. Descriptive Statistics
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   - 「女用機」比較值錢？
   - Estimating the second-hand iPhone Demand
   - Estimating the Demand Curve via IV Regression
   - The probability of successfully selling an iPhone 6s

Core Question

1. 「女用機」比較值錢？
2. Estimating the second-hand iPhone Demand
3. The probability of successfully selling an iPhone 6s
4. Analysis based on the geographical distribution of second hand iPhone selling and buying

Data Description

Descriptive Statistics

Results

「女用機」比較值錢？

- 欲出售 iphone 的貼文內標注「女用機」或「女生用」
- 「女用機」真的可以賣得比較貴嗎?
- 將此“premium”稱為“gender rent”

「女用機」比較值錢？

在 163950 則交易 iPhone 的貼文

- 標注「男用機」：83 則；標注「女用機」：2922 則
- 需要區別「成交價格」以及「非成交價格」

考量線性迴歸模型：

$$price_i = \beta_0 + \beta_1 D_{female,i} + \beta_2 D_{male,i} + \gamma W_i + u_i$$

where W is the control variable and W contains:

$$TimeUsed, ROM, color$$

「女用機」比較值錢？

```
t test of coefficients:

               Estimate  Std. Error  t value  Pr(>|t|)
(Intercept)  6.6765e+04  3.8878e+03  17.1730 < 2.2e-16 ***
IsFemale    -5.2049e+03  5.8177e+02  -8.9466 < 2.2e-16 ***
IsMale      -6.4808e+03  2.8031e+03  -2.3120   0.02084 *
TimeUsed    -3.9740e-05  2.6729e-06 -14.8675 < 2.2e-16 ***
ROM          8.7480e+01  2.4696e+00  35.4230 < 2.2e-16 ***
color_紅     3.9561e+03  6.8944e+02   5.7382 1.037e-08 ***
color_灰     2.6941e+03  4.6818e+02   5.7544 9.428e-09 ***
color_金     2.5873e+03  3.6616e+02   7.0661 1.909e-12 ***
color_藍     9.7082e+03  1.5156e+03   6.4054 1.696e-10 ***
color_綠     9.4491e+03  1.1865e+03   7.9641 2.220e-15 ***
color_玫瑰   1.0511e+03  4.8286e+02   2.1768   0.02956 *
color_銀     2.0776e+03  4.6752e+02   4.4440 9.099e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

「女用機」比較值錢？

- 與預期相反，在所有型號中且是「已售出」或「已徵得」的 iPhone 中，標注有「女用機」的貼文的成交價格是比較低的。
- 若是限制在 iPhone 6s 這個機型的話，則沒有顯著地異於零，但大致的方向仍是負的，意味著標示「女用機」並沒有辦法「提升價格」。
- 在 PTT 的文化中，更常見的是嘲諷標注女用機的貼文者

「女用機」比較值錢？

考量線性迴歸模型，並將樣本限制在成交的 iPhone 6s 貼文中：

$$price_i = \beta_0 + \beta_1 D_{female,i} + \beta_2 D_{male,i} + \gamma W_i + u_i$$

where W is the control variable and W contains:

$$TimeUsed, ROM, color$$

「女用機」比較值錢？

```
t test of coefficients:

               Estimate  Std. Error  t value  Pr(>|t|)
(Intercept) 21343.68352  1480.37045  14.4178 < 2.2e-16 ***
IsFemale     -457.14882  1492.68059  -0.3063    0.7596
TimeUsed      -15.22156     0.55273 -27.5388 < 2.2e-16 ***
ROM            50.24563     8.26413   6.0800  3.39e-09 ***
color_灰     -572.08213  1215.11728  -0.4708    0.6381
color_金      941.82397  1267.18374   0.7432    0.4579
color_玫瑰   1200.32805  1205.09409   0.9960    0.3200
color_銀     -294.11541  1313.01866  -0.2240    0.8229
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

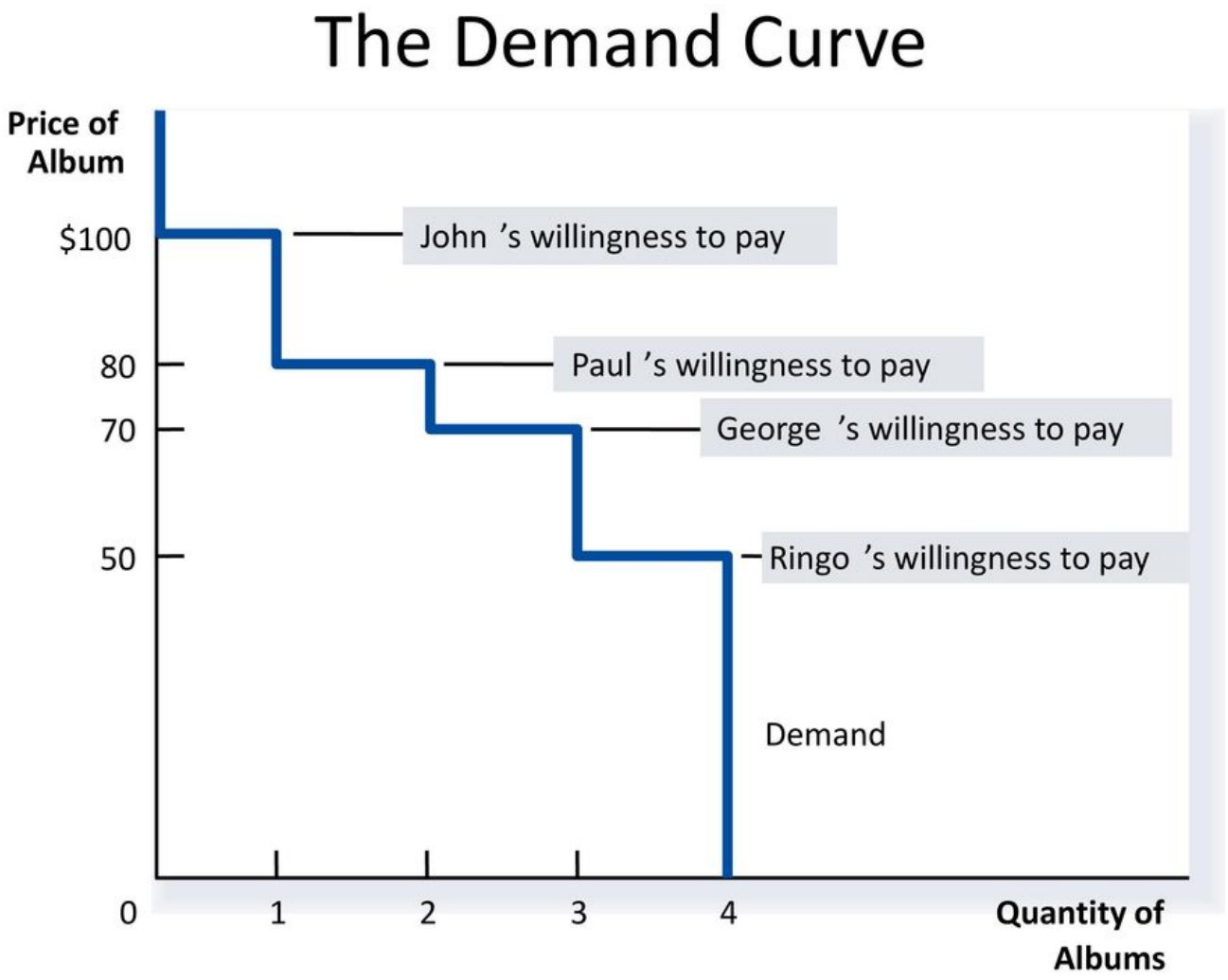
Definition

- Demand function characterizes the quantity demanded q^d when given a price p

Notice that q^d is a function of p

- The Inverse Demand function characterizes the price p when given a quantity demanded q^d
- Economists usually use inverse demand to characterize the "Willingness to Pay"

Definition


The Demand Curve
Price of Album
$100
80
70
50
0
1
2
3
4
Quantity of Albums
John 's willingness to pay
Paul 's willingness to pay
George 's willingness to pay
Ringo 's willingness to pay
Demand

Estimating Demand?

If we do not restrict the data on the SOLD and BOUGHT one, then we are not at the equilibrium.

- If we do not restrict the data on the SOLD and BOUGHT one, then we are not at the equilibrium.
- However, we have the label: Whether the poster is a potential buyer or seller.
- Thus, we're looking the Willingness to pay (WTP) for buyers.
- What about sellers? "Willingness to be paid" (WTBP)

Estimating WTP and WTBP

由於 iPhone 6s 此一機型非常地暢銷，自 2015 年發售以來便持續活躍於二手交易市場，以致於在關鍵字為 iPhone 的 19 萬則貼文中，儘管 iPhone 有從 3GS 到 iPhone 12 等數十個型號，但仍有近 10% 的貼文是此單一機型，因此我們將所估計的財貨限制在此一型號

由於二手交易版需要使用者在貼文時標注自己希望「出售」還是「購買」(徵求)。在使用者打算「徵求」購買一支二手的手機時，我們可以將帶有「購買」分類標籤的貼文簡單地視為使用者標注了自己的“Willingness To Pay”(願付價格); 而對於打算出售二手手機的使用者，文內的「希望價格」我們則以“Willingness To Be Paid”來稱之。

Estimating WTP and WTBP

若分別以 inverse supply function 以及 inverse demand function 的角度視之，我們可以分別寫下:

$$p_t = \alpha_0 + \alpha_1 q_t^s + \alpha W_t + u_t$$

$$p_t = \beta_0 + \beta_1 q_t^s + \beta W_t + v_t$$

where q_t^s, q_t^d 分別代表時間 t 時，iPhone 6s 的供給以及需求

Estimating WTP and WTBP

在此，由於我們有區別是在 supply side 或 demand side 的分類標籤，因此無須處理 simultaneous equation 的問題。當然，我們所估計的上面兩條迴歸式尚且不能稱之為供給及需求函數，但可以作為此二函數的近似。在此，我們尚且稱呼此二式為 Willingness To Be Paid (WTBP) 及 Willingness To Pay (WTP)

Estimating WTBP

WTBP:

$$p = 22346.26 + 20.54q^s$$

```
t test of coefficients:

               Estimate  Std. Error  t value  Pr(>|t|)
(Intercept) 22346.26298   543.25356  41.1341 < 2.2e-16 ***
quantity       20.53982     5.76329   3.5639  0.000436 ***
TimeUsed      -12.53909     0.35069 -35.7552 < 2.2e-16 ***
ROM             3.27603     4.90388   0.6680  0.504706
Is_6s_plus    160.45261   289.86773   0.5535  0.580381
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Estimating WTP

WTBP:

$$p = 23691.78 - 8.54q^d$$

```
t test of coefficients:

              Estimate Std. Error  t value Pr(>|t|)
(Intercept) 23691.7842   954.1712  24.8297  < 2e-16 ***
quantity       -8.5358    55.3531  -0.1542  0.87762
TimeUsed      -12.4746     0.7538 -16.5489  < 2e-16 ***
ROM           -18.4653     8.3369  -2.2149  0.02799 *
Is_6s_plus   1134.3397   552.4897   2.0531  0.04147 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Definition

Recall the Introduction to Econometrics class:

- Quantity and Price are determined simultaneously in a system
- q and p are endogenous variables in this system
- OLS fails without identification

Definition

Take supply function estimation for example:

Supply side:

$$Q = \beta_1 P + \varepsilon$$

Demand side:

$$Q = \alpha_1 P + \alpha_2 Income + u$$

where $Income$ is an exogenous variable (determined outside the system).

Definition

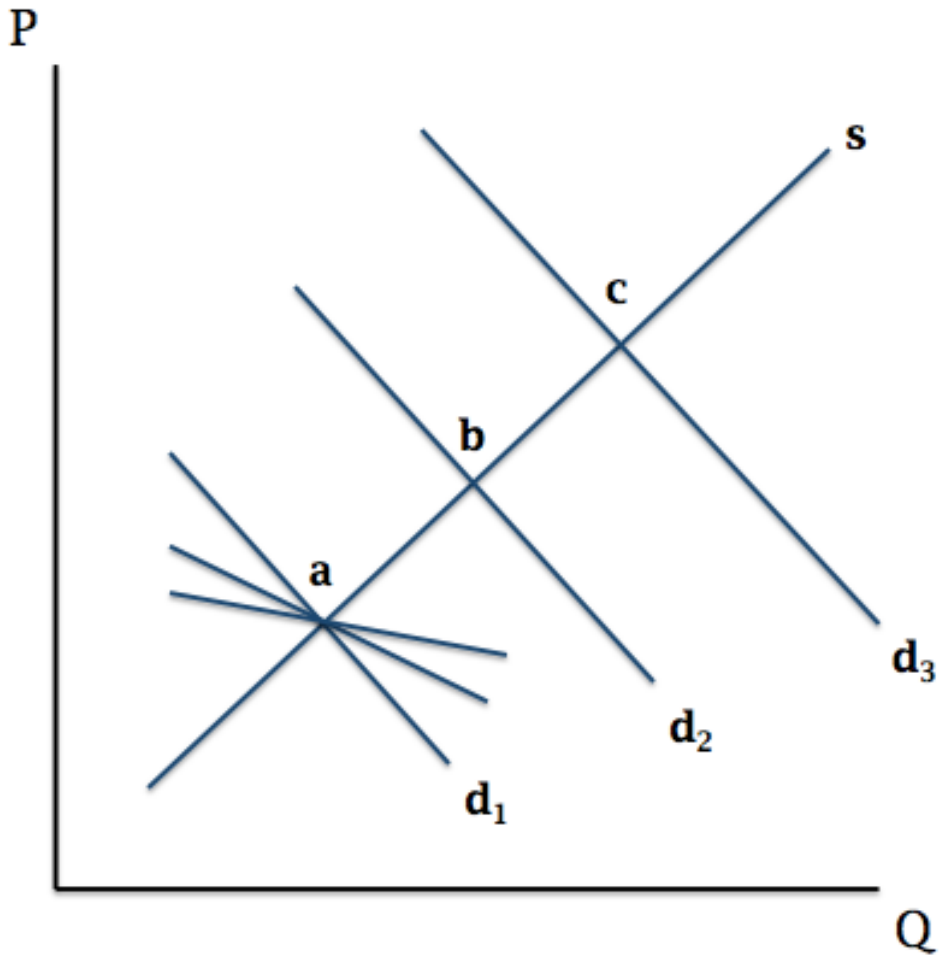
We cannot estimate β_1 for the supply function via estimating the following regression model with OLS:

$$Q = \beta_1 P + \varepsilon$$

Why? Because of Endogeneity!

We need to find the demand shifter! $\rightarrow Income$

Definition



Definition

A demand shifter only affects the quantity demanded, and do no effects on quantity supplied.

Similarly, as long as we want to find the demand curve, we need to find a supply shifter.

A supply shifter is simply an IV (Instrument Variable)

IV: TSMC or Samsung?

我們 propose 一個 IV，它是「販賣或購買 iPhone 6s 的貼文內是否標注了『台積電/TSMC 晶片』或『三星/Samsung 晶片』」，因此我們的 IV 為兩個 Dummy Variable，分別以 $IsTSMC$ 及 $IsSamsung$ 稱之

由於 2015.9.25 發表 iPhone 6s 及 6s Plus 之後，隨即發生了「晶片門」事件

IV: TSMC or Samsung?

我們真實想估計的 demand function(非 inverse demand function) 是

$$q_t^d = \beta_0 + \beta_1 p_t + \beta_3 W_t + \varepsilon_t$$

where W_t 表示其他外生變數。但由於 p_t 存在內生性問題 $Cov(p_t, \varepsilon_t) \neq 0$，因此我們可以透過 $IsTSMC$ 以及 $IsSamsung$ 此二外生變數來 serve p_t

IV: TSMC or Samsung?

```
Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  4284.6034 18815.6238   0.228    0.820
price          -0.1833     0.8156  -0.225    0.822
TimeUsed       -2.3286    10.1989  -0.228    0.820
ROM             0.1215     1.1386   0.107    0.915
Is_6s_plus     36.8174   167.6908   0.220    0.826

Diagnostic tests:
                 df1 df2 statistic p-value
Weak instruments   2 251     0.026 0.97427
Wu-Hausman         1 251    10.771 0.00118 **
Sargan             1  NA     0.013 0.90755
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

IV Regression

也就是 demand function 是：

$$q^d = 4284.60 - 0.18328p$$

移項得到 inverse demand function:

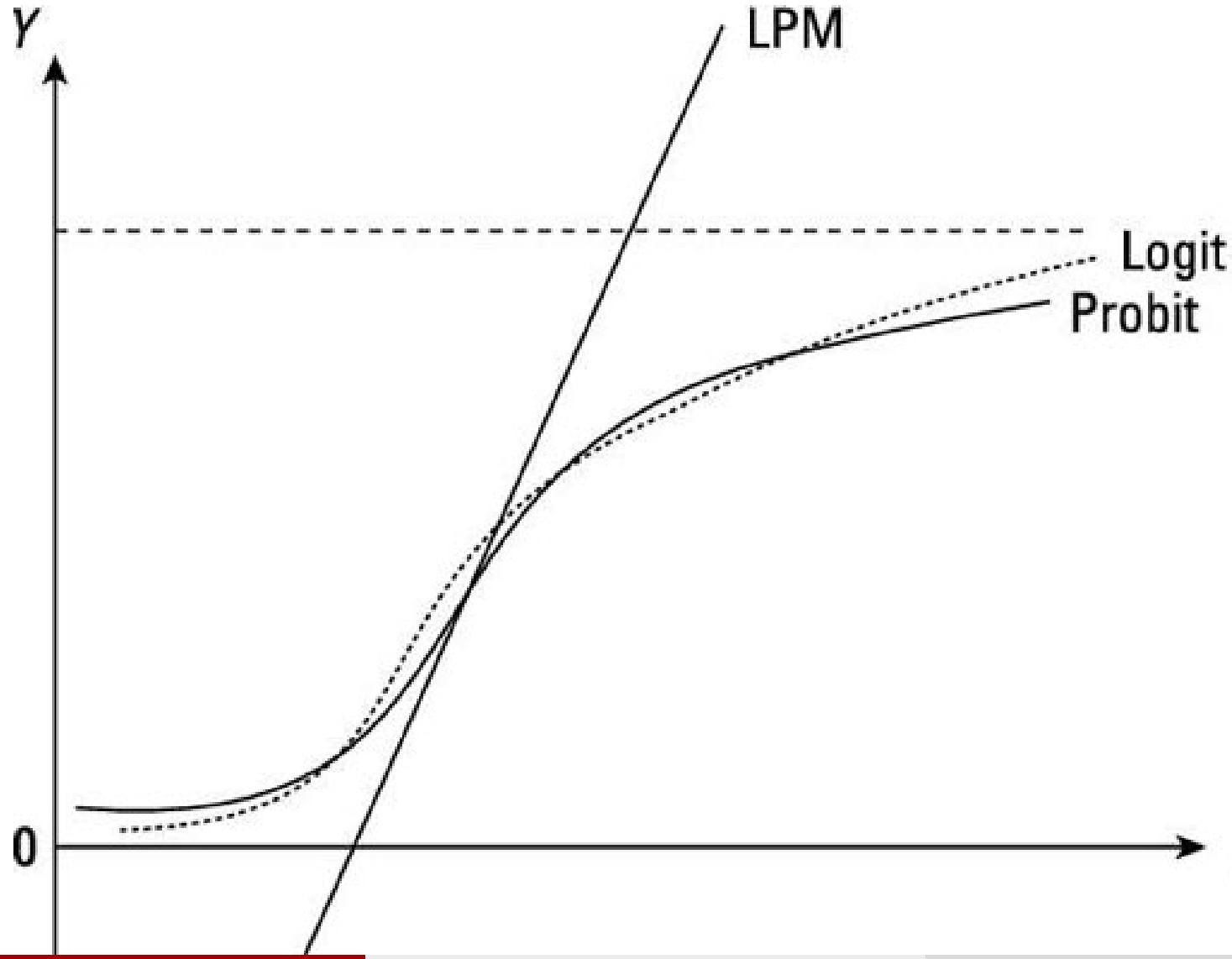
$$p = 23377.34 - 5.4561q^d$$

Recall the WTP estimated:

$$p = 23691.78 - 8.64q^d$$

IV Estimation 所給我們的估計較為保守

Binary Response Model



Binary Response Model

以「是否賣出」為被解釋變數

$$IsSold = \beta_0 + \beta_1 price + \beta_2 ROM + \beta_3 i6sPlus + \beta_4 TimeUsed + \beta_5 D_{female} + \beta_6 color$$

Binary Response Model : LPM

```
t test of coefficients:

               Estimate  Std. Error t value Pr(>|t|)
(Intercept)  3.7299e-02  1.3766e-02  2.7095 0.006748 **
avg_price   -1.3428e-06  4.7938e-07 -2.8011 0.005101 **
ROM          5.6730e-06  4.9910e-05  0.1137 0.909505
Is_6s_plus   1.0190e-02  3.5333e-03  2.8839 0.003935 **
TimeUsed    -1.0668e-05  9.0650e-06 -1.1768 0.239304
IsFemale    -3.4201e-03  9.0412e-03 -0.3783 0.705230
color_灰     1.0223e-02  7.0065e-03  1.4590 0.144582
color_金     1.2327e-02  6.9306e-03  1.7787 0.075320 .
color_玫瑰   1.3615e-02  6.5062e-03  2.0927 0.036399 *
color_銀     9.1335e-03  7.3937e-03  1.2353 0.216739
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Binary Response Model : Probit

```
z test of coefficients:

               Estimate  Std. Error z value  Pr(>|z|)
(Intercept) -1.7569e+00  2.4610e-01 -7.1389 9.407e-13 ***
avg_price   -2.4706e-05  8.0708e-06 -3.0611  0.002205 **
ROM          1.3855e-04  8.2493e-04  0.1679  0.866625
Is_6s_plus   1.6549e-01  5.6492e-02  2.9294  0.003396 **
TimeUsed    -2.0327e-04  1.4356e-04 -1.4159  0.156794
IsFemale    -5.6058e-02  1.4617e-01 -0.3835  0.701349
color_灰     2.1121e-01  1.5505e-01  1.3622  0.173143
color_金     2.3960e-01  1.5243e-01  1.5719  0.115985
color_玫瑰   2.6174e-01  1.4728e-01  1.7772  0.075532 .
color_銀     1.8686e-01  1.6171e-01  1.1555  0.247867
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Binary Response Model : Logit

```
z test of coefficients:

               Estimate  Std. Error z value  Pr(>|z|)
(Intercept) -3.1681e+00  5.9295e-01 -5.3430 9.144e-08 ***
avg_price   -5.9276e-05  1.9055e-05 -3.1107  0.001866 **
ROM          2.2993e-04  1.9502e-03  0.1179  0.906144
Is_6s_plus   4.0372e-01  1.3258e-01  3.0451  0.002326 **
TimeUsed    -4.8572e-04  3.3617e-04 -1.4449  0.148493
IsFemale    -1.2858e-01  3.4595e-01 -0.3717  0.710136
color_灰     4.8629e-01  3.8594e-01  1.2600  0.207661
color_金     5.6200e-01  3.7943e-01  1.4812  0.138555
color_玫瑰   6.1361e-01  3.6748e-01  1.6698  0.094962 .
color_銀     4.3925e-01  4.0170e-01  1.0935  0.274191
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Binary Response Model

- 最重要的因素仍是價格: 價格越低，成交的機率就越高
- 「玫瑰金」在 2015 年推出 iPhone 6s 時是新出的顏色