iPhone的二手市場－

以PTT Macshop版為例

G13

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Outline

- Core Question
- Data Description
- Descriptive Statistics
- Geographic Visualization

Core Questions

Core Question

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

Data Description

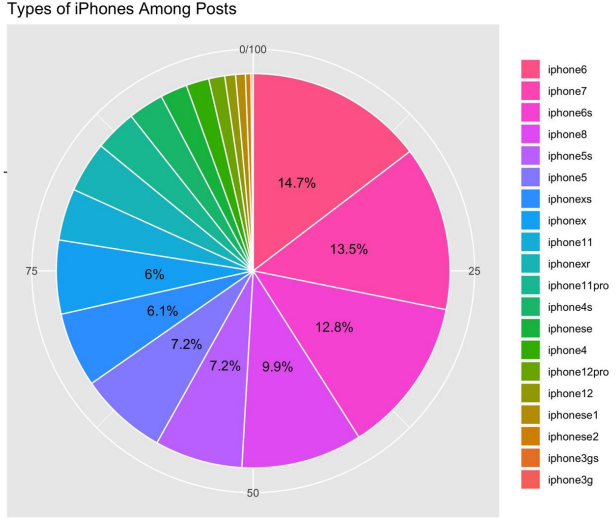
Data Description

- 以網路爬蟲抓取PTT Macshop版中關鍵字包含iPhone的文章
- 資料總數：192786筆
- 資料期間：2010/12/13 - 2020/12/24
- 原始資料包含文章標題、內文、發文時間及文章對應網址

Descriptive Statistics

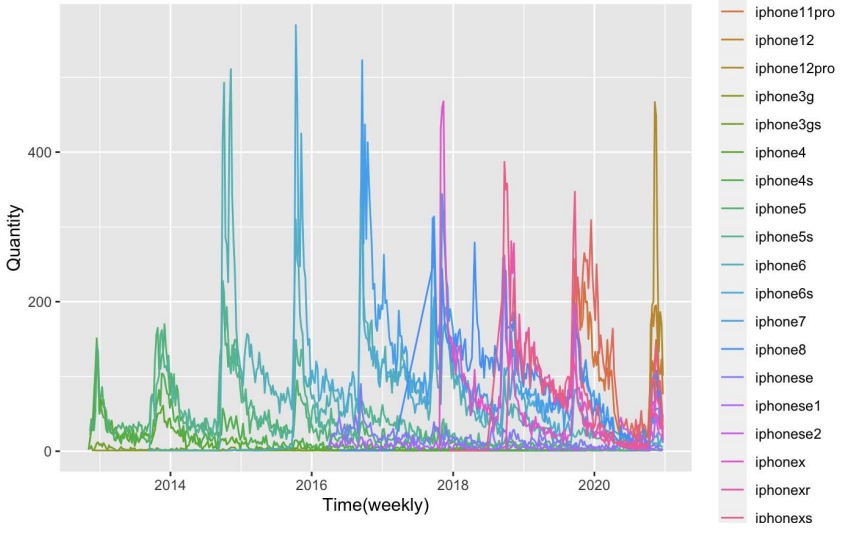
圖一 iPhone各個型號占總貼文數的比例

可知清理完後的資料共有144848筆，其中以iPhone6的件數最多，約占14.7%。第二多的是iPhone7，約占13.5%。



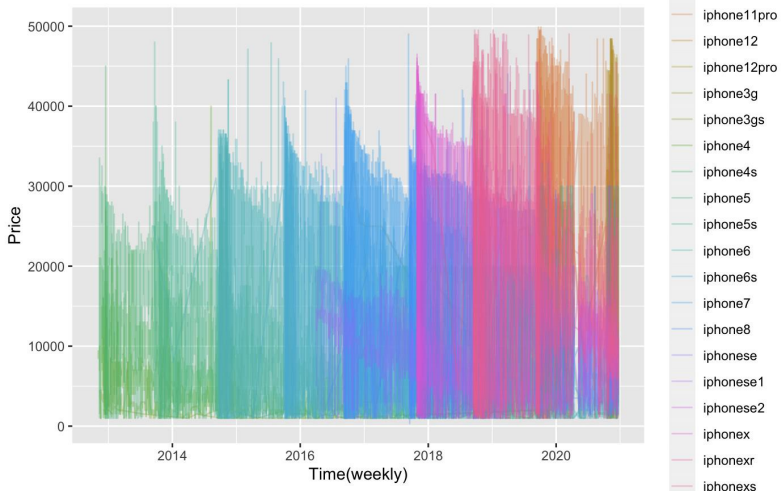
圖二 不同型號iPhone的貼文數量趨勢

橫軸為週次、縱軸為貼文數量，依顏色區分不同的型號(type)，可以看出剛推出新品時，上一代手機的貼文數會突然大增，可見舊機換新機的風氣。



圖三 不同型號iPhone的價格趨勢

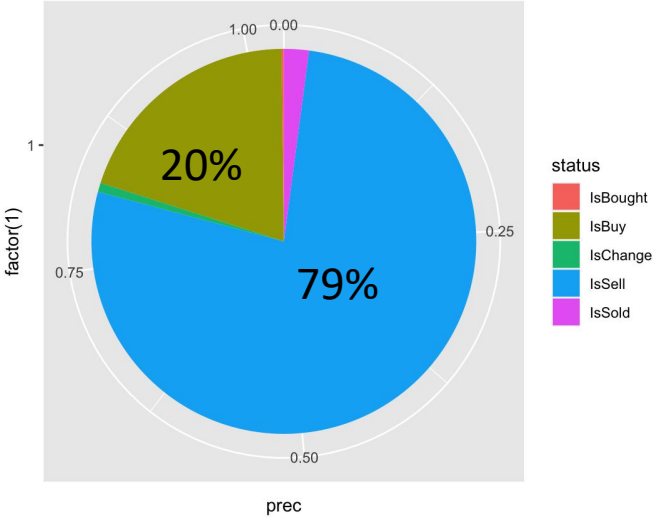
橫軸為週次、縱軸為平均價格，依顏色區分不同的型號(type)，可以看出不論哪種 iPhone型號，推出新品後一年約折價1萬元，一年之後折價速度會減緩。



圖四 iPhone不同交易狀態占總貼文數的比例

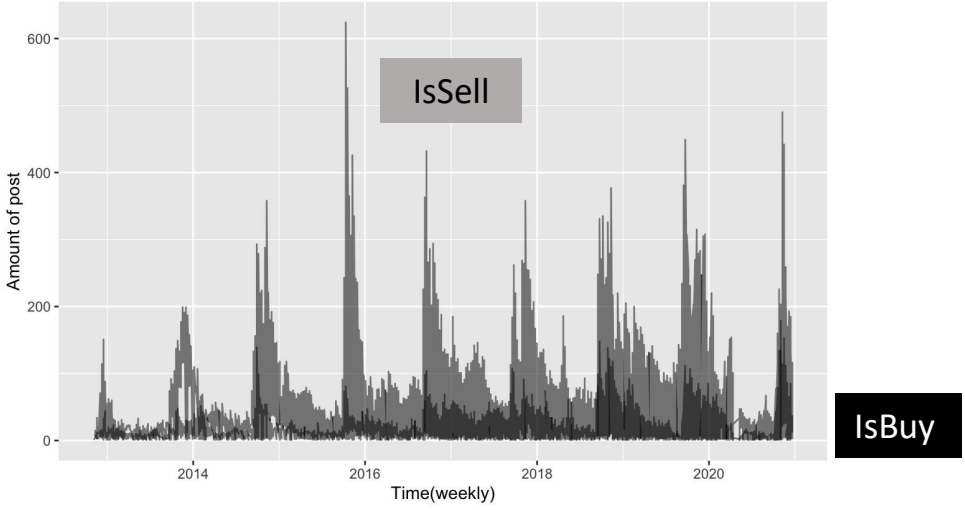
(IsBuy, IsBought, IsSell, IsSold, IsChange)

可知以買/賣的貼文數最多，但已成交(已售/已購買)的件數卻非常少。



圖五「出售」、「購買」數量與時間的走勢

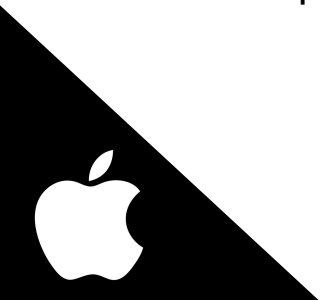
其中，再以占大部分貼文數的「出售」以及「購買」來畫圖，可看出賣的人出價比買的人高很多。



Results

「女用機」比較値錢？

- 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？

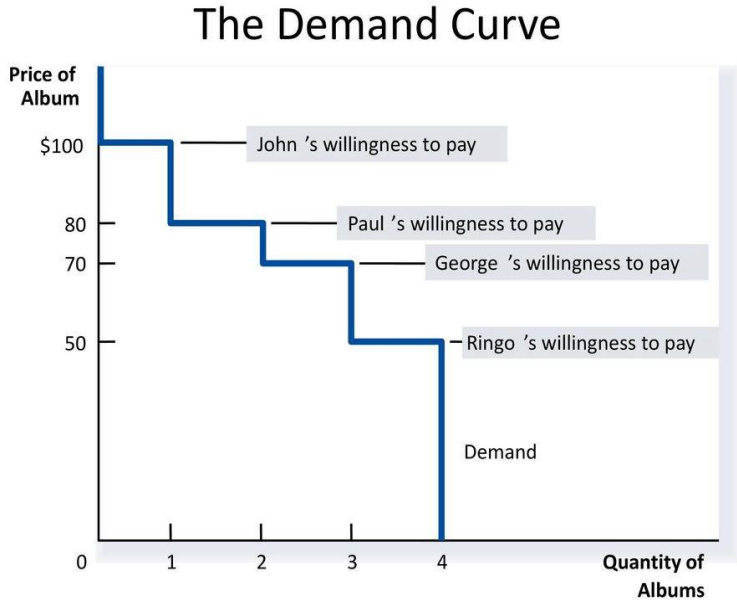
```
t test of coefficients:

               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.
- 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

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
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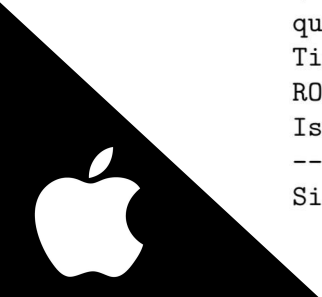


Estimating WTP

WTP :

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

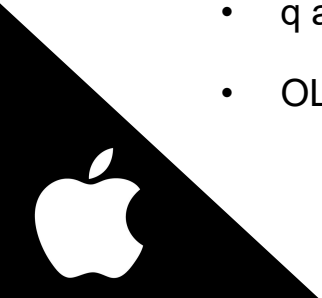
```
t test of coefficients:

              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

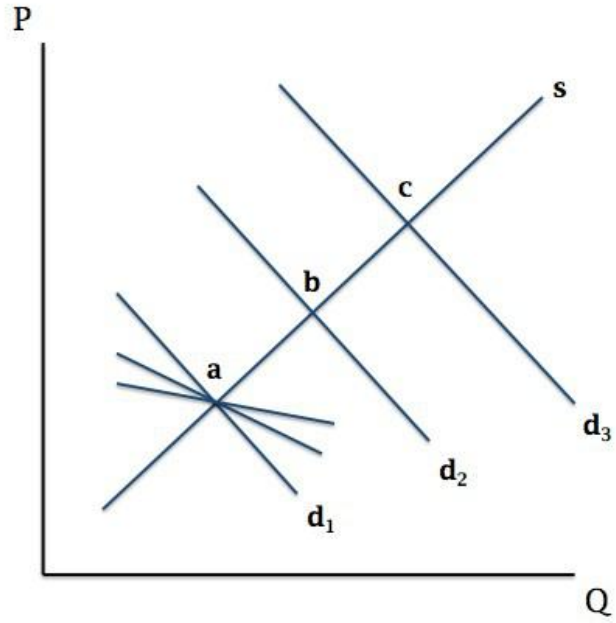
We cannot estimate β_1 for the supply function via estimating the following regression model with OLS:

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

Why? Because of Endogeneity!

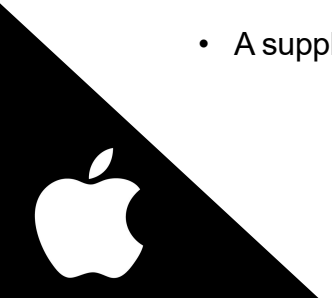
We need to find the demand shifter! $\rightarrow Income$

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：

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

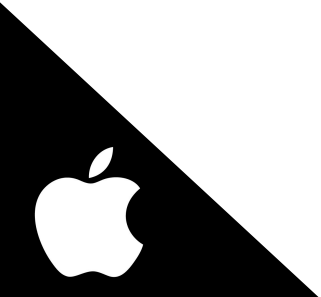
移項得到 inverse demand function:

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

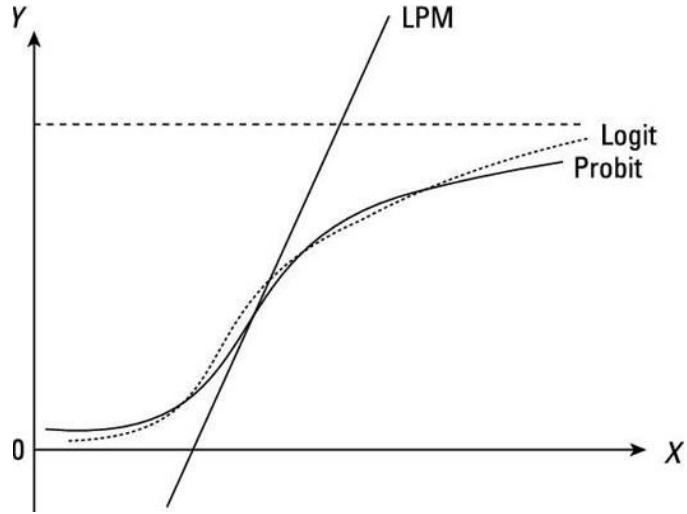
Recall the WTP estimated:

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

IV Estimation 所給我們的估計較為保守



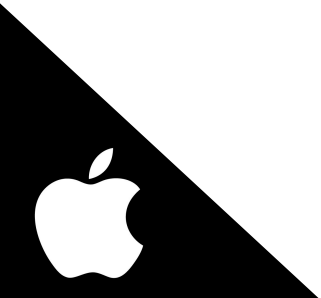
Binary Response Model



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

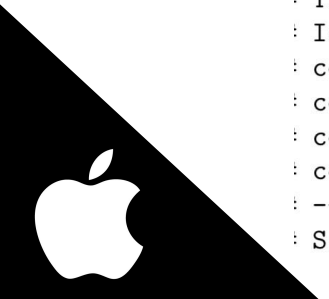
```
t test of coefficients:

                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
```



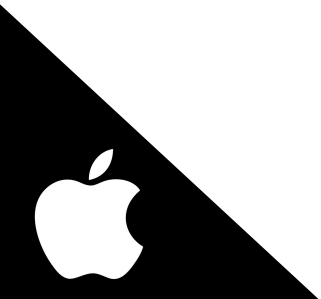
Binary Response Model：Logit

```
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
```

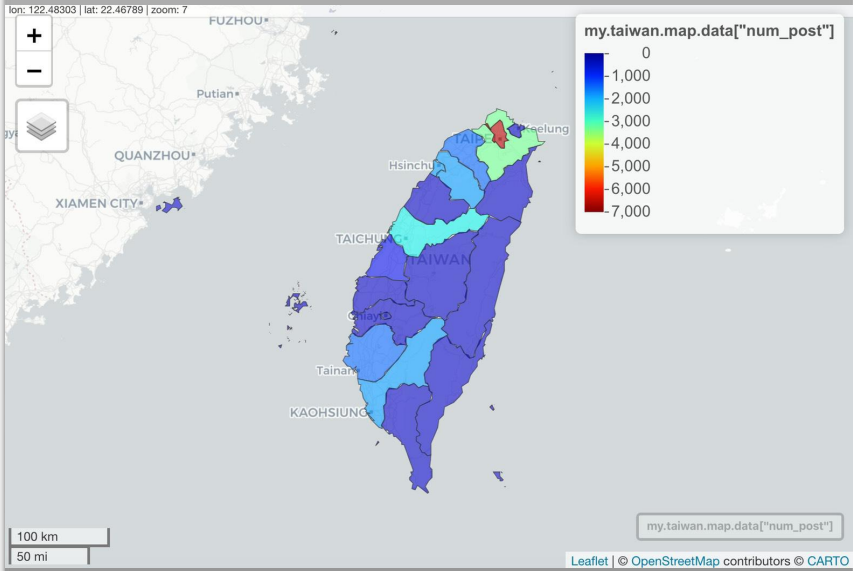
Binary Response Model

- 最重要的因素仍是價格
- 「玫瑰金」作為2015年隨著iPhone 6s 發表的新顏色，在二手交易市場有較高的可能性被售出



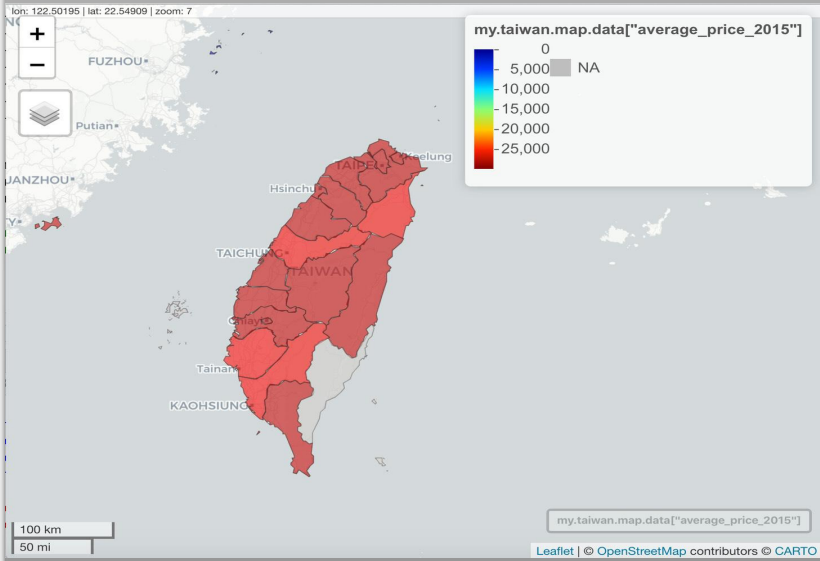
Graphical Visualization

- 把各地方面交的頻率上色
- 北北基、台中、台南、高雄的面交數量遠遠勝過其他地區



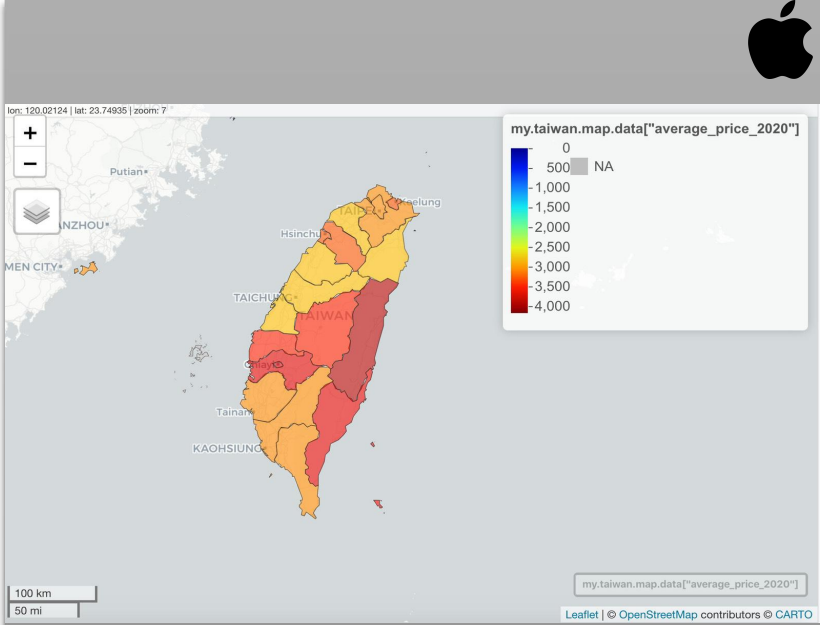
台灣各縣市iPhone 6s交易貼文數量圖

- 在2015年各地的iPhone 6s二手交易平均價格相差不大，落在28000到29000



2015台灣各縣市iPhone 6s平均價格

- 在2020年花東、雲嘉地區的交易均價相對於大城市更高
- 可能是城市人持有舊機的機會成本較高，因此iphone保值的程度相對其他地方低



2020台灣各縣市iPhone 6s平均價格