

IEOR E4650 Business Analytics (Fall 2021)

Project Name: Campaign Strategy

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Import Data

```
In [ ]: #Import the library, authenticate, and create the interface to csv files.
!pip install -U -q PyDrive
from pydrive.auth import GoogleAuth
from pydrive.drive import GoogleDrive
from google.colab import auth
from oauth2client.client import GoogleCredentials
# Authenticate and create the PyDrive client.
auth.authenticate_user()
gauth = GoogleAuth()
gauth.credentials = GoogleCredentials.get_application_default()
drive = GoogleDrive(gauth)
```

```
In [ ]: import numpy as np
import pandas as pd
from statsmodels.formula.api import poisson
import matplotlib.pyplot as plt
from statsmodels.base.model import GenericLikelihoodModel
from sklearn.preprocessing import StandardScaler
from statsmodels.formula.api import logit
import copy
import scipy.stats as spst
```

```
In [ ]: ## change the link to the link to your csv file on Google Drive
# link="https://drive.google.com/open?id=17Sa-DuRFCWfPzCW6uRbPwxAyoImQARUn"
# _, id=link.split("=")
link='https://drive.google.com/file/d/128s5Rz5U3QKYEtqQ9hjeFpV_C5vHjEJ/'
_, id=link.split("/d/")
downloaded = drive.CreateFile({'id':id})
downloaded.GetContentFile('marketing_campaign.csv')
data = pd.read_csv('marketing_campaign.csv', sep='\t')
data
```

Data Preprocessing

```
In [ ]: from dataclasses import dataclass
# get dummies for categorical data
educations = pd.get_dummies(data.Education, prefix='E')
marital = pd.get_dummies(data.Marital_Status, prefix='M')
data = pd.concat([data, educations, marital], axis=1)

# log transform income
data['log_Income'] = data.Income.apply(lambda x: np.log(x))

# add columns for modeling
data['NumTotalPurchases'] = data['NumStorePurchases'] + data['NumWebPurchases'] + data['NumCatalogPurchases']
data['DealsPercentage'] = np.where(data['NumTotalPurchases'] > 0, data['NumDealsPurchases'] / data['NumTotalPurchases'], 0)
data['TotalAccept'] = data['AcceptedCmp3'] + data['AcceptedCmp4'] + data['AcceptedCmp5'] \
    + data['AcceptedCmp1'] + data['AcceptedCmp2'] + data['Response']
data['LargerWeb'] = np.where(data['NumWebPurchases'] > data['NumStorePurchases'], 1, 0)

data['age'] = data.Year_Birth.apply(lambda x: 2021 - int(x))
data = data.astype({'Dt_Customer': 'datetime64'})
data['duration'] = (pd.Timestamp('2021-06-30') - data['Dt_Customer']).dt.days

data['total_amount'] = data['MntWines'] + data['MntFruits'] + data['MntMeatProducts'] + data['MntFishProducts'] + data['MntSweetProducts']
data['wine_rate'] = np.where(data['total_amount'] > 0, data['MntWines'] / data['total_amount'], 0)
data['fruit_rate'] = np.where(data['total_amount'] > 0, data['MntFruits'] / data['total_amount'], 0)
data['meat_rate'] = np.where(data['total_amount'] > 0, data['MntMeatProducts'] / data['total_amount'], 0)
data['fish_rate'] = np.where(data['total_amount'] > 0, data['MntFishProducts'] / data['total_amount'], 0)
data['sweet_rate'] = np.where(data['total_amount'] > 0, data['MntSweetProducts'] / data['total_amount'], 0)
data['gold_rate'] = np.where(data['total_amount'] > 0, data['MntGoldProds'] / data['total_amount'], 0)

data['Together'] = np.where((data['Marital_Status'] == 'Together') | (data['Marital_Status'] == 'Married'), 1, 0)
# data["Education1"] = data["Education"]
data["Education"] = data["Education"].replace({"Basic": 1, "2n Cycle": 1, "Graduation": 2, "Master": 2, "PhD": 3})
# data["Education1"] = data["Education1"].replace({"Basic": 1, "2n Cycle": 1, "Graduation": 2, "Master": 2, "PhD": 3})
data['kid_teen'] = data['Teenhome'] + data['Kidhome']

# data = data.drop(['Education', 'Marital_Status', 'Z_CostContact', 'Z_Revenue'], axis=1)
# data.rename(columns={"Education1": "Education"}, inplace=True)

# deal with null data
data = data.dropna()
```

data

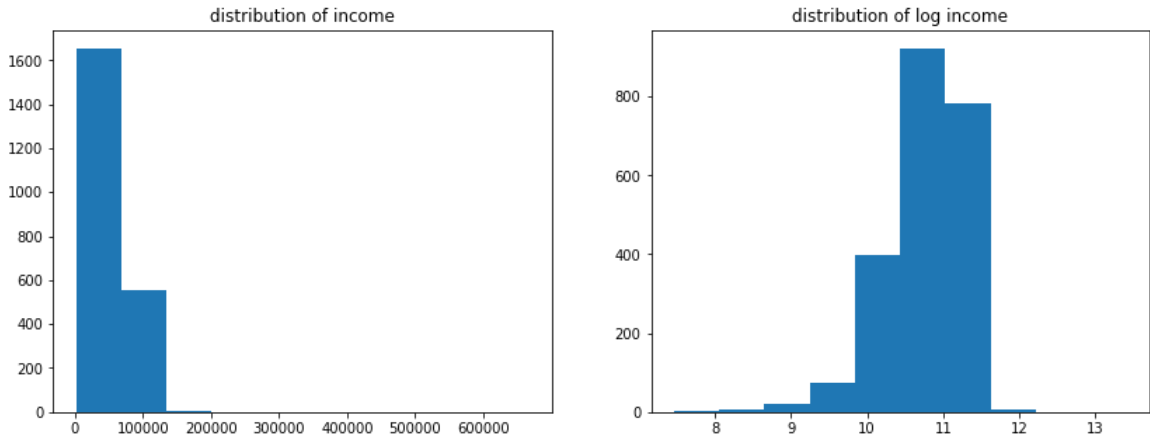
Out []:

	ID	Year_Birth	Education	Marital_Status	Income	Kidhome	Teenhome	Dt_Customer	Recency	MntWines	MntFruits	MntMeatProducts	M
0	5524	1957	2	Single	58138.0	0	0	2012-04-09	58	635	88	546	
1	2174	1954	2	Single	46344.0	1	1	2014-08-03	38	11	1	6	
2	4141	1965	2	Together	71613.0	0	0	2013-08-21	26	426	49	127	
3	6182	1984	2	Together	26646.0	1	0	2014-10-02	26	11	4	20	
4	5324	1981	3	Married	58293.0	1	0	2014-01-19	94	173	43	118	
...
2235	10870	1967	2	Married	61223.0	0	1	2013-06-13	46	709	43	182	
2236	4001	1946	3	Together	64014.0	2	1	2014-10-06	56	406	0	30	
2237	7270	1981	2	Divorced	56981.0	0	0	2014-01-25	91	908	48	217	
2238	8235	1956	2	Together	69245.0	0	1	2014-01-24	8	428	30	214	
2239	9405	1954	3	Married	52869.0	1	1	2012-10-15	40	84	3	61	

2216 rows × 58 columns

In []:

```
plt.figure(figsize=(14,5))
plt.subplot(121)
plt.hist(data.Income)
plt.title('distribution of income')
plt.subplot(122)
plt.hist(data.log_Income)
plt.title('distribution of log income')
plt.show()
```



Probability attending future campaign

In []:

```
# response~other variables (logistic reg)
data.rename(columns={"E_2n_Cycle":"E_2n_Cycle"},inplace=True)
cols = list(data.columns)
print(cols)

['ID', 'Year_Birth', 'Education', 'Marital_Status', 'Income', 'Kidhome', 'Teenhome', 'Dt_Customer', 'Recency', 'MntWines', 'MntFruits', 'MntMeatProducts', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumDealsPurchases', 'NumWebPurchases', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'AcceptedCmp3', 'AcceptedCmp4', 'AcceptedCmp5', 'AcceptedCmp1', 'AcceptedCmp2', 'Complain', 'Z_CostContact', 'Z_Revenue', 'Response', 'E_2n_Cycle', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'M_Absurd', 'M_Alone', 'M_Divorced', 'M_Married', 'M_Single', 'M_Together', 'M_Widow', 'M_YOLO', 'log_Income', 'NumTotalPurchases', 'DealsPercentage', 'TotalAccept', 'LargerWeb', 'age', 'duration', 'total_amount', 'wine_rate', 'fruit_rate', 'meat_rate', 'fish_rate', 'sweet_rate', 'gold_rate', 'Together', 'kid_teen']
```

In []:

```
x = ['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntMeatProducts', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumDealsPurchases', 'NumWebPurchases', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Complain', 'E_2n_Cycle', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'M_Absurd', 'M_Alone', 'M_Divorced', 'M_Married', 'M_Single', 'M_Together', 'M_Widow', 'M_YOLO', 'log_Income', 'DealsPercentage', 'LargerWeb', 'age', 'duration']
def construct_m(variables):
    model= "Response~" +variables[0]
    for i in range(1,len(variables)):
```

```
model=model+" "+variables[i]
return model
```

```
In [ ]: # model using all variables at first
cmp = ['AcceptedCmp3', 'AcceptedCmp4', 'AcceptedCmp5', 'AcceptedCmp1', 'AcceptedCmp2']
x1 = cmp+x
model=construct_m(x1)
model_cmp_all = logit(model, data).fit(method="newton")
model_cmp_all.summary()
```

Optimization terminated successfully.
Current function value: 0.251543
Iterations 12

/usr/local/lib/python3.7/dist-packages/statsmodels/base/model.py:1286: RuntimeWarning: invalid value encountered in sqrt
bse_ = np.sqrt(np.diag(self.cov_params()))

Out[]:

Logit Regression Results

Dep. Variable:	Response	No. Observations:	2216
Model:	Logit	Df Residuals:	2179
Method:	MLE	Df Model:	36
Date:	Wed, 29 Dec 2021	Pseudo R-squ.:	0.4056
Time:	17:18:42	Log-Likelihood:	-557.42
converged:	True	LL-Null:	-937.76
Covariance Type:	nonrobust	LLR p-value:	1.414e-136

	coef	std err	z	P> z	[0.025	0.975]
Intercept	-12.4414	nan	nan	nan	nan	nan
AcceptedCmp3	2.0223	0.237	8.522	0.000	1.557	2.487
AcceptedCmp4	1.2233	0.300	4.080	0.000	0.636	1.811
AcceptedCmp5	1.8396	0.297	6.191	0.000	1.257	2.422
AcceptedCmp1	1.5560	0.292	5.333	0.000	0.984	2.128
AcceptedCmp2	1.6671	0.560	2.977	0.003	0.570	2.765
Kidhome	0.2320	0.223	1.042	0.297	-0.204	0.669
Teenhome	-1.0949	0.210	-5.221	0.000	-1.506	-0.684
Recency	-0.0313	0.003	-10.378	0.000	-0.037	-0.025
MntWines	-0.0005	0.000	-1.325	0.185	-0.001	0.000
MntFruits	0.0028	0.002	1.174	0.240	-0.002	0.007
MntMeatProducts	0.0022	0.001	4.218	0.000	0.001	0.003
MntFishProducts	-0.0019	0.002	-1.002	0.316	-0.006	0.002
MntSweetProducts	0.0010	0.002	0.418	0.676	-0.004	0.006
MntGoldProds	0.0032	0.002	1.923	0.054	-6.07e-05	0.006
NumDealsPurchases	0.1229	0.050	2.436	0.015	0.024	0.222
NumWebPurchases	0.0538	0.043	1.246	0.213	-0.031	0.138
NumCatalogPurchases	0.0428	0.042	1.016	0.310	-0.040	0.125
NumStorePurchases	-0.1517	0.041	-3.713	0.000	-0.232	-0.072
NumWebVisitsMonth	0.1574	0.053	2.954	0.003	0.053	0.262
Complain	-0.0547	1.068	-0.051	0.959	-2.148	2.039
E_2n_Cycle	-2.8260	4.82e+06	-5.87e-07	1.000	-9.44e+06	9.44e+06
E_Basic	-3.8047	4.82e+06	-7.9e-07	1.000	-9.44e+06	9.44e+06
E_Graduation	-2.4472	4.82e+06	-5.08e-07	1.000	-9.44e+06	9.44e+06
E_Master	-2.0431	4.81e+06	-4.24e-07	1.000	-9.44e+06	9.44e+06
E_PhD	-1.4369	4.82e+06	-2.98e-07	1.000	-9.44e+06	9.44e+06
M_Absurd	-0.6546	5.17e+06	-1.27e-07	1.000	-1.01e+07	1.01e+07
M_Alone	-0.2752	5.17e+06	-5.32e-08	1.000	-1.01e+07	1.01e+07
M_Divorced	-1.3841	5.17e+06	-2.68e-07	1.000	-1.01e+07	1.01e+07
M_Married	-2.6778	5.17e+06	-5.18e-07	1.000	-1.01e+07	1.01e+07
M_Single	-1.3328	5.17e+06	-2.58e-07	1.000	-1.01e+07	1.01e+07
M_Together	-2.6920	5.17e+06	-5.2e-07	1.000	-1.01e+07	1.01e+07
M_Widow	-1.3806	5.17e+06	-2.67e-07	1.000	-1.01e+07	1.01e+07
M_YOLO	-2.0637	5.17e+06	-3.99e-07	1.000	-1.01e+07	1.01e+07

log_Income	0.3956	0.272	1.453	0.146	-0.138	0.929
DealsPercentage	-0.1732	0.167	-1.037	0.300	-0.501	0.154
LargerWeb	0.2539	0.255	0.996	0.319	-0.246	0.754
age	0.0078	0.007	1.084	0.278	-0.006	0.022
duration	0.0034	0.000	8.541	0.000	0.003	0.004

```
In [ ]: # remove insignificant variables
x1_copy=copy.copy(x1)
for i in range(1,len(model_cmp_all.pvalues)):
    if model_cmp_all.pvalues[i] >= 0.05:
        rem = x1[i-1]
        x1_copy.remove(rem)
model=construct_m(x1_copy)
model_cmp_all_insig = logit(model,data).fit(method="newton")
model_cmp_all_insig.summary()
```

Optimization terminated successfully.
Current function value: 0.282535
Iterations 7

Out[]:

Logit Regression Results

Dep. Variable:	Response	No. Observations:	2216
Model:	Logit	Df Residuals:	2203
Method:	MLE	Df Model:	12
Date:	Wed, 29 Dec 2021	Pseudo R-squ.:	0.3323
Time:	17:18:48	Log-Likelihood:	-626.10
converged:	True	LL-Null:	-937.76
Covariance Type:	nonrobust	LLR p-value:	1.101e-125

	coef	std err	z	P> z	[0.025	0.975]
Intercept	-10.5082	1.037	-10.129	0.000	-12.542	-8.475
AcceptedCmp3	2.0396	0.214	9.531	0.000	1.620	2.459
AcceptedCmp4	1.1635	0.267	4.361	0.000	0.641	1.686
AcceptedCmp5	1.6260	0.260	6.254	0.000	1.116	2.136
AcceptedCmp1	1.4118	0.261	5.415	0.000	0.901	1.923
AcceptedCmp2	1.3313	0.512	2.598	0.009	0.327	2.335
Teenhome	-0.6650	0.169	-3.927	0.000	-0.997	-0.333
Recency	-0.0289	0.003	-10.253	0.000	-0.034	-0.023
MntMeatProducts	0.0026	0.000	6.460	0.000	0.002	0.003
NumDealsPurchases	0.1262	0.041	3.058	0.002	0.045	0.207
NumStorePurchases	-0.1103	0.029	-3.756	0.000	-0.168	-0.053
NumWebVisitsMonth	0.1103	0.041	2.690	0.007	0.030	0.191
duration	0.0030	0.000	8.297	0.000	0.002	0.004

```
In [ ]: # repeat last procedure for ensuring
# final model
x1_copy2=copy.copy(x1_copy)
for i in range(1,len(model_cmp_all_insig.pvalues)):
    if model_cmp_all_insig.pvalues[i] >= 0.05:
        rem = x1_copy[i-1]
        x1_copy2.remove(rem)
model=construct_m(x1_copy2)
model_cmp_all_insig = logit(model,data).fit(method="newton")
model_cmp_all_insig.summary()
```

Optimization terminated successfully.
Current function value: 0.282535
Iterations 7

Out[]:

Logit Regression Results

Dep. Variable:	Response	No. Observations:	2216
Model:	Logit	Df Residuals:	2203
Method:	MLE	Df Model:	12
Date:	Tue, 28 Dec 2021	Pseudo R-squ.:	0.3323
Time:	04:24:37	Log-Likelihood:	-626.10
converged:	True	LL-Null:	-937.76
Covariance Type:	nonrobust	LLR p-value:	1.101e-125

	coef	std err	z	P> z	[0.025	0.975]
Intercept	-10.5082	1.037	-10.129	0.000	-12.542	-8.475
AcceptedCmp3	2.0396	0.214	9.531	0.000	1.620	2.459
AcceptedCmp4	1.1635	0.267	4.361	0.000	0.641	1.686
AcceptedCmp5	1.6260	0.260	6.254	0.000	1.116	2.136
AcceptedCmp1	1.4118	0.261	5.415	0.000	0.901	1.923
AcceptedCmp2	1.3313	0.512	2.598	0.009	0.327	2.335
Teenhome	-0.6650	0.169	-3.927	0.000	-0.997	-0.333
Recency	-0.0289	0.003	-10.253	0.000	-0.034	-0.023
MntMeatProducts	0.0026	0.000	6.460	0.000	0.002	0.003
NumDealsPurchases	0.1262	0.041	3.058	0.002	0.045	0.207
NumStorePurchases	-0.1103	0.029	-3.756	0.000	-0.168	-0.053
NumWebVisitsMonth	0.1103	0.041	2.690	0.007	0.030	0.191
duration	0.0030	0.000	8.297	0.000	0.002	0.004

```
In [ ]: # variables
print('Variables used for final model and their coefficients:',model_cmp_all_insig.params)

Variables used for final model and their coefficients: Intercept          -10.508199
AcceptedCmp3                   2.039631
AcceptedCmp4                   1.163462
AcceptedCmp5                   1.625963
AcceptedCmp1                   1.411791
AcceptedCmp2                   1.331274
Teenhome                      -0.664970
Recency                       -0.028881
MntMeatProducts                0.002596
NumDealsPurchases              0.126207
NumStorePurchases             -0.110261
NumWebVisitsMonth              0.110256
duration                       0.002960
dtype: float64

In [ ]:
```

PREDICT NumDealPurchases

```
In [ ]: # use forward stepwise to select vars for poisson model

In [ ]: var = ['Kidhome', 'Teenhome',
               'Recency', 'MntWines', 'MntFruits', 'MntMeatProducts',
               'MntFishProducts', 'MntSweetProducts', 'MntGoldProds',
               'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth',
               'Complain', 'Response', 'C(E_Basic)', 'C(E_Graduation)',
               'C(E_Master)', 'C(E_PhD)', 'C(M_Alone)', 'C(M_Divorced)', 'C(M_Married)',
               'C(M_Single)', 'C(M_Together)', 'C(M_Widow)', 'C(M_YOLO)', 'log_Income',
               'TotalAccept', 'C(LargerWeb)', 'age']

In [ ]: model = 'NumDealsPurchases~'
best_llf = -10000
llf = []
add_var = []
add = ''

for i in range(len(var)):
    print(i)
    for j in range(len(var)):
        print(j)
        if not j and not i:
            model_use = model+var[j]
        else:
            model_use = model+'+' +var[j]
            print(model_use)
        poisson_m = poisson(model_use,data).fit(maxiter=5000)
        if poisson_m.llf > best_llf:
            best_llf = poisson_m.llf
            llf.append(best_llf)
            add = var[j]
    add_var.append(add)

    if i>0 and llf[i] <= llf[i-1]:
        break
    else:
        if i==0:
            model = model+add
```

```
else:
    model = model+' '+add
    print(model)
    var.remove(add)
```

```
In [ ]: model = 'NumDealsPurchases~'+'.join(add_var)
        poisson_m = poisson(model, data).fit(maxiter=5000)
        poisson_m.summary()
```

Optimization terminated successfully.
Current function value: 1.566897
Iterations 8

Out[]:

Poisson Regression Results						
Dep. Variable:	NumDealsPurchases	No. Observations:	2216			
Model:	Poisson	Df Residuals:	2186			
Method:	MLE	Df Model:	29			
Date:	Tue, 28 Dec 2021	Pseudo R-squ.:	0.1705			
Time:	05:47:57	Log-Likelihood:	-3472.2			
converged:	True	LL-Null:	-4186.2			
Covariance Type:	nonrobust	LLR p-value:	1.327e-282			
	coef	std err	z	P> z	[0.025	0.975]
Intercept	1.8887	0.707	2.672	0.008	0.503	3.274
C(LargerWeb)[T.1]	0.2914	0.039	7.499	0.000	0.215	0.368
C(E_PhD)[T.1]	-0.1159	0.059	-1.958	0.050	-0.232	0.000
C(M_Single)[T.1]	-0.7007	0.508	-1.379	0.168	-1.696	0.295
C(E_Graduation)[T.1]	-0.0629	0.052	-1.213	0.225	-0.165	0.039
C(M_YOLO)[T.1]	-0.3608	0.602	-0.600	0.549	-1.540	0.819
C(M_Divorced)[T.1]	-0.6906	0.509	-1.356	0.175	-1.689	0.307
C(M_Together)[T.1]	-0.6661	0.508	-1.311	0.190	-1.662	0.330
C(M_Alone)[T.1]	-0.4646	0.591	-0.786	0.432	-1.623	0.694
C(E_Master)[T.1]	-0.0387	0.060	-0.646	0.519	-0.156	0.079
C(M_Married)[T.1]	-0.6483	0.508	-1.277	0.202	-1.644	0.347
C(M_Widow)[T.1]	-0.6242	0.512	-1.218	0.223	-1.629	0.380
C(E_Basic)[T.1]	-0.0426	0.115	-0.370	0.711	-0.269	0.183
Teenhome	0.5449	0.030	18.116	0.000	0.486	0.604
NumWebVisitsMonth	0.1067	0.008	12.625	0.000	0.090	0.123
NumStorePurchases	0.0975	0.007	13.577	0.000	0.083	0.112
Kidhome	0.4510	0.031	14.377	0.000	0.390	0.513
NumCatalogPurchases	0.0767	0.008	9.520	0.000	0.061	0.093
log_Income	-0.1941	0.045	-4.341	0.000	-0.282	-0.106
MntWines	-0.0002	7.91e-05	-2.252	0.024	-0.000	-2.31e-05
MntFruits	-0.0015	0.001	-2.728	0.006	-0.003	-0.000
MntGoldProds	0.0010	0.000	3.125	0.002	0.000	0.002
TotalAccept	-0.1652	0.030	-5.562	0.000	-0.223	-0.107
Response	0.3109	0.061	5.104	0.000	0.192	0.430
MntFishProducts	-0.0008	0.000	-2.060	0.039	-0.002	-4.13e-05
age	-0.0024	0.001	-1.661	0.097	-0.005	0.000
MntSweetProducts	-0.0009	0.001	-1.712	0.087	-0.002	0.000
MntMeatProducts	0.0001	0.000	0.975	0.329	-0.000	0.000
Complain	-0.1042	0.144	-0.721	0.471	-0.387	0.179
Recency	0.0002	0.001	0.491	0.624	-0.001	0.001

```
In [ ]: # use forward stepwise to select vars for NBD model
```

```
In [ ]: var = ['Kidhome', 'Teenhome',
              'Recency', 'MntWines', 'MntFruits',
              'MntFishProducts', 'MntSweetProducts', 'MntGoldProds',
              'NumWebPurchases', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth',
              'Response', 'log_Income', 'E_Basic', 'E_Graduation',
```

```
'E_Master', 'E_PhD',  
'TotalAccept', 'LargerWeb']
```

```
In [ ]: class NBD_cov(GenericLikelihoodModel):  
        def loglike(self, params):  
            y=self.endog  
            x=self.exog  
            gamma=np. exp(params[0])  
            alpha = np. exp(params[1])  
            xparam = 0  
            for i in range(x. shape[1]):  
                xparam += params[2+i]*x[:,i]  
            alpha = alpha/np. exp(xparam)  
            Likelihood=spst. nbinom. pmf(y, n=gamma, p=alpha/(1+alpha))  
            LogLike=np. log(Likelihood)  
            return np. sum(LogLike)
```

```
In [ ]: best_llf = -10000  
llf = []  
add_var = []  
add = ''  
  
for i in range(len(var)):  
    print(i)  
    for j in range(len(var)):  
        print(j)  
        print(var)  
        print(var[j])  
        add_var. append(var[j])  
        print(add_var)  
        model_used=NBD_cov(data['NumDealsPurchases'], data[add_var]). fit(start_params=[0]*(len(add_var)+2), maxiter=25000)  
        print(model_used. summary())  
        print(model_used. llf)  
        if model_used. llf > best_llf:  
            best_llf = model_used. llf  
            llf. append(best_llf)  
            add = var[j]  
        add_var. remove(var[j])  
    add_var. append(add)  
    print(llf)  
  
if i>0 and llf[i] <= llf[i-1]:  
    print('here')  
    break  
else:  
    print('here')  
    print(add_var)  
    print(add)  
    print('pre', var)  
    if add not in var:  
        break  
    else:  
        var. remove(add)  
    print(var)
```

```
0  
0  
['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchase  
s', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Maste  
r', 'E_PhD', 'TotalAccept', 'LargerWeb']  
Kidhome  
['Kidhome']  
Optimization terminated successfully.  
Current function value: 1.822879  
Iterations: 181  
Function evaluations: 328  
NBD_cov Results  
=====
```

Dep. Variable:	NumDealsPurchases	Log-Likelihood:	-4039.5
Model:	NBD_cov	AIC:	8081.
Method:	Maximum Likelihood	BIC:	8087.
Date:	Wed, 29 Dec 2021		
Time:	15:46:44		
No. Observations:	2216		
Df Residuals:	2215		
Df Model:	0		

```
=====
```

	coef	std err	z	P> z	[0.025	0.975]
Kidhome	2.0274	0.111	18.224	0.000	1.809	2.245
par0	1.3429	0.113	11.867	0.000	1.121	1.565
par1	0.3241	0.029	11.172	0.000	0.267	0.381

```
=====
```

```
-4039.4994252997167  
1  
['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchase  
s', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Maste  
r', 'E_PhD', 'TotalAccept', 'LargerWeb']  
Teenhome
```

```
['Teenhome']
Optimization terminated successfully.
Current function value: 1.758932
Iterations: 169
Function evaluations: 305
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3897.8
Model:           NBD_cov              AIC:              7798.
Method:          Maximum Likelihood    BIC:              7803.
Date:            Wed, 29 Dec 2021
Time:            15:46:44
No. Observations: 2216
Df Residuals:    2215
Df Model:        0
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome      2.4543     0.147     16.682     0.000      2.166     2.743
par0          1.9506     0.148     13.163     0.000      1.660     2.241
par1          0.5739     0.028     20.621     0.000      0.519     0.628
=====
-3897.79414546681
2
['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchase
s', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Maste
r', 'E_PhD', 'TotalAccept', 'LargerWeb']
Recency
['Recency']
Optimization terminated successfully.
Current function value: 1.850267
Iterations: 173
Function evaluations: 306
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4100.2
Model:           NBD_cov              AIC:              8202.
Method:          Maximum Likelihood    BIC:              8208.
Date:            Wed, 29 Dec 2021
Time:            15:46:44
No. Observations: 2216
Df Residuals:    2215
Df Model:        0
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Recency       1.8627     0.100     18.584     0.000      1.666     2.059
par0          1.0226     0.105      9.717     0.000      0.816     1.229
par1         6.084e-05     0.001      0.108     0.914     -0.001     0.001
=====
-4100.190971096566
3
['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchase
s', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Maste
r', 'E_PhD', 'TotalAccept', 'LargerWeb']
MntWines
['MntWines']
Optimization terminated successfully.
Current function value: 2.168103
Iterations: 18
Function evaluations: 33
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4804.5
Model:           NBD_cov              AIC:              9611.
Method:          Maximum Likelihood    BIC:              9617.
Date:            Wed, 29 Dec 2021
Time:            15:46:44
No. Observations: 2216
Df Residuals:    2215
Df Model:        0
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
MntWines      0.0003     0.054      0.006     0.995     -0.106     0.107
par0         -0.0008     0.044     -0.018     0.986     -0.087     0.086
par1          0.0014    9.85e-05     14.423     0.000      0.001     0.002
=====
-4804.5169549516995
4
['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchase
s', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Maste
r', 'E_PhD', 'TotalAccept', 'LargerWeb']
MntFruits
['MntFruits']
Optimization terminated successfully.
Current function value: 1.838355
Iterations: 166
Function evaluations: 293
NBD_cov Results
=====
```



```
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4073.8
Model:           NBD_cov               AIC:              8150.
Method:          Maximum Likelihood     BIC:              8155.
Date:            Wed, 29 Dec 2021
Time:            15:46:45
No. Observations: 2216
Df Residuals:    2215
Df Model:        0
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
MntFruits      1.9291     0.104     18.472     0.000      1.724      2.134
par0           1.0089     0.106      9.501     0.000      0.801      1.217
par1          -0.0032     0.000     -7.098     0.000     -0.004     -0.002
=====
-4073.7943998697037
5
['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchase
s', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Maste
r', 'E_PhD', 'TotalAccept', 'LargerWeb']
MntFishProducts
['MntFishProducts']
Optimization terminated successfully.
    Current function value: 1.836826
    Iterations: 160
    Function evaluations: 289
                NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4070.4
Model:           NBD_cov               AIC:              8143.
Method:          Maximum Likelihood     BIC:              8149.
Date:            Wed, 29 Dec 2021
Time:            15:46:45
No. Observations: 2216
Df Residuals:    2215
Df Model:        0
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
MntFishProducts  1.9388     0.105     18.450     0.000      1.733      2.145
par0             1.0113     0.107      9.466     0.000      0.802      1.221
par1            -0.0025     0.000     -7.546     0.000     -0.003     -0.002
=====
-4070.407388493684
6
['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchase
s', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Maste
r', 'E_PhD', 'TotalAccept', 'LargerWeb']
MntSweetProducts
['MntSweetProducts']
Optimization terminated successfully.
    Current function value: 1.840681
    Iterations: 158
    Function evaluations: 276
                NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4078.9
Model:           NBD_cov               AIC:              8160.
Method:          Maximum Likelihood     BIC:              8166.
Date:            Wed, 29 Dec 2021
Time:            15:46:45
No. Observations: 2216
Df Residuals:    2215
Df Model:        0
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
MntSweetProducts  1.9163     0.104     18.494     0.000      1.713      2.119
par0             1.0045     0.105      9.531     0.000      0.798      1.211
par1            -0.0028     0.000     -6.387     0.000     -0.004     -0.002
=====
-4078.948376286941
7
['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchase
s', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Maste
r', 'E_PhD', 'TotalAccept', 'LargerWeb']
MntGoldProds
['MntGoldProds']
Optimization terminated successfully.
    Current function value: 1.848686
    Iterations: 163
    Function evaluations: 297
                NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4096.7
Model:           NBD_cov               AIC:              8195.
Method:          Maximum Likelihood     BIC:              8201.
Date:            Wed, 29 Dec 2021
Time:            15:46:46
No. Observations: 2216
Df Residuals:    2215
```

```
Df Model: 0
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
MntGoldProds    1.8714      0.101    18.571    0.000      1.674      2.069
par0             1.0656      0.103    10.351    0.000      0.864      1.267
par1             0.0008      0.000     2.665    0.008      0.000      0.001
=====
-4096.6886424859085
8
['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchase
s', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Maste
r', 'E_PhD', 'TotalAccept', 'LargerWeb']
NumWebPurchases
['NumWebPurchases']
Optimization terminated successfully.
    Current function value: 1.816444
    Iterations: 190
    Function evaluations: 345
    NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4025.2
Model:           NBD_cov              AIC:              8052.
Method:          Maximum Likelihood    BIC:              8058.
Date:            Wed, 29 Dec 2021
Time:            15:46:46
No. Observations: 2216
Df Residuals:    2215
Df Model:        0
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
NumWebPurchases    2.0452      0.111    18.350    0.000      1.827      2.264
par0               1.5058      0.114    13.224    0.000      1.283      1.729
par1               0.0698      0.006    12.406    0.000      0.059      0.081
=====
-4025.239801485911
9
['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchase
s', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Maste
r', 'E_PhD', 'TotalAccept', 'LargerWeb']
NumCatalogPurchases
['NumCatalogPurchases']
Optimization terminated successfully.
    Current function value: 1.850188
    Iterations: 154
    Function evaluations: 278
    NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4100.0
Model:           NBD_cov              AIC:              8202.
Method:          Maximum Likelihood    BIC:              8208.
Date:            Wed, 29 Dec 2021
Time:            15:46:46
No. Observations: 2216
Df Residuals:    2215
Df Model:        0
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
NumCatalogPurchases    1.8633      0.100    18.582    0.000      1.667      2.060
par0                   1.0116      0.103     9.863    0.000      0.811      1.213
par1                   -0.0033      0.005    -0.600    0.549     -0.014      0.007
=====
-4100.0163212217785
10
['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchase
s', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Maste
r', 'E_PhD', 'TotalAccept', 'LargerWeb']
NumStorePurchases
['NumStorePurchases']
Optimization terminated successfully.
    Current function value: 1.847676
    Iterations: 139
    Function evaluations: 249
    NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4094.4
Model:           NBD_cov              AIC:              8191.
Method:          Maximum Likelihood    BIC:              8197.
Date:            Wed, 29 Dec 2021
Time:            15:46:47
No. Observations: 2216
Df Residuals:    2215
Df Model:        0
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
NumStorePurchases    1.8771      0.101    18.562    0.000      1.679      2.075
par0                 1.1341      0.106    10.657    0.000      0.926      1.343
par1                 0.0170      0.005     3.402    0.001      0.007      0.027
```

```
=====
-4094.4499915964416
11
['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchase
s', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Maste
r', 'E_PhD', 'TotalAccept', 'LargerWeb']
NumWebVisitsMonth
['NumWebVisitsMonth']
Optimization terminated successfully.
Current function value: 1.778102
Iterations: 197
Function evaluations: 353
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3940.3
Model:            NBD_cov              AIC:              7883.
Method:          Maximum Likelihood    BIC:              7888.
Date:            Wed, 29 Dec 2021
Time:            15:46:47
No. Observations: 2216
Df Residuals:    2215
Df Model:        0
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
NumWebVisitsMonth    2.3125     0.134    17.254     0.000     2.050     2.575
par0                 2.1231     0.138    15.423     0.000     1.853     2.393
par1                 0.1155     0.006    18.056     0.000     0.103     0.128
=====
-3940.274605044432
12
['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchase
s', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Maste
r', 'E_PhD', 'TotalAccept', 'LargerWeb']
Response
['Response']
Optimization terminated successfully.
Current function value: 1.850262
Iterations: 209
Function evaluations: 380
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4100.2
Model:            NBD_cov              AIC:              8202.
Method:          Maximum Likelihood    BIC:              8208.
Date:            Wed, 29 Dec 2021
Time:            15:46:47
No. Observations: 2216
Df Residuals:    2215
Df Model:        0
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Response            1.8627     0.100    18.584     0.000     1.666     2.059
par0                1.0208     0.102    10.030     0.000     0.821     1.220
par1                0.0080     0.045     0.175     0.861    -0.081     0.097
=====
-4100.181406252738
13
['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchase
s', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Maste
r', 'E_PhD', 'TotalAccept', 'LargerWeb']
log_Income
['log_Income']
Optimization terminated successfully.
Current function value: 1.846162
Iterations: 194
Function evaluations: 345
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4091.1
Model:            NBD_cov              AIC:              8184.
Method:          Maximum Likelihood    BIC:              8190.
Date:            Wed, 29 Dec 2021
Time:            15:46:48
No. Observations: 2216
Df Residuals:    2215
Df Model:        0
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
log_Income          1.8879     0.102    18.530     0.000     1.688     2.088
par0               -0.3859     0.348    -1.109     0.268    -1.068     0.296
par1              -0.1333     0.031    -4.300     0.000    -0.194    -0.073
=====
-4091.0945329036267
14
['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchase
s', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Maste
r', 'E_PhD', 'TotalAccept', 'LargerWeb']
E_Basic
```

```
['E_Basic']
Optimization terminated successfully.
Current function value: 1.849053
Iterations: 197
Function evaluations: 356
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4097.5
Model:            NBD_cov              AIC:               8197.
Method:           Maximum Likelihood    BIC:               8203.
Date:             Wed, 29 Dec 2021
Time:             15:46:48
No. Observations: 2216
Df Residuals:     2215
Df Model:         0
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
E_Basic      1.8695     0.101     18.573     0.000        1.672     2.067
par0          1.0208     0.102     10.009     0.000         0.821     1.221
par1         -0.2630     0.116     -2.269     0.023        -0.490    -0.036
=====
-4097.502514305055
15
['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchase
s', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Maste
r', 'E_PhD', 'TotalAccept', 'LargerWeb']
E_Graduation
['E_Graduation']
Optimization terminated successfully.
Current function value: 1.850247
Iterations: 192
Function evaluations: 342
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4100.1
Model:            NBD_cov              AIC:               8202.
Method:           Maximum Likelihood    BIC:               8208.
Date:             Wed, 29 Dec 2021
Time:             15:46:49
No. Observations: 2216
Df Residuals:     2215
Df Model:         0
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
E_Graduation  1.8629     0.100     18.583     0.000         1.666     2.059
par0          1.0147     0.103      9.865     0.000         0.813     1.216
par1         -0.0102     0.033     -0.313     0.754        -0.074     0.054
=====
-4100.147905940741
16
['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchase
s', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Maste
r', 'E_PhD', 'TotalAccept', 'LargerWeb']
E_Master
['E_Master']
Optimization terminated successfully.
Current function value: 1.849955
Iterations: 205
Function evaluations: 367
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4099.5
Model:            NBD_cov              AIC:               8201.
Method:           Maximum Likelihood    BIC:               8207.
Date:             Wed, 29 Dec 2021
Time:             15:46:49
No. Observations: 2216
Df Residuals:     2215
Df Model:         0
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
E_Master      1.8646     0.100     18.580     0.000         1.668     2.061
par0          1.0302     0.102     10.107     0.000         0.830     1.230
par1          0.0512     0.043      1.184     0.236        -0.034     0.136
=====
-4099.500446928325
17
['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchase
s', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Maste
r', 'E_PhD', 'TotalAccept', 'LargerWeb']
E_PhD
['E_PhD']
Optimization terminated successfully.
Current function value: 1.850212
Iterations: 219
Function evaluations: 396
NBD_cov Results
=====
```

```
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4100.1
Model:            NBD_cov              AIC:              8202.
Method:           Maximum Likelihood    BIC:              8208.
Date:             Wed, 29 Dec 2021
Time:             15:46:49
No. Observations: 2216
Df Residuals:     2215
Df Model:         0
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
E_PhD         1.8631     0.100     18.583     0.000     1.667     2.060
par0          1.0243     0.102     10.049     0.000     0.825     1.224
par1          0.0197     0.039      0.502     0.615    -0.057     0.097
=====
-4100.070705126034
18
['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchase
s', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Maste
r', 'E_PhD', 'TotalAccept', 'LargerWeb']
TotalAccept
['TotalAccept']
Optimization terminated successfully.
    Current function value: 1.844418
    Iterations: 175
    Function evaluations: 307
                NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4087.2
Model:            NBD_cov              AIC:              8176.
Method:           Maximum Likelihood    BIC:              8182.
Date:             Wed, 29 Dec 2021
Time:             15:46:50
No. Observations: 2216
Df Residuals:     2215
Df Model:         0
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
TotalAccept     1.8927     0.102     18.545     0.000     1.693     2.093
par0            1.0084     0.104      9.722     0.000     0.805     1.212
par1           -0.0998     0.020     -5.000     0.000    -0.139    -0.061
=====
-4087.229903523392
19
['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchase
s', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Maste
r', 'E_PhD', 'TotalAccept', 'LargerWeb']
LargerWeb
['LargerWeb']
Optimization terminated successfully.
    Current function value: 1.825424
    Iterations: 179
    Function evaluations: 324
                NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4045.1
Model:            NBD_cov              AIC:              8092.
Method:           Maximum Likelihood    BIC:              8098.
Date:             Wed, 29 Dec 2021
Time:             15:46:50
No. Observations: 2216
Df Residuals:     2215
Df Model:         0
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
LargerWeb       2.0267     0.112     18.149     0.000     1.808     2.246
par0            1.2668     0.113     11.199     0.000     1.045     1.489
par1            0.4204     0.039     10.794     0.000     0.344     0.497
=====
-4045.13863417797
[-4039.4994252997167, -3897.79414546681]
here
['Teenhome']
Teenhome
pre ['Kidhome', 'Teenhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurc
hases', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_M
aster', 'E_PhD', 'TotalAccept', 'LargerWeb']
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata
logPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD',
'TotalAccept', 'LargerWeb']
1
0
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata
logPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD',
'TotalAccept', 'LargerWeb']
Kidhome
['Teenhome', 'Kidhome']
Optimization terminated successfully.
    Current function value: 1.723108
```

```
Iterations: 396
Function evaluations: 669
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3818.4
Model:            NBD_cov              AIC:               7641.
Method:           Maximum Likelihood    BIC:               7652.
Date:             Wed, 29 Dec 2021
Time:             15:46:51
No. Observations: 2216
Df Residuals:     2214
Df Model:         1
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----+-----
Teenhome      2.7042     0.175    15.452     0.000     2.361     3.047
Kidhome       2.3778     0.175    13.570     0.000     2.034     2.721
par0          0.5869     0.027     21.495     0.000     0.533     0.640
par1          0.3469     0.027     12.777     0.000     0.294     0.400
=====
-3818.40668072864
1
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata
logPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD',
'TotalAccept', 'LargerWeb']
Recency
['Teenhome', 'Recency']
Optimization terminated successfully.
Current function value: 1.758918
Iterations: 411
Function evaluations: 701
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3897.8
Model:            NBD_cov              AIC:               7800.
Method:           Maximum Likelihood    BIC:               7811.
Date:             Wed, 29 Dec 2021
Time:             15:46:51
No. Observations: 2216
Df Residuals:     2214
Df Model:         1
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----+-----
Teenhome      2.4549     0.147    16.676     0.000     2.166     2.743
Recency       1.9449     0.150    12.947     0.000     1.650     2.239
par0          0.5741     0.028     20.622     0.000     0.520     0.629
par1         -0.0001     0.001     -0.249     0.803    -0.001     0.001
=====
-3897.7630547370045
2
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata
logPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD',
'TotalAccept', 'LargerWeb']
MntWines
['Teenhome', 'MntWines']
Optimization terminated successfully.
Current function value: 1.758924
Iterations: 369
Function evaluations: 601
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3897.8
Model:            NBD_cov              AIC:               7800.
Method:           Maximum Likelihood    BIC:               7811.
Date:             Wed, 29 Dec 2021
Time:             15:46:52
No. Observations: 2216
Df Residuals:     2214
Df Model:         1
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----+-----
Teenhome      2.4526     0.147    16.660     0.000     2.164     2.741
MntWines      1.9464     0.150    12.994     0.000     1.653     2.240
par0          0.5741     0.028     20.608     0.000     0.520     0.629
par1         -8.878e-06    4.7e-05    -0.189     0.850    -0.000     8.33e-05
=====
-3897.7762988341037
3
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata
logPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD',
'TotalAccept', 'LargerWeb']
MntFruits
['Teenhome', 'MntFruits']
Optimization terminated successfully.
Current function value: 1.754672
Iterations: 273
Function evaluations: 452
NBD_cov Results
=====
```

```
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3888.4
Model:            NBD_cov              AIC:              7781.
Method:           Maximum Likelihood    BIC:              7792.
Date:             Wed, 29 Dec 2021
Time:             15:46:52
No. Observations: 2216
Df Residuals:     2214
Df Model:         1

=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome      2.4700     0.148     16.637     0.000     2.179     2.761
MntFruits     1.9098     0.150     12.704     0.000     1.615     2.204
par0          0.5540     0.028     19.672     0.000     0.499     0.609
par1         -0.0019     0.000     -4.266     0.000    -0.003    -0.001
=====
-3888.3525225146004
4
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata
logPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD',
'TotalAccept', 'LargerWeb']
MntFishProducts
['Teenhome', 'MntFishProducts']
Optimization terminated successfully.
Current function value: 1.754970
Iterations: 321
Function evaluations: 541
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3889.0
Model:            NBD_cov              AIC:              7782.
Method:           Maximum Likelihood    BIC:              7793.
Date:             Wed, 29 Dec 2021
Time:             15:46:53
No. Observations: 2216
Df Residuals:     2214
Df Model:         1

=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome      2.4709     0.149     16.620     0.000     2.179     2.762
MntFishProducts 1.9089     0.151     12.675     0.000     1.614     2.204
par0          0.5507     0.028     19.448     0.000     0.495     0.606
par1         -0.0013     0.000     -4.124     0.000    -0.002    -0.001
=====
-3889.0127646899527
5
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata
logPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD',
'TotalAccept', 'LargerWeb']
MntSweetProducts
['Teenhome', 'MntSweetProducts']
Optimization terminated successfully.
Current function value: 1.755630
Iterations: 332
Function evaluations: 556
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3890.5
Model:            NBD_cov              AIC:              7785.
Method:           Maximum Likelihood    BIC:              7796.
Date:             Wed, 29 Dec 2021
Time:             15:46:54
No. Observations: 2216
Df Residuals:     2214
Df Model:         1

=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome      2.4600     0.147     16.688     0.000     2.171     2.749
MntSweetProducts 1.9080     0.149     12.775     0.000     1.615     2.201
par0          0.5578     0.028     19.832     0.000     0.503     0.613
par1         -0.0016     0.000     -3.764     0.000    -0.002    -0.001
=====
-3890.47508513523
6
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata
logPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD',
'TotalAccept', 'LargerWeb']
MntGoldProds
['Teenhome', 'MntGoldProds']
Optimization terminated successfully.
Current function value: 1.757028
Iterations: 339
Function evaluations: 573
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3893.6
Model:            NBD_cov              AIC:              7791.
Method:           Maximum Likelihood    BIC:              7803.
Date:             Wed, 29 Dec 2021
```

```
Time: 15:46:54
No. Observations: 2216
Df Residuals: 2214
Df Model: 1
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome      2.4836      0.150     16.503      0.000      2.189      2.779
MntGoldProds   2.0186      0.153     13.236      0.000      1.720      2.317
par0           0.5741      0.028     20.690      0.000      0.520      0.628
par1           0.0009      0.000      2.935      0.003      0.000      0.001
=====
-3893.5733292024097
7
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
NumWebPurchases
['Teenhome', 'NumWebPurchases']
Optimization terminated successfully.
      Current function value: 1.739014
      Iterations: 368
      Function evaluations: 616
      NBD_cov Results
=====
Dep. Variable: NumDealsPurchases      Log-Likelihood: -3853.7
Model: NBD_cov      AIC: 7711.
Method: Maximum Likelihood      BIC: 7723.
Date: Wed, 29 Dec 2021
Time: 15:46:55
No. Observations: 2216
Df Residuals: 2214
Df Model: 1
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome      2.6299      0.166     15.878      0.000      2.305      2.955
NumWebPurchases  2.3193      0.167     13.892      0.000      1.992      2.646
par0           0.5290      0.028     19.012      0.000      0.474      0.584
par1           0.0505      0.005      9.564      0.000      0.040      0.061
=====
-3853.654100570611
8
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
NumCatalogPurchases
['Teenhome', 'NumCatalogPurchases']
Optimization terminated successfully.
      Current function value: 1.758518
      Iterations: 347
      Function evaluations: 572
      NBD_cov Results
=====
Dep. Variable: NumDealsPurchases      Log-Likelihood: -3896.9
Model: NBD_cov      AIC: 7798.
Method: Maximum Likelihood      BIC: 7809.
Date: Wed, 29 Dec 2021
Time: 15:46:55
No. Observations: 2216
Df Residuals: 2214
Df Model: 1
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome      2.4650      0.148     16.599      0.000      2.174      2.756
NumCatalogPurchases  1.9826      0.151     13.127      0.000      1.687      2.279
par0           0.5775      0.028     20.677      0.000      0.523      0.632
par1           0.0072      0.005      1.364      0.173     -0.003      0.018
=====
-3896.8757583211395
9
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
NumStorePurchases
['Teenhome', 'NumStorePurchases']
Optimization terminated successfully.
      Current function value: 1.757899
      Iterations: 379
      Function evaluations: 638
      NBD_cov Results
=====
Dep. Variable: NumDealsPurchases      Log-Likelihood: -3895.5
Model: NBD_cov      AIC: 7795.
Method: Maximum Likelihood      BIC: 7806.
Date: Wed, 29 Dec 2021
Time: 15:46:56
No. Observations: 2216
Df Residuals: 2214
Df Model: 1
```


=====						
	coef	std err	z	P> z	[0.025	0.975]

Teenhome	2.4803	0.150	16.489	0.000	2.186	2.775
NumStorePurchases	2.0344	0.155	13.100	0.000	1.730	2.339
par0	0.5696	0.028	20.470	0.000	0.515	0.624
par1	0.0102	0.005	2.150	0.032	0.001	0.020
=====						
-3895.5037280486645						
10						
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata						
logPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD',						
'TotalAccept', 'LargerWeb']						
NumWebVisitsMonth						
['Teenhome', 'NumWebVisitsMonth']						
Optimization terminated successfully.						
Current function value: 1.692758						
Iterations: 396						
Function evaluations: 661						
NBD_cov Results						
=====						
Dep. Variable:	NumDealsPurchases	Log-Likelihood:		-3751.2		
Model:	NBD_cov	AIC:		7506.		
Method:	Maximum Likelihood	BIC:		7518.		
Date:	Wed, 29 Dec 2021					
Time:	15:46:57					
No. Observations:	2216					
Df Residuals:	2214					
Df Model:	1					
=====						
	coef	std err	z	P> z	[0.025	0.975]

Teenhome	3.0572	0.227	13.467	0.000	2.612	3.502
NumWebVisitsMonth	3.1402	0.228	13.762	0.000	2.693	3.587
par0	0.5322	0.027	19.908	0.000	0.480	0.585
par1	0.1077	0.006	17.594	0.000	0.096	0.120
=====						
-3751.15225993872						
11						
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata						
logPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD',						
'TotalAccept', 'LargerWeb']						
Response						
['Teenhome', 'Response']						
Optimization terminated successfully.						
Current function value: 1.756730						
Iterations: 372						
Function evaluations: 620						
NBD_cov Results						
=====						
Dep. Variable:	NumDealsPurchases	Log-Likelihood:		-3892.9		
Model:	NBD_cov	AIC:		7790.		
Method:	Maximum Likelihood	BIC:		7801.		
Date:	Wed, 29 Dec 2021					
Time:	15:46:57					
No. Observations:	2216					
Df Residuals:	2214					
Df Model:	1					
=====						
	coef	std err	z	P> z	[0.025	0.975]

Teenhome	2.4870	0.151	16.471	0.000	2.191	2.783
Response	2.0111	0.153	13.177	0.000	1.712	2.310
par0	0.5859	0.028	20.915	0.000	0.531	0.641
par1	0.1369	0.043	3.161	0.002	0.052	0.222
=====						
-3892.914689503003						
12						
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata						
logPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD',						
'TotalAccept', 'LargerWeb']						
log_Income						
['Teenhome', 'log_Income']						
Optimization terminated successfully.						
Current function value: 1.744699						
Iterations: 371						
Function evaluations: 635						
NBD_cov Results						
=====						
Dep. Variable:	NumDealsPurchases	Log-Likelihood:		-3866.3		
Model:	NBD_cov	AIC:		7737.		
Method:	Maximum Likelihood	BIC:		7748.		
Date:	Wed, 29 Dec 2021					
Time:	15:46:58					
No. Observations:	2216					
Df Residuals:	2214					
Df Model:	1					
=====						
	coef	std err	z	P> z	[0.025	0.975]

Teenhome	2.5044	0.151	16.599	0.000	2.209	2.800

```
log_Income      -0.6186      0.364      -1.697      0.090      -1.333      0.096
par0             0.6107      0.028      21.607      0.000      0.555      0.666
par1            -0.2460      0.031      -8.056      0.000      -0.306     -0.186
=====
-3866.2540619368597
13
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata
logPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD',
'TotalAccept', 'LargerWeb']
E_Basic
['Teenhome', 'E_Basic']
Optimization terminated successfully.
Current function value: 1.758928
Iterations: 480
Function evaluations: 799
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3897.8
Model:           NBD_cov              AIC:              7800.
Method:          Maximum Likelihood    BIC:              7811.
Date:            Wed, 29 Dec 2021
Time:            15:46:59
No. Observations: 2216
Df Residuals:    2214
Df Model:        1
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome      2.4542      0.147      16.682      0.000      2.166      2.743
E_Basic       1.9512      0.148      13.164      0.000      1.661      2.242
par0           0.5744      0.028      20.460      0.000      0.519      0.629
par1           0.0151      0.111      0.135      0.892     -0.203      0.233
=====
-3897.7850252713147
14
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata
logPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD',
'TotalAccept', 'LargerWeb']
E_Graduation
['Teenhome', 'E_Graduation']
Optimization terminated successfully.
Current function value: 1.758917
Iterations: 342
Function evaluations: 578
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3897.8
Model:           NBD_cov              AIC:              7800.
Method:          Maximum Likelihood    BIC:              7811.
Date:            Wed, 29 Dec 2021
Time:            15:46:59
No. Observations: 2216
Df Residuals:    2214
Df Model:        1
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome      2.4544      0.147      16.681      0.000      2.166      2.743
E_Graduation  1.9549      0.149      13.119      0.000      1.663      2.247
par0           0.5742      0.028      20.619      0.000      0.520      0.629
par1           0.0079      0.031      0.258      0.796     -0.052      0.068
=====
-3897.7606439608726
15
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata
logPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD',
'TotalAccept', 'LargerWeb']
E_Master
['Teenhome', 'E_Master']
Optimization terminated successfully.
Current function value: 1.758816
Iterations: 438
Function evaluations: 729
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3897.5
Model:           NBD_cov              AIC:              7799.
Method:          Maximum Likelihood    BIC:              7810.
Date:            Wed, 29 Dec 2021
Time:            15:47:00
No. Observations: 2216
Df Residuals:    2214
Df Model:        1
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome      2.4562      0.147      16.670      0.000      2.167      2.745
E_Master      1.9572      0.149      13.170      0.000      1.666      2.248
par0           0.5734      0.028      20.599      0.000      0.519      0.628
par1           0.0294      0.041      0.719      0.472     -0.051      0.109
=====
```

```
-3897.5368010200564
16
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
E_PhD
['Teenhome', 'E_PhD']
Optimization terminated successfully.
    Current function value: 1.758440
    Iterations: 390
    Function evaluations: 657
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3896.7
Model:            NBD_cov              AIC:              7797.
Method:           Maximum Likelihood    BIC:              7809.
Date:             Wed, 29 Dec 2021
Time:             15:47:01
No. Observations: 2216
Df Residuals:     2214
Df Model:         1
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome      2.4578     0.147     16.666     0.000      2.169     2.747
E_PhD         1.9446     0.149     13.077     0.000      1.653     2.236
par0          0.5780     0.028     20.666     0.000      0.523     0.633
par1         -0.0549     0.037     -1.471     0.141     -0.128     0.018
=====
-3896.704121067311
17
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
TotalAccept
['Teenhome', 'TotalAccept']
Optimization terminated successfully.
    Current function value: 1.757618
    Iterations: 361
    Function evaluations: 609
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3894.9
Model:            NBD_cov              AIC:              7794.
Method:           Maximum Likelihood    BIC:              7805.
Date:             Wed, 29 Dec 2021
Time:             15:47:02
No. Observations: 2216
Df Residuals:     2214
Df Model:         1
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome      2.4532     0.147     16.703     0.000      2.165     2.741
TotalAccept   1.9250     0.149     12.954     0.000      1.634     2.216
par0          0.5643     0.028     20.070     0.000      0.509     0.619
par1         -0.0459     0.019     -2.386     0.017     -0.084    -0.008
=====
-3894.881855533462
18
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
LargerWeb
['Teenhome', 'LargerWeb']
Optimization terminated successfully.
    Current function value: 1.740149
    Iterations: 369
    Function evaluations: 606
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3856.2
Model:            NBD_cov              AIC:              7716.
Method:           Maximum Likelihood    BIC:              7728.
Date:             Wed, 29 Dec 2021
Time:             15:47:02
No. Observations: 2216
Df Residuals:     2214
Df Model:         1
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome      2.6218     0.166     15.785     0.000      2.296     2.947
LargerWeb     2.1719     0.167     13.008     0.000      1.845     2.499
par0          0.5492     0.028     19.890     0.000      0.495     0.603
par1          0.3447     0.037      9.375     0.000      0.273     0.417
=====
-3856.171145332236
[-4039.4994252997167, -3897.79414546681, -3818.40668072864, -3751.15225993872]
here
['Teenhome', 'NumWebVisitsMonth']
```

```
NumWebVisitsMonth
pre ['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'Num
CatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_P
hD', 'TotalAccept', 'LargerWeb']
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata
logPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'Larg
erWeb']
2
0
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata
logPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'Larg
erWeb']
Kidhome
['Teenhome', 'NumWebVisitsMonth', 'Kidhome']
Optimization terminated successfully.
Current function value: 1.895630
Iterations: 299
Function evaluations: 493

NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4200.7
Model:           NBD_cov              AIC:              8407.
Method:          Maximum Likelihood    BIC:              8425.
Date:            Wed, 29 Dec 2021
Time:            15:47:03
No. Observations:    2216
Df Residuals:      2213
Df Model:          2
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome          0.5811     0.059      9.828     0.000      0.465     0.697
NumWebVisitsMonth -0.2371     0.107     -2.220     0.026     -0.446    -0.028
Kidhome           0.3184     0.041      7.835     0.000      0.239     0.398
par0              -0.0044     0.010     -0.442     0.658     -0.024     0.015
par1              -0.0630     0.044     -1.431     0.152     -0.149     0.023
=====
-4200.71563762519
1
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata
logPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'Larg
erWeb']
Recency
['Teenhome', 'NumWebVisitsMonth', 'Recency']
Optimization terminated successfully.
Current function value: 1.692758
Iterations: 744
Function evaluations: 1201

NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3751.2
Model:           NBD_cov              AIC:              7508.
Method:          Maximum Likelihood    BIC:              7525.
Date:            Wed, 29 Dec 2021
Time:            15:47:04
No. Observations:    2216
Df Residuals:      2213
Df Model:          2
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome          3.0572     0.227     13.464     0.000      2.612     3.502
NumWebVisitsMonth  3.1400     0.229     13.698     0.000      2.691     3.589
Recency           0.5322     0.027     19.901     0.000      0.480     0.585
par0              0.1077     0.006     17.593     0.000      0.096     0.120
par1             -6.423e-06     0.001     -0.013     0.990     -0.001     0.001
=====
-3751.1521791293712
2
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata
logPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'Larg
erWeb']
MntWines
['Teenhome', 'NumWebVisitsMonth', 'MntWines']
Optimization terminated successfully.
Current function value: 1.688101
Iterations: 755
Function evaluations: 1202

NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3740.8
Model:           NBD_cov              AIC:              7488.
Method:          Maximum Likelihood    BIC:              7505.
Date:            Wed, 29 Dec 2021
Time:            15:47:05
No. Observations:    2216
Df Residuals:      2213
Df Model:          2
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
```

Teenhome	3.1750	0.250	12.700	0.000	2.685	3.665
NumWebVisitsMonth	3.3525	0.252	13.292	0.000	2.858	3.847
MntWines	0.5200	0.027	19.494	0.000	0.468	0.572
par0	0.1145	0.006	18.361	0.000	0.102	0.127
par1	0.0002	4.51e-05	4.617	0.000	0.000	0.000

-3740.8309260020897

3

```
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
```

MntFruits

```
['Teenhome', 'NumWebVisitsMonth', 'MntFruits']
```

Optimization terminated successfully.

Current function value: 1.691855

Iterations: 614

Function evaluations: 974

NBD_cov Results

Dep. Variable:	NumDealsPurchases	Log-Likelihood:	-3749.2
Model:	NBD_cov	AIC:	7504.
Method:	Maximum Likelihood	BIC:	7521.
Date:	Wed, 29 Dec 2021		
Time:	15:47:06		
No. Observations:	2216		
Df Residuals:	2213		
Df Model:	2		

	coef	std err	z	P> z	[0.025	0.975]
Teenhome	3.0745	0.230	13.383	0.000	2.624	3.525
NumWebVisitsMonth	3.2083	0.232	13.814	0.000	2.753	3.664
MntFruits	0.5388	0.027	20.020	0.000	0.486	0.591
par0	0.1123	0.007	17.228	0.000	0.100	0.125
par1	0.0009	0.000	2.020	0.043	2.63e-05	0.002

-3749.150022337993

4

```
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
```

MntFishProducts

```
['Teenhome', 'NumWebVisitsMonth', 'MntFishProducts']
```

Optimization terminated successfully.

Current function value: 1.691318

Iterations: 767

Function evaluations: 1213

NBD_cov Results

Dep. Variable:	NumDealsPurchases	Log-Likelihood:	-3748.0
Model:	NBD_cov	AIC:	7502.
Method:	Maximum Likelihood	BIC:	7519.
Date:	Wed, 29 Dec 2021		
Time:	15:47:07		
No. Observations:	2216		
Df Residuals:	2213		
Df Model:	2		

	coef	std err	z	P> z	[0.025	0.975]
Teenhome	3.0797	0.230	13.373	0.000	2.628	3.531
NumWebVisitsMonth	3.2309	0.233	13.883	0.000	2.775	3.687
MntFishProducts	0.5424	0.027	20.081	0.000	0.489	0.595
par0	0.1138	0.007	17.350	0.000	0.101	0.127
par1	0.0008	0.000	2.554	0.011	0.000	0.001

-3747.9613644894043

5

```
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
```

MntSweetProducts

```
['Teenhome', 'NumWebVisitsMonth', 'MntSweetProducts']
```

Optimization terminated successfully.

Current function value: 1.691139

Iterations: 631

Function evaluations: 990

NBD_cov Results

Dep. Variable:	NumDealsPurchases	Log-Likelihood:	-3747.6
Model:	NBD_cov	AIC:	7501.
Method:	Maximum Likelihood	BIC:	7518.
Date:	Wed, 29 Dec 2021		
Time:	15:47:08		
No. Observations:	2216		
Df Residuals:	2213		
Df Model:	2		

	coef	std err	z	P> z	[0.025	0.975]
Teenhome	3.0935	0.233	13.269	0.000	2.637	3.550

```
NumWebVisitsMonth      3.2441      0.236      13.757      0.000      2.782      3.706
MntSweetProducts       0.5401      0.027      20.118      0.000      0.488      0.593
par0                    0.1139      0.007      17.487      0.000      0.101      0.127
par1                    0.0011      0.000      2.713      0.007      0.000      0.002
=====
-3747.5647207989223
6
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
MntGoldProds
['Teenhome', 'NumWebVisitsMonth', 'MntGoldProds']
Optimization terminated successfully.
    Current function value: 1.682551
    Iterations: 701
    Function evaluations: 1122
    NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases      Log-Likelihood:    -3728.5
Model:           NBD_cov                AIC:              7463.
Method:          Maximum Likelihood      BIC:              7480.
Date:            Wed, 29 Dec 2021
Time:            15:47:09
No. Observations: 2216
Df Residuals:    2213
Df Model:        2
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome                3.2248      0.258      12.488      0.000      2.719      3.731
NumWebVisitsMonth       3.4327      0.259      13.256      0.000      2.925      3.940
MntGoldProds            0.5261      0.026      19.853      0.000      0.474      0.578
par0                    0.1152      0.006      18.820      0.000      0.103      0.127
par1                    0.0019      0.000      6.911      0.000      0.001      0.002
=====
-3728.5322319185216
7
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
NumWebPurchases
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases']
Optimization terminated successfully.
    Current function value: 1.666260
    Iterations: 638
    Function evaluations: 1035
    NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases      Log-Likelihood:    -3692.4
Model:           NBD_cov                AIC:              7391.
Method:          Maximum Likelihood      BIC:              7408.
Date:            Wed, 29 Dec 2021
Time:            15:47:10
No. Observations: 2216
Df Residuals:    2213
Df Model:        2
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome                3.6293      0.368      9.871      0.000      2.909      4.350
NumWebVisitsMonth       3.9446      0.370      10.672      0.000      3.220      4.669
NumWebPurchases         0.4765      0.027      17.929      0.000      0.424      0.529
par0                    0.1126      0.006      18.807      0.000      0.101      0.124
par1                    0.0547      0.005      11.264      0.000      0.045      0.064
=====
-3692.4326596513383
8
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
NumCatalogPurchases
['Teenhome', 'NumWebVisitsMonth', 'NumCatalogPurchases']
Optimization terminated successfully.
    Current function value: 1.668091
    Iterations: 807
    Function evaluations: 1298
    NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases      Log-Likelihood:    -3696.5
Model:           NBD_cov                AIC:              7399.
Method:          Maximum Likelihood      BIC:              7416.
Date:            Wed, 29 Dec 2021
Time:            15:47:12
No. Observations: 2216
Df Residuals:    2213
Df Model:        2
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome                3.3377      0.278      11.998      0.000      2.792      3.883
NumWebVisitsMonth       3.7469      0.277      13.540      0.000      3.205      4.289
```

```
NumCatalogPurchases      0.5383      0.026      20.403      0.000      0.487      0.590
par0                      0.1372      0.007      20.802      0.000      0.124      0.150
par1                      0.0593      0.005      10.995      0.000      0.049      0.070
=====
-3696.4890915419182
9
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
NumStorePurchases
['Teenhome', 'NumWebVisitsMonth', 'NumStorePurchases']
Optimization terminated successfully.
Current function value: 1.668268
Iterations: 609
Function evaluations: 969
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3696.9
Model:           NBD_cov              AIC:              7400.
Method:          Maximum Likelihood    BIC:              7417.
Date:            Wed, 29 Dec 2021
Time:            15:47:13
No. Observations: 2216
Df Residuals:    2213
Df Model:        2
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome      3.5698      0.344      10.374      0.000      2.895      4.244
NumWebVisitsMonth 4.0875      0.347      11.778      0.000      3.407      4.768
NumStorePurchases 0.4915      0.026      18.624      0.000      0.440      0.543
par0          0.1351      0.006      20.913      0.000      0.122      0.148
par1          0.0517      0.005      10.711      0.000      0.042      0.061
=====
-3696.8827986511824
10
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
Response
['Teenhome', 'NumWebVisitsMonth', 'Response']
Optimization terminated successfully.
Current function value: 1.691286
Iterations: 749
Function evaluations: 1232
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3747.9
Model:           NBD_cov              AIC:              7502.
Method:          Maximum Likelihood    BIC:              7519.
Date:            Wed, 29 Dec 2021
Time:            15:47:14
No. Observations: 2216
Df Residuals:    2213
Df Model:        2
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome      3.0990      0.235      13.162      0.000      2.637      3.560
NumWebVisitsMonth 3.1991      0.237      13.503      0.000      2.735      3.663
Response      0.5405      0.027      20.120      0.000      0.488      0.593
par0          0.1070      0.006      17.514      0.000      0.095      0.119
par1          0.1076      0.042      2.582      0.010      0.026      0.189
=====
-3747.8903149757543
11
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
log_Income
['Teenhome', 'NumWebVisitsMonth', 'log_Income']
Optimization terminated successfully.
Current function value: 1.690649
Iterations: 738
Function evaluations: 1177
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3746.5
Model:           NBD_cov              AIC:              7499.
Method:          Maximum Likelihood    BIC:              7516.
Date:            Wed, 29 Dec 2021
Time:            15:47:15
No. Observations: 2216
Df Residuals:    2213
Df Model:        2
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome      3.1424      0.245      12.837      0.000      2.663      3.622
NumWebVisitsMonth 4.5591      0.520      8.759      0.000      3.539      5.579
log_Income    0.5063      0.028      18.147      0.000      0.452      0.561
```

```
par0          0.1226      0.008      15.670      0.000      0.107      0.138
par1          0.1178      0.039       3.046      0.002      0.042      0.194
=====
-3746.4790885878856
12
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata
logPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'Larg
erWeb']
E_Basic
['Teenhome', 'NumWebVisitsMonth', 'E_Basic']
Optimization terminated successfully.
    Current function value: 1.692350
    Iterations: 689
    Function evaluations: 1117
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3750.2
Model:           NBD_cov              AIC:              7506.
Method:          Maximum Likelihood    BIC:              7524.
Date:            Wed, 29 Dec 2021
Time:            15:47:16
No. Observations:    2216
Df Residuals:      2213
Df Model:          2
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome        3.0623      0.228      13.438      0.000      2.616      3.509
NumWebVisitsMonth  3.1423      0.229      13.726      0.000      2.694      3.591
E_Basic         0.5268      0.027      19.513      0.000      0.474      0.580
par0            0.1083      0.006      17.667      0.000      0.096      0.120
par1           -0.1428      0.108      -1.321      0.187     -0.355      0.069
=====
-3750.2483492125616
13
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata
logPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'Larg
erWeb']
E_Graduation
['Teenhome', 'NumWebVisitsMonth', 'E_Graduation']
Optimization terminated successfully.
    Current function value: 1.692710
    Iterations: 670
    Function evaluations: 1062
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3751.0
Model:           NBD_cov              AIC:              7508.
Method:          Maximum Likelihood    BIC:              7525.
Date:            Wed, 29 Dec 2021
Time:            15:47:17
No. Observations:    2216
Df Residuals:      2213
Df Model:          2
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome        3.0591      0.227      13.448      0.000      2.613      3.505
NumWebVisitsMonth  3.1494      0.229      13.730      0.000      2.700      3.599
E_Graduation     0.5325      0.027      19.913      0.000      0.480      0.585
par0            0.1078      0.006      17.603      0.000      0.096      0.120
par1            0.0137      0.030       0.463      0.643     -0.044      0.072
=====
-3751.0449198451633
14
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata
logPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'Larg
erWeb']
E_Master
['Teenhome', 'NumWebVisitsMonth', 'E_Master']
Optimization terminated successfully.
    Current function value: 1.692461
    Iterations: 698
    Function evaluations: 1127
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3750.5
Model:           NBD_cov              AIC:              7507.
Method:          Maximum Likelihood    BIC:              7524.
Date:            Wed, 29 Dec 2021
Time:            15:47:18
No. Observations:    2216
Df Residuals:      2213
Df Model:          2
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome        3.0641      0.228      13.416      0.000      2.616      3.512
NumWebVisitsMonth  3.1552      0.230      13.733      0.000      2.705      3.605
E_Master        0.5312      0.027      19.868      0.000      0.479      0.584
par0            0.1079      0.006      17.623      0.000      0.096      0.120
```



```

par1          0.0453      0.039      1.152      0.249      -0.032      0.122
=====
-3750.4938277818374
15
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata
logPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'Larg
erWeb']
E_PhD
['Teenhome', 'NumWebVisitsMonth', 'E_PhD']
Optimization terminated successfully.
      Current function value: 1.888169
      Iterations: 451
      Function evaluations: 736
      NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4184.2
Model:           NBD_cov              AIC:              8374.
Method:          Maximum Likelihood    BIC:              8391.
Date:            Wed, 29 Dec 2021
Time:            15:47:19
No. Observations: 2216
Df Residuals:    2213
Df Model:        2
=====
               coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome        0.7034      0.062     11.313     0.000      0.582      0.825
NumWebVisitsMonth -0.1579      0.109     -1.445     0.149     -0.372      0.056
E_PhD           0.1062      0.041      2.596     0.009      0.026      0.186
par0            0.0116      0.009      1.286     0.199     -0.006      0.029
par1           -0.1985      0.050     -3.966     0.000     -0.297     -0.100
=====
-4184.1824166698025
16
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata
logPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'Larg
erWeb']
TotalAccept
['Teenhome', 'NumWebVisitsMonth', 'TotalAccept']
Optimization terminated successfully.
      Current function value: 1.692343
      Iterations: 659
      Function evaluations: 1058
      NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3750.2
Model:           NBD_cov              AIC:              7506.
Method:          Maximum Likelihood    BIC:              7524.
Date:            Wed, 29 Dec 2021
Time:            15:47:20
No. Observations: 2216
Df Residuals:    2213
Df Model:        2
=====
               coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome        3.0542      0.227     13.479     0.000      2.610      3.498
NumWebVisitsMonth 3.1218      0.228     13.669     0.000      2.674      3.569
TotalAccept      0.5281      0.027     19.636     0.000      0.475      0.581
par0            0.1072      0.006     17.478     0.000      0.095      0.119
par1           -0.0253      0.019     -1.347     0.178     -0.062      0.012
=====
-3750.2330127600244
17
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'NumCata
logPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'Larg
erWeb']
LargerWeb
['Teenhome', 'NumWebVisitsMonth', 'LargerWeb']
Optimization terminated successfully.
      Current function value: 1.685379
      Iterations: 691
      Function evaluations: 1099
      NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3734.8
Model:           NBD_cov              AIC:              7476.
Method:          Maximum Likelihood    BIC:              7493.
Date:            Wed, 29 Dec 2021
Time:            15:47:21
No. Observations: 2216
Df Residuals:    2213
Df Model:        2
=====
               coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome        3.1831      0.251     12.669     0.000      2.691      3.676
NumWebVisitsMonth 3.2569      0.252     12.907     0.000      2.762      3.752
LargerWeb        0.5193      0.027     19.459     0.000      0.467      0.572
par0            0.1001      0.006     16.046     0.000      0.088      0.112
par1            0.2105      0.036      5.820     0.000      0.140      0.281

```

```
=====
-3734.800911730141
[-4039.4994252997167, -3897.79414546681, -3818.40668072864, -3751.15225993872, -3751.1521791293712, -3740.8309260020897, -3728.532
2319185216, -3692.4326596513383]
here
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases']
NumWebPurchases
pre ['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumWebPurchases', 'Num
CatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept',
'LargerWeb']
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumCatalogPurchases', 'Num
StorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
3
0
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumCatalogPurchases', 'Num
StorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
Kidhome
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'Kidhome']
Optimization terminated successfully.
Current function value: 1.863545
Iterations: 733
Function evaluations: 1132
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4129.6
Model:            NBD_cov              AIC:              8267.
Method:          Maximum Likelihood    BIC:              8290.
Date:            Wed, 29 Dec 2021
Time:            15:47:23
No. Observations: 2216
Df Residuals:    2212
Df Model:        3
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome      0.4022     0.052     7.785     0.000     0.301     0.503
NumWebVisitsMonth 0.9362     0.088    10.682     0.000     0.764     1.108
NumWebPurchases 0.8022     0.046    17.411     0.000     0.712     0.892
Kidhome       0.0518     0.010     4.993     0.000     0.031     0.072
par0          0.0799     0.009     8.420     0.000     0.061     0.098
par1          0.5982     0.052    11.533     0.000     0.497     0.700
=====
-4129.616355228118
1
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumCatalogPurchases', 'Num
StorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
Recency
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'Recency']
Optimization terminated successfully.
Current function value: 1.667283
Iterations: 656
Function evaluations: 1043
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3694.7
Model:            NBD_cov              AIC:              7397.
Method:          Maximum Likelihood    BIC:              7420.
Date:            Wed, 29 Dec 2021
Time:            15:47:24
No. Observations: 2216
Df Residuals:    2212
Df Model:        3
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome      4.9122         nan         nan         nan         nan         nan
NumWebVisitsMonth 5.2236         nan         nan         nan         nan         nan
NumWebPurchases 0.4621         nan         nan         nan         nan         nan
Recency       0.1128         nan         nan         nan         nan         nan
par0          0.0552         nan         nan         nan         nan         nan
par1         1.318e-05         nan         nan         nan         nan         nan
=====
-3694.698938683304
2
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumCatalogPurchases', 'Num
StorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
MntWines
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntWines']
/usr/local/lib/python3.7/dist-packages/statsmodels/base/model.py:492: HessianInversionWarning: Inverting hessian failed, no bse or
cov_params available
'available', HessianInversionWarning)
Optimization terminated successfully.
Current function value: 1.734452
Iterations: 749
Function evaluations: 1171
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3843.5
Model:            NBD_cov              AIC:              7695.
Method:          Maximum Likelihood    BIC:              7718.
Date:            Wed, 29 Dec 2021
```

```
Time: 15:47:25
No. Observations: 2216
Df Residuals: 2212
Df Model: 3
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome      1.5023      0.074     20.214     0.000      1.357      1.648
NumWebVisitsMonth 1.4326      0.101     14.196     0.000      1.235      1.630
NumWebPurchases 0.7192      0.034     21.202     0.000      0.653      0.786
MntWines       0.0467      0.008      5.936     0.000      0.031      0.062
par0           0.0502      0.008      6.436     0.000      0.035      0.065
par1          -0.0003     6.99e-05    -4.689     0.000     -0.000     -0.000
=====
-3843.5460502651276
3
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumCatalogPurchases', 'Num
StorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
MntFruits
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntFruits']
Optimization terminated successfully.
    Current function value: 1.872727
    Iterations: 568
    Function evaluations: 872
NBD_cov Results
=====
Dep. Variable: NumDealsPurchases      Log-Likelihood: -4150.0
Model: NBD_cov      AIC: 8308.
Method: Maximum Likelihood      BIC: 8331.
Date: Wed, 29 Dec 2021
Time: 15:47:26
No. Observations: 2216
Df Residuals: 2212
Df Model: 3
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome      0.7806      0.064     12.130     0.000      0.654      0.907
NumWebVisitsMonth -0.1784      0.124     -1.442     0.149     -0.421      0.064
NumWebPurchases 0.0697      0.041      1.702     0.089     -0.011      0.150
MntFruits     -0.0105      0.010     -1.082     0.279     -0.029      0.008
par0          0.0296      0.008      3.656     0.000      0.014      0.046
par1         -0.0056      0.001     -8.605     0.000     -0.007     -0.004
=====
-4149.96272410684
4
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumCatalogPurchases', 'Num
StorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
MntFishProducts
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntFishProducts']
Optimization terminated successfully.
    Current function value: 1.926179
    Iterations: 382
    Function evaluations: 602
NBD_cov Results
=====
Dep. Variable: NumDealsPurchases      Log-Likelihood: -4268.4
Model: NBD_cov      AIC: 8545.
Method: Maximum Likelihood      BIC: 8568.
Date: Wed, 29 Dec 2021
Time: 15:47:27
No. Observations: 2216
Df Residuals: 2212
Df Model: 3
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome      0.4737      0.060      7.939     0.000      0.357      0.591
NumWebVisitsMonth -0.5174      0.128     -4.056     0.000     -0.767     -0.267
NumWebPurchases -0.0405      0.047     -0.867     0.386     -0.132      0.051
MntFishProducts -0.0096      0.011     -0.909     0.363     -0.030      0.011
par0          0.0369      0.009      4.132     0.000      0.019      0.054
par1         -0.0043      0.001     -8.387     0.000     -0.005     -0.003
=====
-4268.413465682301
5
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumCatalogPurchases', 'Num
StorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
MntSweetProducts
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntSweetProducts']
Optimization terminated successfully.
    Current function value: 1.840928
    Iterations: 608
    Function evaluations: 945
NBD_cov Results
=====
Dep. Variable: NumDealsPurchases      Log-Likelihood: -4079.5
Model: NBD_cov      AIC: 8167.
Method: Maximum Likelihood      BIC: 8190.
Date: Wed, 29 Dec 2021
Time: 15:47:28
```

```
No. Observations:      2216
Df Residuals:          2212
Df Model:              3
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----+-----
Teenhome            0.9803      0.067     14.551     0.000      0.848      1.112
NumWebVisitsMonth    0.0790      0.120      0.655     0.512     -0.157      0.315
NumWebPurchases      0.1628      0.038      4.319     0.000      0.089      0.237
MntSweetProducts    -0.0111      0.009     -1.206     0.228     -0.029      0.007
par0                 0.0287      0.008      3.723     0.000      0.014      0.044
par1                -0.0050      0.001     -8.280     0.000     -0.006     -0.004
=====
-4079.4971863366627
6
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumCatalogPurchases', 'Num
StorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
MntGoldProds
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds']
Optimization terminated successfully.
      Current function value: 1.664965
      Iterations: 1051
      Function evaluations: 1620
      NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases      Log-Likelihood:    -3689.6
Model:           NBD_cov                AIC:              7387.
Method:          Maximum Likelihood      BIC:              7410.
Date:            Wed, 29 Dec 2021
Time:            15:47:29
No. Observations:    2216
Df Residuals:        2212
Df Model:            3
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----+-----
Teenhome            3.6453      0.372      9.811     0.000      2.917      4.374
NumWebVisitsMonth    3.9846      0.373     10.680     0.000      3.253      4.716
NumWebPurchases      0.4795      0.027     18.025     0.000      0.427      0.532
MntGoldProds         0.1149      0.006     19.043     0.000      0.103      0.127
par0                 0.0491      0.005      9.093     0.000      0.038      0.060
par1                 0.0007      0.000      2.415     0.016      0.000      0.001
=====
-3689.5620957993756
7
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumCatalogPurchases', 'Num
StorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
NumCatalogPurchases
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'NumCatalogPurchases']
Optimization terminated successfully.
      Current function value: 1.858910
      Iterations: 524
      Function evaluations: 815
      NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases      Log-Likelihood:    -4119.3
Model:           NBD_cov                AIC:              8247.
Method:          Maximum Likelihood      BIC:              8270.
Date:            Wed, 29 Dec 2021
Time:            15:47:30
No. Observations:    2216
Df Residuals:        2212
Df Model:            3
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----+-----
Teenhome            0.8913      0.068     13.192     0.000      0.759      1.024
NumWebVisitsMonth    0.0227      0.131      0.173     0.862     -0.234      0.280
NumWebPurchases      0.1574      0.039      4.086     0.000      0.082      0.233
NumCatalogPurchases -0.0014      0.010     -0.136     0.892     -0.021      0.019
par0                 0.0205      0.008      2.591     0.010      0.005      0.036
par1                -0.0380      0.008     -4.566     0.000     -0.054     -0.022
=====
-4119.343910620928
8
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumCatalogPurchases', 'Num
StorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
NumStorePurchases
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'NumStorePurchases']
Optimization terminated successfully.
      Current function value: 1.967768
      Iterations: 729
      Function evaluations: 1130
      NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases      Log-Likelihood:    -4360.6
Model:           NBD_cov                AIC:              8729.
Method:          Maximum Likelihood      BIC:              8752.
Date:            Wed, 29 Dec 2021
Time:            15:47:32
No. Observations:    2216
```

```

Df Residuals:      2212
Df Model:          3
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome          0.1087      0.051      2.137      0.033      0.009      0.208
NumWebVisitsMonth -0.5925      0.132     -4.504      0.000     -0.850     -0.335
NumWebPurchases    0.2918      0.048      6.099      0.000      0.198      0.386
NumStorePurchases  0.0143      0.012      1.199      0.230     -0.009      0.038
par0               0.0576      0.012      4.955      0.000      0.035      0.080
par1              -0.0505      0.011     -4.786      0.000     -0.071     -0.030
=====
-4360.572870646625
9
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumCatalogPurchases', 'Num
StorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
Response
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'Response']
Optimization terminated successfully.
    Current function value: 1.666089
    Iterations: 1203
    Function evaluations: 1854
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3692.1
Model:            NBD_cov             AIC:              7392.
Method:           Maximum Likelihood   BIC:              7415.
Date:             Wed, 29 Dec 2021
Time:             15:47:33
No. Observations: 2216
Df Residuals:     2212
Df Model:         3
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome          3.6406      0.372      9.798      0.000      2.912      4.369
NumWebVisitsMonth 3.9589      0.374     10.597      0.000      3.227      4.691
NumWebPurchases    0.4802      0.027     17.858      0.000      0.427      0.533
Response           0.1123      0.006     18.738      0.000      0.101      0.124
par0               0.0540      0.005     10.970      0.000      0.044      0.064
par1               0.0361      0.041      0.874      0.382     -0.045      0.117
=====
-3692.0531265570753
10
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumCatalogPurchases', 'Num
StorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
log_Income
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'log_Income']
Optimization terminated successfully.
    Current function value: 1.684994
    Iterations: 528
    Function evaluations: 831
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3733.9
Model:            NBD_cov             AIC:              7476.
Method:           Maximum Likelihood   BIC:              7499.
Date:             Wed, 29 Dec 2021
Time:             15:47:34
No. Observations: 2216
Df Residuals:     2212
Df Model:         3
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome          2.3557      0.120     19.631      0.000      2.121      2.591
NumWebVisitsMonth -2.4415      0.589     -4.142      0.000     -3.597     -1.286
NumWebPurchases    0.5371      0.030     17.811      0.000      0.478      0.596
log_Income         0.0527      0.009      5.928      0.000      0.035      0.070
par0               0.0853      0.007     12.675      0.000      0.072      0.099
par1              -0.4603      0.048     -9.495      0.000     -0.555     -0.365
=====
-3733.946177921185
11
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumCatalogPurchases', 'Num
StorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
E_Basic
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'E_Basic']
Optimization terminated successfully.
    Current function value: 1.747901
    Iterations: 704
    Function evaluations: 1100
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3873.3
Model:            NBD_cov             AIC:              7755.
Method:           Maximum Likelihood   BIC:              7778.
Date:             Wed, 29 Dec 2021
Time:             15:47:36
No. Observations: 2216
Df Residuals:     2212

```

```
Df Model: 3
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome      1.8064      0.084     21.559      0.000       1.642       1.971
NumWebVisitsMonth 2.0336      0.101     20.146      0.000       1.836       2.231
NumWebPurchases 0.4138      0.031     13.263      0.000       0.353       0.475
E_Basic        0.1141      0.007     16.108      0.000       0.100       0.128
par0           0.0474      0.006      7.934      0.000       0.036       0.059
par1          -2.3588      0.283     -8.347      0.000      -2.913      -1.805
=====
-3873.348081020924
12
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumCatalogPurchases', 'Num
StorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
E_Graduation
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'E_Graduation']
Optimization terminated successfully.
      Current function value: 1.815223
      Iterations: 785
      Function evaluations: 1232
              NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4022.5
Model:           NBD_cov              AIC:              8053.
Method:          Maximum Likelihood    BIC:              8076.
Date:            Wed, 29 Dec 2021
Time:            15:47:37
No. Observations: 2216
Df Residuals:    2212
Df Model:        3
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome      1.1603      0.070     16.580      0.000       1.023       1.297
NumWebVisitsMonth 1.6127      0.093     17.318      0.000       1.430       1.795
NumWebPurchases 0.1274      0.037      3.417      0.001       0.054       0.200
E_Graduation   0.1722      0.009     20.095      0.000       0.155       0.189
par0           0.0966      0.007     13.406      0.000       0.082       0.111
par1          -0.4691      0.041    -11.498      0.000      -0.549      -0.389
=====
-4022.5349110041984
13
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumCatalogPurchases', 'Num
StorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
E_Master
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'E_Master']
Optimization terminated successfully.
      Current function value: 1.880771
      Iterations: 719
      Function evaluations: 1122
              NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4167.8
Model:           NBD_cov              AIC:              8344.
Method:          Maximum Likelihood    BIC:              8366.
Date:            Wed, 29 Dec 2021
Time:            15:47:38
No. Observations: 2216
Df Residuals:    2212
Df Model:        3
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome      0.6915      0.062     11.166      0.000       0.570       0.813
NumWebVisitsMonth -0.1361      0.118     -1.155      0.248      -0.367       0.095
NumWebPurchases 0.2811      0.040      7.088      0.000       0.203       0.359
E_Master      -0.0001      0.009     -0.014      0.988      -0.018       0.018
par0           0.0015      0.008      0.185      0.853      -0.014       0.017
par1          -0.3208      0.056     -5.709      0.000      -0.431      -0.211
=====
-4167.789374641261
14
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumCatalogPurchases', 'Num
StorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
E_PhD
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'E_PhD']
Optimization terminated successfully.
      Current function value: 1.871191
      Iterations: 666
      Function evaluations: 1021
              NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4146.6
Model:           NBD_cov              AIC:              8301.
Method:          Maximum Likelihood    BIC:              8324.
Date:            Wed, 29 Dec 2021
Time:            15:47:39
No. Observations: 2216
Df Residuals:    2212
Df Model:        3
```

```
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome      0.7081      0.061      11.578      0.000      0.588      0.828
NumWebVisitsMonth -0.0517      0.114      -0.453      0.650      -0.275      0.172
NumWebPurchases  0.3949      0.039      10.026      0.000      0.318      0.472
E_PhD          0.0026      0.009      0.289      0.773      -0.015      0.020
par0           0.0062      0.008      0.782      0.434      -0.009      0.022
par1          -0.4556      0.052      -8.809      0.000      -0.557      -0.354
=====
-4146.558382035693
15
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumCatalogPurchases', 'Num
StorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
TotalAccept
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'TotalAccept']
Optimization terminated successfully.
      Current function value: 1.848598
      Iterations: 623
      Function evaluations: 976
      NBD_cov Results
=====
Dep. Variable:      NumDealsPurchases      Log-Likelihood:      -4096.5
Model:              NBD_cov      AIC:      8201.
Method:             Maximum Likelihood      BIC:      8224.
Date:              Wed, 29 Dec 2021
Time:              15:47:40
No. Observations:      2216
Df Residuals:      2212
Df Model:      3
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome      0.8427      0.063      13.285      0.000      0.718      0.967
NumWebVisitsMonth -0.0286      0.115      0.249      0.803      -0.196      0.254
NumWebPurchases  0.3070      0.038      8.049      0.000      0.232      0.382
TotalAccept     -0.0043      0.009      -0.483      0.629      -0.022      0.013
par0            0.0107      0.008      1.385      0.166      -0.004      0.026
par1          -0.1714      0.025      -6.723      0.000      -0.221      -0.121
=====
-4096.493911611908
16
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumCatalogPurchases', 'Num
StorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
LargerWeb
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'LargerWeb']
Optimization terminated successfully.
      Current function value: 1.863680
      Iterations: 650
      Function evaluations: 1021
      NBD_cov Results
=====
Dep. Variable:      NumDealsPurchases      Log-Likelihood:      -4129.9
Model:              NBD_cov      AIC:      8268.
Method:             Maximum Likelihood      BIC:      8291.
Date:              Wed, 29 Dec 2021
Time:              15:47:41
No. Observations:      2216
Df Residuals:      2212
Df Model:      3
=====
              coef      std err          z      P>|z|      [0.025      0.975]
-----
Teenhome      0.7749      0.063      12.356      0.000      0.652      0.898
NumWebVisitsMonth -0.0464      0.118      -0.394      0.694      -0.277      0.184
NumWebPurchases  0.3552      0.038      9.249      0.000      0.280      0.431
LargerWeb     -0.0118      0.009      -1.247      0.212      -0.030      0.007
par0          -0.0051      0.009      -0.562      0.574      -0.023      0.013
par1           0.0436      0.062      0.704      0.482      -0.078      0.165
=====
-4129.914275620944
[-4039.4994252997167, -3897.79414546681, -3818.40668072864, -3751.15225993872, -3751.1521791293712, -3740.8309260020897, -3728.532
2319185216, -3692.4326596513383, -3689.5620957993756]
here
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds']
MntGoldProds
pre ['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'MntGoldProds', 'NumCatalogPurchases',
'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases',
'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
4
0
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases',
'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
Kidhome
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'Kidhome']
Optimization terminated successfully.
      Current function value: 1.975786
      Iterations: 813
      Function evaluations: 1241
      NBD_cov Results
```

```
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4378.3
Model:           NBD_cov              AIC:              8767.
Method:          Maximum Likelihood    BIC:              8795.
Date:            Wed, 29 Dec 2021
Time:            15:47:43
No. Observations: 2216
Df Residuals:    2211
Df Model:        4
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome      0.2332     0.059      3.982     0.000      0.118     0.348
NumWebVisitsMonth -0.2409     0.121     -1.994     0.046     -0.478    -0.004
NumWebPurchases -0.0721     0.050     -1.441     0.150     -0.170     0.026
MntGoldProds   0.0960     0.012      8.197     0.000      0.073     0.119
Kidhome        0.0206     0.010      1.968     0.049     8.92e-05     0.041
par0           -0.0006     0.001     -1.065     0.287     -0.002     0.000
par1           -0.3061     0.058     -5.256     0.000     -0.420    -0.192
=====
-4378.34197709906
1
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases',
 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
Recency
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'Recency']
Optimization terminated successfully.
      Current function value: 1.664965
      Iterations: 1527
      Function evaluations: 2296
      NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3689.6
Model:           NBD_cov              AIC:              7389.
Method:          Maximum Likelihood    BIC:              7418.
Date:            Wed, 29 Dec 2021
Time:            15:47:45
No. Observations: 2216
Df Residuals:    2211
Df Model:        4
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome      3.6456     0.372      9.806     0.000      2.917     4.374
NumWebVisitsMonth 3.9840     0.374     10.667     0.000      3.252     4.716
NumWebPurchases 0.4795     0.027     18.015     0.000      0.427     0.532
MntGoldProds   0.1149     0.006     19.043     0.000      0.103     0.127
Recency        0.0491     0.005      9.092     0.000      0.038     0.060
par0           0.0007     0.000      2.415     0.016      0.000     0.001
par1          -1.648e-05  0.001     -0.033     0.974     -0.001     0.001
=====
-3689.561565908777
2
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases',
 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
MntWines
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'MntWines']
Optimization terminated successfully.
      Current function value: 1.907506
      Iterations: 678
      Function evaluations: 1043
      NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4227.0
Model:           NBD_cov              AIC:              8464.
Method:          Maximum Likelihood    BIC:              8493.
Date:            Wed, 29 Dec 2021
Time:            15:47:46
No. Observations: 2216
Df Residuals:    2211
Df Model:        4
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome      0.3633     0.053      6.820     0.000      0.259     0.468
NumWebVisitsMonth -0.2590     0.111     -2.337     0.019     -0.476    -0.042
NumWebPurchases 0.5750     0.044     12.942     0.000      0.488     0.662
MntGoldProds   0.0017     0.010      0.162     0.871     -0.019     0.022
MntWines       0.0286     0.011      2.617     0.009      0.007     0.050
par0           -0.0004     0.001     -0.855     0.392     -0.001     0.001
par1          -0.0005     9.04e-05  -5.027     0.000     -0.001    -0.000
=====
-4227.0339415633935
3
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases',
 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
MntFruits
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'MntFruits']
Optimization terminated successfully.
      Current function value: 1.865977
      Iterations: 1001
```



```
Function evaluations: 1498
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4135.0
Model:            NBD_cov              AIC:              8280.
Method:          Maximum Likelihood    BIC:              8309.
Date:            Wed, 29 Dec 2021
Time:            15:47:48
No. Observations: 2216
Df Residuals:    2211
Df Model:        4
=====
               coef    std err          z      P>|z|      [0.025    0.975]
-----+-----
Teenhome        0.5784     0.056    10.370     0.000     0.469     0.688
NumWebVisitsMonth 0.0239     0.108     0.221     0.825    -0.188     0.236
NumWebPurchases  0.6282     0.043    14.759     0.000     0.545     0.712
MntGoldProds     -0.0102     0.010    -1.006     0.314    -0.030     0.010
MntFruits        0.0418     0.009     4.515     0.000     0.024     0.060
par0             -0.0005     0.000    -1.058     0.290    -0.001     0.000
par1             -0.0042     0.001    -6.059     0.000    -0.006    -0.003
=====
-4135.006043405282
4
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases',
'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
MntFishProducts
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'MntFishProducts']
Optimization terminated successfully.
Current function value: 1.896934
Iterations: 919
Function evaluations: 1383
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4203.6
Model:            NBD_cov              AIC:              8417.
Method:          Maximum Likelihood    BIC:              8446.
Date:            Wed, 29 Dec 2021
Time:            15:47:49
No. Observations: 2216
Df Residuals:    2211
Df Model:        4
=====
               coef    std err          z      P>|z|      [0.025    0.975]
-----+-----
Teenhome        0.5461     0.058     9.362     0.000     0.432     0.660
NumWebVisitsMonth -0.4210     0.123    -3.413     0.001    -0.663    -0.179
NumWebPurchases  0.2328     0.043     5.445     0.000     0.149     0.317
MntGoldProds     -0.0214     0.010    -2.042     0.041    -0.042    -0.001
MntFishProducts  0.0217     0.009     2.351     0.019     0.004     0.040
par0             6.495e-05     0.000     0.131     0.896    -0.001     0.001
par1            -0.0041     0.001    -7.814     0.000    -0.005    -0.003
=====
-4203.605999607237
5
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases',
'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
MntSweetProducts
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'MntSweetProducts']
Optimization terminated successfully.
Current function value: 1.914102
Iterations: 781
Function evaluations: 1163
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4241.6
Model:            NBD_cov              AIC:              8493.
Method:          Maximum Likelihood    BIC:              8522.
Date:            Wed, 29 Dec 2021
Time:            15:47:51
No. Observations: 2216
Df Residuals:    2211
Df Model:        4
=====
               coef    std err          z      P>|z|      [0.025    0.975]
-----+-----
Teenhome        0.3554     0.053     6.651     0.000     0.251     0.460
NumWebVisitsMonth -0.3859     0.115    -3.355     0.001    -0.611    -0.160
NumWebPurchases  0.4556     0.045    10.224     0.000     0.368     0.543
MntGoldProds     -0.0169     0.011    -1.567     0.117    -0.038     0.004
MntSweetProducts  0.0361     0.010     3.642     0.000     0.017     0.056
par0             -0.0006     0.001    -1.125     0.261    -0.002     0.000
par1            -0.0045     0.001    -6.389     0.000    -0.006    -0.003
=====
-4241.649720700279
6
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases',
'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
NumCatalogPurchases
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'NumCatalogPurchases']
Optimization terminated successfully.
```

```
Current function value: 1.861761
Iterations: 1162
Function evaluations: 1736
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4125.7
Model:           NBD_cov              AIC:               8261.
Method:          Maximum Likelihood    BIC:               8290.
Date:            Wed, 29 Dec 2021
Time:            15:47:52
No. Observations: 2216
Df Residuals:    2211
Df Model:        4
=====
               coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome         1.0084      0.074     13.632    0.000      0.863      1.153
NumWebVisitsMonth 0.2640      0.133      1.978    0.048      0.002      0.526
NumWebPurchases  -0.0633      0.041     -1.554    0.120     -0.143      0.017
MntGoldProds      0.0351      0.010      3.665    0.000      0.016      0.054
NumCatalogPurchases 0.0205      0.008      2.537    0.011      0.005      0.036
par0              9.369e-05      0.000      0.220    0.826     -0.001      0.001
par1             -0.0314      0.008     -3.776    0.000     -0.048     -0.015
=====
-4125.661904829538
7
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases',
 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
NumStorePurchases
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'NumStorePurchases']
Optimization terminated successfully.
Current function value: 1.889732
Iterations: 738
Function evaluations: 1112
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4187.6
Model:           NBD_cov              AIC:               8385.
Method:          Maximum Likelihood    BIC:               8414.
Date:            Wed, 29 Dec 2021
Time:            15:47:54
No. Observations: 2216
Df Residuals:    2211
Df Model:        4
=====
               coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome         0.5104      0.057      9.030    0.000      0.400      0.621
NumWebVisitsMonth -0.2785      0.130     -2.134    0.033     -0.534     -0.023
NumWebPurchases   0.6356      0.043     14.765    0.000      0.551      0.720
MntGoldProds     -0.0075      0.011     -0.678    0.498     -0.029      0.014
NumStorePurchases 0.0398      0.010      3.796    0.000      0.019      0.060
par0              1.317e-05      0.000      0.027    0.979     -0.001      0.001
par1             -0.0638      0.010     -6.521    0.000     -0.083     -0.045
=====
-4187.646107442658
8
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases',
 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
Response
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'Response']
Optimization terminated successfully.
Current function value: 1.806469
Iterations: 1088
Function evaluations: 1658
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4003.1
Model:           NBD_cov              AIC:               8016.
Method:          Maximum Likelihood    BIC:               8045.
Date:            Wed, 29 Dec 2021
Time:            15:47:55
No. Observations: 2216
Df Residuals:    2211
Df Model:        4
=====
               coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome         1.0808      0.070     15.363    0.000      0.943      1.219
NumWebVisitsMonth 1.2892      0.096     13.408    0.000      1.101      1.478
NumWebPurchases   0.4472      0.037     12.232    0.000      0.376      0.519
MntGoldProds      0.0763      0.008      9.274    0.000      0.060      0.092
Response          0.0665      0.008      8.452    0.000      0.051      0.082
par0             -0.0009      0.000     -2.170    0.030     -0.002     -8.99e-05
par1              0.8149      0.064     12.663    0.000      0.689      0.941
=====
-4003.1344128863466
9
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases',
 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
log_Income
```

```
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'log_Income']
Optimization terminated successfully.
Current function value: 1.703206
Iterations: 1023
Function evaluations: 1554
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3774.3
Model:           NBD_cov              AIC:              7559.
Method:         Maximum Likelihood    BIC:              7587.
Date:           Wed, 29 Dec 2021
Time:           15:47:57
No. Observations: 2216
Df Residuals:    2211
Df Model:        4
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome      2.3605     0.120     19.743     0.000      2.126     2.595
NumWebVisitsMonth 7.3163     0.565     12.954     0.000      6.209     8.423
NumWebPurchases 0.3944     0.030     13.189     0.000      0.336     0.453
MntGoldProds   0.1686     0.009     18.446     0.000      0.151     0.186
log_Income     0.0270     0.007      3.850     0.000      0.013     0.041
par0           0.0006     0.000      1.648     0.099     -0.000     0.001
par1           0.4148     0.052      7.994     0.000      0.313     0.517
=====
-3774.305166720226
10
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases',
'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
E_Basic
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'E_Basic']
Optimization terminated successfully.
Current function value: 1.920013
Iterations: 507
Function evaluations: 781
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4254.7
Model:           NBD_cov              AIC:              8519.
Method:         Maximum Likelihood    BIC:              8548.
Date:           Wed, 29 Dec 2021
Time:           15:47:58
No. Observations: 2216
Df Residuals:    2211
Df Model:        4
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome      0.3676     0.055      6.710     0.000      0.260     0.475
NumWebVisitsMonth -0.3803     0.116     -3.282     0.001     -0.607    -0.153
NumWebPurchases 0.4132     0.044      9.376     0.000      0.327     0.500
MntGoldProds   0.0053     0.010      0.516     0.606     -0.015     0.025
E_Basic        -0.0060     0.010     -0.628     0.530     -0.025     0.013
par0           -0.0010     0.001     -2.067     0.039     -0.002    -5.34e-05
par1           -0.0219     0.159     -0.138     0.890     -0.333     0.290
=====
-4254.748405427381
11
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases',
'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
E_Graduation
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'E_Graduation']
Optimization terminated successfully.
Current function value: 1.758770
Iterations: 846
Function evaluations: 1268
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3897.4
Model:           NBD_cov              AIC:              7805.
Method:         Maximum Likelihood    BIC:              7833.
Date:           Wed, 29 Dec 2021
Time:           15:47:59
No. Observations: 2216
Df Residuals:    2211
Df Model:        4
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome      1.2036     0.065     18.652     0.000      1.077     1.330
NumWebVisitsMonth 1.9611     0.086     22.772     0.000      1.792     2.130
NumWebPurchases 0.7509     0.037     20.450     0.000      0.679     0.823
MntGoldProds   0.1353     0.008     16.169     0.000      0.119     0.152
E_Graduation    0.0822     0.008     10.592     0.000      0.067     0.097
par0           0.0007     0.000      1.656     0.098     -0.000     0.002
par1          -0.0759     0.038     -1.975     0.048     -0.151    -0.001
=====
-3897.433330709343
12
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases',
```

```
'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
E_Master
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'E_Master']
Optimization terminated successfully.
Current function value: 1.897724
Iterations: 793
Function evaluations: 1200
```

NBD_cov Results

```
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4205.4
Model:           NBD_cov              AIC:              8421.
Method:          Maximum Likelihood    BIC:              8449.
Date:            Wed, 29 Dec 2021
Time:            15:48:01
No. Observations: 2216
Df Residuals:    2211
Df Model:        4
=====
```

	coef	std err	z	P> z	[0.025	0.975]
Teenhome	0.3883	0.053	7.317	0.000	0.284	0.492
NumWebVisitsMonth	0.1050	0.103	1.020	0.308	-0.097	0.307
NumWebPurchases	0.7066	0.045	15.631	0.000	0.618	0.795
MntGoldProds	0.0521	0.010	5.280	0.000	0.033	0.071
E_Master	-0.0024	0.010	-0.245	0.807	-0.021	0.017
par0	-0.0001	0.001	-0.284	0.777	-0.001	0.001
par1	-0.4033	0.062	-6.522	0.000	-0.524	-0.282

```
=====
-4205.355474604301
```

```
13
```

```
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases',
'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
E_PhD
```

```
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'E_PhD']
```

```
Optimization terminated successfully.
Current function value: 1.894806
Iterations: 726
Function evaluations: 1104
```

NBD_cov Results

```
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4198.9
Model:           NBD_cov              AIC:              8408.
Method:          Maximum Likelihood    BIC:              8436.
Date:            Wed, 29 Dec 2021
Time:            15:48:02
No. Observations: 2216
Df Residuals:    2211
Df Model:        4
=====
```

	coef	std err	z	P> z	[0.025	0.975]
Teenhome	0.7530	0.068	11.107	0.000	0.620	0.886
NumWebVisitsMonth	-0.0488	0.125	-0.389	0.697	-0.294	0.197
NumWebPurchases	-0.0558	0.043	-1.288	0.198	-0.141	0.029
MntGoldProds	0.0089	0.009	0.963	0.336	-0.009	0.027
E_PhD	0.0329	0.008	3.940	0.000	0.017	0.049
par0	-0.0011	0.000	-2.498	0.012	-0.002	-0.000
par1	0.0747	0.050	1.489	0.137	-0.024	0.173

```
=====
-4198.890717184943
```

```
14
```

```
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases',
'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
```

```
TotalAccept
```

```
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'TotalAccept']
```

```
Optimization terminated successfully.
Current function value: 1.763009
Iterations: 1138
Function evaluations: 1712
```

NBD_cov Results

```
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3906.8
Model:           NBD_cov              AIC:              7824.
Method:          Maximum Likelihood    BIC:              7852.
Date:            Wed, 29 Dec 2021
Time:            15:48:04
No. Observations: 2216
Df Residuals:    2211
Df Model:        4
=====
```

	coef	std err	z	P> z	[0.025	0.975]
Teenhome	1.2526	0.068	18.363	0.000	1.119	1.386
NumWebVisitsMonth	1.0364	0.101	10.248	0.000	0.838	1.235
NumWebPurchases	0.7113	0.036	19.673	0.000	0.640	0.782
MntGoldProds	0.0411	0.008	5.137	0.000	0.025	0.057
TotalAccept	0.0153	0.008	2.023	0.043	0.000	0.030
par0	-7.85e-05	0.000	-0.193	0.847	-0.001	0.001
par1	-0.0766	0.024	-3.248	0.001	-0.123	-0.030

```
=====
-3906.8281260054946
```

```
15
['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases',
'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
LargerWeb
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'LargerWeb']
Optimization terminated successfully.
    Current function value: 1.847522
    Iterations: 617
    Function evaluations: 944
    NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4094.1
Model:            NBD_cov    AIC:    8198.
Method:          Maximum Likelihood    BIC:    8227.
Date:            Wed, 29 Dec 2021
Time:            15:48:05
No. Observations:    2216
Df Residuals:    2211
Df Model:    4
=====
               coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome             0.6910      0.058      11.915      0.000       0.577      0.805
NumWebVisitsMonth    0.4415      0.104       4.263      0.000       0.239      0.644
NumWebPurchases      0.6942      0.041      16.790      0.000       0.613      0.775
MntGoldProds         0.0730      0.009       7.701      0.000       0.054      0.092
LargerWeb            -0.0796      0.011      -7.240      0.000      -0.101     -0.058
par0                  0.0014      0.000       3.054      0.002       0.001      0.002
par1                  0.5375      0.068       7.899      0.000       0.404      0.671
=====
-4094.1084491289266
[-4039.4994252997167, -3897.79414546681, -3818.40668072864, -3751.15225993872, -3751.1521791293712, -3740.8309260020897, -3728.532
2319185216, -3692.4326596513383, -3689.5620957993756, -3689.561565908777]
here
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'Recency']
Recency
pre ['Kidhome', 'Recency', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchas
es', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
['Kidhome', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases', 'Respons
e', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
5
0
['Kidhome', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases', 'Respons
e', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
Kidhome
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'Recency', 'Kidhome']
Optimization terminated successfully.
    Current function value: 1.941895
    Iterations: 1042
    Function evaluations: 1539
    NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4303.2
Model:            NBD_cov    AIC:    8618.
Method:          Maximum Likelihood    BIC:    8653.
Date:            Wed, 29 Dec 2021
Time:            15:48:06
No. Observations:    2216
Df Residuals:    2210
Df Model:    5
=====
               coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome             0.5263      0.068       7.707      0.000       0.392      0.660
NumWebVisitsMonth   -0.1998      0.140      -1.422      0.155      -0.475      0.076
NumWebPurchases     -0.2811      0.052      -5.407      0.000      -0.383     -0.179
MntGoldProds         0.0188      0.010       1.859      0.063      -0.001      0.039
Recency              0.0681      0.009       7.299      0.000       0.050      0.086
Kidhome             -0.0006      0.000      -1.287      0.198      -0.002      0.000
par0                -0.0023      0.001      -2.969      0.003      -0.004     -0.001
par1                 0.1294      0.048       2.710      0.007       0.036      0.223
=====
-4303.2399876041445
1
['Kidhome', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases', 'Respons
e', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
MntWines
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'Recency', 'MntWines']
Optimization terminated successfully.
    Current function value: 1.882980
    Iterations: 1620
    Function evaluations: 2353
    NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4172.7
Model:            NBD_cov    AIC:    8357.
Method:          Maximum Likelihood    BIC:    8392.
Date:            Wed, 29 Dec 2021
Time:            15:48:09
No. Observations:    2216
Df Residuals:    2210
```

```

Df Model:          5
=====
              coef    std err          z      P>|z|      [0.025      0.975]
-----
Teenhome          0.5273      0.055      9.523      0.000      0.419      0.636
NumWebVisitsMonth 1.6796      0.092     18.298      0.000      1.500      1.859
NumWebPurchases   0.1826      0.043      4.230      0.000      0.098      0.267
MntGoldProds       0.2222      0.011     19.419      0.000      0.200      0.245
Recency            0.0878      0.011      7.980      0.000      0.066      0.109
MntWines           0.0017      0.001      3.244      0.001      0.001      0.003
par0               0.0028      0.001      3.560      0.000      0.001      0.004
par1              3.05e-06    9.02e-05    0.034      0.973     -0.000      0.000
=====
-4172.683115037947
2
['Kidhome', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
MntFruits
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'Recency', 'MntFruits']
Optimization terminated successfully.
    Current function value: 1.900162
    Iterations: 1327
    Function evaluations: 1928
    NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4210.8
Model:           NBD_cov              AIC:              8434.
Method:          Maximum Likelihood    BIC:              8468.
Date:            Wed, 29 Dec 2021
Time:            15:48:11
No. Observations: 2216
Df Residuals:    2210
Df Model:        5
=====
              coef    std err          z      P>|z|      [0.025      0.975]
-----
Teenhome          0.5492      0.059      9.319      0.000      0.434      0.665
NumWebVisitsMonth -0.5937      0.135     -4.407      0.000     -0.858     -0.330
NumWebPurchases   0.2963      0.042      7.044      0.000      0.214      0.379
MntGoldProds      -0.0250      0.010     -2.384      0.017     -0.045     -0.004
Recency            0.0242      0.009      2.625      0.009      0.006      0.042
MntFruits          0.0001      0.000      0.287      0.774     -0.001      0.001
par0              -0.0049      0.001     -6.255      0.000     -0.006     -0.003
par1              -0.0052      0.001     -7.421      0.000     -0.007     -0.004
=====
-4210.758254724968
3
['Kidhome', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
MntFishProducts
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'Recency', 'MntFishProducts']
Optimization terminated successfully.
    Current function value: 1.839516
    Iterations: 1422
    Function evaluations: 2071
    NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4076.4
Model:           NBD_cov              AIC:              8165.
Method:          Maximum Likelihood    BIC:              8199.
Date:            Wed, 29 Dec 2021
Time:            15:48:13
No. Observations: 2216
Df Residuals:    2210
Df Model:        5
=====
              coef    std err          z      P>|z|      [0.025      0.975]
-----
Teenhome          0.6578      0.056     11.812      0.000      0.549      0.767
NumWebVisitsMonth 1.2348      0.096     12.823      0.000      1.046      1.424
NumWebPurchases   0.7971      0.043     18.385      0.000      0.712      0.882
MntGoldProds       0.0787      0.010      8.039      0.000      0.059      0.098
Recency            0.1101      0.010     11.373      0.000      0.091      0.129
MntFishProducts   -0.0004      0.001     -0.872      0.383     -0.001      0.001
par0               0.0013      0.001      1.702      0.089     -0.000      0.003
par1              -0.0008      0.001     -1.495      0.135     -0.002      0.000
=====
-4076.368438199995
4
['Kidhome', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
MntSweetProducts
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'Recency', 'MntSweetProducts']
Optimization terminated successfully.
    Current function value: 1.899472
    Iterations: 740
    Function evaluations: 1100
    NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4209.2
Model:           NBD_cov              AIC:              8430.

```

```
Method:           Maximum Likelihood   BIC:           8465.
Date:             Wed, 29 Dec 2021
Time:             15:48:14
No. Observations: 2216
Df Residuals:     2210
Df Model:         5
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----+-----
Teenhome         0.3633      0.052      6.925    0.000      0.260      0.466
NumWebVisitsMonth 0.0060      0.113      0.053    0.958     -0.215      0.227
NumWebPurchases   0.7975      0.047     17.023    0.000      0.706      0.889
MntGoldProds      0.0277      0.010      2.646    0.008      0.007      0.048
Recency           0.0187      0.010      1.864    0.062     -0.001      0.038
MntSweetProducts  0.0002      0.001      0.474    0.636     -0.001      0.001
par0              -0.0027      0.001     -3.282    0.001     -0.004     -0.001
par1              -0.0021      0.001     -2.961    0.003     -0.003     -0.001
=====
-4209.229269043124
5
['Kidhome', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
NumCatalogPurchases
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'Recency', 'NumCatalogPurchases']
Optimization terminated successfully.
    Current function value: 1.797936
    Iterations: 1377
    Function evaluations: 2004
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3984.2
Model:           NBD_cov              AIC:              7980.
Method:          Maximum Likelihood    BIC:              8015.
Date:            Wed, 29 Dec 2021
Time:            15:48:17
No. Observations: 2216
Df Residuals:    2210
Df Model:        5
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----+-----
Teenhome         1.3825      0.079     17.502    0.000      1.228      1.537
NumWebVisitsMonth 0.6635      0.133      5.005    0.000      0.404      0.923
NumWebPurchases   0.1277      0.035      3.682    0.000      0.060      0.196
MntGoldProds      0.0290      0.009      3.244    0.001      0.011      0.046
Recency           0.0599      0.008      7.954    0.000      0.045      0.075
NumCatalogPurchases -0.0005      0.000     -1.297    0.195     -0.001      0.000
par0              -0.0037      0.001     -5.983    0.000     -0.005     -0.002
par1              -0.0378      0.008     -4.570    0.000     -0.054     -0.022
=====
-3984.226950203594
6
['Kidhome', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
NumStorePurchases
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'Recency', 'NumStorePurchases']
Optimization terminated successfully.
    Current function value: 1.803432
    Iterations: 1499
    Function evaluations: 2172
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3996.4
Model:           NBD_cov              AIC:              8005.
Method:          Maximum Likelihood    BIC:              8039.
Date:            Wed, 29 Dec 2021
Time:            15:48:20
No. Observations: 2216
Df Residuals:    2210
Df Model:        5
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----+-----
Teenhome         1.0880      0.067     16.174    0.000      0.956      1.220
NumWebVisitsMonth 0.3045      0.133      2.282    0.023      0.043      0.566
NumWebPurchases   0.5909      0.036     16.315    0.000      0.520      0.662
MntGoldProds      0.0145      0.009      1.540    0.124     -0.004      0.033
Recency           0.0381      0.009      4.322    0.000      0.021      0.055
NumStorePurchases 0.0001      0.000      0.329    0.742     -0.001      0.001
par0              -0.0040      0.001     -5.931    0.000     -0.005     -0.003
par1              -0.0484      0.008     -5.784    0.000     -0.065     -0.032
=====
-3996.4048347318603
7
['Kidhome', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
Response
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'Recency', 'Response']
Optimization terminated successfully.
    Current function value: 1.813284
    Iterations: 914
```

```
Function evaluations: 1343
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4018.2
Model:            NBD_cov              AIC:              8048.
Method:          Maximum Likelihood    BIC:              8083.
Date:            Wed, 29 Dec 2021
Time:            15:48:21
No. Observations: 2216
Df Residuals:    2210
Df Model:        5
=====
               coef    std err          z      P>|z|      [0.025    0.975]
-----+-----
Teenhome        1.1749     0.072    16.294     0.000     1.034     1.316
NumWebVisitsMonth 0.2969     0.127     2.335     0.020     0.048     0.546
NumWebPurchases  0.3378     0.035     9.656     0.000     0.269     0.406
MntGoldProds     0.0265     0.008     3.270     0.001     0.011     0.042
Recency         -0.0053     0.008    -0.687     0.492    -0.020     0.010
Response        -9.651e-05     0.000    -0.238     0.811    -0.001     0.001
par0            -0.0052     0.001    -7.751     0.000    -0.007    -0.004
par1            -0.1172     0.054    -2.165     0.030    -0.223    -0.011
=====
-4018.237401878131
8
['Kidhome', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
log_Income
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'Recency', 'log_Income']
Optimization terminated successfully.
Current function value: 1.997602
Iterations: 920
Function evaluations: 1376
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4426.7
Model:            NBD_cov              AIC:              8865.
Method:          Maximum Likelihood    BIC:              8900.
Date:            Wed, 29 Dec 2021
Time:            15:48:23
No. Observations: 2216
Df Residuals:    2210
Df Model:        5
=====
               coef    std err          z      P>|z|      [0.025    0.975]
-----+-----
Teenhome        0.2023     0.058     3.463     0.001     0.088     0.317
NumWebVisitsMonth -0.1970     0.757    -0.260     0.795    -1.681     1.287
NumWebPurchases -0.3143     0.057    -5.554     0.000    -0.425    -0.203
MntGoldProds     0.0869     0.013     6.576     0.000     0.061     0.113
Recency          0.0205     0.011     1.817     0.069    -0.002     0.043
log_Income       0.0011     0.001     2.008     0.045    2.57e-05     0.002
par0            -0.0002     0.001    -0.252     0.801    -0.002     0.001
par1             0.0022     0.069     0.032     0.975    -0.133     0.138
=====
-4426.686116257833
9
['Kidhome', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
E_Basic
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'Recency', 'E_Basic']
Optimization terminated successfully.
Current function value: 1.785636
Iterations: 1244
Function evaluations: 1814
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3957.0
Model:            NBD_cov              AIC:              7926.
Method:          Maximum Likelihood    BIC:              7960.
Date:            Wed, 29 Dec 2021
Time:            15:48:25
No. Observations: 2216
Df Residuals:    2210
Df Model:        5
=====
               coef    std err          z      P>|z|      [0.025    0.975]
-----+-----
Teenhome        1.5312     0.075    20.411     0.000     1.384     1.678
NumWebVisitsMonth 1.4399     0.106    13.593     0.000     1.232     1.648
NumWebPurchases  0.3192     0.033     9.792     0.000     0.255     0.383
MntGoldProds     0.0909     0.007    12.226     0.000     0.076     0.105
Recency          0.0363     0.007     5.236     0.000     0.023     0.050
E_Basic          0.0002     0.000     0.617     0.537    -0.001     0.001
par0            -0.0013     0.001    -2.116     0.034    -0.002    -9.37e-05
par1            -2.7223     0.317    -8.601     0.000    -3.343    -2.102
=====
-3956.9691124669275
10
['Kidhome', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
```



```
E_Graduation
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'Recency', 'E_Graduation']
Optimization terminated successfully.
```

```
Current function value: 1.826422
```

```
Iterations: 1398
```

```
Function evaluations: 2046
```

```
NBD_cov Results
```

```
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4047.4
Model:           NBD_cov              AIC:              8107.
Method:          Maximum Likelihood    BIC:              8141.
Date:            Wed, 29 Dec 2021
Time:            15:48:27
No. Observations: 2216
Df Residuals:    2210
Df Model:        5
=====
```

	coef	std err	z	P> z	[0.025	0.975]
Teenhome	0.9280	0.064	14.518	0.000	0.803	1.053
NumWebVisitsMonth	0.1393	0.122	1.138	0.255	-0.100	0.379
NumWebPurchases	0.4915	0.037	13.249	0.000	0.419	0.564
MntGoldProds	0.0385	0.009	4.506	0.000	0.022	0.055
Recency	-0.0013	0.008	-0.160	0.873	-0.017	0.015
E_Graduation	0.0001	0.000	0.340	0.734	-0.001	0.001
par0	-0.0047	0.001	-6.661	0.000	-0.006	-0.003
par1	-0.2953	0.041	-7.263	0.000	-0.375	-0.216

```
-4047.3511902050313
```

```
11
```

```
['Kidhome', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
```

```
E_Master
```

```
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'Recency', 'E_Master']
```

```
Optimization terminated successfully.
```

```
Current function value: 1.718897
```

```
Iterations: 1833
```

```
Function evaluations: 2673
```

```
NBD_cov Results
```

```
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -3809.1
Model:           NBD_cov              AIC:              7630.
Method:          Maximum Likelihood    BIC:              7664.
Date:            Wed, 29 Dec 2021
Time:            15:48:30
No. Observations: 2216
Df Residuals:    2210
Df Model:        5
=====
```

	coef	std err	z	P> z	[0.025	0.975]
Teenhome	2.1686	0.113	19.109	0.000	1.946	2.391
NumWebVisitsMonth	2.0824	0.136	15.259	0.000	1.815	2.350
NumWebPurchases	0.4055	0.029	13.853	0.000	0.348	0.463
MntGoldProds	0.0712	0.007	10.454	0.000	0.058	0.085
Recency	0.0284	0.006	4.549	0.000	0.016	0.041
E_Master	0.0005	0.000	1.462	0.144	-0.000	0.001
par0	-0.0016	0.001	-2.868	0.004	-0.003	-0.000
par1	0.4575	0.041	11.146	0.000	0.377	0.538

```
-3809.076249978541
```

```
12
```

```
['Kidhome', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
```

```
E_PhD
```

```
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'Recency', 'E_PhD']
```

```
Optimization terminated successfully.
```

```
Current function value: 1.811584
```

```
Iterations: 1129
```

```
Function evaluations: 1672
```

```
NBD_cov Results
```

```
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4014.5
Model:           NBD_cov              AIC:              8041.
Method:          Maximum Likelihood    BIC:              8075.
Date:            Wed, 29 Dec 2021
Time:            15:48:32
No. Observations: 2216
Df Residuals:    2210
Df Model:        5
=====
```

	coef	std err	z	P> z	[0.025	0.975]
Teenhome	1.1913	0.073	16.413	0.000	1.049	1.334
NumWebVisitsMonth	0.3197	0.127	2.516	0.012	0.071	0.569
NumWebPurchases	0.3371	0.035	9.727	0.000	0.269	0.405
MntGoldProds	0.0236	0.008	2.900	0.004	0.008	0.040
Recency	0.0106	0.008	1.407	0.159	-0.004	0.025
E_PhD	-0.0008	0.000	-1.952	0.051	-0.002	3.27e-06
par0	-0.0046	0.001	-7.044	0.000	-0.006	-0.003
par1	-0.3162	0.046	-6.825	0.000	-0.407	-0.225

```
=====
-4014.4710193206934
13
['Kidhome', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
TotalAccept
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'Recency', 'TotalAccept']
Optimization terminated successfully.
Current function value: 1.889537
Iterations: 1131
Function evaluations: 1672
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4187.2
Model:            NBD_cov              AIC:              8386.
Method:          Maximum Likelihood    BIC:              8421.
Date:            Wed, 29 Dec 2021
Time:            15:48:33
No. Observations: 2216
Df Residuals:    2210
Df Model:        5
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome             0.5966     0.060      9.931     0.000     0.479     0.714
NumWebVisitsMonth   -0.4438     0.132     -3.363     0.001    -0.702    -0.185
NumWebPurchases      0.2321     0.041     5.599     0.000     0.151     0.313
MntGoldProds         0.0205     0.009     2.169     0.030     0.002     0.039
Recency              0.0055     0.009     0.610     0.542    -0.012     0.023
TotalAccept          8.425e-06     0.000     0.018     0.986    -0.001     0.001
par0                 -0.0061     0.001    -7.729     0.000    -0.008    -0.005
par1                 -0.2185     0.028    -7.852     0.000    -0.273    -0.164
=====
-4187.214922133788
14
['Kidhome', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
LargerWeb
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'Recency', 'LargerWeb']
Optimization terminated successfully.
Current function value: 1.906167
Iterations: 1091
Function evaluations: 1606
NBD_cov Results
=====
Dep. Variable:    NumDealsPurchases    Log-Likelihood:    -4224.1
Model:            NBD_cov              AIC:              8460.
Method:          Maximum Likelihood    BIC:              8494.
Date:            Wed, 29 Dec 2021
Time:            15:48:35
No. Observations: 2216
Df Residuals:    2210
Df Model:        5
=====
              coef    std err          z      P>|z|      [0.025    0.975]
-----
Teenhome             0.4147     0.055     7.586     0.000     0.308     0.522
NumWebVisitsMonth    0.1030     0.114     0.907     0.364    -0.120     0.326
NumWebPurchases      0.4154     0.043     9.612     0.000     0.331     0.500
MntGoldProds         0.0757     0.010     7.476     0.000     0.056     0.096
Recency              0.0711     0.011     6.438     0.000     0.049     0.093
LargerWeb           -0.0005     0.000    -1.042     0.297    -0.002     0.000
par0                 -0.0045     0.001    -5.584     0.000    -0.006    -0.003
par1                 -0.6646     0.073    -9.144     0.000    -0.807    -0.522
=====
-4224.066018311585
[-4039.4994252997167, -3897.79414546681, -3818.40668072864, -3751.15225993872, -3751.1521791293712, -3740.8309260020897, -3728.5322319185216, -3692.4326596513383, -3689.5620957993756, -3689.561565908777]
here
['Teenhome', 'NumWebVisitsMonth', 'NumWebPurchases', 'MntGoldProds', 'Recency', 'Recency']
Recency
pre ['Kidhome', 'MntWines', 'MntFruits', 'MntFishProducts', 'MntSweetProducts', 'NumCatalogPurchases', 'NumStorePurchases', 'Response', 'log_Income', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD', 'TotalAccept', 'LargerWeb']
```

```
In [ ]: add_var

Out[ ]: ['Teenhome',
        'NumWebVisitsMonth',
        'NumWebPurchases',
        'MntGoldProds',
        'Recency',
        'Recency']

In [ ]: NBD_cov(data['NumDealsPurchases'],data[add_var[:-1]]).fit(start_params=[0]*(len(add_var[:-1])+2),maxiter=25000).summary()

Optimization terminated successfully.
Current function value: 1.664965
Iterations: 1527
Function evaluations: 2296
Out[ ]: NBD_cov Results
```

Dep. Variable:	NumDealsPurchases	Log-Likelihood:	-3689.6
Model:	NBD_cov	AIC:	7389.
Method:	Maximum Likelihood	BIC:	7418.
Date:	Wed, 29 Dec 2021		
Time:	01:27:57		
No. Observations:	2216		
Df Residuals:	2211		
Df Model:	4		

	coef	std err	z	P> z	[0.025	0.975]
Teenhome	3.6456	0.372	9.806	0.000	2.917	4.374
NumWebVisitsMonth	3.9840	0.374	10.667	0.000	3.252	4.716
NumWebPurchases	0.4795	0.027	18.015	0.000	0.427	0.532
MntGoldProds	0.1149	0.006	19.043	0.000	0.103	0.127
Recency	0.0491	0.005	9.092	0.000	0.038	0.060
par0	0.0007	0.000	2.415	0.016	0.000	0.001
par1	-1.648e-05	0.001	-0.033	0.974	-0.001	0.001

```
In [ ]: important_var = ['Kidhome', 'Teenhome', 'MntFruits', 'MntGoldProds',
                    'NumWebPurchases', 'NumCatalogPurchases', 'NumStorePurchases',
                    'NumWebVisitsMonth', 'Response', 'log_Income', 'TotalAccept', 'C(LargerWeb)']
model = 'NumDealsPurchases' + '+' + '.join(important_var)
poisson_f = poisson(model, data).fit(maxiter=5000)
poisson_f.summary()
```

Optimization terminated successfully.
Current function value: 1.568988
Iterations 6

Out[]:

Poisson Regression Results

Dep. Variable:	NumDealsPurchases	No. Observations:	2216
Model:	Poisson	Df Residuals:	2203
Method:	MLE	Df Model:	12
Date:	Thu, 30 Dec 2021	Pseudo R-squ.:	0.1694
Time:	14:07:33	Log-Likelihood:	-3476.9
converged:	True	LL-Null:	-4186.2
Covariance Type:	nonrobust	LLR p-value:	1.392e-296

	coef	std err	z	P> z	[0.025	0.975]
Intercept	1.7880	0.440	4.067	0.000	0.926	2.650
C(LargerWeb)[T.1]	0.1502	0.048	3.152	0.002	0.057	0.244
Kidhome	0.4894	0.031	16.030	0.000	0.430	0.549
Teenhome	0.5203	0.027	19.117	0.000	0.467	0.574
MntFruits	-0.0021	0.000	-4.175	0.000	-0.003	-0.001
MntGoldProds	0.0007	0.000	2.387	0.017	0.000	0.001
NumWebPurchases	0.0342	0.008	4.439	0.000	0.019	0.049
NumCatalogPurchases	0.0706	0.006	11.455	0.000	0.058	0.083
NumStorePurchases	0.0731	0.007	10.158	0.000	0.059	0.087
NumWebVisitsMonth	0.0959	0.008	12.175	0.000	0.080	0.111
Response	0.3013	0.058	5.226	0.000	0.188	0.414
log_Income	-0.2598	0.041	-6.315	0.000	-0.340	-0.179
TotalAccept	-0.1789	0.028	-6.427	0.000	-0.233	-0.124

Part one conclusion

```
In [ ]: def profit(price=1, cost=0):
        return np.sum(poisson_f.predict() * model_cmp_all_insig.predict()*price) - cost

profit(price=data.Z_Revenue[0], cost=data.Z_CostContact[0], profit())
```

Out[]: (7868.239346604292, 715.567213327663)

Customers and Campaign

```
In [ ]: data.iloc[:,9:15].describe()
```

	MntWines	MntFruits	MntMeatProducts	MntFishProducts	MntSweetProducts	MntGoldProds
count	2216.000000	2216.000000	2216.000000	2216.000000	2216.000000	2216.000000
mean	305.091606	26.356047	166.995939	37.637635	27.028881	43.965253
std	337.327920	39.793917	224.283273	54.752082	41.072046	51.815414
min	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
25%	24.000000	2.000000	16.000000	3.000000	1.000000	9.000000
50%	174.500000	8.000000	68.000000	12.000000	8.000000	24.500000
75%	505.000000	33.000000	232.250000	50.000000	33.000000	56.000000
max	1493.000000	199.000000	1725.000000	259.000000	262.000000	321.000000

```
In [ ]: SSmodel=StandardScaler()
SSmodel.fit(data.iloc[:,9:15])
fav_product=SSmodel.transform(data.iloc[:,9:15])
fav_product2=fav_product.copy()
for i in range(len(fav_product)):
    for j in range(len(fav_product[i])):
        if fav_product[i][j]==max(fav_product[i]):
            fav_product2[i][j]=1
        else:
            fav_product2[i][j]=0
fav_product2
```

Out []:	array([[0., 0., 0., 1., 0., 0.],
	[0., 0., 0., 0., 1., 0.],
	[0., 0., 0., 1., 0., 0.],
	...,
	[1., 0., 0., 0., 0., 0.],
	[0., 0., 0., 1., 0., 0.],
	[0., 0., 0., 0., 0., 1.]])

```
In [ ]: xnames=['MntFruits0','MntFruits1','MntFruits2','MntFruits3',
'MntMeatProducts0', 'MntMeatProducts1', 'MntMeatProducts2', 'MntMeatProducts3',
'MntFishProducts0', 'MntFishProducts1', 'MntFishProducts2', 'MntFishProducts3',
'MntSweetProducts0','MntSweetProducts1', 'MntSweetProducts2', 'MntSweetProducts3',
'Mntgold0','Mntgold1','Mntgold2','Mntgold3']

class M_logit(GenericLikelihoodModel):
    def loglike(self, params):
        y=self.endog
        x=self.exog
        Utility=np.empty((len(y),6))
        for i in range(5):
            Utility[:,i+1]=params[4*i+0]+x[:,0]*params[4*i+1]+x[:,1]*params[4*i+2]+x[:,2]*params[4*i+3]
            Utility[:,0]=0

        #computing the probability of choosing each option for the consumers
        Exp_total=np.sum(np.exp(Utility),axis=1)
        Exp_total=np.expand_dims(Exp_total,axis=1)
        P=np.exp(Utility)/Exp_total
        ind_L= np.sum(y*P,axis=1)
        loglikelihood=np.log(ind_L)
        return np.sum(loglikelihood)

Multi_choice_a=M_logit(fav_product2, data[['DealsPercentage', 'TotalAccept','LargerWeb']]).fit(start_params=[0]*20,maxiter=5000,m
print(Multi_choice_a.summary(xname=xnames))
```

Optimization terminated successfully.
Current function value: 1.649212
Iterations 21

M_logit Results						
Dep. Variable:	['y1', 'y2', 'y3', 'y4', 'y5', 'y6']				Log-Likelihood:	-3654.7
Model:	M_logit				AIC:	7315.
Method:	Maximum Likelihood				BIC:	7332.
Date:	Tue, 28 Dec 2021					
Time:	03:59:06					
No. Observations:	2216					
Df Residuals:	2213					
Df Model:	2					
	coef	std err	z	P> z	[0.025	0.975]
MntWines0	0.1423	0.128	1.108	0.268	-0.110	0.394
MntWines1	-2.3265	0.390	-5.971	0.000	-3.090	-1.563

MntWines2	0.3670	0.075	4.864	0.000	0.219	0.515
MntWines3	0.0649	0.155	0.419	0.675	-0.239	0.369
MntFruits0	0.1087	0.100	1.092	0.275	-0.086	0.304
MntFruits1	-0.1158	0.192	-0.605	0.545	-0.491	0.260
MntFruits2	-0.2837	0.108	-2.616	0.009	-0.496	-0.071
MntFruits3	-1.8224	0.253	-7.207	0.000	-2.318	-1.327
MntMeatProducts0	0.1317	0.166	0.795	0.426	-0.193	0.456
MntMeatProducts1	-5.6307	0.715	-7.880	0.000	-7.031	-4.230
MntMeatProducts2	0.2553	0.091	2.814	0.005	0.077	0.433
MntMeatProducts3	-1.0885	0.270	-4.036	0.000	-1.617	-0.560
MntFishProducts0	0.3022	0.132	2.297	0.022	0.044	0.560
MntFishProducts1	-1.5955	0.396	-4.024	0.000	-2.373	-0.818
MntFishProducts2	-0.3641	0.114	-3.198	0.001	-0.587	-0.141
MntFishProducts3	-0.9608	0.203	-4.733	0.000	-1.359	-0.563
MntSweetProducts0	0.3601	0.088	4.088	0.000	0.187	0.533
MntSweetProducts1	-0.0688	0.141	-0.487	0.626	-0.346	0.208
MntSweetProducts2	-0.1980	0.093	-2.131	0.033	-0.380	-0.016
MntSweetProducts3	-1.4051	0.194	-7.258	0.000	-1.785	-1.026

=====

In []:

Clustering on customers

In []:

```
data.columns
```

Out[]:

```
Index(['ID', 'Year_Birth', 'Education', 'Marital_Status', 'Income', 'Kidhome',
      'Teenhome', 'Dt_Customer', 'Recency', 'MntWines', 'MntFruits',
      'MntMeatProducts', 'MntFishProducts', 'MntSweetProducts',
      'MntGoldProds', 'NumDealsPurchases', 'NumWebPurchases',
      'NumCatalogPurchases', 'NumStorePurchases', 'NumWebVisitsMonth',
      'AcceptedCmp3', 'AcceptedCmp4', 'AcceptedCmp5', 'AcceptedCmpl',
      'AcceptedCmp2', 'Complain', 'Z_CostContact', 'Z_Revenue', 'Response',
      'E_2n_Cycle', 'E_Basic', 'E_Graduation', 'E_Master', 'E_PhD',
      'M_Absurd', 'M_Alone', 'M_Divorced', 'M_Married', 'M_Single',
      'M_Together', 'M_Widow', 'M_YOLO', 'log_Income', 'NumTotalPurchases',
      'DealsPercentage', 'TotalAccept', 'LargerWeb', 'age', 'duration',
      'total_amount', 'wine_rate', 'fruit_rate', 'meat_rate', 'fish_rate',
      'sweet_rate', 'gold_rate', 'Together', 'kid_teen'],
      dtype='object')
```

In []:

```
knn_data = data[['age', 'Income', 'kid_teen', 'Education', 'Together', 'duration', 'Recency', 'Complain', 'wine_rate', 'fruit_rate', 'meat_rate', 'fish_rate', 'sweet_rate']]
knn_data = knn_data.dropna()
from sklearn.cluster import KMeans
n_cluster=6
model=KMeans(n_clusters=n_cluster)
model.fit(knn_data.iloc[:, :8])
clusters=model.predict(knn_data.iloc[:, :8])
knn_data=knn_data.assign(clusters=clusters)
grouped = knn_data.groupby("clusters")
grouped.mean()
```

Out[]:

	age	Income	kid_teen	Education	Together	duration	Recency	Complain	wine_rate	fruit_rate	meat_rate	fish_rate	sweet_rate
clusters													
0	55.376221	60609.548860	1.013029	2.200326	0.664495	2923.547231	48.965798	0.008143	0.578451	0.038950	0.210761	0.052290	0.03
1	46.457965	23218.809735	0.988938	1.851770	0.646018	2922.471239	48.701327	0.011062	0.244594	0.081022	0.248948	0.122355	0.08
2	44.000000	666666.000000	1.000000	2.000000	1.000000	3066.000000	23.000000	0.000000	0.145161	0.225806	0.290323	0.129032	0.01
3	53.349301	79345.025948	0.341317	2.135729	0.632735	2893.499002	49.542914	0.003992	0.457656	0.048325	0.314132	0.068759	0.05
4	49.142857	158024.285714	0.571429	2.571429	0.857143	2935.857143	52.285714	0.000000	0.273875	0.046932	0.520622	0.050848	0.04
5	52.283931	41413.494540	1.332293	2.154446	0.633385	2900.622465	48.867395	0.014041	0.498291	0.038226	0.231988	0.057213	0.03



In []: