# Обработка пропусков в данных

In [1]:

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
sns.set(style="ticks")
from sklearn.impute import SimpleImputer
from sklearn.impute import MissingIndicator
import scipy.stats as stats
```

In [2]:

```
data = pd.read_csv('/Users/da.karpov/Desktop/МАГА/УЧЕБА/2 сем/ML_MSc_1course/датасеты/netflix_titles.csv', sep=",")
```

In [3]:

```
data.head()
```

Out[3]:

| | show_id | type | title | director | cast | country | date_added | release_year | rating | duration | listed_in | des |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | s1 | TV Show | 3% | NaN | João Miguel, Bianca Comparato, Michel Gomes, R... | Brazil | August 14, 2020 | 2020 | TV-MA | 4 Seasons | International TV Shows, TV Dramas, TV Sci-Fi &... | In where inl i |
| 1 | s2 | Movie | 7:19 | Jorge Michel Grau | Demián Bichir, Héctor Bonilla, Oscar Serrano, ... | Mexico | December 23, 2016 | 2016 | TV-MA | 93 min | Dramas, International Movies | deva earthqua Mexi |
| 2 | s3 | Movie | 23:59 | Gilbert Chan | Tedd Chan, Stella Chung, Henley Hii, Lawrence ... | Singapore | December 20, 2018 | 2011 | R | 78 min | Horror Movies, International Movies | When a recruit i d |
| 3 | s4 | Movie | 9 | Shane Acker | Elijah Wood, John C. Reilly, Jennifer Connelly... | United States | November 16, 2017 | 2009 | PG-13 | 80 min | Action & Adventure, Independent Movies, Sci-Fi... | postapo world, rob |
| 4 | s5 | Movie | 21 | Robert Luketic | Jim Sturgess, Kevin Spacey, Kate Bosworth, Aar... | United States | January 1, 2020 | 2008 | PG-13 | 123 min | Dramas | A brillian of s becom |

In [4]:

```
data.shape
```

Out[4]:

```
(7787, 12)
```

In [5]:

```
data.dtypes
```

Out[5]:

```
show_id         object
type            object
title           object
director        object
cast            object
country         object
date_added      object
release_year     int64
rating          object
duration        object
listed_in       object
description     object
dtype: object
```

In [6]:

```
data.isnull().sum()
```

Out[6]:

```
show_id            0
type               0
title              0
director        2389
cast             718
country          507
date_added        10
release_year       0
rating             7
duration           0
listed_in          0
description        0
dtype: int64
```

In [7]:

```
data.isnull().mean()
```

Out[7]:

```
show_id         0.000000
type            0.000000
title           0.000000
director        0.306793
cast            0.092205
country         0.065109
date_added      0.001284
release_year    0.000000
rating          0.000899
duration        0.000000
listed_in       0.000000
description     0.000000
dtype: float64
```

# Удаление колонок

**Можно и необходимо удалить непоказательный столбец - directorтак как в этом столбце наблюдается более 30% пропущенных значений.**

In [8]:

```
# Колонки, которые можно удалить:
colsForDel = ['director']
```

In [9]:

```
dataWithoutColumns = data.drop(columns=colsForDel)
dataWithoutColumns.shape
```

Out[9]:

```
(7787, 11)
```

**Таким образом мы получили более достоверные данные, при этом потеряли 1 из 12 признаков, но не потеряли количество строк**

# Удаление строк с пропусками

Попробуем удалить строки с пропусками из следующих колонок: **name, host_name.** В данных колнках пропусков меньше **5%,** что позволяет удалить часть экспериментов без потери самих колонок.

In [10]:

```
colsForDelExp = ['rating', 'date_added']
```

In [11]:

```
# Удаление пропусков
data_drop_exp = data[colsForDelExp].dropna()
data_drop_exp.shape
```

Out[11]:

```
(7770, 2)
```

### Посмотрим, как это повлияло на данные и их распределение:

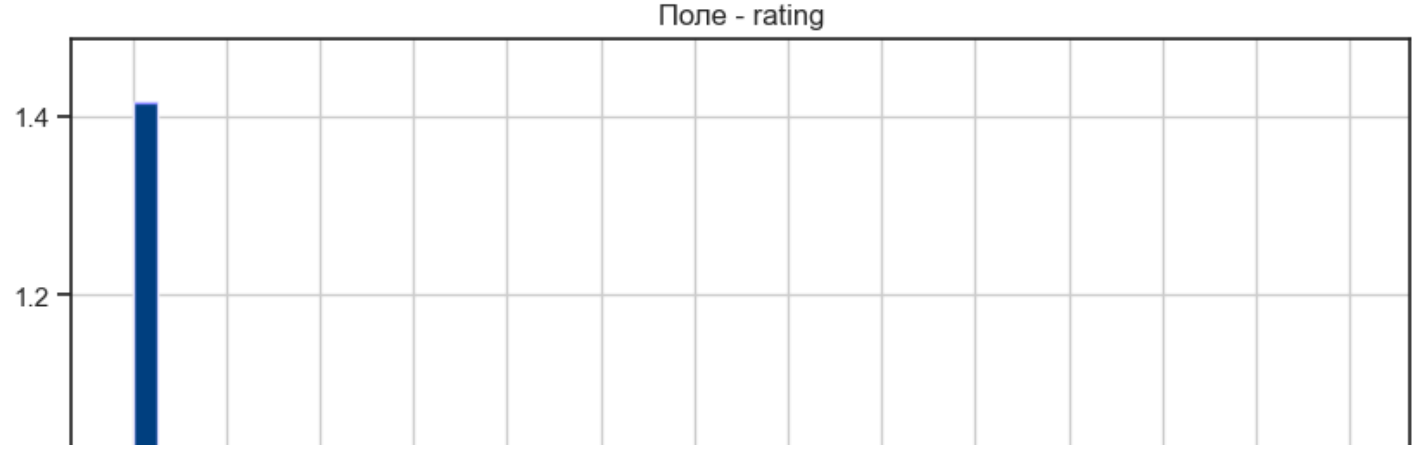
Скопировал из лекции функцию для вывода графиков с распределениями

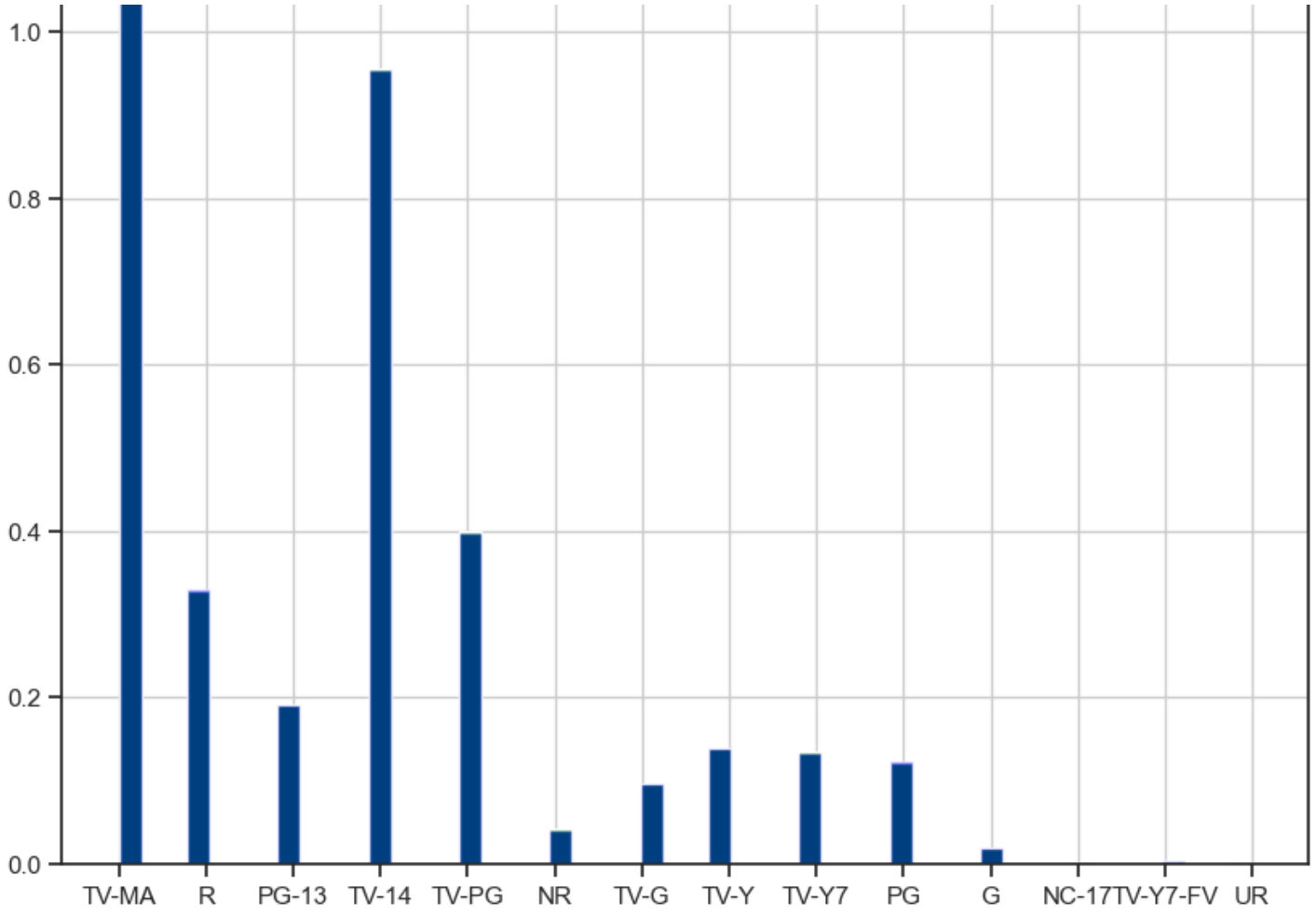
In [12]:

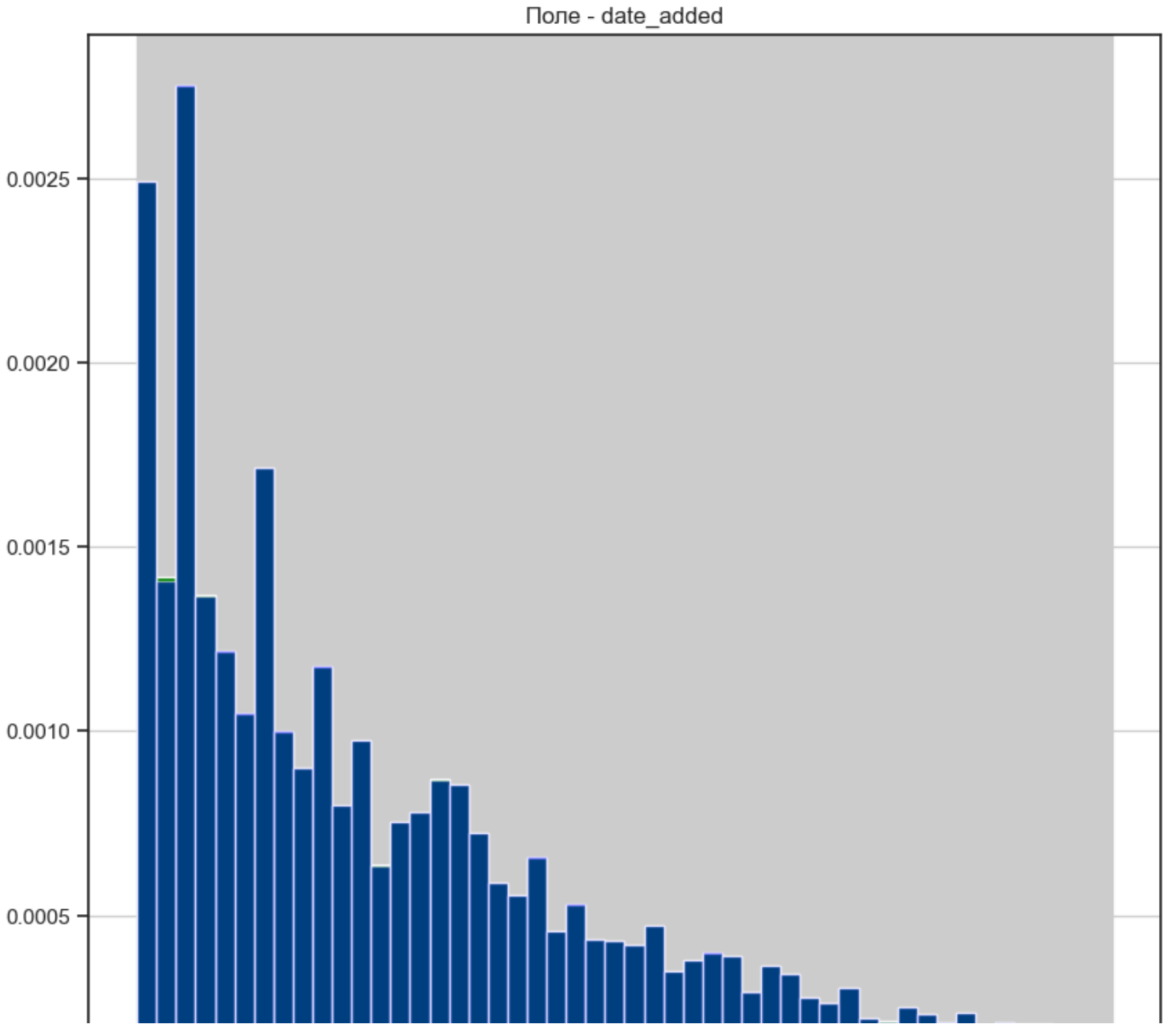
```
def plot_hist_diff(old_ds, new_ds, cols):
    """
    Разница между распределениями до и после устранения пропусков
    """
    for c in cols:
        fig, ax = plt.subplots(figsize=(10,10))
        ax.title.set_text('Поле - ' + str(c))
        old_ds[c].hist(bins=50, ax=ax, density=True, color='green')
        new_ds[c].hist(bins=50, ax=ax, color='blue', density=True, alpha=0.5)
        plt.show()
```

In [13]:

```
plot_hist_diff(data, data_drop_exp, colsForDelExp)
```




1.0
0.8
0.6
0.4
0.2
0.0
TV-MA
R
PG-13
TV-14
TV-PG
NR
TV-G
TV-Y
TV-Y7
PG
G
NC-17
TV-Y7-FV
UR


Поле - date_added
0.0025
0.0020
0.0015
0.0010
0.0005


Заметна небольшая разница только на признаке **date_added** во второй колонке

# Заполнение значений для одного признака

### В данном датасете имеются пропуски только в категориальных признаках, поэтому рассмотрим избавление от них разными способами:

### Заполнение наиболее распространенным значением категории для поля **name**

In [14]:

```
dataNew = data[['country', 'cast']].copy()
```

In [15]:

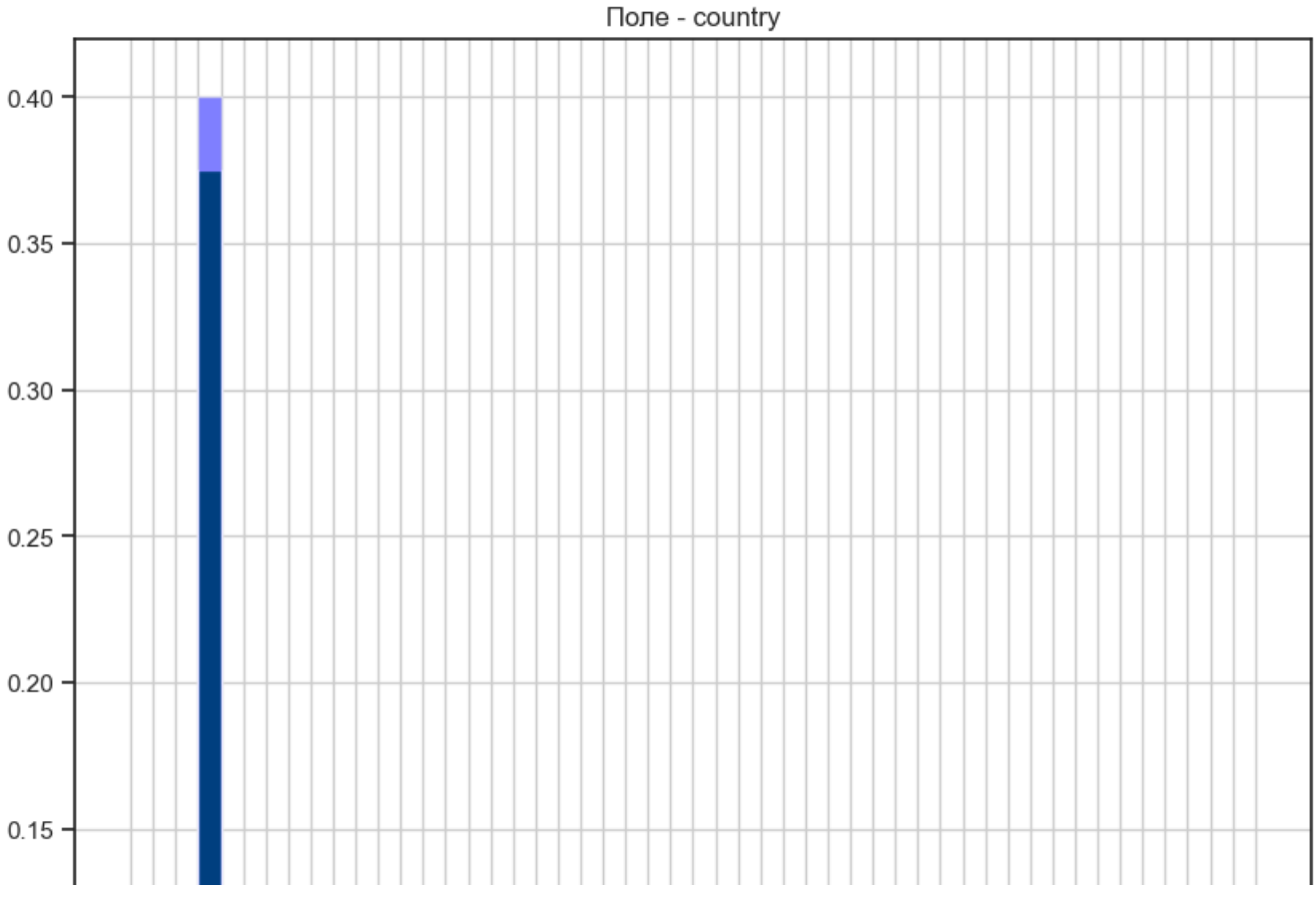
```
imputerCountry = SimpleImputer(strategy='most_frequent',
                               fill_value=None)
dataNewFreqImpCountry = imputerCountry.fit_transform(dataNew[['country']].values)

imputerCast = SimpleImputer(strategy='most_frequent',
                            fill_value='country')
dataNewFreqImpCast = imputerCast.fit_transform(dataNew[['country']].values)
```

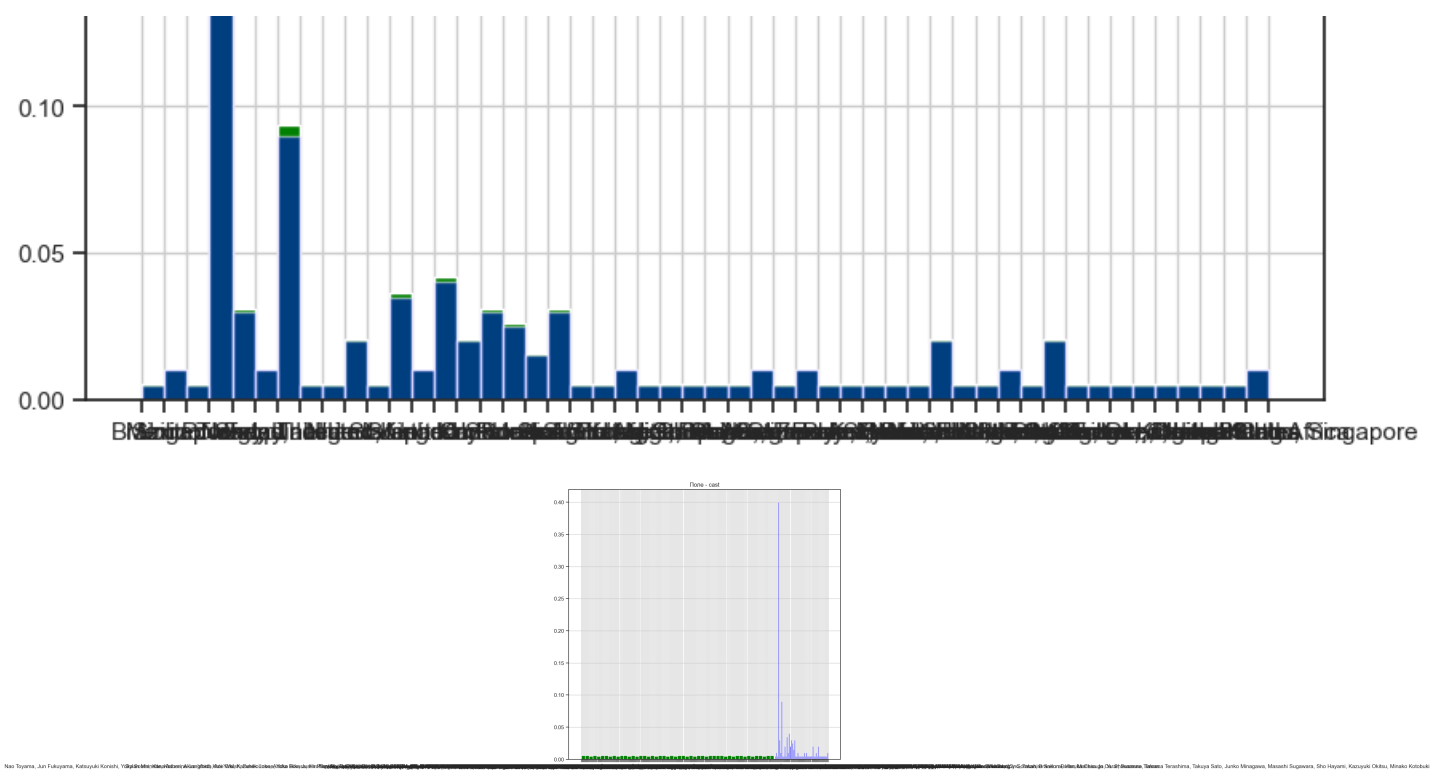
In [16]:

```
dataNew['country'] = dataNewFreqImpCountry
dataNew['cast'] = dataNewFreqImpCast
```

In [17]:

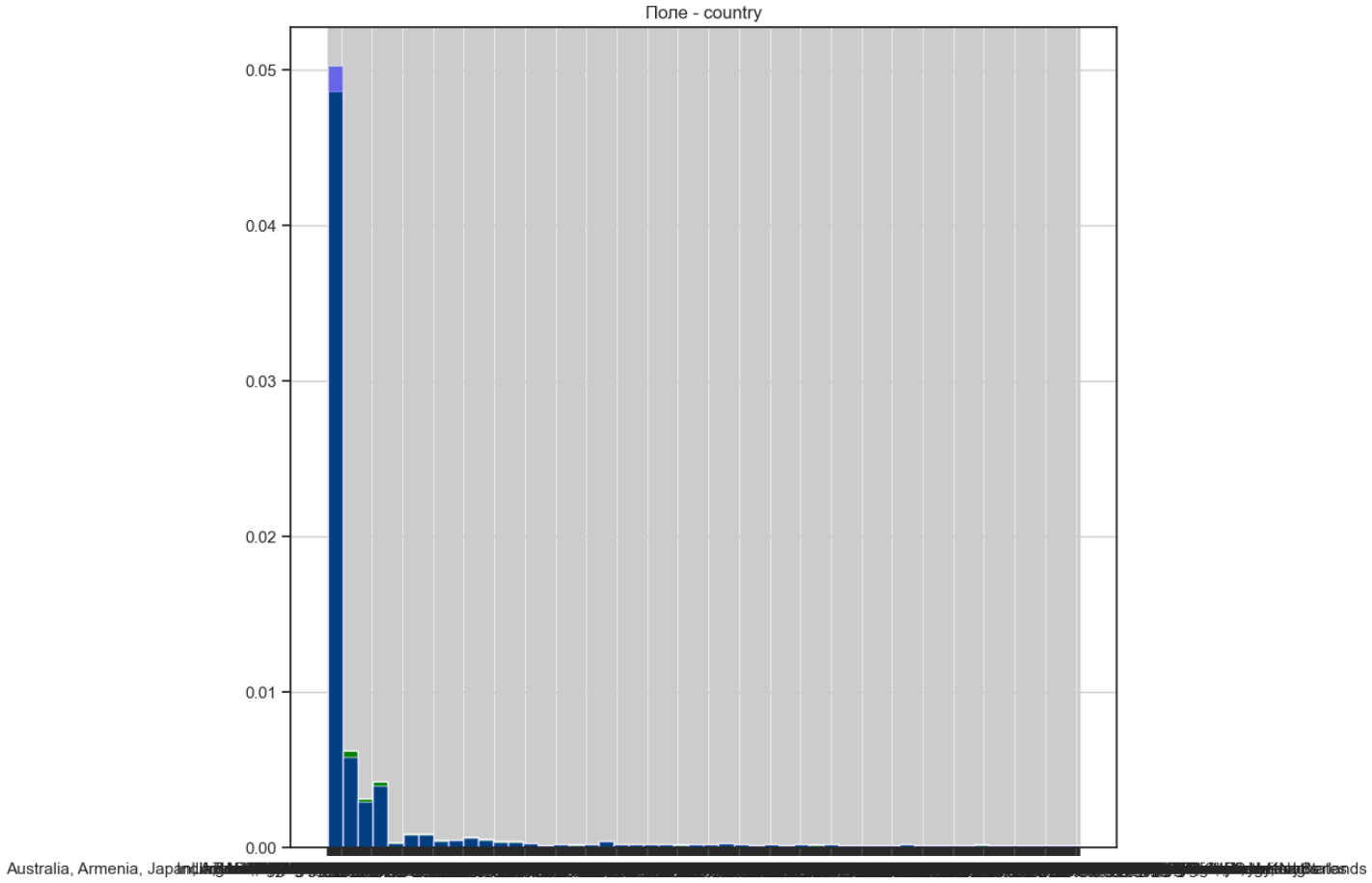
```
plot_hist_diff(data.head(200), dataNew.head(200), ['country', 'cast'])
```






In [18]:

```
plot_hist_diff(data, dataNew, ['country'])
```




Данный признак оказался не очяень показательным на данной задаче, поэтому рассмотрим эту же задачу на признаке - **rating**

In [19]:

```
dataNewRating = data[['rating']].copy()
```

In [20]:

```
imputerRating = SimpleImputer(strategy='most_frequent',
```

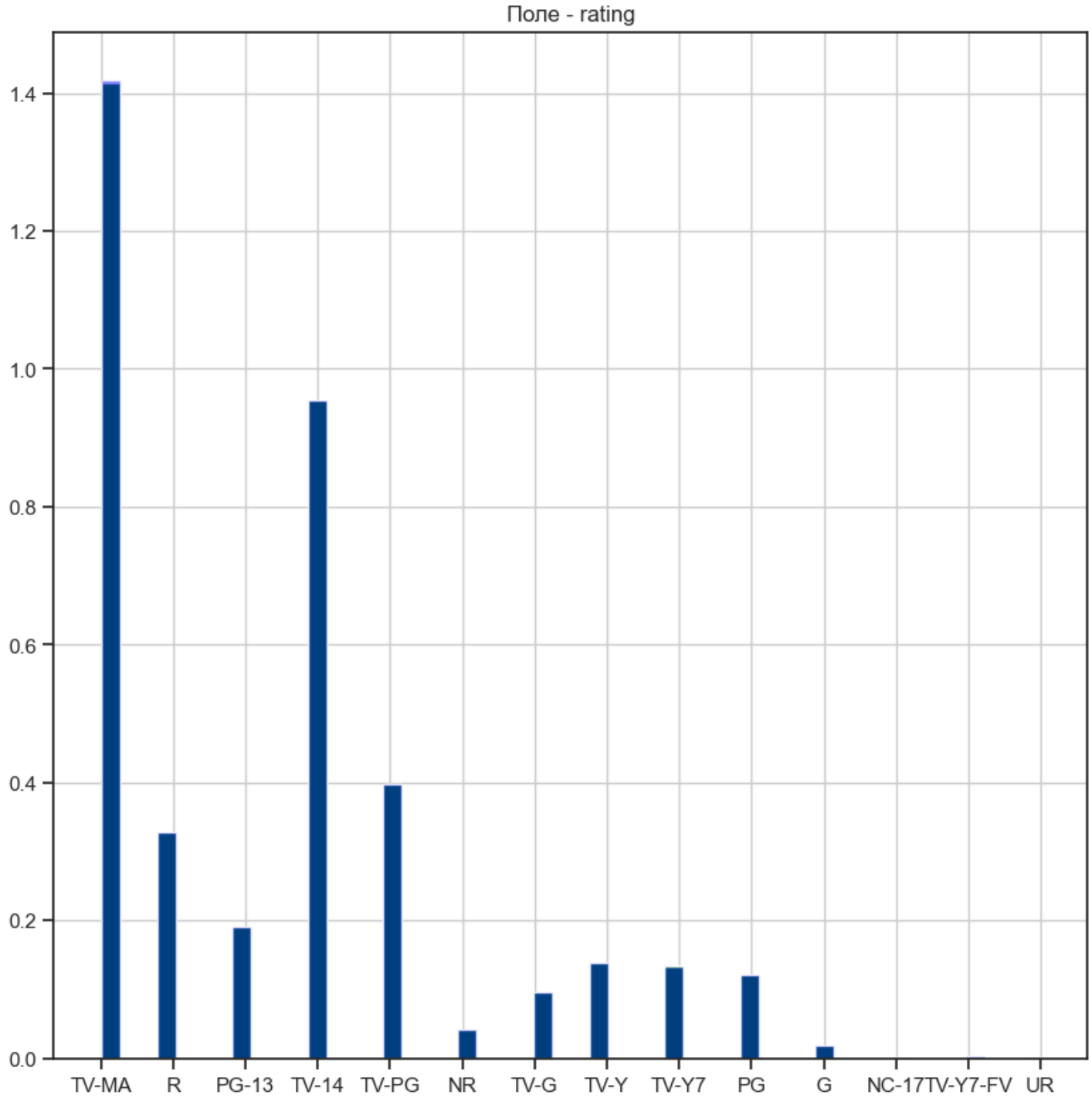
```
                        fill_value=None)
dataNewFreqImpRating = imputerRating.fit_transform(dataNewRating[['rating']].values)
```

In [21]:

```
dataNewRating['rating'] = dataNewFreqImpRating
```

In [22]:

```
plot_hist_diff(data, dataNewRating, ['rating'])
```




In [23]:

```
imputerRating = SimpleImputer(strategy='constant',
                        fill_value='null')
dataNewConstRating = imputerRating.fit_transform(dataNewRating[['rating']].values)
```

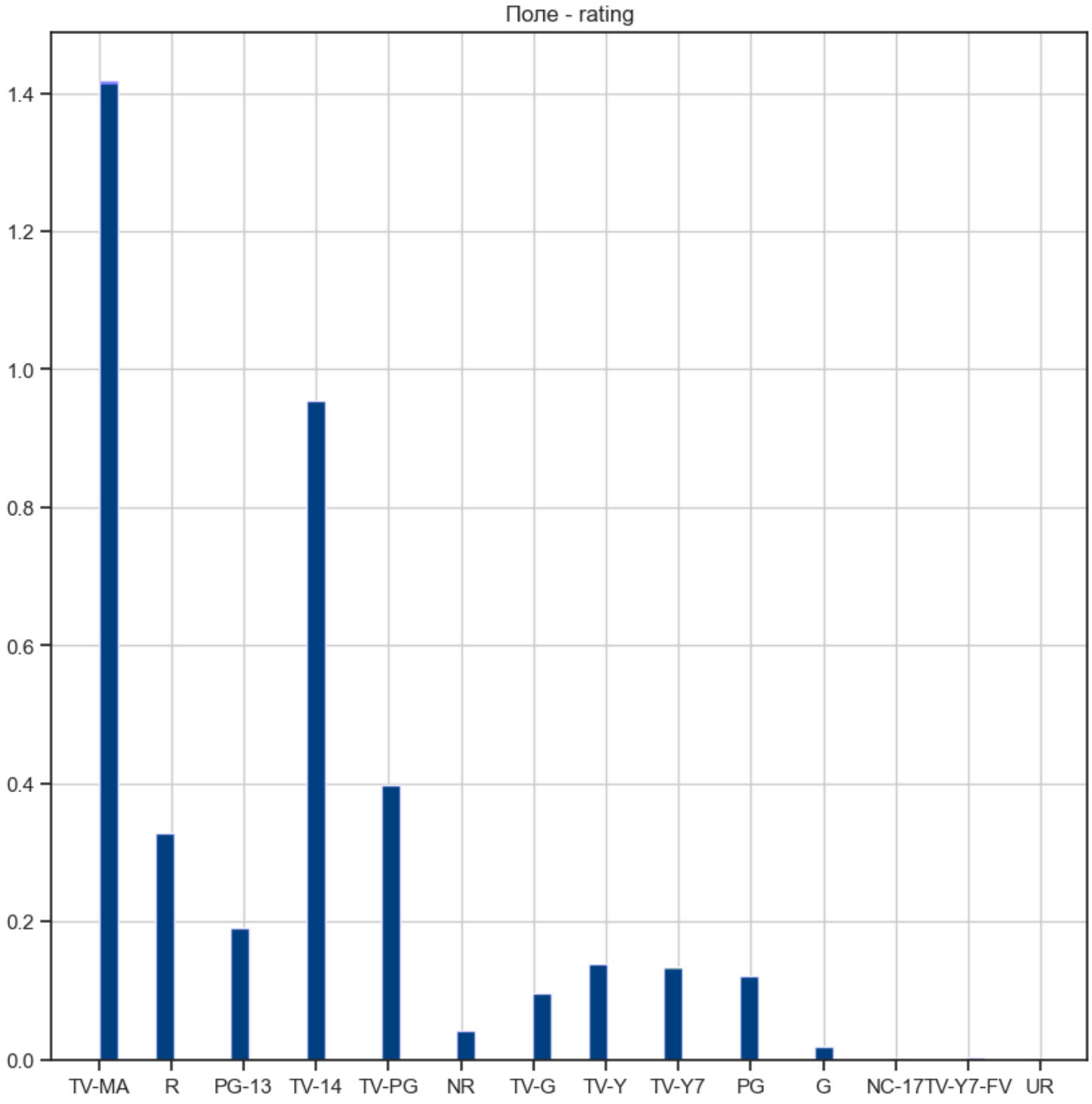
In [24]:

```
dataNewRating['rating'] = dataNewConstRating
```

In [25]:

```
plot_hist_diff(data, dataNewRating, ['rating'])
```

plot_hist_diff(data, dataNewRating, ['rating'])




In [26]:

```
def impute_column(dataset, column, strategy_param, fill_value_param=None):
    """
    Заполнение пропусков в одном признаке
    """
    temp_data = dataset[[column]].values
    size = temp_data.shape[0]

    indicator = MissingIndicator()
    mask_missing_values_only = indicator.fit_transform(temp_data)

    imputer = SimpleImputer(strategy=strategy_param,
                            fill_value=fill_value_param)
    all_data = imputer.fit_transform(temp_data)

    missed_data = temp_data[mask_missing_values_only]
    filled_data = all_data[mask_missing_values_only]

    return all_data.reshape((size,)), filled_data, missed_data
```

In [27]:

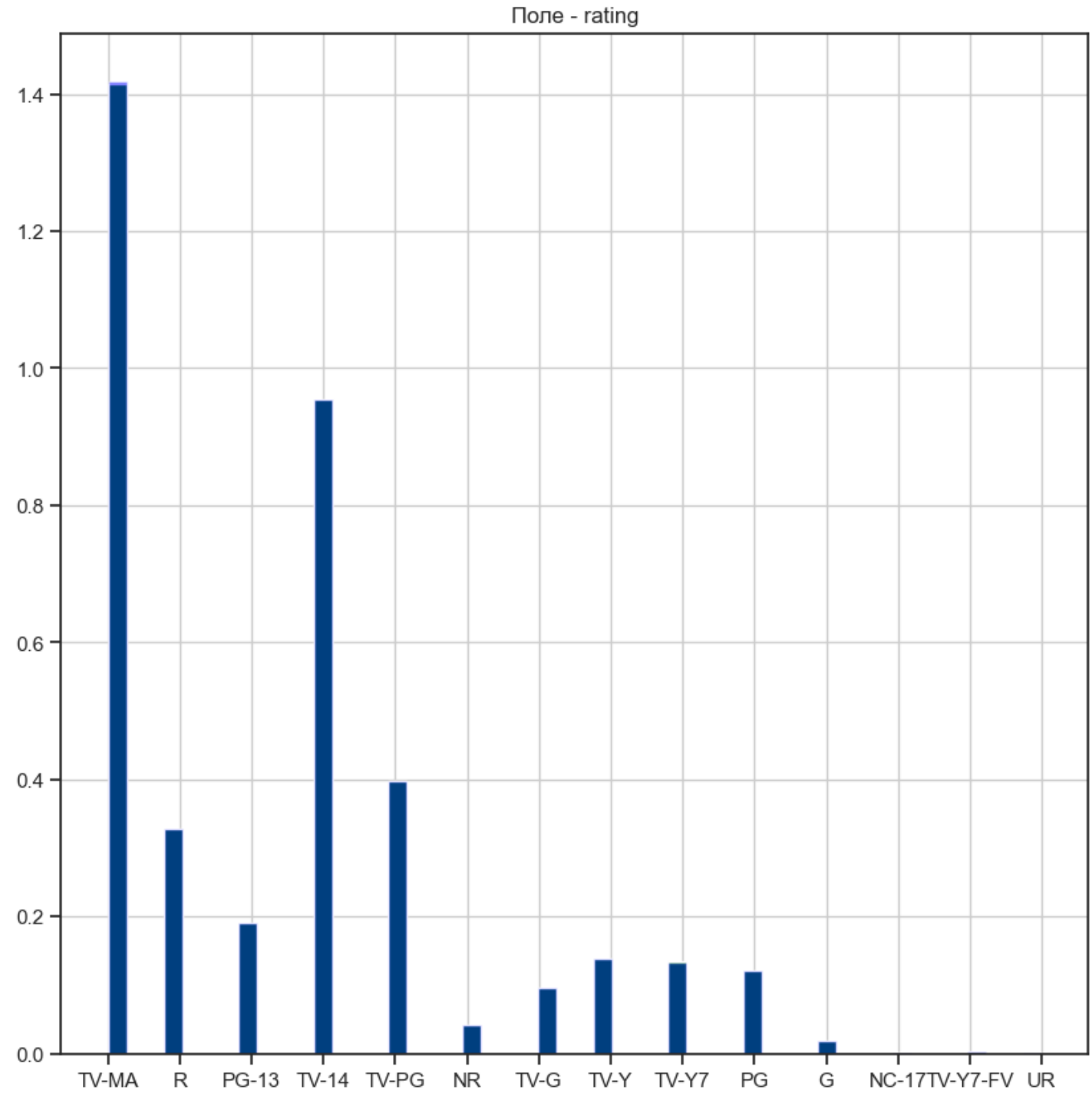
```
GarageType_cat_na_temp, _, _ = impute_column(dataNewRating, 'rating', 'constant', fill_v
alue_param='NA')
```

In [28]:

```
dataNewRating['rating'] = GarageType_cat_na_temp
```

In [29]:

```
plot_hist_diff(data, dataNewRating, ['rating'])
```




# Преобразование категориальных признаков в числовые

Для данной задачи я выбрал другой датасет.

In [30]:

```
data2 = pd.read_csv('/Users/da.karpov/Desktop/МАГА/УЧЕБА/2 сем/ML_MSc_1course/датасеты/go
ogleplaystore.csv', sep=",")
```

In [31]:

```
data2.head(10)
```

Out[31]:

| | App | Category | Rating | Reviews | Size | Installs | Type | Price | Content Rating | Genres | Last Updated |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Photo Editor & Candy Camera & Grid & ScrapBook | ART_AND_DESIGN | 4.1 | 159 | 19M | 10,000+ | Free | 0 | Everyone | Art & Design | January 7, 2018 |
| 1 | Coloring book moana | ART_AND_DESIGN | 3.9 | 967 | 14M | 500,000+ | Free | 0 | Everyone | Art & Design;Pretend Play | January 15, 2018 |
| 2 | U Launcher Lite – FREE Live Cool Themes, Hide ... | ART_AND_DESIGN | 4.7 | 87510 | 8.7M | 5,000,000+ | Free | 0 | Everyone | Art & Design | August 1, 2018 |
| 3 | Sketch - Draw & Paint | ART_AND_DESIGN | 4.5 | 215644 | 25M | 50,000,000+ | Free | 0 | Teen | Art & Design | June 8, 2018 |
| 4 | Pixel Draw - Number Art Coloring Book | ART_AND_DESIGN | 4.3 | 967 | 2.8M | 100,000+ | Free | 0 | Everyone | Art & Design;Creativity | June 20, 2018 |
| 5 | Paper flowers instructions | ART_AND_DESIGN | 4.4 | 167 | 5.6M | 50,000+ | Free | 0 | Everyone | Art & Design | March 26, 2017 |
| 6 | Smoke Effect Photo Maker - Smoke Editor | ART_AND_DESIGN | 3.8 | 178 | 19M | 50,000+ | Free | 0 | Everyone | Art & Design | April 26, 2018 |
| 7 | Infinite Painter | ART_AND_DESIGN | 4.1 | 36815 | 29M | 1,000,000+ | Free | 0 | Everyone | Art & Design | June 14, 2018 |
| 8 | Garden Coloring Book | ART_AND_DESIGN | 4.4 | 13791 | 33M | 1,000,000+ | Free | 0 | Everyone | Art & Design | September 20, 2017 |
| 9 | Kids Paint Free - Drawing Fun | ART_AND_DESIGN | 4.7 | 121 | 3.1M | 10,000+ | Free | 0 | Everyone | Art & Design;Creativity | July 3, 2018 |

Так как это уже другой датасет, необходимо проверить его на нулевые значения.

In [32]:

```
data2.dtypes
```

Out[32]:

```
App                object
Category           object
Rating            float64
Reviews            object
Size               object
Installs           object
Type               object
Price              object
Content Rating     object
Genres             object
```

```
Genres             object
Last Updated       object
Current Ver        object
Android Ver        object
dtype: object
```

In [33]:

```
data2.isnull().sum()
```

Out[33]:

```
App                  0
Category             0
Rating            1474
Reviews              0
Size                 0
Installs             0
Type                 1
Price                0
Content Rating       1
Genres               0
Last Updated         0
Current Ver          8
Android Ver          3
dtype: int64
```

В пункте **"Category"** нет ни одного нулевого значения. Именно поэтому далее я буду рассматривать его. В этой колонке описывается категория, к которой относится приложение.

In [34]:

```
data2.shape
```

Out[34]:

```
(10841, 13)
```

In [35]:

```
cat_data = data2[['Category']]
```

In [36]:

```
print(data2['Category'].unique().size)
data2['Category'].unique()
```

```
34
```

Out[36]:

```
array(['ART_AND_DESIGN', 'AUTO_AND_VEHICLES', 'BEAUTY',
       'BOOKS_AND_REFERENCE', 'BUSINESS', 'COMICS', 'COMMUNICATION',
       'DATING', 'EDUCATION', 'ENTERTAINMENT', 'EVENTS', 'FINANCE',
       'FOOD_AND_DRINK', 'HEALTH_AND_FITNESS', 'HOUSE_AND_HOME',
       'LIBRARIES_AND_DEMO', 'LIFESTYLE', 'GAME', 'FAMILY', 'MEDICAL',
       'SOCIAL', 'SHOPPING', 'PHOTOGRAPHY', 'SPORTS', 'TRAVEL_AND_LOCAL',
       'TOOLS', 'PERSONALIZATION', 'PRODUCTIVITY', 'PARENTING', 'WEATHER',
       'VIDEO_PLAYERS', 'NEWS_AND_MAGAZINES', 'MAPS_AND_NAVIGATION',
       '1.9'], dtype=object)
```

Видно, что всего уникальных значений у этого признака **- 34.** Следовательно, этот признак можно **закодировать целочисленными значениями.**

In [37]:

```
from sklearn.preprocessing import LabelEncoder, OneHotEncoder
```

In [38]:

```
le = LabelEncoder()
```

```
cat_enc_le = le.fit_transform(data2[['Category']])
```

```
/Users/da.karpov/opt/anaconda3/lib/python3.9/site-packages/sklearn/preprocessing/_label.py:115: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
```

In [39]:

```
np.unique(cat_enc_le)
```

Out[39]:

```
array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16,
       17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33])
```

In [40]:

```
le.inverse_transform([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16,
       17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33])
```

Out[40]:

```
array(['1.9', 'ART_AND_DESIGN', 'AUTO_AND_VEHICLES', 'BEAUTY',
       'BOOKS_AND_REFERENCE', 'BUSINESS', 'COMICS', 'COMMUNICATION',
       'DATING', 'EDUCATION', 'ENTERTAINMENT', 'EVENTS', 'FAMILY',
       'FINANCE', 'FOOD_AND_DRINK', 'GAME', 'HEALTH_AND_FITNESS',
       'HOUSE_AND_HOME', 'LIBRARIES_AND_DEMO', 'LIFESTYLE',
       'MAPS_AND_NAVIGATION', 'MEDICAL', 'NEWS_AND_MAGAZINES',
       'PARENTING', 'PERSONALIZATION', 'PHOTOGRAPHY', 'PRODUCTIVITY',
       'SHOPPING', 'SOCIAL', 'SPORTS', 'TOOLS', 'TRAVEL_AND_LOCAL',
       'VIDEO_PLAYERS', 'WEATHER'], dtype=object)
```

In [41]:

```
print(data2['Type'].unique().size)
data2['Type'].unique()
```

```
4
```

Out[41]:

```
array(['Free', 'Paid', nan, '0'], dtype=object)
```

Так как в типе есть одно пропущенное значение, я просто удалю строку, в которой оно содержится.

In [42]:

```
colsForDelExp = ['Type']
data_drop_exp = data2[colsForDelExp].dropna()
data_drop_exp.shape
```

Out[42]:

```
(10840, 1)
```

In [43]:

```
print(data_drop_exp['Type'].unique().size)
data_drop_exp['Type'].unique()
```

```
3
```

Out[43]:

```
array(['Free', 'Paid', '0'], dtype=object)
```

Теперь в данной колонке осталось только **3** значения: бесплатное **0** и платное.

In [44]:

```
ohe = OneHotEncoder()
```

```
cat_enc_ohe = ohe.fit_transform(data_drop_exp[['Type']])
```

In [45]:

```
data_drop_exp[['Type']].shape
```

Out[45]:

```
(10840, 1)
```

In [46]:

```
cat_enc_ohe.shape
```

Out[46]:

```
(10840, 3)
```

In [47]:

```
cat_enc_ohe.todense()[7030:7040]
```

Out[47]:

```
matrix([[0., 1., 0.],
        [0., 1., 0.],
        [0., 1., 0.],
        [0., 1., 0.],
        [0., 1., 0.],
        [0., 1., 0.],
        [0., 1., 0.],
        [0., 0., 1.],
        [0., 1., 0.],
        [0., 1., 0.]])
```

In [48]:

```
data2[['Type']][7030:7040]
```

Out[48]:

| | Type |
|---|---|
| **7030** | **Free** |
| **7031** | **Free** |
| **7032** | **Free** |
| **7033** | **Free** |
| **7034** | **Free** |
| **7035** | **Free** |
| **7036** | **Free** |
| **7037** | **Paid** |
| **7038** | **Free** |
| **7039** | **Free** |

In [49]:

```
pd.get_dummies(data_drop_exp[['Type']])[7030:7040]
```

Out[49]:

| | Type_0 | Type_Free | Type_Paid |
|---|---|---|---|
| **7030** | **0** | **1** | **0** |
| **7031** | **0** | **1** | **0** |
| **7032** | **0** | **1** | **0** |

| | Type_0 | Type_Free | Type_Paid |
|---|---|---|---|
| 7033 | 0 | 1 | 0 |
| 7034 | 0 | 1 | 0 |
| 7035 | 0 | 1 | 0 |
| 7036 | 0 | 1 | 0 |
| 7037 | 0 | 0 | 1 |
| 7038 | 0 | 1 | 0 |
| 7039 | 0 | 1 | 0 |

# Нормализация данных

In [50]:

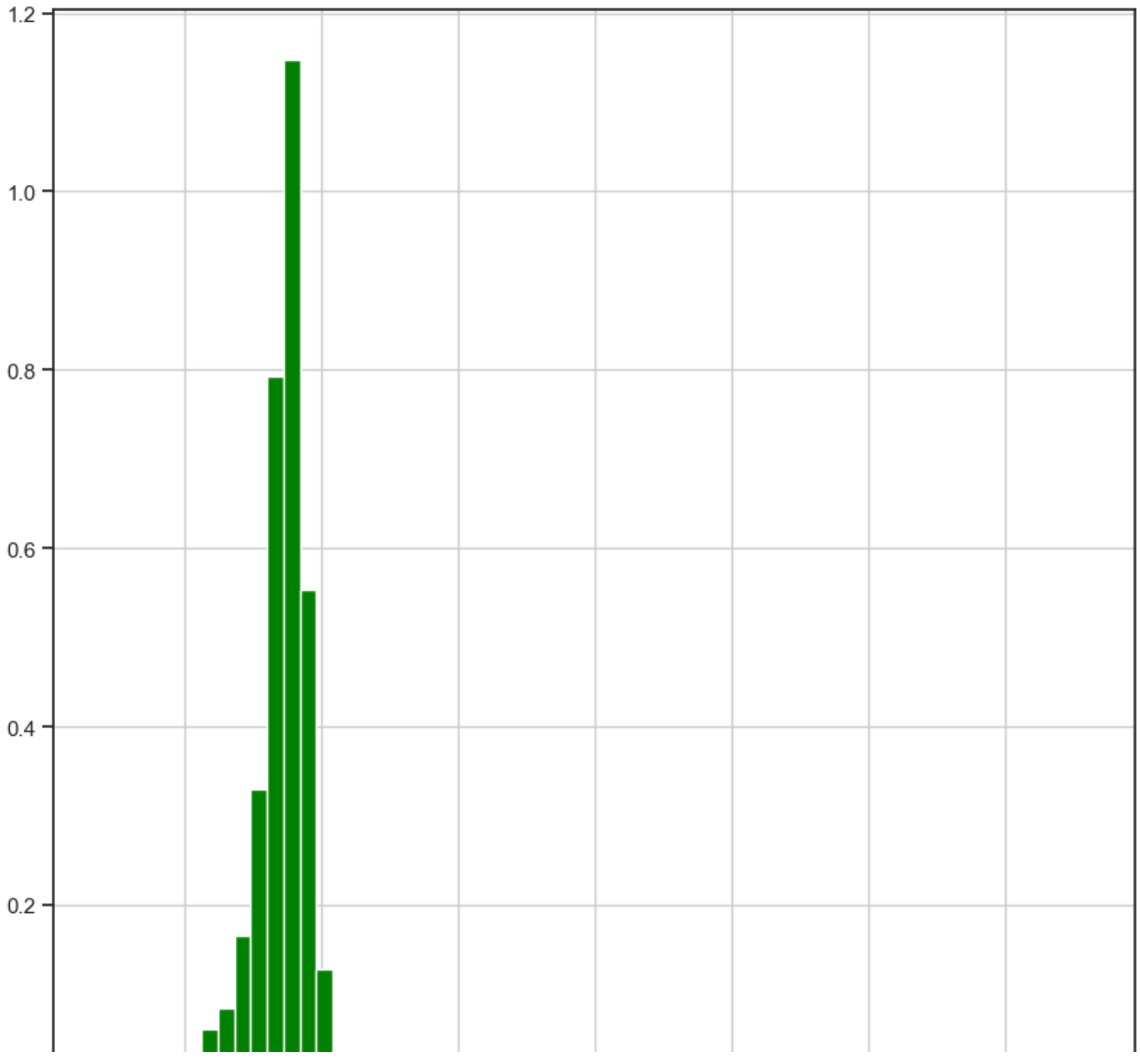
```
data2 = pd.read_csv('/Users/da.karpov/Desktop/МАГА/УЧЕБА/2 сем/ML_MSc_1course/датасеты/googleplaystore.csv', sep=",")
```

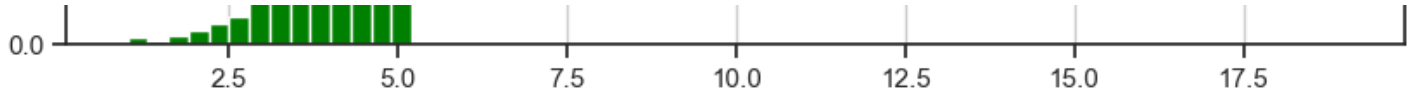
In [51]:

```
fig, ax = plt.subplots(figsize=(10,10))
data2['Rating'].hist(bins=60, ax=ax, density=True, color='green')
```

Out[51]:

<AxesSubplot:>



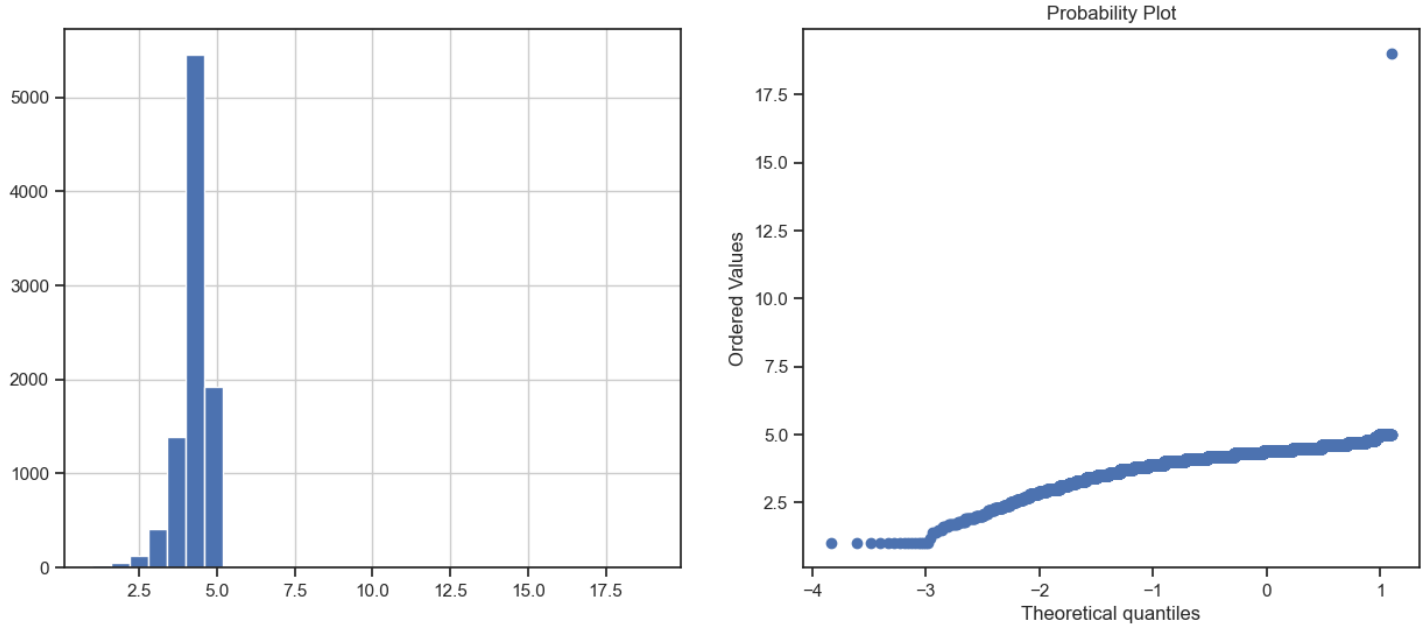



In [52]:

```
def diagnostic_plots(df, variable):
    plt.figure(figsize=(15,6))
    # гистограмма
    plt.subplot(1, 2, 1)
    df[variable].hist(bins=30)
    ## Q-Q plot
    plt.subplot(1, 2, 2)
    stats.probplot(df[variable], dist="norm", plot=plt)
    plt.show()
```

In [53]:

```
diagnostic_plots(data2, 'Rating')
```

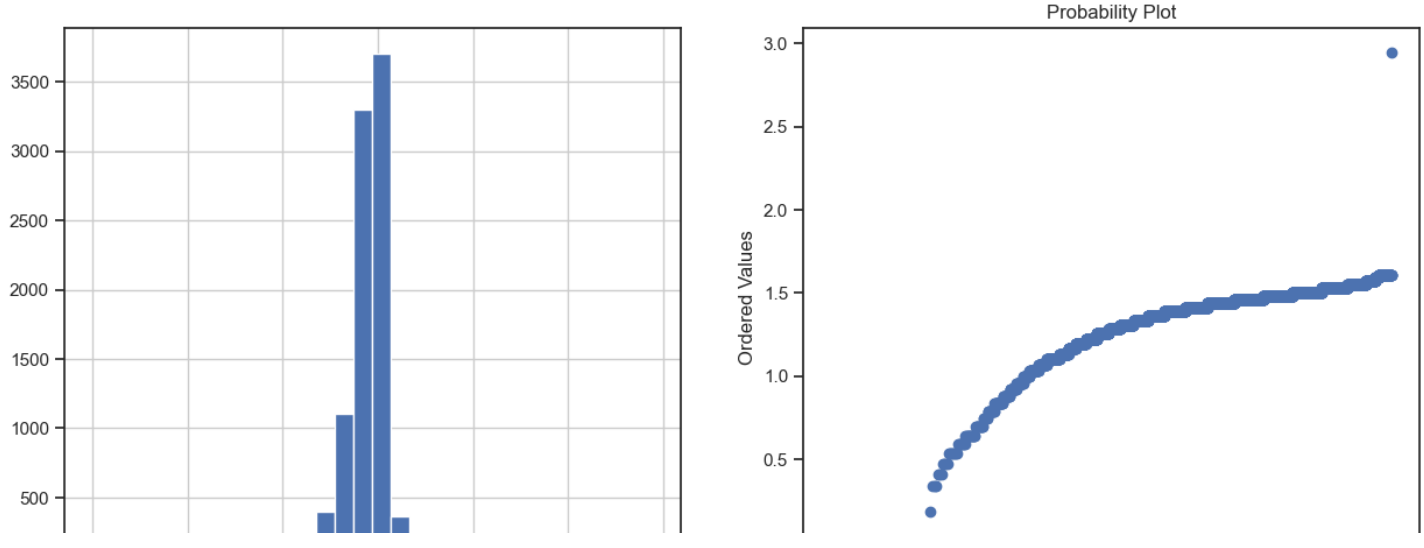


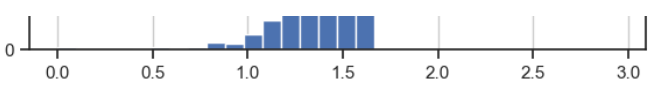

## Логарифмическое преобразование

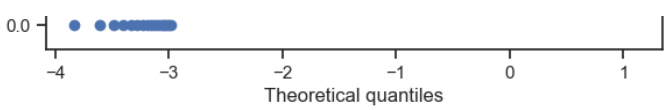
In [54]:

```
data2['RatingLog'] = np.log(data2['Rating'])
diagnostic_plots(data2, 'RatingLog')
```

```
/Users/da.karpov/opt/anaconda3/lib/python3.9/site-packages/pandas/core/arraylike.py:397:
RuntimeWarning: invalid value encountered in log
  result = getattr(ufunc, method)(*inputs, **kwargs)
```



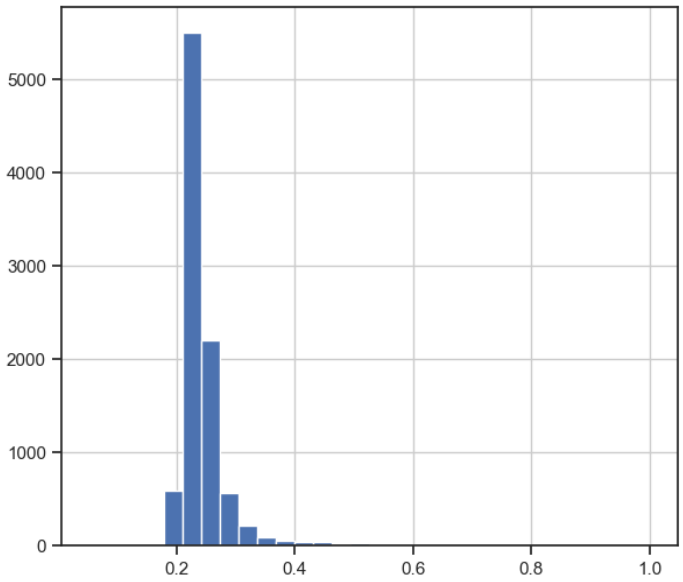


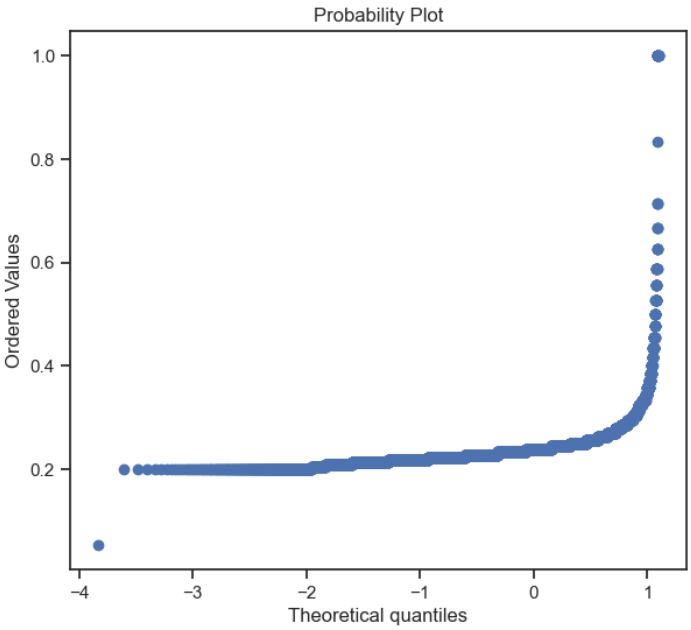




## Обратное преобразование

In [55]:

```
data2['RatingRev'] = 1/(data2['Rating'])
diagnostic_plots(data2, 'RatingRev')
```

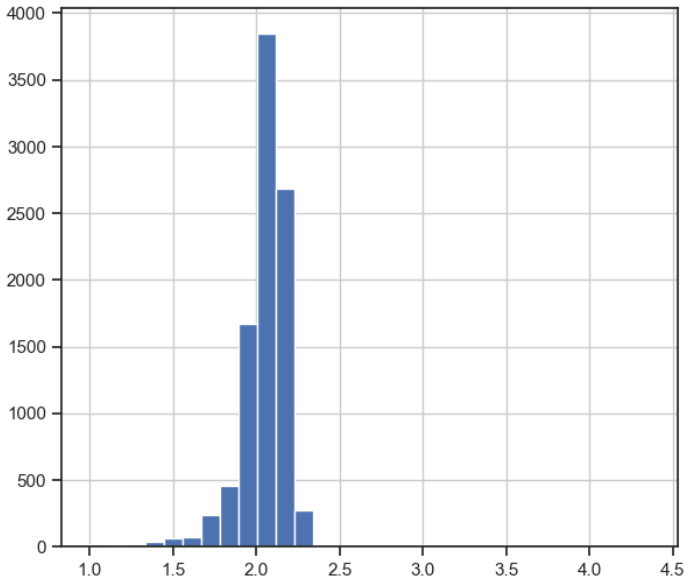


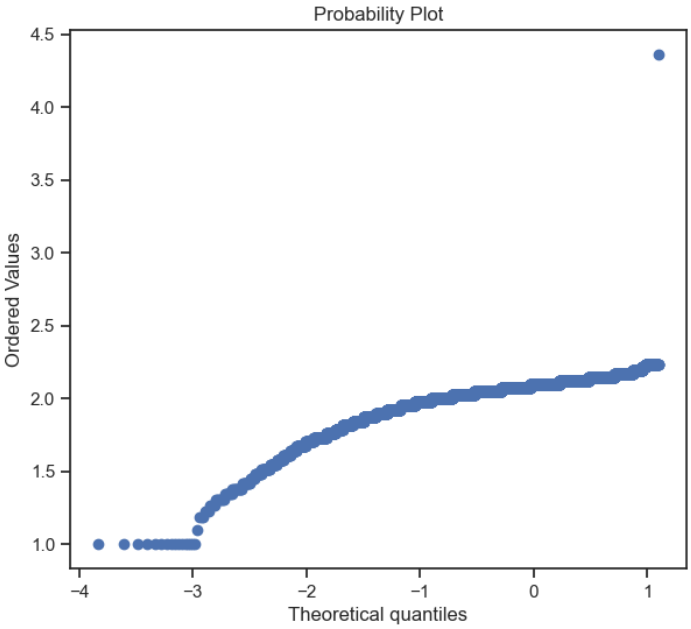




## Квадратный корень

In [56]:

```
data2['Ratingsqr'] = data2['Rating']**(1/2)
diagnostic_plots(data2, 'Ratingsqr')
```



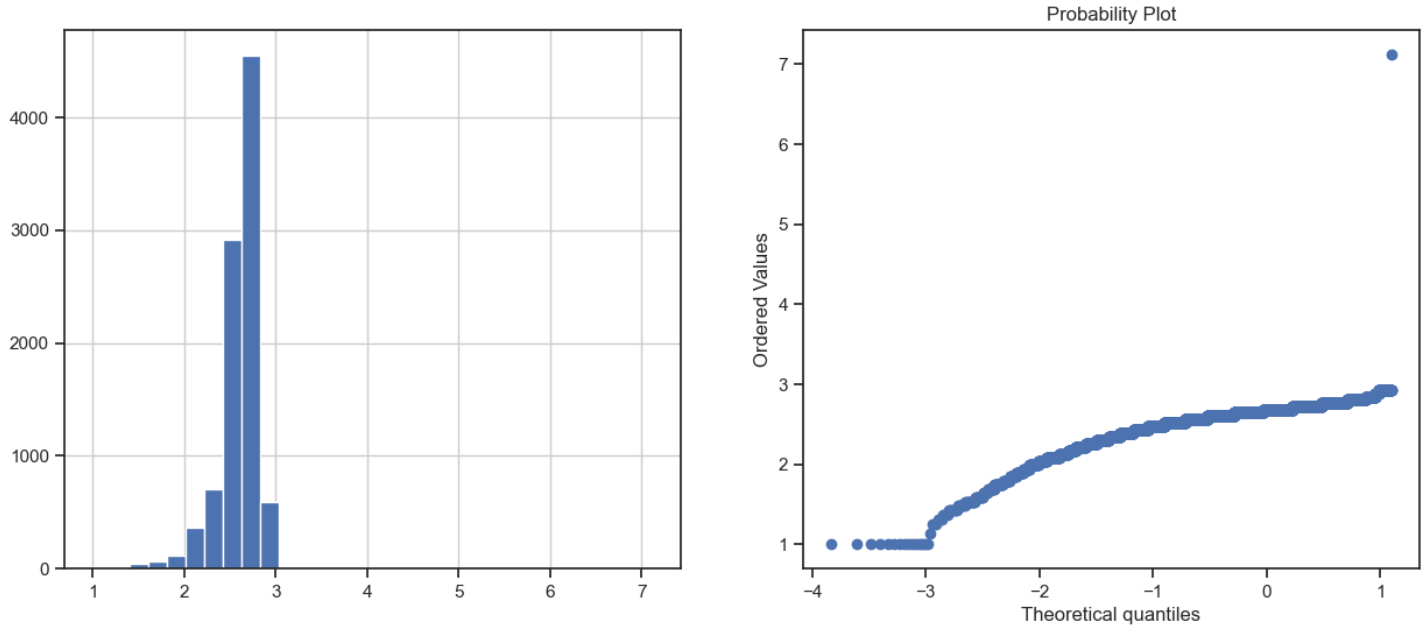




## Возведение в степень

In [57]:

```
data2['RatingExp1'] = data2['Rating']**(1/1.5)
```

```
diagnostic_plots(data2, 'RatingExp1')
```



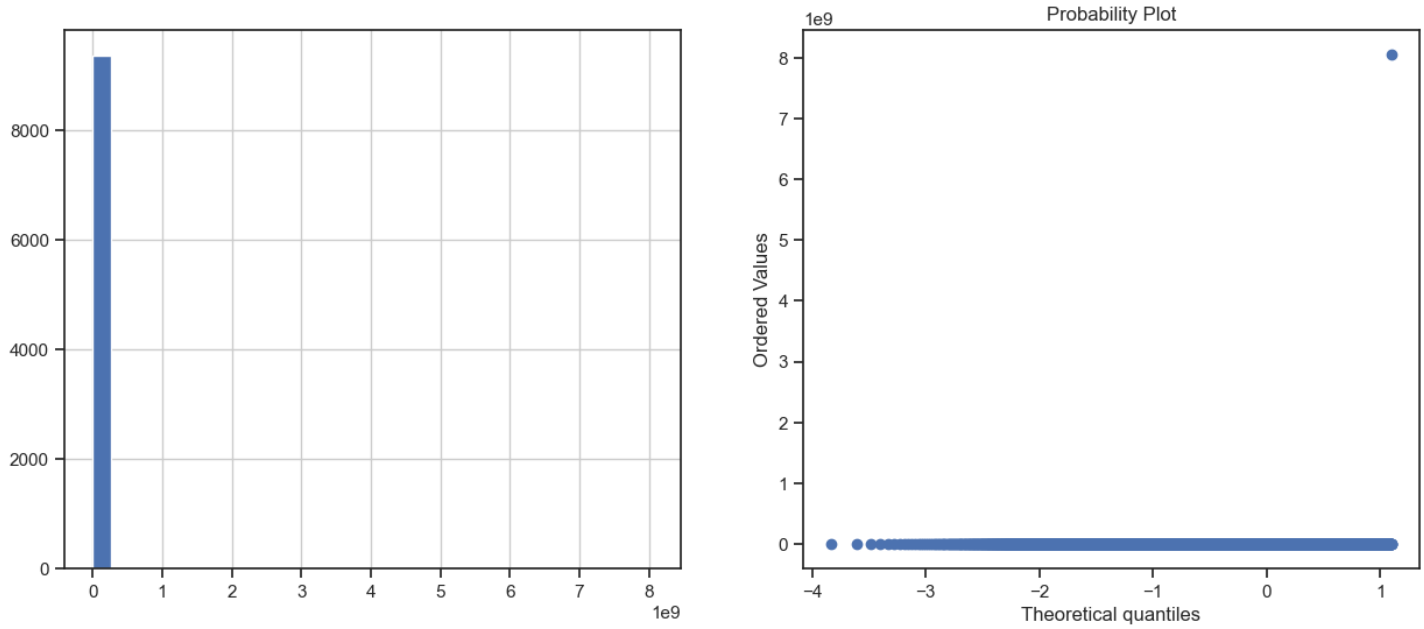

## Преобразование Бокса-Кокса

In [58]:

```
data2['RatingBoxcox'], param = stats.boxcox(data2['Rating'])
print('Оптимальное значение λ = {}'.format(param))
diagnostic_plots(data2, 'RatingBoxcox')
```

```
/Users/da.karpov/opt/anaconda3/lib/python3.9/site-packages/scipy/stats/_morestats.py:913:
RuntimeWarning: invalid value encountered in log
  logdata = np.log(data)
/Users/da.karpov/opt/anaconda3/lib/python3.9/site-packages/scipy/stats/_morestats.py:924:
RuntimeWarning: invalid value encountered in log
  return (lmb - 1) * np.sum(logdata, axis=0) - N/2 * np.log(variance)
```

```
Оптимальное значение λ = 8.472135811722177
```



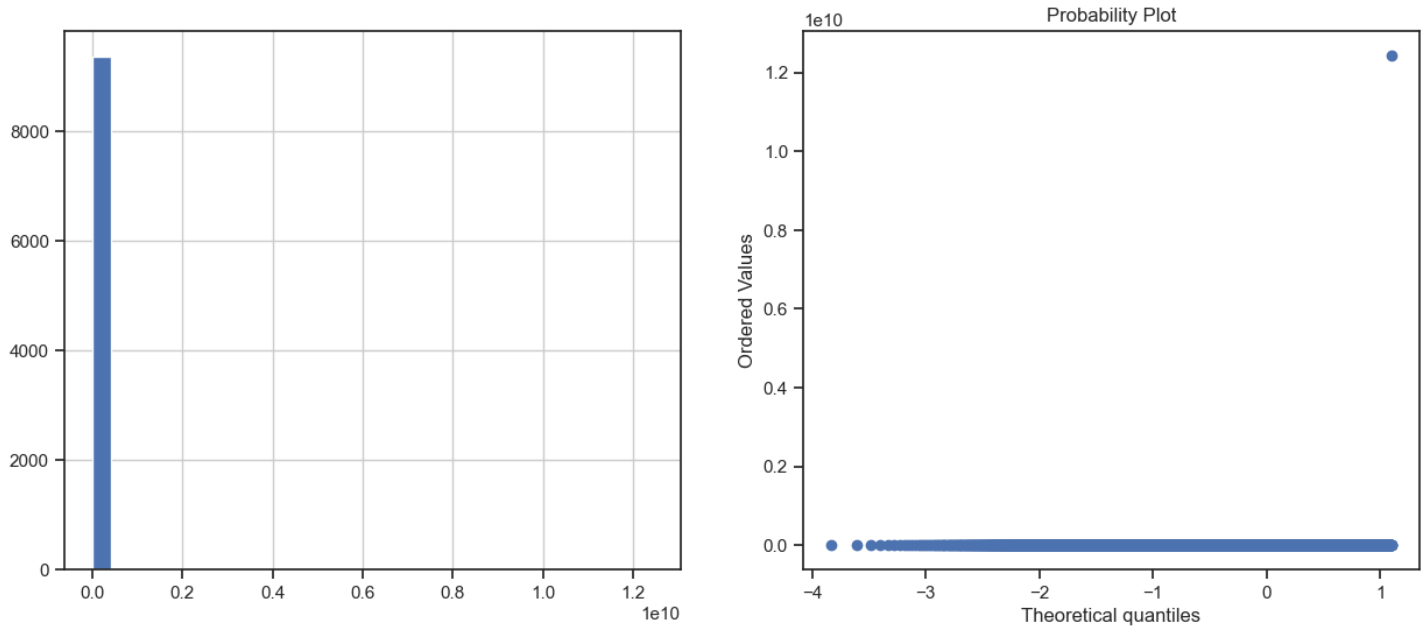

## Преобразование Йео-Джонсона

In [59]:

```
# Необходимо преобразовать данные к действительному типу
data2['Rating'] = data2['Rating'].astype('float')
```

```
data2['RatingYeojohnson'], param = stats.yeojohnson(data2['Rating'])
print('Оптимальное значение λ = {}'.format(param))
diagnostic_plots(data2, 'RatingYeojohnson')
```

```
Оптимальное значение λ = 8.472135811722177
```

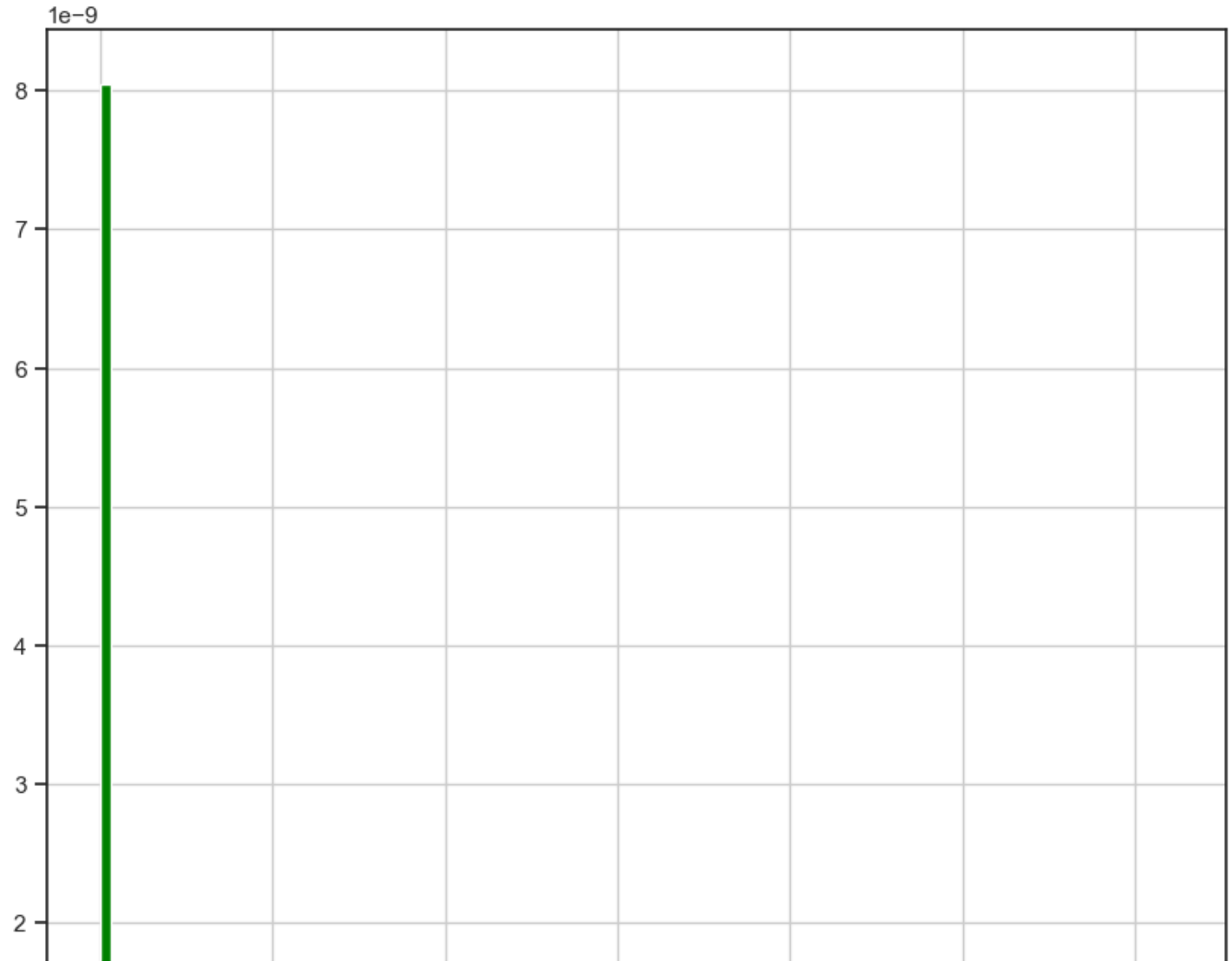


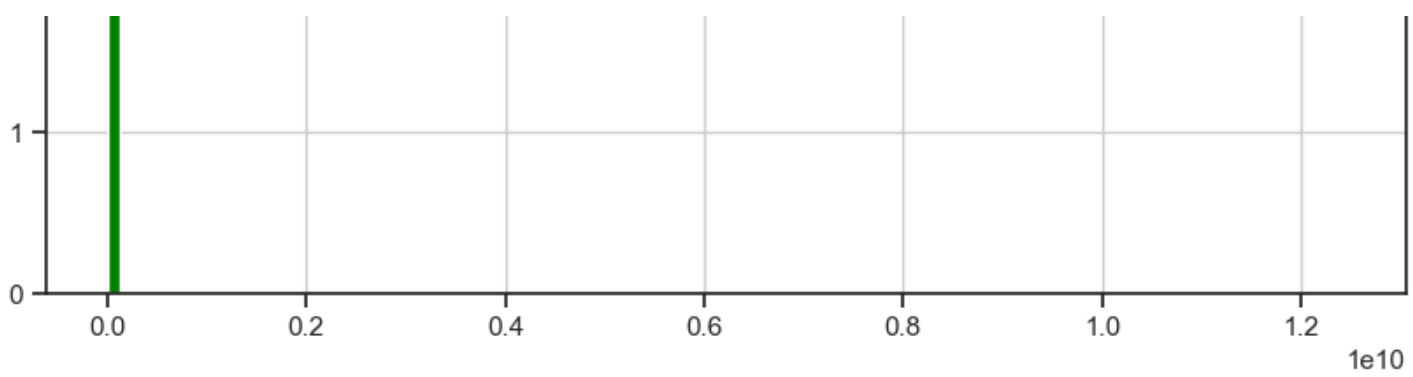

In [60]:

```
fig, ax = plt.subplots(figsize=(10,10))
data2['RatingYeojohnson'].hist(bins=100, ax=ax, density=True, color='green')
```

Out[60]:

```
<AxesSubplot:>
```




1
0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1e10