Survey of the mobile operator plans

Company "Megaline" - Federal Mobile operator rolls out new mobile plans - "Smart" and "Ultra". Based on the provided data from mobile operator it's required to analyze two plans and client's behavior to understand what plan would bring higher income to the company.

The tasks are following:

- Import the data, and conduct overview analysis;
- Prepare data fo the further analysis;
- Define the distribution type of data on both plans for internet, messages and minutes usage, find the expected mean value, dispersion and standard deviation.
- Test the hypotheses;
- Make the conclusion on the conduct data analysis.

Data Import

In [1]:
```
import pandas as pd
import math
import pylab as pl
import numpy as np
from scipy import stats as st
```

Data import and overview

In [2]:
```
calls = pd.read_csv('calls.csv')

calls.head()
```

Out[2]:

	id	call_date	duration	user_id
0	1000_0	2018-07-25	0.00	1000
1	1000_1	2018-08-17	0.00	1000
2	1000_2	2018-06-11	2.85	1000
3	1000_3	2018-09-21	13.80	1000
4	1000_4	2018-12-15	5.18	1000

In [3]:
```
calls.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 202607 entries, 0 to 202606
Data columns (total 4 columns):
 #   Column     Non-Null Count   Dtype  
---  ------     --------------   -----  
 0   id         202607 non-null  object 
 1   call_date  202607 non-null  object 
 2   duration   202607 non-null  float64
 3   user_id    202607 non-null  int64  
dtypes: float64(1), int64(1), object(2)
memory usage: 6.2+ MB
```

In [4]:
```
# changing of datatype of column call_date
calls['call_date'] = pd.to_datetime(calls['call_date'],format='%Y-%m-%d')
```

In [5]:
```
internet = pd.read_csv('internet.csv',index_col=[0] )

internet.head()
```

Out[5]:

	id	mb_used	session_date	user_id
0	1000_0	112.95	2018-11-25	1000
1	1000_1	1052.81	2018-09-07	1000
2	1000_2	1197.26	2018-06-25	1000
3	1000_3	550.27	2018-08-22	1000
4	1000_4	302.56	2018-09-24	1000

In [6]:
```
internet.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 149396 entries, 0 to 149395
Data columns (total 4 columns):
 #   Column        Non-Null Count   Dtype  
---  ------        --------------   -----  
 0   id            149396 non-null  object 
 1   mb_used       149396 non-null  float64
 2   session_date  149396 non-null  object 
 3   user_id       149396 non-null  int64  
dtypes: float64(1), int64(1), object(2)
memory usage: 5.7+ MB
```

In [7]:
```
# changing of datatype of column session_date
internet['session_date'] = pd.to_datetime(internet['session_date'],format='%Y-%m-%d')
```

In [8]:
```
tariffs = pd.read_csv('tariffs.csv')

tariffs.head()
```

Out[8]:

	messages_included	mb_per_month_included	minutes_included	rub_monthly_fee	rub_per_gb	rub_per_message	rub_per_minute	tariff_name
0	50	15360	500	550	200	3	3	smart
1	1000	30720	3000	1950	150	1	1	ultra

In [9]:
```
users = pd.read_csv('users.csv')

users.head()
```

Out[9]:

	user_id	age	churn_date	city	first_name	last_name	reg_date	tariff
0	1000	52	NaN	Краснодар	Рафаил	Верещагин	2018-05-25	ultra
1	1001	41	NaN	Москва	Иван	Ежов	2018-11-01	smart
2	1002	59	NaN	Стерлитамак	Евгений	Абрамович	2018-06-17	smart
3	1003	23	NaN	Москва	Белла	Белякова	2018-08-17	ultra
4	1004	68	NaN	Новокузнецк	Татьяна	Авдеенко	2018-05-14	ultra

In [10]:
```
users.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 500 entries, 0 to 499
Data columns (total 8 columns):
 #   Column      Non-Null Count  Dtype 
---  ------      --------------  ----- 
 0   user_id     500 non-null    int64 
 1   age         500 non-null    int64 
 2   churn_date  38 non-null     object
 3   city        500 non-null    object
 4   first_name  500 non-null    object
 5   last_name   500 non-null    object
 6   reg_date    500 non-null    object
 7   tariff      500 non-null    object
dtypes: int64(2), object(6)
memory usage: 31.4+ KB
```

In [11]:
```
messages = pd.read_csv('messages.csv')

messages.head()
```

Out[11]:

	id	message_date	user_id
0	1000_0	2018-06-27	1000
1	1000_1	2018-10-08	1000
2	1000_2	2018-08-04	1000
3	1000_3	2018-06-16	1000
4	1000_4	2018-12-05	1000

In [12]:
```
messages.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 123036 entries, 0 to 123035
Data columns (total 3 columns):
 #   Column        Non-Null Count   Dtype 
---  ------        --------------   ----- 
 0   id            123036 non-null  object
 1   message_date  123036 non-null  object
 2   user_id       123036 non-null  int64 
dtypes: int64(1), object(2)
memory usage: 2.8+ MB
```

In [13]:
```
messages['message_date'] = pd.to_datetime(messages['message_date'] ,format='%Y-%m-%d')
```

Data import and overview conclusion

Five datasets were imported: calls, tariffs, internet, users and messages;

1) calls dataset has 202607 rows and 4 columns: user id, call date, call id, duration;

2) tarrifs dataset - 2 rows (two plans - ultra and smart) and 8 columns:

- messages_included ;
- mb_per_month_included ;
- minutes_included ;
- rub_monthly_fee (monthly payment);
- rub_per_gb (in case of exceeding monthly package);

- rub_per_message (in case of exceeding monthly package);
- rub_per_minute (in case of exceeding monthly package);
- tariff_name;

3) internet dataset has 149396 rows and 4 columns - session id, mb_used,session_date, user_id;

4) users dataset has 500 rows and following columns:

- client age;
- churn_date;
- client city;
- first_name;
- last_name;
- reg_date;
- tariff (plans);

5) messages dataset has 123036 rows and 3 columns with information on message id, user id and message date.

Data Preparation

Dataset merging and data preparation

Calculation of total quantity of messages per month

In [14]:
```
messages['month'] = messages['message_date'].dt.month
messages['month'] = messages['month'].astype(int)
messages
```

Out[14]:

	id	message_date	user_id	month
0	1000_0	2018-06-27	1000	6
1	1000_1	2018-10-08	1000	10
2	1000_2	2018-08-04	1000	8
3	1000_3	2018-06-16	1000	6
4	1000_4	2018-12-05	1000	12
...	...	...	...	...
123031	1499_179	2018-12-12	1499	12
123032	1499_180	2018-09-28	1499	9
123033	1499_181	2018-09-27	1499	9
123034	1499_182	2018-11-15	1499	11
123035	1499_183	2018-11-16	1499	11

123036 rows × 4 columns

In [15]:
```
messages_months = messages.groupby(['user_id','month']).count().reset_index()
messages_months = messages_months.drop(columns = 'id')
messages_months
```

Out[15]:

	user_id	month	message_date
0	1000	5	22
1	1000	6	60
2	1000	7	75
3	1000	8	81
4	1000	9	57
...	...	...	...
2712	1498	10	42
2713	1499	9	11
2714	1499	10	48
2715	1499	11	59
2716	1499	12	66

2717 rows × 3 columns

Calculation of total quantity of spent minutes per month

In [16]:
```
calls['month'] = calls['call_date'].dt.month
calls['month'] = calls['month'].astype(int)
calls
```

Out[16]:

	id	call_date	duration	user_id	month
0	1000_0	2018-07-25	0.00	1000	7
1	1000_1	2018-08-17	0.00	1000	8
2	1000_2	2018-06-11	2.85	1000	6
3	1000_3	2018-09-21	13.80	1000	9
4	1000_4	2018-12-15	5.18	1000	12
...	...	...	...	...	...
202602	1499_215	2018-12-26	0.76	1499	12
202603	1499_216	2018-10-18	18.83	1499	10
202604	1499_217	2018-11-10	10.81	1499	11
202605	1499_218	2018-10-06	4.27	1499	10
202606	1499_219	2018-12-14	19.62	1499	12

202607 rows × 5 columns

Data calculation on each client

In [17]:
```
# function for calculation of correct calls duration
def calls_duration_func (data_calls):
    duration = data_calls['duration']
    if duration > 0:
        correct_duration = (math.ceil(data_calls['duration']))
        return(correct_duration)
    else:
        return(0)
```

In [18]:
```
# calls duration calculation
calls['correct_duration'] = calls.apply(calls_duration_func,axis=1)
calls.head()
```

Out[18]:

	id	call_date	duration	user_id	month	correct_duration
0	1000_0	2018-07-25	0.00	1000	7	0
1	1000_1	2018-08-17	0.00	1000	8	0
2	1000_2	2018-06-11	2.85	1000	6	3
3	1000_3	2018-09-21	13.80	1000	9	14
4	1000_4	2018-12-15	5.18	1000	12	6

In [19]:

```
# calls calculation on user per month
calls_months = calls.groupby(['user_id','month']).sum().reset_index()
calls_months = calls_months.drop(columns = 'duration')
calls_months
```

Out[19]:

	user_id	month	correct_duration
0	1000	5	159
1	1000	6	172
2	1000	7	340
3	1000	8	408
4	1000	9	466
...	...	...	...
3169	1498	10	247
3170	1499	9	70
3171	1499	10	449
3172	1499	11	612
3173	1499	12	492

3174 rows × 3 columns

In [20]:

```
# internet calculation
internet['month'] = internet['session_date'].dt.month
```

```
internet['month'] = internet['month'].astype(int)
internet
```

Out[20]:

	id	mb_used	session_date	user_id	month
0	1000_0	112.95	2018-11-25	1000	11
1	1000_1	1052.81	2018-09-07	1000	9
2	1000_2	1197.26	2018-06-25	1000	6
3	1000_3	550.27	2018-08-22	1000	8
4	1000_4	302.56	2018-09-24	1000	9
...	...	...	...	...	...
149391	1499_152	318.90	2018-10-03	1499	10
149392	1499_153	490.13	2018-12-14	1499	12
149393	1499_154	0.00	2018-10-27	1499	10
149394	1499_155	1246.32	2018-11-26	1499	11
149395	1499_156	544.37	2018-10-26	1499	10

149396 rows × 5 columns

In [21]:

```
# internet calculation on user per month
internet_months = internet.groupby(['user_id','month']).sum().reset_index()
internet_months
```

Out[21]:

	user_id	month	mb_used
0	1000	5	2253.49
1	1000	6	23233.77
2	1000	7	14003.64
3	1000	8	14055.93
4	1000	9	14568.91
...	...	...	...
3198	1498	10	20579.36
3199	1499	9	1845.75
3200	1499	10	17788.51
3201	1499	11	17963.31
3202	1499	12	13055.58

3203 rows × 3 columns

In [22]:

```
# merging datasets users and calls
users = pd.merge(users,calls_months,on='user_id',how='left')
users = users.rename(columns={'correct_duration': 'calls_duration'})
users
```

Out[22]:

	user_id	age	churn_date	city	first_name	last_name	reg_date	tariff	month	calls_duration
0	1000	52	NaN	Краснодар	Рафаил	Верещагин	2018-05-25	ultra	5.0	159.0
1	1000	52	NaN	Краснодар	Рафаил	Верещагин	2018-05-25	ultra	6.0	172.0
2	1000	52	NaN	Краснодар	Рафаил	Верещагин	2018-05-25	ultra	7.0	340.0
3	1000	52	NaN	Краснодар	Рафаил	Верещагин	2018-05-25	ultra	8.0	408.0
4	1000	52	NaN	Краснодар	Рафаил	Верещагин	2018-05-25	ultra	9.0	466.0
...	...	...	...	...	...	...	...	...	...	...
3177	1498	68	2018-10-25	Владикавказ	Всеволод	Акимчин	2018-07-19	smart	10.0	247.0
3178	1499	35	NaN	Пермь	Гектор	Корнилов	2018-09-27	smart	9.0	70.0
3179	1499	35	NaN	Пермь	Гектор	Корнилов	2018-09-27	smart	10.0	449.0
3180	1499	35	NaN	Пермь	Гектор	Корнилов	2018-09-27	smart	11.0	612.0
3181	1499	35	NaN	Пермь	Гектор	Корнилов	2018-09-27	smart	12.0	492.0

3182 rows × 10 columns

In [23]:

```
# addition of internet usage info to datset
users = pd.merge(users,internet_months,on=['user_id','month'],how='left')
users
```

Out[23]:

	user_id	age	churn_date	city	first_name	last_name	reg_date	tariff	month	calls_duration	mb_used
0	1000	52	NaN	Краснодар	Рафаил	Верещагин	2018-05-25	ultra	5.0	159.0	2253.49
1	1000	52	NaN	Краснодар	Рафаил	Верещагин	2018-05-25	ultra	6.0	172.0	23233.77
2	1000	52	NaN	Краснодар	Рафаил	Верещагин	2018-05-25	ultra	7.0	340.0	14003.64
3	1000	52	NaN	Краснодар	Рафаил	Верещагин	2018-05-25	ultra	8.0	408.0	14055.93
4	1000	52	NaN	Краснодар	Рафаил	Верещагин	2018-05-25	ultra	9.0	466.0	14568.91
...	...	...	...	...	...	...	...	...	...	...	...
3177	1498	68	2018-10-25	Владикавказ	Всеволод	Акимчин	2018-07-19	smart	10.0	247.0	20579.36
3178	1499	35	NaN	Пермь	Гектор	Корнилов	2018-09-27	smart	9.0	70.0	1845.75
3179	1499	35	NaN	Пермь	Гектор	Корнилов	2018-09-27	smart	10.0	449.0	17788.51
3180	1499	35	NaN	Пермь	Гектор	Корнилов	2018-09-27	smart	11.0	612.0	17963.31
3181	1499	35	NaN	Пермь	Гектор	Корнилов	2018-09-27	smart	12.0	492.0	13055.58

3182 rows × 11 columns

In [24]:

```
# addition of messages info to dataset
users = pd.merge(users,messages_months,on=['user_id','month'],how='left')
users = users.rename(columns={'message_date': 'messages_qty'})
users
```

Out[24]:

	user_id	age	churn_date	city	first_name	last_name	reg_date	tariff	month	calls_duration	mb_used	messages_qty
0	1000	52	NaN	Краснодар	Рафаил	Верещагин	2018-05-25	ultra	5.0	159.0	2253.49	22.0
1	1000	52	NaN	Краснодар	Рафаил	Верещагин	2018-05-25	ultra	6.0	172.0	23233.77	60.0
2	1000	52	NaN	Краснодар	Рафаил	Верещагин	2018-05-25	ultra	7.0	340.0	14003.64	75.0
3	1000	52	NaN	Краснодар	Рафаил	Верещагин	2018-05-25	ultra	8.0	408.0	14055.93	81.0
4	1000	52	NaN	Краснодар	Рафаил	Верещагин	2018-05-25	ultra	9.0	466.0	14568.91	57.0
...	...	...	...	...	...	...	...	...	...	...	...	...
3177	1498	68	2018-10-25	Владикавказ	Всеволод	Акимчин	2018-07-19	smart	10.0	247.0	20579.36	42.0
3178	1499	35	NaN	Пермь	Гектор	Корнилов	2018-09-27	smart	9.0	70.0	1845.75	11.0
3179	1499	35	NaN	Пермь	Гектор	Корнилов	2018-09-27	smart	10.0	449.0	17788.51	48.0
3180	1499	35	NaN	Пермь	Гектор	Корнилов	2018-09-27	smart	11.0	612.0	17963.31	59.0
3181	1499	35	NaN	Пермь	Гектор	Корнилов	2018-09-27	smart	12.0	492.0	13055.58	66.0

3182 rows × 12 columns

In [25]:
```
# display of tarriffs dataset
tariffs.head()
```

Out[25]:

	messages_included	mb_per_month_included	minutes_included	rub_monthly_fee	rub_per_gb	rub_per_message	rub_per_minute	tariff_name
0	50	15360	500	550	200	3	3	smart
1	1000	30720	3000	1950	150	1	1	ultra

In [26]:
```
smart = tariffs.query('tariff_name == "smart"').reset_index()
```

In [27]:
```
ultra = tariffs.query('tariff_name == "ultra"').reset_index()
```

Calculation of total income of company from each client*

In [28]:
```
def total_fee (user_name):
    tariff = user_name['tariff']
    calls = user_name['calls_duration']
    msgs = user_name['messages_qty']
    internet = user_name['mb_used']
    if tariff == 'smart':
        total_fee=smart['rub_monthly_fee'][0]
        if calls > smart['minutes_included'][0]:
            total_fee += (calls-smart['minutes_included'][0])*smart['rub_per_minute'][0]
        if msgs>smart['messages_included'][0]:
            total_fee+= (msgs-smart['rub_per_message'][0])*3
        if internet > smart['mb_per_month_included'][0]:
            total_fee+= math.ceil((internet-smart['mb_per_month_included'][0])/1000)*smart['rub_per_gb'][0]
        return(total_fee)
    else:
        total_fee=ultra['rub_monthly_fee'][0]
        if calls > ultra['minutes_included'][0]:
            total_fee += (calls-ultra['minutes_included'][0])*ultra['rub_per_minute'][0]
        if msgs>ultra['messages_included'][0]:
            total_fee+= (msgs-ultra['rub_per_message'][0])*3
        if internet > ultra['mb_per_month_included'][0]:
            total_fee+= math.ceil((internet-ultra['mb_per_month_included'][0])/1000)*ultra['rub_per_gb'][0]
        return(total_fee)
```

In [29]:
```
# creation new column - total fee using function
users['total_fee'] = users.apply(total_fee,axis=1)
users
```

Out[29]:

	user_id	age	churn_date	city	first_name	last_name	reg_date	tariff	month	calls_duration	mb_used	messages_qty	total_fee
0	1000	52	NaN	Краснодар	Рафаил	Верещагин	2018-05-25	ultra	5.0	159.0	2253.49	22.0	1950.0
1	1000	52	NaN	Краснодар	Рафаил	Верещагин	2018-05-25	ultra	6.0	172.0	23233.77	60.0	1950.0
2	1000	52	NaN	Краснодар	Рафаил	Верещагин	2018-05-25	ultra	7.0	340.0	14003.64	75.0	1950.0
3	1000	52	NaN	Краснодар	Рафаил	Верещагин	2018-05-25	ultra	8.0	408.0	14055.93	81.0	1950.0
4	1000	52	NaN	Краснодар	Рафаил	Верещагин	2018-05-25	ultra	9.0	466.0	14568.91	57.0	1950.0
...	...	...	...	...	...	...	...	...	...	...	...	...	...
3177	1498	68	2018-10-25	Владикавказ	Всеволод	Акимчин	2018-07-19	smart	10.0	247.0	20579.36	42.0	1750.0
3178	1499	35	NaN	Пермь	Гектор	Корнилов	2018-09-27	smart	9.0	70.0	1845.75	11.0	550.0
3179	1499	35	NaN	Пермь	Гектор	Корнилов	2018-09-27	smart	10.0	449.0	17788.51	48.0	1150.0
3180	1499	35	NaN	Пермь	Гектор	Корнилов	2018-09-27	smart	11.0	612.0	17963.31	59.0	1654.0
3181	1499	35	NaN	Пермь	Гектор	Корнилов	2018-09-27	smart	12.0	492.0	13055.58	66.0	739.0

3182 rows × 13 columns

Data Analysis

Splitting the data on two groups by plans

In [30]:

```
ultra_users = users.query('tariff == "ultra"')
smart_users = users.query('tariff == "smart"')
```

Display the information on the minutes usage on plan smart

In [31]:

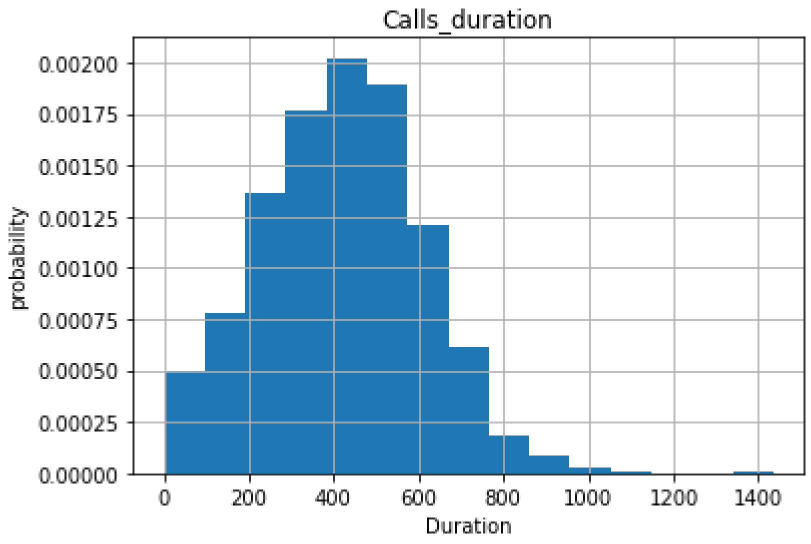
```
print('expectation:',smart_users.calls_duration.mean(),'\n',
      'variance:',np.var(smart_users.calls_duration),'\n',
      'st dev:',np.std(smart_users.calls_duration))
smart_users.calls_duration.hist(density=True,bins=15)

# Set title
pl.title("Calls_duration")
```

```
# adding labels
pl.xlabel('Duration')
pl.ylabel('probability')
```

```
expectation: 419.0629779577148
 variance: 35828.06530953033
 st dev: 189.2830296395594
```

Out[31]:

```
Text(0, 0.5, 'probability')
```



Based on histogram we can say that data is distributed in accordance with binominal law

Display the information on the internet usage on plan smart

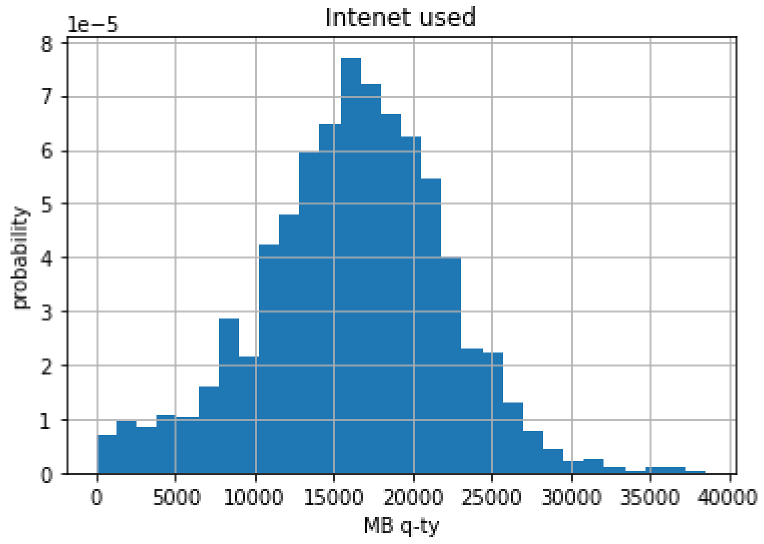
In [32]:

```
print('expectation:',smart_users.mb_used.mean(),'\n',
      'variance:',np.var(smart_users.mb_used),'\n',
      'st dev:',np.std(smart_users.mb_used))

smart_users.mb_used.hist(density=True,bins=30)

# Set title
pl.title("Intenet used")

# adding labels
```

```
pl.xlabel('MB q-ty')
pl.ylabel('probability')
```

```
expectation: 16216.661273627364
 variance: 34412098.45716458
 st dev: 5866.182613690489
```

Out[32]:
```
Text(0, 0.5, 'probability')
```



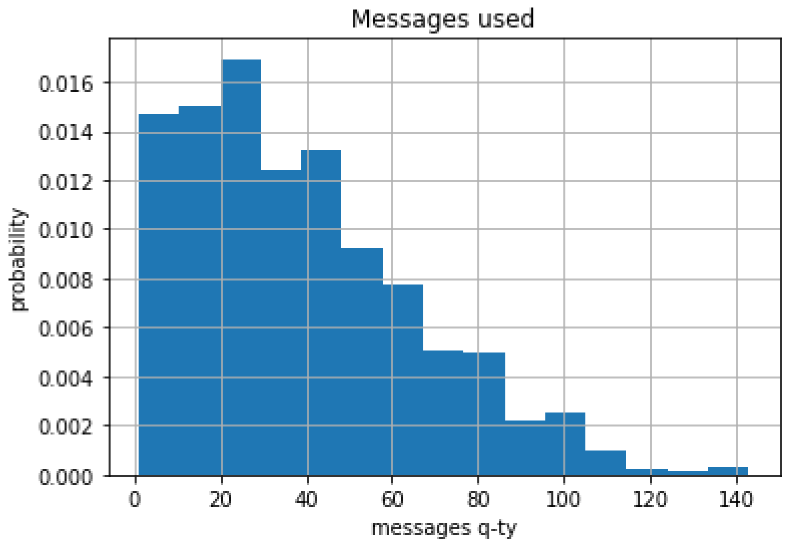
Based on histogram we can say that data is distributed in accordance with standard distribution

Display the information on the message usage on plan smart

In [33]:
```
print('expectation:',smart_users.messages_qty.mean(),'\n',
      'variance:',np.var(smart_users.messages_qty),'\n',
      'st dev:',np.std(smart_users.messages_qty))

smart_users.messages_qty.hist(density=True,bins=15)

# Set title
pl.title("Messages used")

# adding labels
pl.xlabel('messages q-ty')
pl.ylabel('probability')
```

```
expectation: 38.74739039665971
 variance: 718.7973574905967
 st dev: 26.810396444114673
```

Out[33]:
```
Text(0, 0.5, 'probability')
```



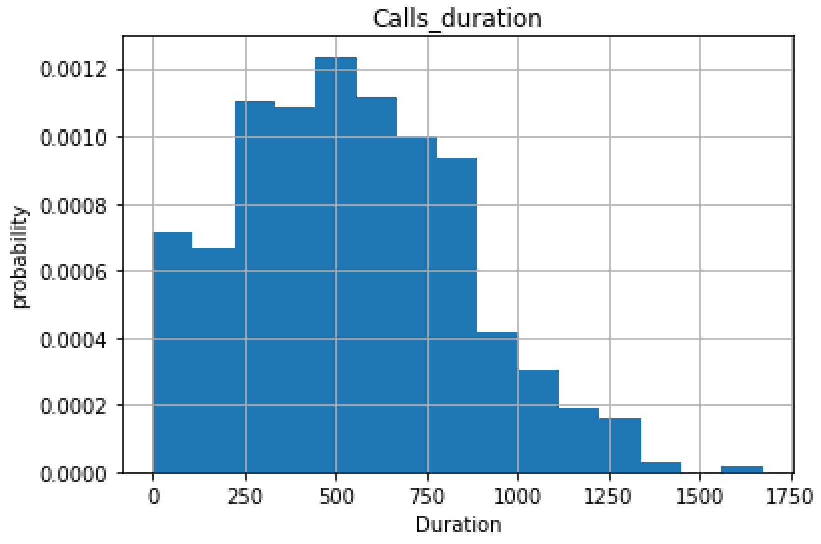
Based on histogram we can say that data is distributed in accordance with geometric distribution

Display the information on the minutes usage on plan ultra

In [34]:
```python
print('expectation:',ultra_users.calls_duration.mean(),'\n',
      'variance:',np.var(ultra_users.calls_duration),'\n',
      'st dev:',np.std(ultra_users.calls_duration))

ultra_users.calls_duration.hist(density=True,bins=15)

# Set title
pl.title("Calls_duration")

# adding labels
pl.xlabel('Duration')
pl.ylabel('probability')
```

```
expectation: 545.4511041009464
 variance: 94104.36117385983
 st dev: 306.76434143143143
```

Out[34]:
```
Text(0, 0.5, 'probability')
```



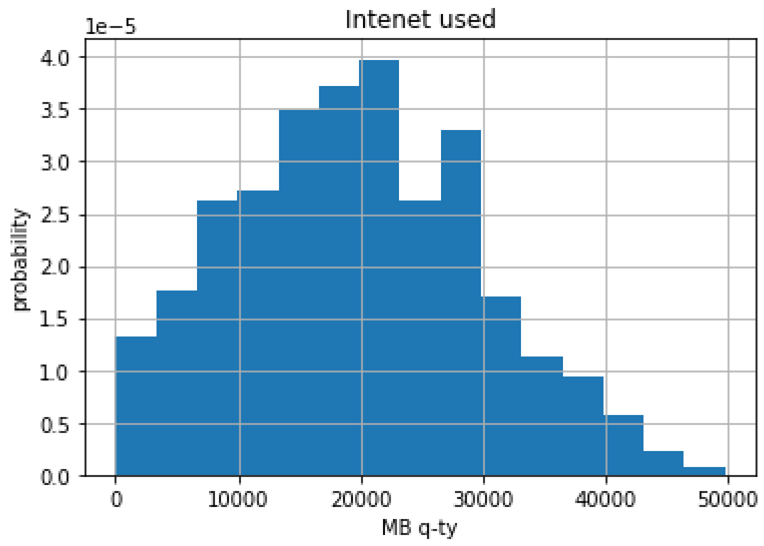
Based on histogram we can say that data is distributed in accordance with binominal law

Display the information on the traffic use on plan smart

In [35]:
```
print('expectation:',ultra_users.mb_used.mean(),'\n',
      'variance:',np.var(ultra_users.mb_used),'\n',
      'st dev:',np.std(ultra_users.mb_used))

ultra_users.mb_used.hist(density=True,bins=15)

# Set title
pl.title("Intenet used")

# adding labels
pl.xlabel('MB q-ty')
pl.ylabel('probability')
```

```
expectation: 19669.283602550477
 variance: 99465187.55618352
 st dev: 9973.223528838784
```

Out[35]:
```
Text(0, 0.5, 'probability')
```



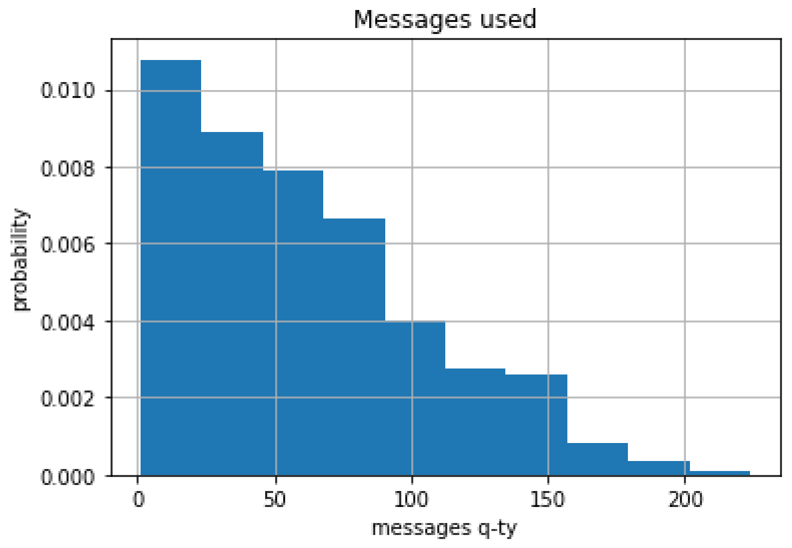
Based on histogram we can say that data is distributed in accordance with binominal law

Display the information on the message usage on plan ultra

In [36]:
```
print('expectation:',ultra_users.messages_qty.mean(),'\n',
      'variance:',np.var(ultra_users.messages_qty),'\n',
      'st dev:',np.std(ultra_users.messages_qty))

ultra_users.messages_qty.hist(density=True,bins =10)

# Set title
pl.title("Messages used")

# adding labels
pl.xlabel('messages q-ty')
pl.ylabel('probability')
```

```
expectation: 61.19553805774278
 variance: 1996.9499538443522
 st dev: 44.68724598634774
```

Out[36]:
```
Text(0, 0.5, 'probability')
```



Based on histogram we can say that data is distributed in accordance with geometric distribution

---

Hypotheses testing

Hypothesis 1

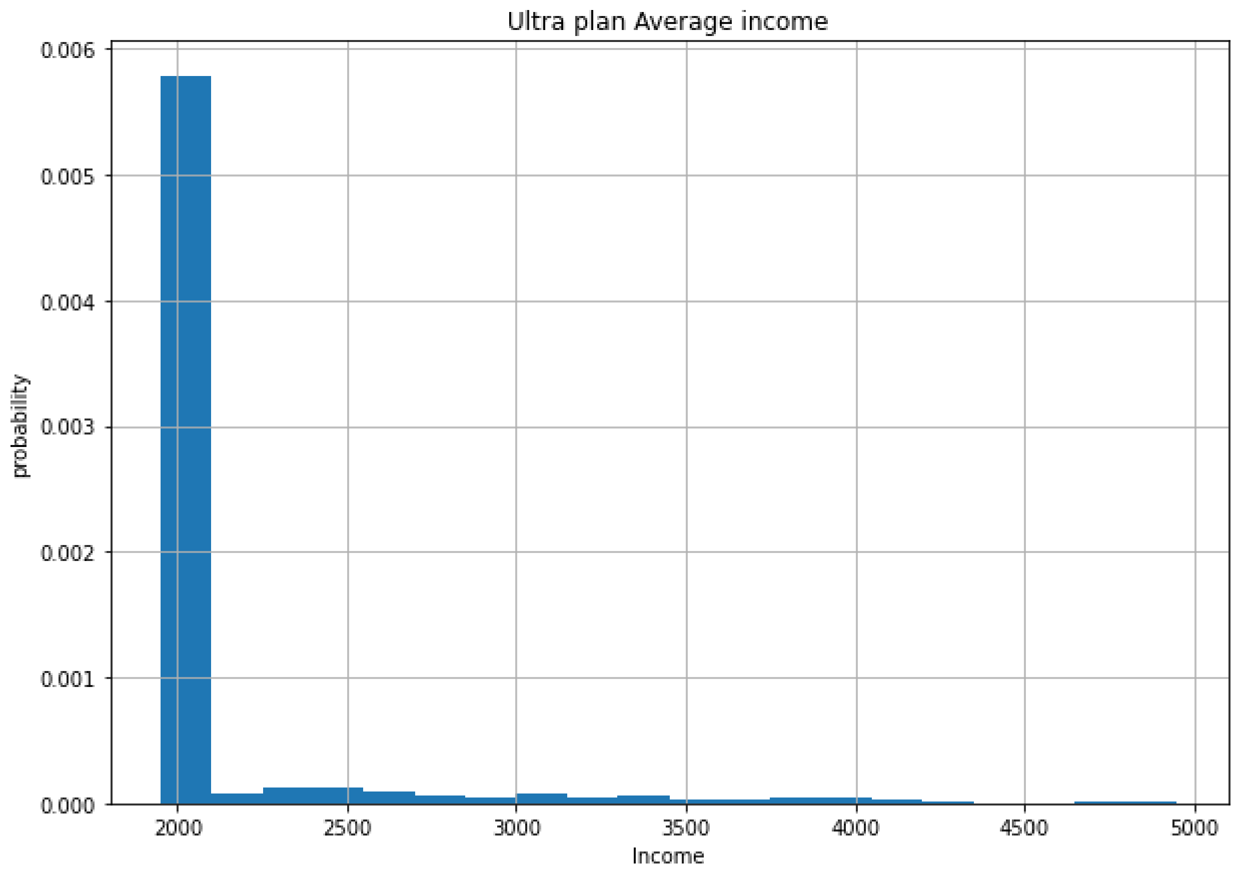
Average income per user on plans ultra and smart are different.

In [37]:
```
print('Average income per client on ultra plan:',round(np.var(ultra_users.total_fee),2),'\t',
      'Average income per client on smart plan:', round(np.var(smart_users.total_fee),2))
```

```
Average income per client on ultra plan: 149647.31 	 Average income per client on smart plan: 710110.72
```

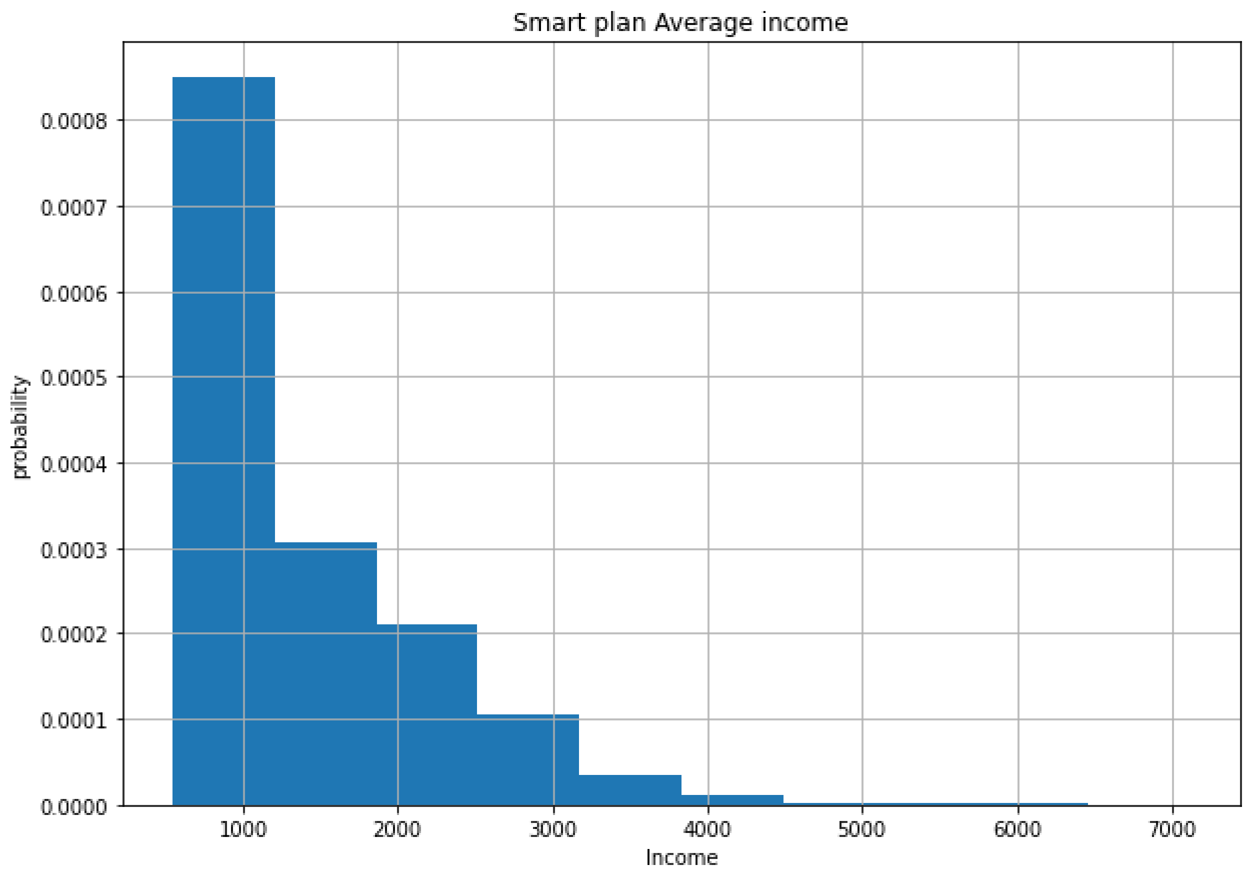
In [38]:
```
ultra_users.total_fee.hist(density=True,bins =20, figsize = (10,7))

# Set title
pl.title("Ultra plan Average income")

# adding labels
pl.xlabel('Income')
pl.ylabel('probability')
```

```
Out[38]: Text(0, 0.5, 'probability')
```



```
In [39]: smart_users.total_fee.hist(density=True,bins =10,figsize = (10,7))

         # Set title
         pl.title("Smart plan Average income")

         # adding labels
         pl.xlabel('Income')
         pl.ylabel('probability')
```

```
Out[39]: Text(0, 0.5, 'probability')
```



In [40]:
```
alpha = 0.05

results = st.ttest_ind(ultra_users.total_fee,smart_users.total_fee,equal_var=False)
print('p.value:',results.pvalue,'\n')

if results.pvalue > alpha:
    print('Result:','Reject the hypothesis')
else:
    print('Result:',"Can not reject the hypothesis")
```

```
p.value: 3.7790205288399806e-212

Result: Can not reject the hypothesis
```

H0 - Average income from clients on plans "smart" and "ultra" is similar.\ H1 - Average income from clients on plans "smart" and "ultra" is different.

Hypothesis is confirmed - p-value < alpha

For hypothesis testing was used ttest_ind for the correct comparison of arrays.

Hypothesis 2

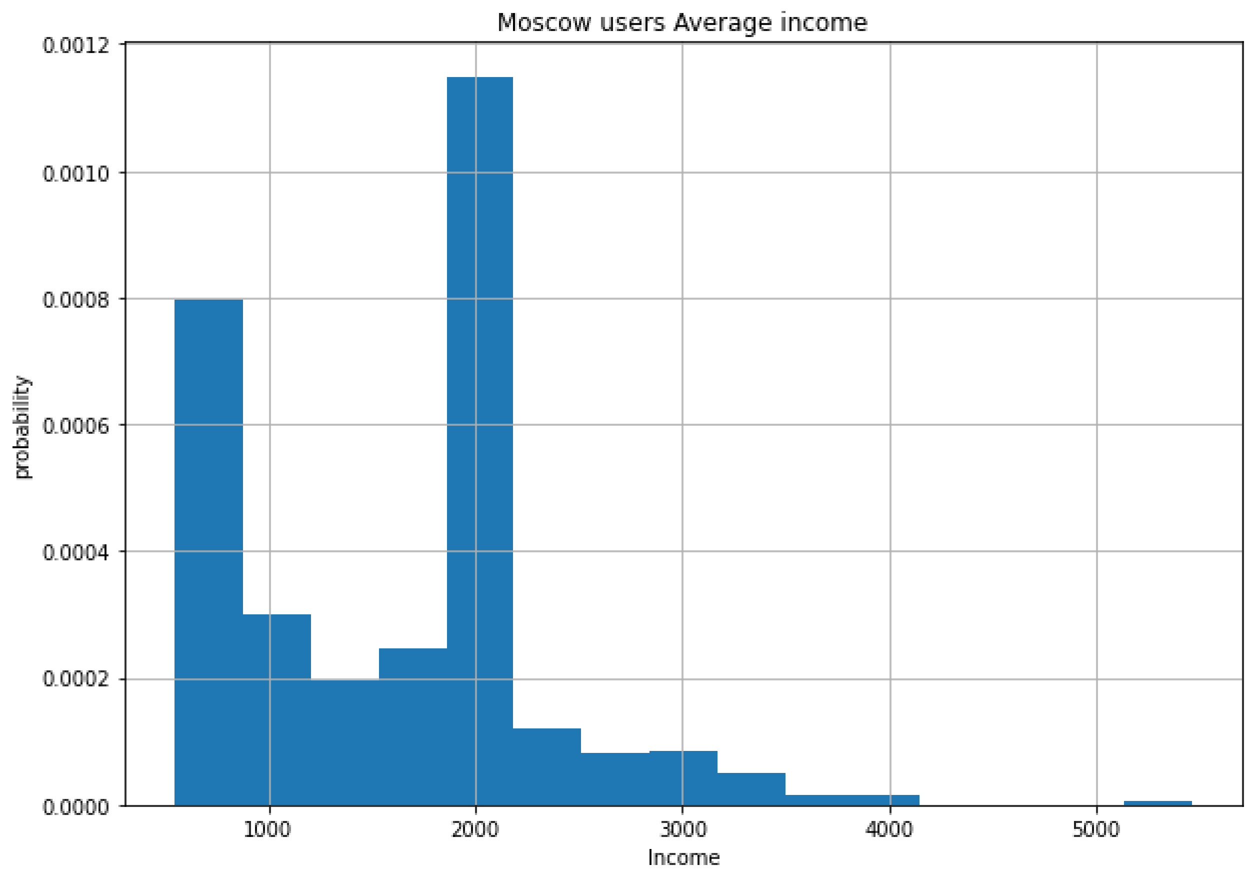
The average income from clients in Moscow and other regions is different.

In [41]:
```
moscow_users = users.query('city == "Москва"')
other_users = users.query('city != "Москва"')

print('Average income per client in Moscow:', round(np.var(moscow_users.total_fee),2),'\t',
      'Average income per client outside Moscow:',round(np.var(other_users.total_fee),2))
```

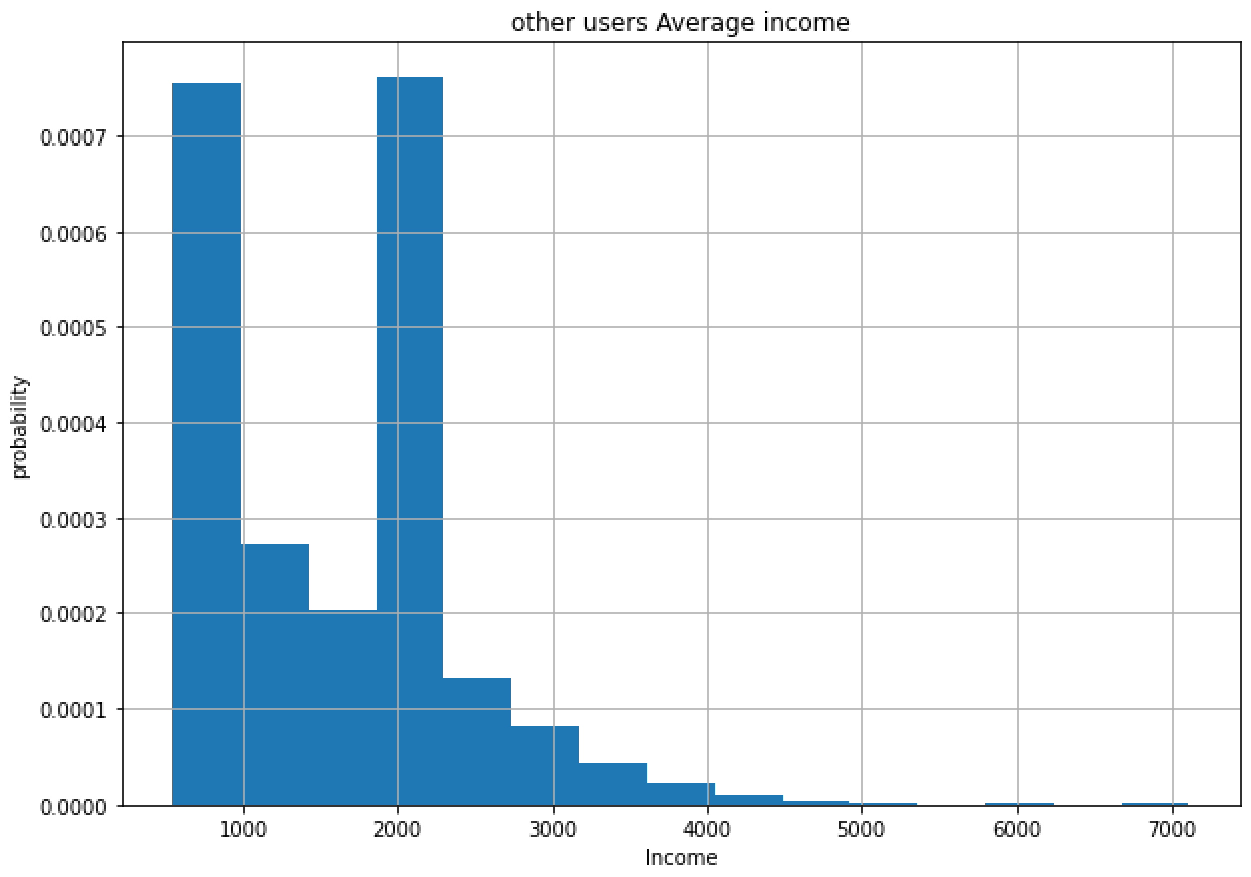
```
Average income per client in Moscow: 573827.65	Average income per client outside Moscow: 673772.45
```

In [42]:
```
moscow_users.total_fee.hist(density=True,bins =15,figsize = (10,7))

# Set title
pl.title("Moscow users Average income")

# adding labels
pl.xlabel('Income')
pl.ylabel('probability')
```

Out[42]:
```
Text(0, 0.5, 'probability')
```



```
In [43]: other_users.total_fee.hist(density=True,bins =15,figsize = (10,7))

         # Set title
         pl.title("other users Average income")

         # adding labels
         pl.xlabel('Income')
         pl.ylabel('probability')

Out[43]: Text(0, 0.5, 'probability')
```



In [44]:
```
alpha = 0.05

results = st.ttest_ind(moscow_users.total_fee,other_users.total_fee,equal_var=False)
print('p.value:',round(results.pvalue,2))

if results.pvalue > alpha:
    print('Result:','Reject the hypothessis')
else:
    print('Result:',"Can not reject the hypothesis")
```

```
p.value: 0.73
Result: Reject the hypothessis
```

H0 - Average income from clients in Moscow and outside Moscow is similar.\ H1 - Average income from clients in Moscow and outside Moscow is different.

Hypothesis is rejected - p-value > alpha

For hypothesis testing was used ttest_ind for the correct comparison of arrays

---

Conclusion

Based on the provided data and merged table, which has all the information on users it's possible to conclude the following:

1) Minutes usage for calls by users are distributed in accordance with binominal law, and has the following statistic indices:

- mobile plan smart:
  ```
  Expected mean value  - ~419
  Dispersion - ~35828
  Standard deviation - ~189
  ```
- mobile plan ultra:
  ```
  Expected mean value - ~545
  Dispersion - ~94104
  Standard deviation - ~306
  ```

2) Internet traffic usage on plans smart is distributed in accordance with geometric distribution, on the ultra plan traffic usage is distributed in accordance with binominal law. The indices for both plans are following:

- mobile plan smart:
  ```
  Expected mean value - ~16216
  Dispersion - ~34412098
  Standard deviation - ~5866
  ```
- mobile plan ultra:
  ```
  Expected mean value  - ~ 19669
  Dispersion - ~99465187
  Standard deviation - ~9973
  ```
  3) Message usage is distributed in accordance with geometric distribution and has the following indices:
- mobile plan smart:
  ```
  Expected mean value - ~38
  Dispersion - ~718
  Standard deviation - ~26
  ```

- mobile plan ultra:
  ```
  Expected mean value - ~61
  Dispersion - ~1996
  Standard deviation - ~44
  ```

4) The Hypothesis 1 - Average income from clients on plans "Ultra" and "Smart" is different is confirmed.

5) The Hypothesis 2 - Average income from clients in and outside Moscow is different is not confirmed.