Health Insurance Marketplace Data

In this exerice, I am doing some exploratory analysis (4 tasks) on the health insurance marketplace data. The *Health Insurance Marketplace Public Use Files* contain data on health and dental plans offered to individuals and small businesses through the US Health Insurance Marketplace. This data was originally prepared and released by the Centers for Medicare & Medicaid Services (CMS) (https://www.cms.gov/). Please read the CMS Disclaimer-User Agreement before using this data. Also, please refer to Centers for Medicare & Medicaid Services (https://www.cms.gov/cciio/resources/data-resources/marketplace-puf) (CMS) for data dictionaries of the fields in the data tables.

The data was published in Kaggle by US Department of Health and Human Services. There were some pre-processing steps done to the original data to facilitate analytics. In this exercise, we will use the version sourced from Kaggle. For your convenience, you only need to use the `rate.csv.tiny.zip` file.

In [1]:

```
# Loading all necessary libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt

# Configure visualisations
%matplotlib inline
```

Task 1 - Data Loading and Auditing

In [2]:

```
?pd.read_xml
```

In [3]:

```
# loading the data, doing an initial exploration of the data, and prin
#

df = pd.read_csv('rate.csv.tiny.zip')
df
```

Out[3]:

	BusinessYear	StateCode	IssuerId	SourceName	VersionNum	ImportDate	IssuerId2
0	2015	AZ	98971	HIOS	7	2014-12-10 11:54:40	98971
1	2015	FL	16842	HIOS	6	2015-05-20 14:11:45	16842
2	2014	LA	19636	HIOS	8	2014-01-21 08:29:49	19636
3	2015	OH	28162	SERFF	4	2014-09-11 12:10:19	28162
4	2016	IN	33380	HIOS	3	2015-08-26 09:56:12	33380
...	...	...	...	...	...	...	...
3173606	2014	GA	50988	HIOS	5	2013-09-12 11:27:35	50988
3173607	2015	WV	31274	SERFF	10	2015-01-22	31274

In [4]:

```
df.describe()
```

Out[4]:

	BusinessYear	IssuerId	VersionNum	IssuerId2	IndividualRate	IndividualTobac
count	3.173611e+06	3.173611e+06	3.173611e+06	3.173611e+06	3.173611e+06	1.2332
mean	2.015034e+03	5.249007e+04	6.863875e+00	5.249007e+04	4.127613e+03	5.4396
std	7.942372e-01	2.640836e+04	3.857042e+00	2.640836e+04	6.146090e+04	2.9539
min	2.014000e+03	1.004600e+04	1.000000e+00	1.004600e+04	0.000000e+00	5.9400
25%	2.014000e+03	3.021900e+04	4.000000e+00	3.021900e+04	2.929000e+01	3.3926
50%	2.015000e+03	4.953200e+04	6.000000e+00	4.953200e+04	2.914900e+02	4.6347
75%	2.016000e+03	7.652600e+04	9.000000e+00	7.652600e+04	4.790000e+02	6.8488
max	2.016000e+03	9.996900e+04	2.400000e+01	9.996900e+04	9.999990e+05	6.4989

In [5]:

```
# what are the columns in rate.csv?
df.columns
```

Out[5]:

```
Index(['BusinessYear', 'StateCode', 'IssuerId', 'SourceName', 'Versi
onNum',
       'ImportDate', 'IssuerId2', 'FederalTIN', 'RateEffectiveDate',
       'RateExpirationDate', 'PlanId', 'RatingAreaId', 'Tobacco', 'A
ge',
       'IndividualRate', 'IndividualTobaccoRate', 'Couple',
       'PrimarySubscriberAndOneDependent', 'PrimarySubscriberAndTwoD
ependents',
       'PrimarySubscriberAndThreeOrMoreDependents', 'CoupleAndOneDep
endent',
       'CoupleAndTwoDependents', 'CoupleAndThreeOrMoreDependents',
       'RowNumber'],
      dtype='object')
```

```
In [6]: # what are the variable types of columns in rate.csv?
        df.dtypes
```

```
Out[6]: BusinessYear                                  int64
        StateCode                                    object
        IssuerId                                      int64
        SourceName                                   object
        VersionNum                                    int64
        ImportDate                                   object
        IssuerId2                                     int64
        FederalTIN                                   object
        RateEffectiveDate                            object
        RateExpirationDate                           object
        PlanId                                       object
        RatingAreaId                                 object
        Tobacco                                      object
        Age                                          object
        IndividualRate                              float64
        IndividualTobaccoRate                       float64
        Couple                                      float64
        PrimarySubscriberAndOneDependent            float64
        PrimarySubscriberAndTwoDependents           float64
        PrimarySubscriberAndThreeOrMoreDependents   float64
        CoupleAndOneDependent                       float64
        CoupleAndTwoDependents                      float64
        CoupleAndThreeOrMoreDependents              float64
        RowNumber                                     int64
        dtype: object
```

In [7]:

```
df.StateCode.value_counts()
```

Out[7]:

```
StateCode
FL    426205
SC    391130
MI    255256
WI    252354
OH    221386
TX    214921
IN    169086
PA    118543
GA    118214
IL    107704
NC     91914
AZ     87739
VA     81258
AL     49003
OK     46320
NJ     43438
LA     43226
IA     42809
WV     40674
TN     39158
MO     37251
MT     37114
KS     28477
ND     26210
AR     21417
UT     21323
AK     21086
NE     20213
SD     18834
ME     18348
ID     17421
OR     17161
WY     11529
MS     10705
NM      9417
NV      7893
NH      4504
DE      4019
HI       351
Name: count, dtype: int64
```

Extracting the following columns from the data, as we will only look into these columns for further tasks.

- `BusinessYear` : Year for which plan provides coverage to enrollees.
- `StateCode` : Two-character state abbreviation indicating the state where the plan is offered.
- `IssuerId` : Five-digit numeric code that identifies the issuer organization in the Health Insurance Oversight System (HIOS).
- `PlanId` : Fourteen-character alpha-numeric code that identifies an insurance plan within HIOS.
- `Age` : Categorical indicator of whether a subscriber's age is used to determine rate eligibility for the insurance plan.

- `IndividualRate` : Dollar value for the insurance premium cost applicable to a nontobacco user for the insurance plan in a rating area, or to a general subscriber if there is no tobacco preference.
- `IndividualTobaccoRate` : Dollar value for the insurance premium cost applicable to a tobacco user for the insurance plan in a rating area.

In [8]:
```
# extract columns of interest
rate = df[['BusinessYear', 'StateCode', 'IssuerId','PlanId','Age','Inc
rate.head()
```

Out[8]:

	BusinessYear	StateCode	IssuerId	PlanId	Age	IndividualRate	IndividualTobacco
0	2015	AZ	98971	98971AZ0020006	25	418.16	43
1	2015	FL	16842	16842FL0120044	42	271.34	32
2	2014	LA	19636	19636LA0220005	56	609.05	74
3	2015	OH	28162	28162OH0200010	34	34.11	
4	2016	IN	33380	33380IN0020005	59	465.52	69

In [9]:
```
# extract data from the year of interest
rate = rate[rate.BusinessYear == 2014]

# check the shape of the extracted dataframe
rate.shape
```

Out[9]:
```
(949129, 7)
```

In [10]:
```
# check some statistics about the variables (columns in the dataframe)
rate.describe()
```

Out[10]:

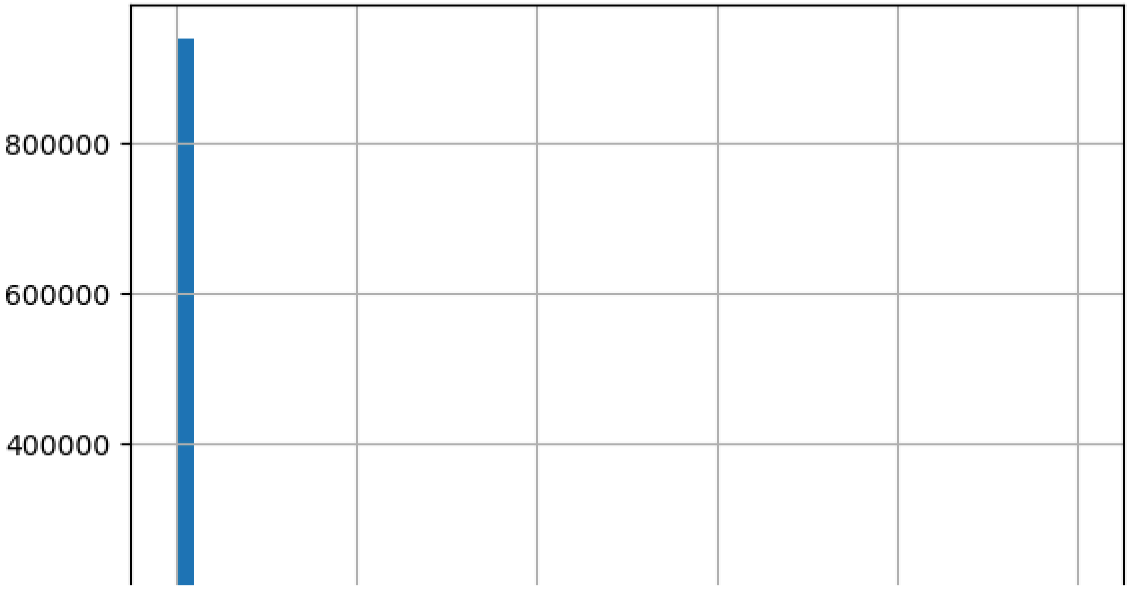
	BusinessYear	IssuerId	IndividualRate	IndividualTobaccoRate
count	949129.0	949129.000000	949129.000000	409076.000000
mean	2014.0	50942.830008	13021.135433	560.377404
std	0.0	26054.313142	111880.168965	335.069784
min	2014.0	10191.000000	0.000000	59.400000
25%	2014.0	30045.000000	32.150000	341.480000
50%	2014.0	49193.000000	296.610000	475.960000
75%	2014.0	71268.000000	480.830000	696.250000
max	2014.0	99969.000000	999999.000000	6498.950000

Auditing the data column `IndividualRate`.

Distribution of `IndividualRate` values is shown using boxplot and histogram.

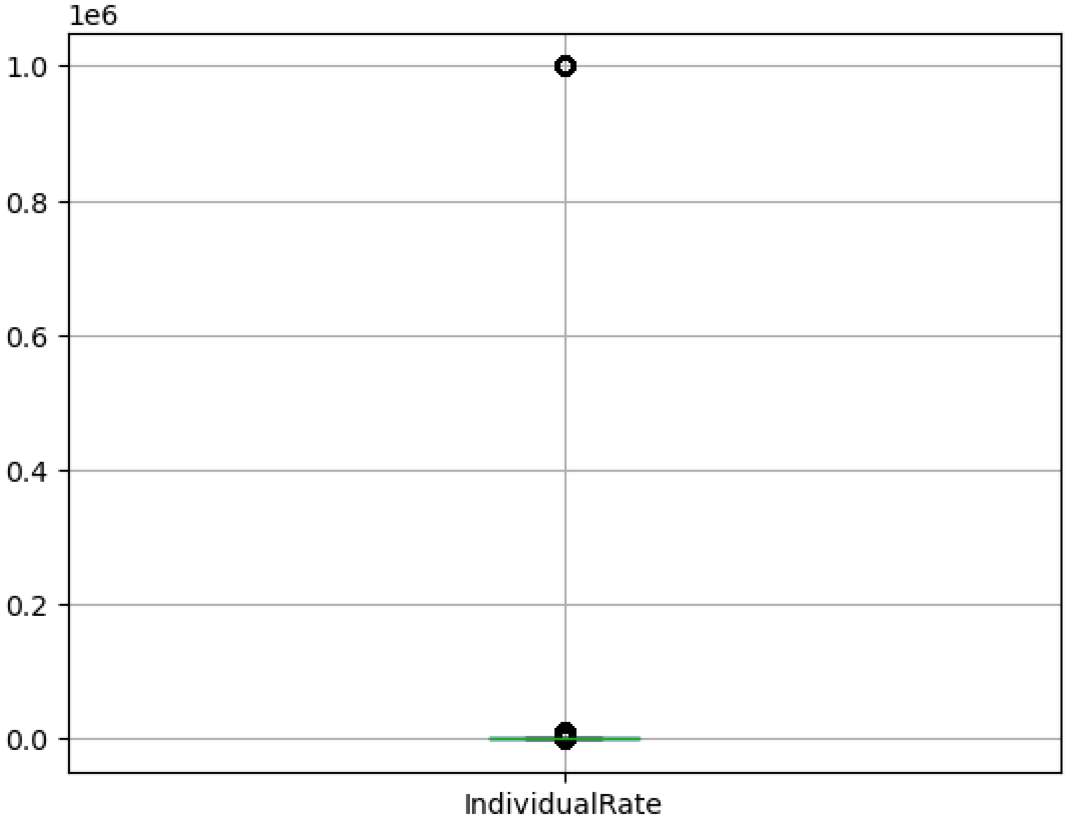
In [11]:
```
#df['IndividualRate'].describe()
rate['IndividualRate'].hist(bins=50)
```

Out[11]:
```
<Axes: >
```



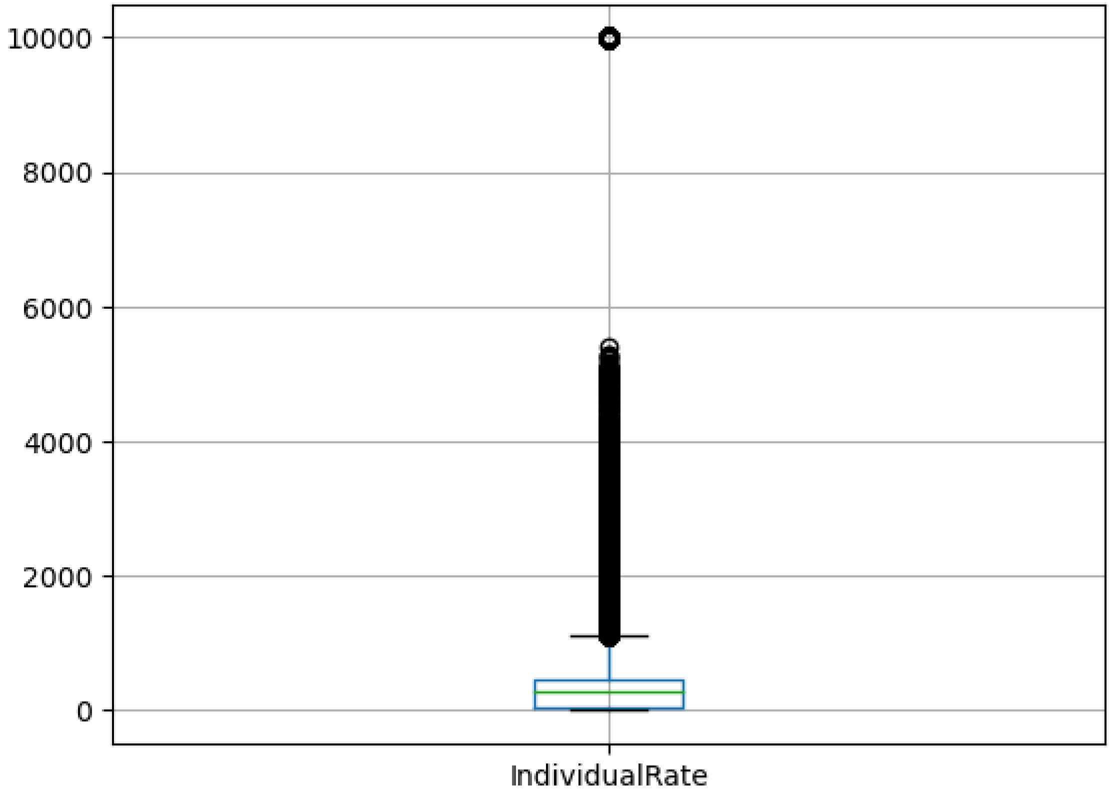
In [12]:
```
rate.boxplot(column = 'IndividualRate')
```

Out[12]:
```
<Axes: >
```



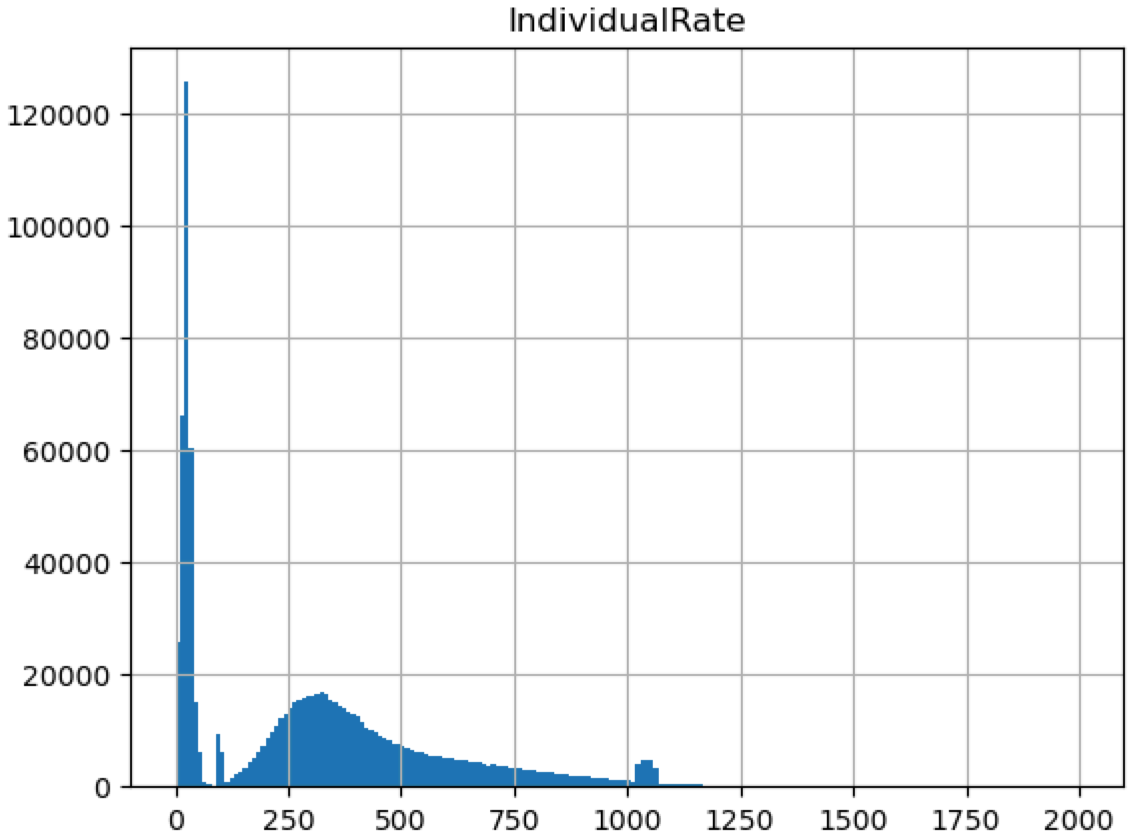
```
In [13]: rate[rate['IndividualRate'] < 10000].boxplot(column = 'IndividualRate'
```

```
Out[13]: <Axes: >
```



```
In [14]: rate[rate['IndividualRate'] < 2000].hist(column = 'IndividualRate', bi
```

```
Out[14]: array([[<Axes: title={'center': 'IndividualRate'}>]], dtype=object)
```



Task 2 - Carrier/Issuer and Plans Diversity Across Different States

In this subtask, I investigate the number of carriers and available plan options in different states. To do this, I have calculated some statistics on the number of unique issuers as well as the number of unique plans in different states.

Visualizing results (e.g., using barchart) and communicating my findings, e.g.,

- Which state has the largest/least number of health insurance issuers or plans?
- Use Google search (or any other information resource you prefer) to investigate whether this is related the population size of the state, e.g. whether there are more plans for where there are larger populations?

Task 2.1

Which state has the largest/least number of health insurance issuers or plans?

In [15]:

```
#states = rate.groupby('StateCode')['IssuerId']

states = rate.groupby('StateCode').agg(issuers = ('IssuerId','nunique'
print(states)
```

```
           issuers  plans
StateCode
AK               8     86
AL               9     92
AR              10    144
AZ              21    396
DE               9     64
FL              24    415
GA              16    185
IA              11    214
ID               8    149
IL              17    222
IN              11    316
KS               9    105
LA              12    170
ME               6     67
MI              25    350
MO              14    131
MS               6     51
MT               8    108
NC               8    114
ND               9    115
NE              10    156
NH               4     28
NJ              13    167
NM               6     65
OH              21    478
OK              12    188
PA              25    394
SC              11    124
SD               8     78
TN               8    129
TX              27    284
UT              12    122
VA              18    243
WI              22    497
WV               6     60
WY               6     58
```

In [16]:

```
states.dtypes
```

Out[16]:

```
issuers    int64
plans      int64
dtype: object
```

In [17]:

```
states.index
```

Out[17]:

```
Index(['AK', 'AL', 'AR', 'AZ', 'DE', 'FL', 'GA', 'IA', 'ID', 'IL',
'IN', 'KS',
       'LA', 'ME', 'MI', 'MO', 'MS', 'MT', 'NC', 'ND', 'NE', 'NH',
'NJ', 'NM',
       'OH', 'OK', 'PA', 'SC', 'SD', 'TN', 'TX', 'UT', 'VA', 'WI',
'WV', 'WY'],
      dtype='object', name='StateCode')
```

In [18]:

```
states = states.reset_index()
states
```

Out[18]:

	StateCode	issuers	plans
0	AK	8	86
1	AL	9	92
2	AR	10	144
3	AZ	21	396
4	DE	9	64
5	FL	24	415
6	GA	16	185
7	IA	11	214
8	ID	8	149
9	IL	17	222
10	IN	11	316
11	KS	9	105
12	LA	12	170
13	ME	6	67
14	MI	25	350
15	MO	14	131
16	MS	6	51
17	MT	8	108
18	NC	8	114
19	ND	9	115
20	NE	10	156
21	NH	4	28
22	NJ	13	167
23	NM	6	65
24	OH	21	478
25	OK	12	188
26	PA	25	394
27	SC	11	124
28	SD	8	78
29	TN	8	129
30	TX	27	284
31	UT	12	122
32	VA	18	243
33	WI	22	497
34	WV	6	60
35	WY	6	58

In [19]:

```
# sort the dataframe by number of issuer and number of plans

states.sort_values(by=['issuers','plans'])
```

Out[19]:

	StateCode	issuers	plans
21	NH	4	28
16	MS	6	51
35	WY	6	58
34	WV	6	60
23	NM	6	65
13	ME	6	67
28	SD	8	78
0	AK	8	86
17	MT	8	108
18	NC	8	114
29	TN	8	129
8	ID	8	149
4	DE	9	64
1	AL	9	92
11	KS	9	105
19	ND	9	115
2	AR	10	144
20	NE	10	156
27	SC	11	124
7	IA	11	214
10	IN	11	316
31	UT	12	122
12	LA	12	170
25	OK	12	188
22	NJ	13	167
15	MO	14	131
6	GA	16	185
9	IL	17	222
32	VA	18	243
3	AZ	21	396
24	OH	21	478
33	WI	22	497
5	FL	24	415
14	MI	25	350
26	PA	25	394
30	TX	27	284

In [20]:
```
states1 = rate.groupby(['StateCode','IssuerId'])['PlanId']
states1.count()
```

Out[20]:
```
StateCode  IssuerId
AK         21989         40
           38344       2506
           38536        115
           42507         74
           45858        122
                       ...
WY         37378        108
           38921         69
           47731        145
           53189        876
           83964        210
Name: PlanId, Length: 450, dtype: int64
```

In [21]:
```
# above task can also be done by:

states2 = rate.groupby(['StateCode','IssuerId']).agg(total = ('PlanId'
states2
```

Out[21]:

		total
StateCode	**IssuerId**	
AK	**21989**	40
	38344	2506
	38536	115
	42507	74
	45858	122
...	**...**	...
WY	**37378**	108
	38921	69
	47731	145
	53189	876
	83964	210

450 rows × 1 columns

In [22]:
```
states3 = rate.groupby('IssuerId').agg(total = ('PlanId','count'))
states3
```

Out[22]:
```
          total
IssuerId
   10191   2654
   10204    153
   10207    305
   11083   1515
   11103    388
     ...    ...
   99663    813
   99708    868
   99734     53
   99787   6172
   99969   4294

450 rows × 1 columns
```

Task 2.2

Whether there are more plans for states with larger populations? [*Hint: you might find the data in 'nst-est2016-01.xlsx', which contains the population by state for the year of 2016, to be useful. I provided a reformatted version, the original version can be found here (https://www2.census.gov/programs-surveys/popest/tables/2010-2016/state/totals/).*]

In [23]:
```
# reading population data

population_df = pd.read_excel('nst-est2016-01.xlsx', sheet_name='NST01
population_df.sample(10)
```

```
/Users/ujjwalkatyal/anaconda3/lib/python3.11/site-packages/openpyxl/
worksheet/_read_only.py:79: UserWarning: Unknown extension is not su
pported and will be removed
  for idx, row in parser.parse():
```

Out[23]:

	State	2010	2011	2012	2013	2014	2015	2016
20	MD	5788584	5843603	5889651	5931129	5967295	5994983	6016447
17	KY	4348662	4369354	4384799	4400477	4413057	4424611	4436974
27	NE	1830051	1842283	1855725	1868559	1881145	1893765	1907116
23	MN	5311147	5348562	5380285	5418521	5453109	5482435	5519952
38	PA	12712343	12744293	12771854	12781338	12790565	12791904	12784227
51	PR	3721525	3678732	3634488	3593077	3534874	3473181	3411307
26	MT	990641	997821	1005196	1014314	1022867	1032073	1042520
2	AZ	6408312	6467163	6549634	6624617	6719993	6817565	6931071
49	WI	5690263	5709640	5726177	5742854	5758377	5767891	5778708
50	WY	564513	567725	576765	582684	583642	586555	585501

In [24]:

```
# extract the data of interest

population_df = population_df[['State',2014]]
population_df.columns = ['State','Population']
population_df
```

Out[24]:

	State	Population
0	AL	4843214
1	AK	736705
2	AZ	6719993
3	AR	2966912
4	CA	38680810
5	CO	5349648
6	CT	3591873
7	DE	934948
8	DC	659005
9	FL	19888741
10	GA	10087231
11	HI	1416349
12	ID	1633532
13	IL	12867544
14	IN	6595233
15	IA	3108030
16	KS	2899360
17	KY	4413057
18	LA	4647880
19	ME	1330719
20	MD	5967295
21	MA	6749911
22	MI	9915767
23	MN	5453109
24	MS	2992400
25	MO	6060930
26	MT	1022867
27	NE	1881145
28	NV	2833013
29	NH	1328743
30	NJ	8925001
31	NM	2083024
32	NY	19718515
33	NC	9934399
34	ND	739904
35	OH	11594408
36	OK	3877499

	State	Population
37	OR	3968371
38	PA	12790565
39	RI	1054480
40	SC	4828430
41	SD	852561
42	TN	6544663
43	TX	26944751
44	UT	2941836
45	VT	626984
46	VA	8317372
47	WA	7054196
48	WV	1848514
49	WI	5758377
50	WY	583642
51	PR	3534874

In [25]:

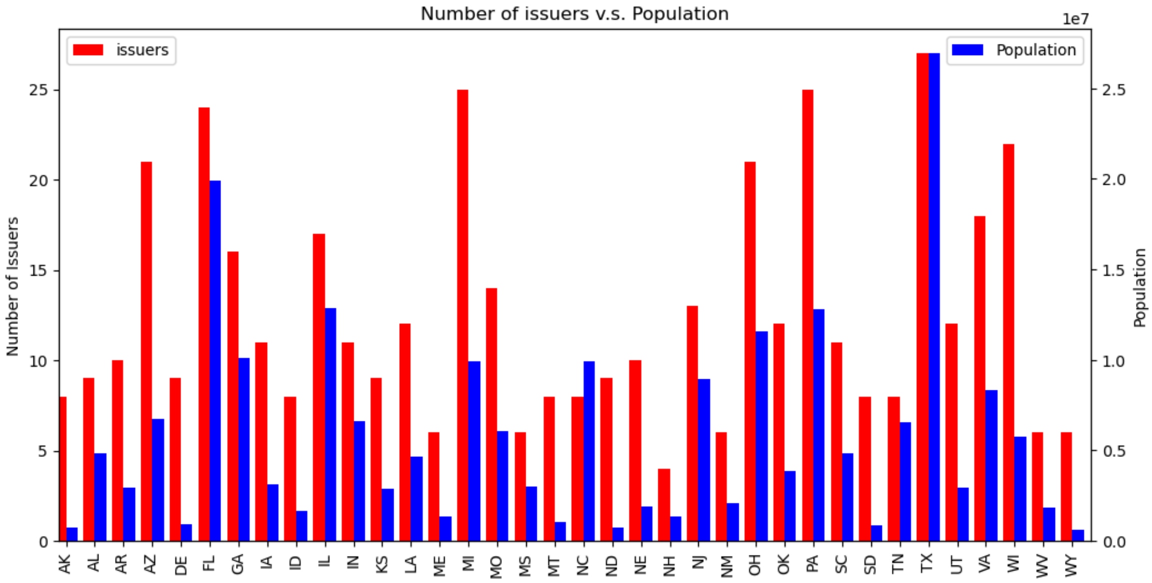
```
# merge two dataframes to compare population and issuers/plans

states_df = states.merge(population_df, left_on = 'StateCode', right_c
states_df.head()
```

Out[25]:

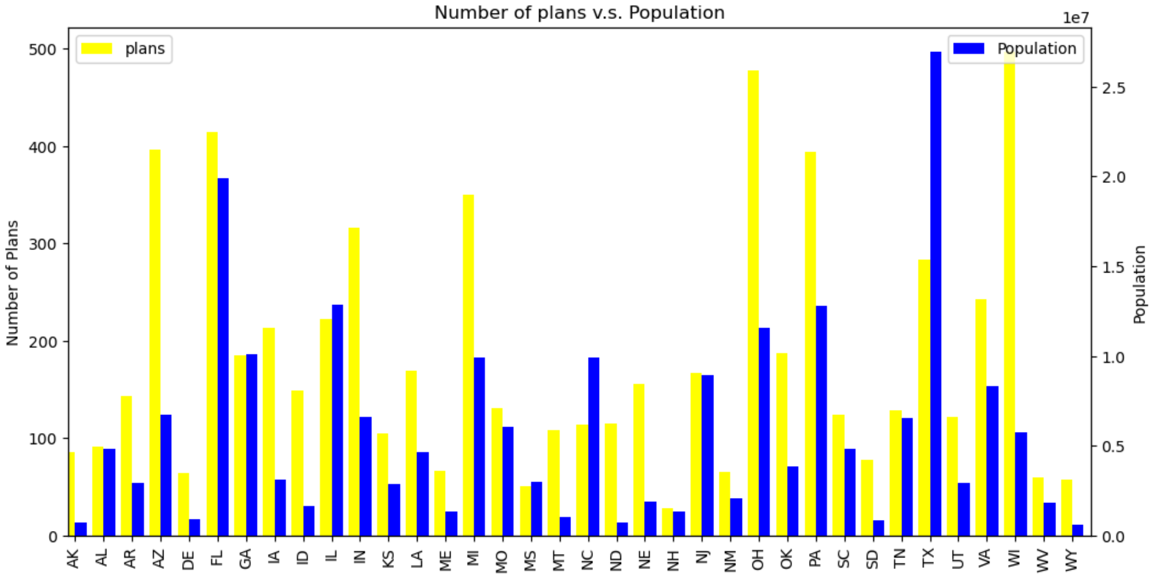
	StateCode	issuers	plans	State	Population
0	AK	8	86	AK	736705
1	AL	9	92	AL	4843214
2	AR	10	144	AR	2966912
3	AZ	21	396	AZ	6719993
4	DE	9	64	DE	934948

In [26]:

```
# Plot along the number of issuers and population side by side

fig = plt.figure() # Create matplotlib figure

ax = fig.add_subplot(111) # Create matplotlib axes, 111 means 1x1 gric
ax2 = ax.twinx() # Create another axes that shares the same x-axis as

width = 0.4 # define the width of the bar

states_df.issuers.plot(kind='bar', color='red', ax=ax, width=width, pc
states_df.Population.plot(kind='bar', color='blue', ax=ax2, width=widt

ax.set_xticklabels(states_df.State)
ax.set_ylabel('Number of Issuers')
ax.legend(loc = 'upper left')
ax2.set_ylabel('Population')
ax2.legend(loc = 'upper right')
plt.title('Number of issuers v.s. Population')
plt.show()
```



In [27]:
```
# Plot along the number of plans and population side by side

fig = plt.figure() # Create matplotlib figure

ax = fig.add_subplot(111) # Create matplotlib axes, 111 means 1x1 gric
ax2 = ax.twinx() # Create another axes that shares the same x-axis as

width = 0.4 # define the width of the bar

states_df.plans.plot(kind='bar', color='yellow', ax=ax, width=width, p
states_df.Population.plot(kind='bar', color='blue', ax=ax2, width=widt

ax.set_xticklabels(states_df.State)
ax.set_ylabel('Number of Plans')
ax.legend(loc = 'upper left')
ax2.set_ylabel('Population')
ax2.legend(loc = 'upper right')
plt.title('Number of plans v.s. Population')
plt.show()
```



Task 3: Carrier/Issuer and Plans Availability of Non-smoker vs. Smoker Across Different States

- How many issuers offer plans to non-smokers vs. smokers across different states? And,
- How about the number of available plans for non-smokers vs. smokers across different states?
- Do all states provided plans for tobacco users?

Note that non-smokers are paying on the `IndividualRate` , while smokers/tobacco users will need to pay the `IndividualTobaccoRate` . [*Hint: Therefore, a plan is available to a non-smoker only if the* `IndividualRate` *has an entry (not NaN, nor an invalid entry). Similarly, a plan is available to a smoker only if the* `IndividualTobaccoRate` *is valid. So we'll have to see how many plans contain valid values in each case.*]

Task 3.1

How many issuers offer plans to non-smokers vs. smokers across different states?

In [28]:
```
rate.IndividualTobaccoRate.isna().sum()
```

Out[28]:
```
540053
```

In [29]:
```
rate['Smoker'] = rate['IndividualTobaccoRate'].apply(lambda x: True if
rate['Smoker'].value_counts()
```

Out[29]:
```
Smoker
False    540053
True     409076
Name: count, dtype: int64
```

In [30]:
```
rate.IndividualRate.isna().sum()
```

Out[30]:
```
0
```

In [31]:
```
# assuming the plan is not available for non-smokers if individual rat

rate['Non-smoker'] = rate['IndividualRate'].apply(lambda x: True if x<
rate['Non-smoker'].value_counts()
```

Out[31]:
```
Non-smoker
True     935424
False     13705
Name: count, dtype: int64
```

In [32]:
```
rate.head()
```

Out[32]:

	BusinessYear	StateCode	IssuerId	PlanId	Age	IndividualRate	IndividualTobacc
2	2014	LA	19636	19636LA0220005	56	609.05	7
7	2014	IN	50816	50816IN0110050	52	646.50	9
9	2014	FL	30115	30115FL0050001	59	33.47	
21	2014	SC	49532	49532SC0380009	37	297.64	3
24	2014	IN	85320	85320IN0010060	31	384.82	4

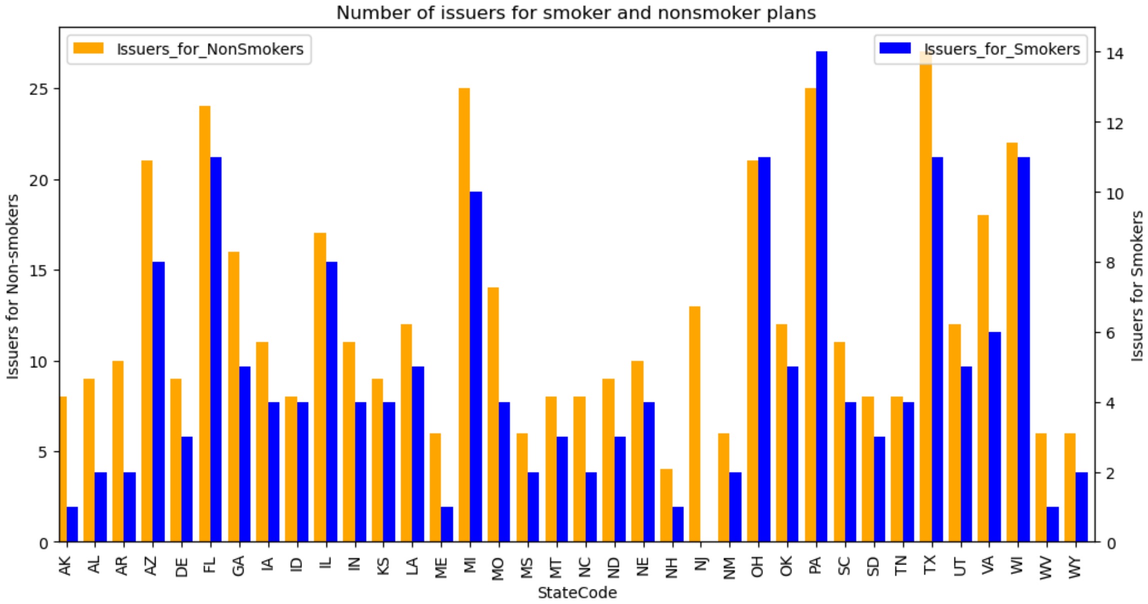
In [33]:
```
agg_result = rate.groupby('StateCode').apply(lambda x: pd.Series(dict(
Issuers_for_NonSmokers = x[x['Non-smoker']]['IssuerId'].nunique(),
Issuers_for_Smokers = x[x['Smoker']]['IssuerId'].nunique(),
Issuers_for_both = len([s for s in x[x['Smoker']]['IssuerId'].unique()
                           ))))
agg_result
```

Out[33]:

	Issuers_for_NonSmokers	Issuers_for_Smokers	Issuers_for_both
StateCode			
AK	8	1	1
AL	9	2	2
AR	10	2	2
AZ	21	8	8
DE	9	3	3
FL	24	11	11
GA	16	5	5
IA	11	4	4
ID	8	4	4
IL	17	8	8
IN	11	4	4
KS	9	4	4
LA	12	5	5
ME	6	1	1
MI	25	10	10
MO	14	4	4
MS	6	2	2
MT	8	3	3
NC	8	2	2
ND	9	3	3
NE	10	4	4
NH	4	1	1
NJ	13	0	0
NM	6	2	2
OH	21	11	11
OK	12	5	5
PA	25	14	14
SC	11	4	4
SD	8	3	3
TN	8	4	4
TX	27	11	11
UT	12	5	5
VA	18	6	6
WI	22	11	11
WV	6	1	1

	Issuers_for_NonSmokers	Issuers_for_Smokers	Issuers_for_both
StateCode			
WY	6	2	2

In [34]:
```
# Plot along the number of plans and population side by side

fig = plt.figure() # Create matplotlib figure

ax = fig.add_subplot(111) # Create matplotlib axes, 111 means 1x1 gric
ax2 = ax.twinx() # Create another axes that shares the same x-axis as

width = 0.4 # define the width of the bar

agg_result.Issuers_for_NonSmokers.plot(kind='bar', color='orange', ax=
agg_result.Issuers_for_Smokers.plot(kind='bar', color='blue', ax=ax2,

ax.set_xticklabels(agg_result.index)
ax.set_ylabel('Issuers for Non-smokers')
ax.legend(loc = 'upper left')
ax2.set_ylabel('Issuers for Smokers')
ax2.legend(loc = 'upper right')
plt.title('Number of issuers for smoker and nonsmoker plans')
plt.show()
```



Task 3.2

How many available plans for non-smokers vs. smokers across different states?

In [35]:

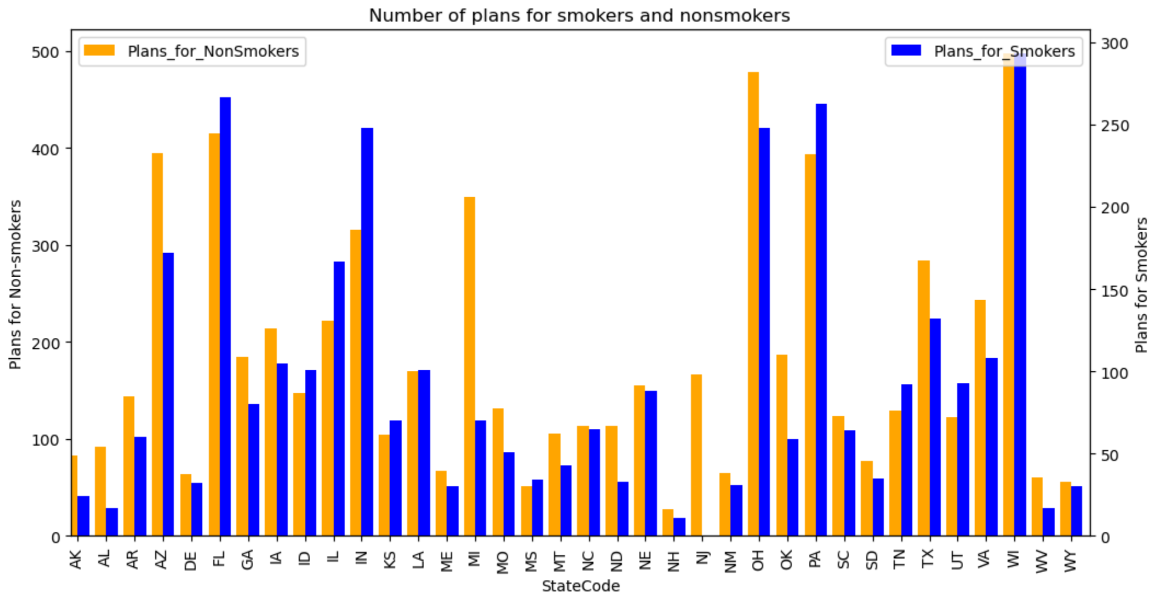
```
agg_result = rate.groupby('StateCode').apply(lambda x: pd.Series(dict(
Plans_for_NonSmokers = x[x['Non-smoker']]['PlanId'].nunique(),
Plans_for_Smokers = x[x['Smoker']]['PlanId'].nunique(),
Plans_for_both = len([s for s in x[x['Smoker']]['PlanId'].unique() if
                           ))))
agg_result
```

Out[35]:

	Plans_for_NonSmokers	Plans_for_Smokers	Plans_for_both
StateCode			
AK	83	24	24
AL	92	17	17
AR	144	60	60
AZ	395	172	172
DE	64	32	32
FL	415	267	267
GA	185	80	80
IA	214	105	105
ID	147	101	101
IL	222	167	167
IN	316	248	248
KS	104	70	70
LA	170	101	101
ME	67	30	30
MI	350	70	70
MO	131	51	51
MS	51	34	34
MT	106	43	43
NC	114	65	65
ND	114	33	33
NE	155	88	88
NH	28	11	11
NJ	167	0	0
NM	65	31	31
OH	478	248	248
OK	187	59	59
PA	394	263	263
SC	124	64	64
SD	77	35	35
TN	129	92	92
TX	284	132	132
UT	122	93	93
VA	243	108	108
WI	497	293	293
WV	60	17	17

StateCode	Plans_for_NonSmokers	Plans_for_Smokers	Plans_for_both
WY	56	30	30

In [36]:
```
# Plot along the number of plans and population side by side

fig = plt.figure() # Create matplotlib figure

ax = fig.add_subplot(111) # Create matplotlib axes, 111 means 1x1 gri
ax2 = ax.twinx() # Create another axes that shares the same x-axis as

width = 0.4 # define the width of the bar

agg_result.Plans_for_NonSmokers.plot(kind='bar', color='orange', ax=ax
agg_result.Plans_for_Smokers.plot(kind='bar', color='blue', ax=ax2, wi

ax.set_xticklabels(agg_result.index)
ax.set_ylabel('Plans for Non-smokers')
ax.legend(loc = 'upper left')
ax2.set_ylabel('Plans for Smokers')
ax2.legend(loc = 'upper right')
plt.title('Number of plans for smokers and nonsmokers')
plt.show()
```



Task 3.3

Do all states provide plans for tobacco users?

In [37]:
```
# from graphs above, we can conclude 'NJ' has 0 issuers/plans for smok

agg_result.loc['NJ']
```

Out[37]:
```
Plans_for_NonSmokers    167
Plans_for_Smokers         0
Plans_for_both            0
Name: NJ, dtype: int64
```

Task 4: Rates for non-smoker vs. smoker across different states

In this task, our focus is the cost/rates of insurance plans. Let us compare the average insurance rates of non-smokers vs. smokers in different states.

Visualize your results and communicate your findings, e.g., do non-smokers and smokers pay the same rate? If not, in general, what are the differences? Who pays higher rates?

In [38]:

```
con = (rate.IndividualRate > 0) & (rate.IndividualRate < 999999) # rul
average_rates = rate[con].groupby('StateCode').agg(Avg_NonSmoker_rate
average_rates
```

Out[38]:

```
           Avg_NonSmoker_rate  Avg_Smoker_rate
StateCode
       AK          683.664118       606.660287
       AL          292.116689       380.041816
       AR          187.881361       525.105899
       AZ          382.443180       541.843427
       DE          314.308516       532.064088
       FL          273.067946       505.538469
       GA          279.795165       582.243692
       IA          354.051612       528.016333
       ID          336.312451       521.410846
       IL          393.393717       508.769218
       IN          469.773866       762.608982
       KS          285.873518       373.417336
       LA          394.196412       538.564046
       ME          382.643484       615.298151
       MI          286.705275       540.092981
       MO          161.409512       485.745286
       MS          327.169414       559.800508
       MT          265.990873       526.850403
       NC          373.424935       476.402448
       ND          337.518592       424.306743
       NE          338.980641       500.738388
       NH          304.444693       464.976016
       NJ          431.422011              NaN
       NM          261.869135       399.143226
       OH          415.881444       524.070148
       OK          369.894600       417.382705
       PA          358.728541       454.234349
       SC          319.387994       513.742740
       SD          440.347467       532.582193
       TN          467.101196       401.589242
       TX          259.457601       484.588645
       UT          473.394081       344.416536
       VA          418.213589       775.210769
       WI          473.797134       598.512193
       WV          204.914917       480.428901
```

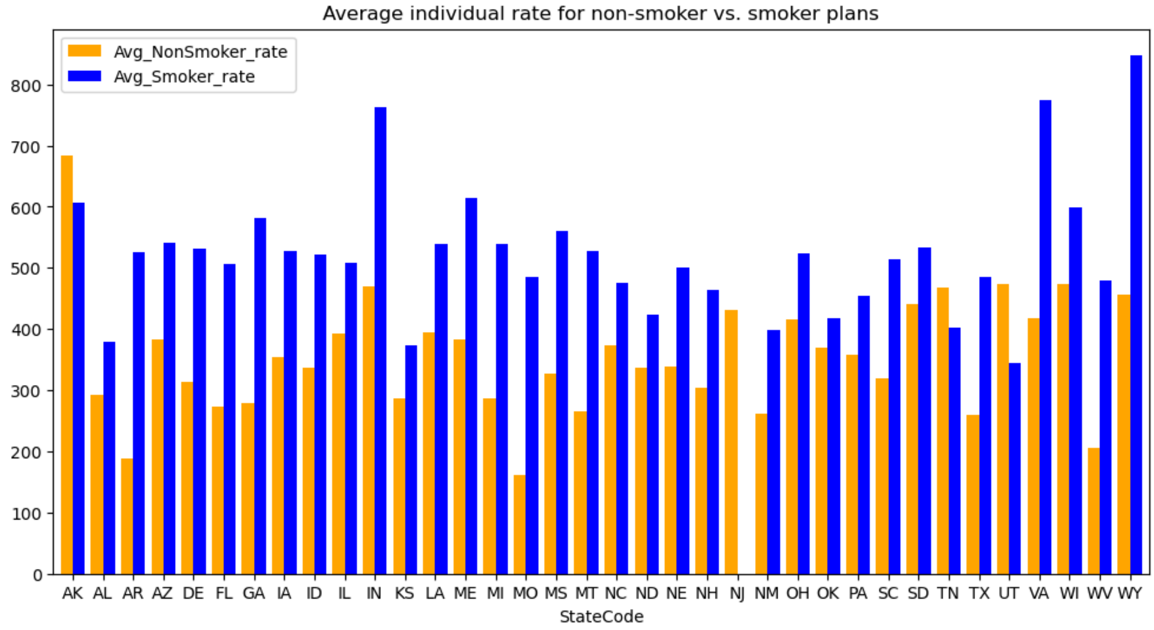
	Avg_NonSmoker_rate	Avg_Smoker_rate
StateCode		
WY	456.480950	848.233723

In [39]:

```
average_rates.plot.bar(
    rot=0,
    width=0.8,
    color=['orange','blue'],
    figsize=(12,6),
    title = "Average individual rate for non-smoker vs. smoker plans")
```

Out[39]:

```
<Axes: title={'center': 'Average individual rate for non-smoker vs.
smoker plans'}, xlabel='StateCode'>
```



In [40]:
```
# Comparing rates for plans available for both smokers and non-smokers

con = (rate.Smoker == True ) & (rate['Non-smoker'] == True)
average_rates = rate[con].groupby('StateCode').agg(Avg_NonSmoker_rate
average_rates
```

Out[40]:

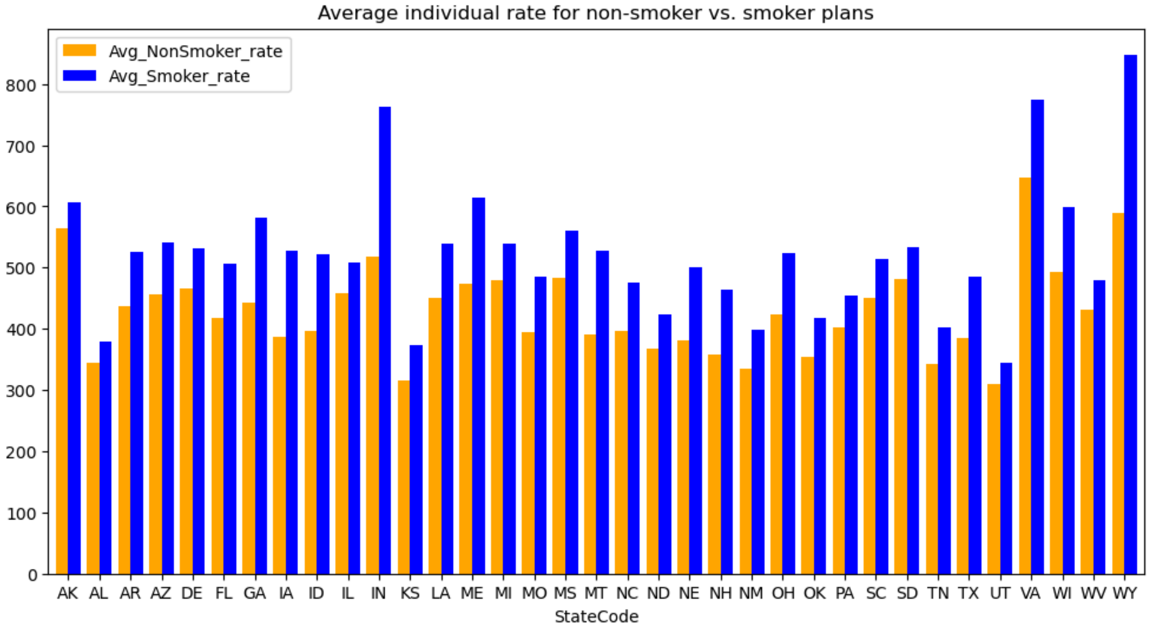
	Avg_NonSmoker_rate	Avg_Smoker_rate
StateCode		
AK	564.793062	606.660287
AL	345.499875	380.041816
AR	437.761672	525.105899
AZ	455.798356	541.843427
DE	465.689726	532.064088
FL	417.501342	505.538469
GA	442.319483	582.243692
IA	387.171724	528.016333
ID	395.687430	521.410846
IL	457.991153	508.769218
IN	518.701204	762.608982
KS	315.411053	373.417336
LA	450.009079	538.564046
ME	474.318551	615.298151
MI	478.789978	540.092981
MO	395.106503	485.745286
MS	483.508317	559.800508
MT	390.864851	526.850403
NC	397.001899	476.402448
ND	366.814721	424.306743
NE	380.863588	500.738388
NH	357.521220	464.976016
NM	335.105853	399.143226
OH	422.768607	524.070148
OK	355.124087	417.382705
PA	402.001204	454.234349
SC	451.198090	513.742740
SD	481.386609	532.582193
TN	341.955235	401.589242
TX	384.854816	484.588645
UT	309.000808	344.416536
VA	648.146206	775.210769
WI	492.772596	598.512193
WV	431.887361	480.428901
WY	589.798519	848.233723

In [41]:

```
average_rates.plot.bar(
    rot=0,
    width=0.8,
    color=['orange','blue'],
    figsize=(12,6),
    title = "Average individual rate for non-smoker vs. smoker plans")
```

Out[41]:

```
<Axes: title={'center': 'Average individual rate for non-smoker vs.
smoker plans'}, xlabel='StateCode'>
```



In [ ]: