jcorteza-eda

January 19, 2021

In [404]:
```
import pandas as pd
import numpy as np
import os
import json
import matplotlib.pyplot as plt
import seaborn as sns
import math
```

In [405]:
```
schlev_data = pd.read_csv('./data_sets/us_census/clean_district_data.csv')
schlev_data.head()
```

Out[405]:

	STATE	NAME_x	NCESID	YRDATA	TOTALREV	TFEDREV	\
0	AL	BALDWIN COUNTY SCHOOL DISTRICT	100270	10	260945	30989	
1	AL	CULLMAN COUNTY SCHOOL DISTRICT	101020	10	84449	13214	
2	AL	ELMORE COUNTY SCHOOL DISTRICT	101290	10	93950	16195	
3	AL	DOTHAN CITY SCHOOL DISTRICT	101230	10	84238	17439	
4	AL	BIRMINGHAM CITY SCHOOL DISTRICT	100390	10	291248	57696	

	FEDRCOMP	FEDRSPEC	FEDRNUTR	FEDROTHR	...	PPSPUPIL	PPSSTAFF	\
0	8795	7272	6023	8899	...	486	419	
1	3403	2906	3091	3814	...	433	319	
2	3076	6214	2693	4212	...	373	490	
3	5107	3146	3498	5688	...	508	451	
4	25318	8501	10947	12930	...	672	939	

	PPSGENAD	PPSSCHAD	DIVISION	REGION	MEAN INCOME	\
0	127	589	East South Central	South	64806	
1	113	614	East South Central	South	45295	
2	174	450	East South Central	South	65957	
3	149	557	East South Central	South	53714	
4	245	685	East South Central	South	42347	

	NAME_y	TOTAL_SCORES	PCT_PASS
0	BALDWIN COUNTY	2263	86.0
1	CULLMAN COUNTY	790	87.0
2	ELMORE COUNTY	894	84.0
3	DOTHAN CITY	760	87.0

```
          4  BIRMINGHAM CITY          2075      73.0

          [5 rows x 69 columns]
```

```
In [406]: schlev_data['TOTALREV'].describe()
```

```
Out[406]: count    1.497000e+03
          mean     3.478117e+05
          std      4.018539e+05
          min      6.994600e+04
          25%      1.441020e+05
          50%      2.218900e+05
          75%      3.757050e+05
          max      3.359206e+06
          Name: TOTALREV, dtype: float64
```

```
In [407]: schlev_data['PCTLTOT'].describe()
```

```
Out[407]: count    1497.000000
          mean       41.488444
          std        16.707048
          min         6.800000
          25%        29.600000
          50%        39.100000
          75%        52.100000
          max        93.300000
          Name: PCTLTOT, dtype: float64
```

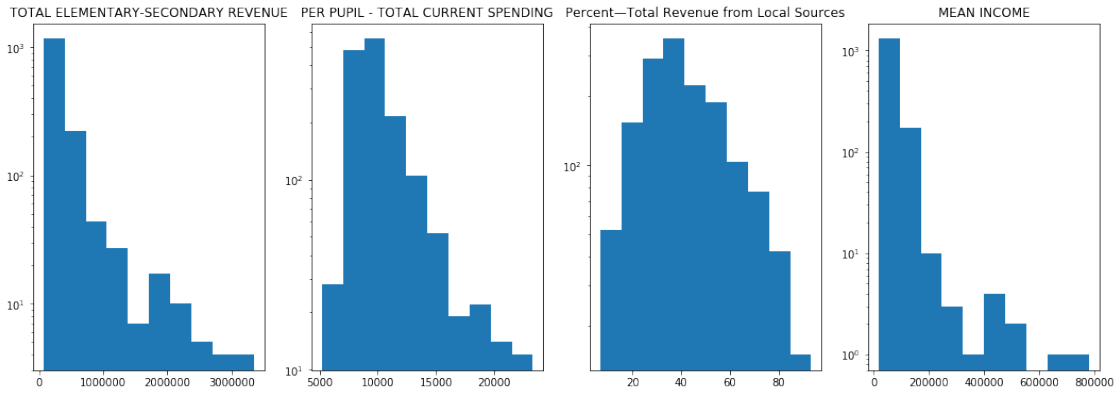
```
In [408]: schlev_data['PPCSTOT'].describe()
```

```
Out[408]: count     1497.000000
          mean     10234.140281
          std       2723.682643
          min       5195.000000
          25%       8486.000000
          50%       9498.000000
          75%      10928.000000
          max      23328.000000
          Name: PPCSTOT, dtype: float64
```

```
In [409]: schlev_data['MEAN INCOME'].describe()
```

```
Out[409]: count      1497.000000
          mean      72098.617234
          std       44653.645741
          min       17760.000000
          25%       54222.000000
          50%       64416.000000
          75%       78046.000000
          max      781796.000000
          Name: MEAN INCOME, dtype: float64
```

```
In [410]: fig, axes = plt.subplots(ncols=4)
          axes[0].hist(x=schlev_data['TOTALREV'], log=True)
          axes[0].set_title('TOTAL ELEMENTARY-SECONDARY REVENUE')
          axes[2].hist(x=schlev_data['PCTLTOT'], log=True)
          axes[2].set_title('PercentTotal Revenue from Local Sources')
          axes[1].hist(x=schlev_data['PPCSTOT'], log=True)
          axes[1].set_title('PER PUPIL - TOTAL CURRENT SPENDING')
          axes[3].hist(x=schlev_data['MEAN INCOME'], log=True)
          axes[3].set_title('MEAN INCOME')
          fig.set_size_inches(18, 6)
```



All the distributions are skewed right except for the percent of revenue from local sources which is more closely normally distributed.

```
In [411]: schlev_data.groupby('REGION').describe()['TOTALREV']
```

```
Out[411]:              count           mean            std       min        25%       50%  \
          REGION
          Midwest      461.0  219769.002169  111331.664744   75340.0  139643.00  185632.0
          Northeast     72.0  319763.944444  200601.410375  104154.0  172630.75  232968.0
          South        718.0  423721.137883  475195.141924   69946.0  143377.00  246452.0
          West         246.0  374413.662602  491532.577438   86163.0  156318.75  271513.5

                         75%        max
          REGION
          Midwest    267937.00   729047.0
          Northeast  533823.50   747268.0
          South      491956.75  2710577.0
          West       394804.75  3359206.0
```

```
In [412]: schlev_data.groupby('REGION').describe()['PPCSTOT']
```

```
Out[412]:              count          mean          std      min       25%       50%  \
          REGION
          Midwest      461.0  10796.206074  1706.197511   7374.0   9632.00  10416.0
```

```
Northeast   72.0  17667.861111  3271.937499  12352.0  14780.75  18104.5
South      718.0   9552.859331  2135.738491   7129.0   8315.25   8893.0
West       246.0   8993.569106  1908.151729   5195.0   7793.00   8567.0

                75%      max
REGION
Midwest    11640.00  17327.0
Northeast  20444.75  23328.0
South      10052.75  21974.0
West        9963.75  15596.0
```

```
In [413]: schlev_data.groupby('REGION').describe()['PCTLTOT']
```

```
Out[413]:            count       mean        std   min     25%    50%     75%   max
REGION
Midwest    461.0  41.085683  15.389311   8.2  29.700  37.80  50.600  81.5
Northeast   72.0  40.323611  27.263350   6.8  10.575  41.50  67.550  84.2
South      718.0  44.991643  15.115095  18.6  34.525  42.05  53.500  93.3
West       246.0  32.359350  15.979565   8.7  19.850  28.95  37.275  79.2
```

```
In [414]: schlev_data.groupby('REGION').describe()['MEAN INCOME']
```

```
Out[414]:            count          mean           std      min       25%      50%  \
REGION
Midwest    461.0  67421.954447  26821.071948  23527.0  51015.00  61208.0
Northeast   72.0  66188.833333  22804.326102  22871.0  48453.50  65018.0
South      718.0  73472.306407  51413.146534  20840.0  55656.75  64075.5
West       246.0  78582.914634  53282.596733  17760.0  60085.50  70714.0

                75%       max
REGION
Midwest    77880.00  157915.0
Northeast  82116.00  114096.0
South      75889.75  685559.0
West       84820.00  781796.0
```

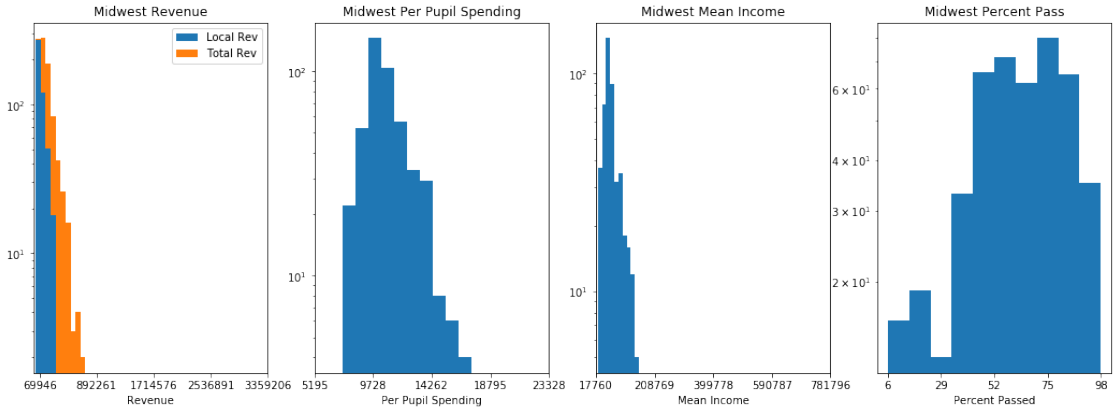
```
In [415]: schlev_data.groupby('REGION').describe()['PCT_PASS']
```

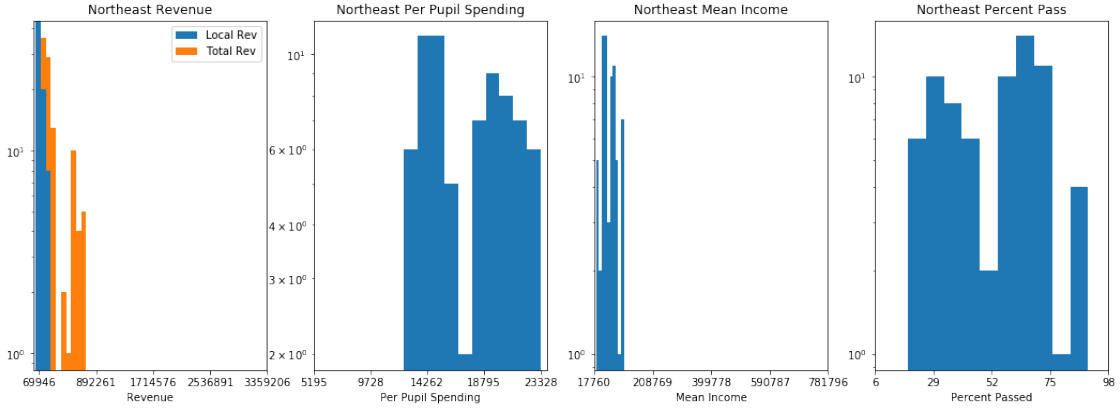
```
Out[415]:            count       mean        std   min   25%   50%     75%   max
REGION
Midwest    461.0  61.296095  20.927558   6.0  48.0  63.0  78.000  98.0
Northeast   72.0  53.000000  19.123026  19.0  36.0  56.5  68.000  90.0
South      718.0  64.142758  14.369871  21.0  55.0  64.0  75.000  96.0
West       246.0  52.635598  20.717153  12.0  32.0  55.0  69.875  94.0
```

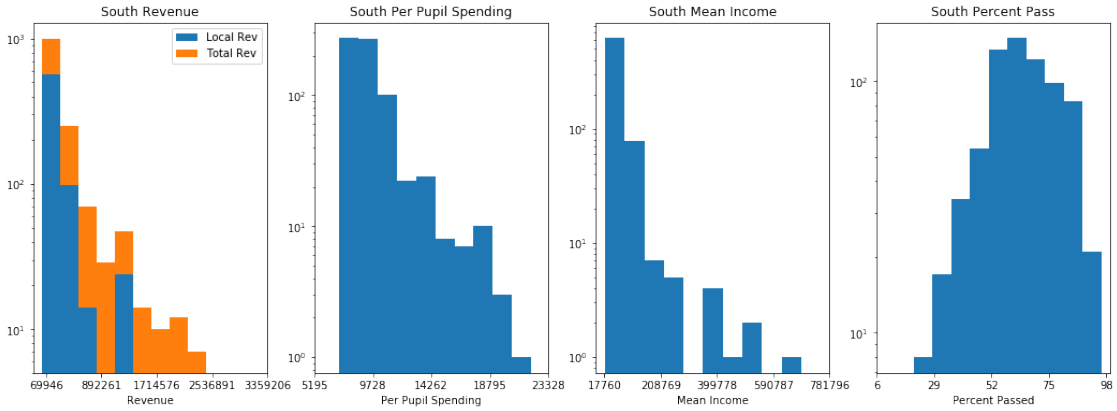
```
In [416]: mean_income = schlev_data['MEAN INCOME']
          min_income = mean_income.min()
          max_income = mean_income.max()
          mean_income_ticks = np.linspace(int(min_income), int(max_income), 5)
```

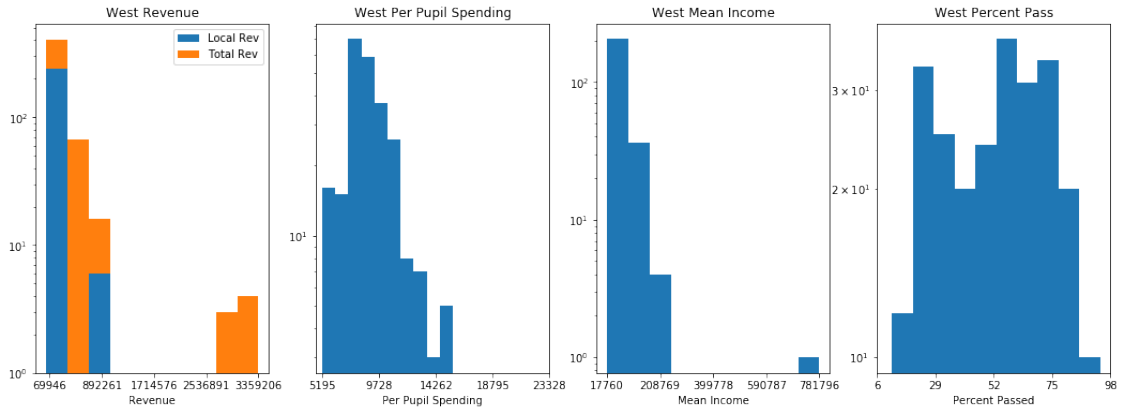
```
total_rev = schlev_data['TOTALREV']
min_rev = total_rev.min()
max_rev = total_rev.max()
total_rev_ticks = np.linspace(int(min_rev), int(max_rev), 5)

per_pupil_spending = schlev_data['PPCSTOT']
min_pps = per_pupil_spending.min()
max_pps = per_pupil_spending.max()
pps_ticks = np.linspace(int(min_pps), int(max_pps), 5)

pct_pass = schlev_data['PCT_PASS']
min_pct_pass = pct_pass.min()
max_pct_pass = pct_pass.max()
pct_pass_ticks = np.linspace(int(min_pct_pass), int(max_pct_pass), 5)
```

In [417]:
```
for name, group in schlev_data.groupby(['REGION']):
    fig, axes = plt.subplots(ncols=4)
    fig.set_size_inches(18, 6)

    axes[0].hist(x=[group['TLOCREV'], group['TOTALREV']], log=True, stacked=True)
    axes[0].legend(['Local Rev', 'Total Rev'])
    axes[0].set_xticks(total_rev_ticks)
    axes[0].set_xlabel('Revenue')
    axes[0].set_title(f'{name} Revenue')

    axes[1].hist(x=group['PPCSTOT'], log=True)
    axes[1].set_title(f'{name} Per Pupil Spending')
    axes[1].set_xticks(pps_ticks)
    axes[1].set_xlabel('Per Pupil Spending')

    axes[2].hist(x=group['MEAN INCOME'], log=True)
    axes[2].set_title(f'{name} Mean Income')
    axes[2].set_xticks(mean_income_ticks)
    axes[2].set_xlabel('Mean Income')

    axes[3].hist(x=group['PCT_PASS'], log=True)
    axes[3].set_title(f'{name} Percent Pass')
    axes[3].set_xticks(pct_pass_ticks)
    axes[3].set_xlabel('Percent Passed')
```


Midwest Revenue
Local Rev
Total Rev
69946 892261 1714576 2536891 3359206
Revenue
Midwest Per Pupil Spending
5195 9728 14262 18795 23328
Per Pupil Spending
Midwest Mean Income
17760 208769 399778 590787 781796
Mean Income
Midwest Percent Pass
6 29 52 75 98
Percent Passed


Northeast Revenue
Local Rev
Total Rev
69946 892261 1714576 2536891 3359206
Revenue
Northeast Per Pupil Spending
5195 9728 14262 18795 23328
Per Pupil Spending
Northeast Mean Income
17760 208769 399778 590787 781796
Mean Income
Northeast Percent Pass
6 29 52 75 98
Percent Passed


South Revenue
Local Rev
Total Rev
69946 892261 1714576 2536891 3359206
Revenue
South Per Pupil Spending
5195 9728 14262 18795 23328
Per Pupil Spending
South Mean Income
17760 208769 399778 590787 781796
Mean Income
South Percent Pass
6 29 52 75 98
Percent Passed



The South and West regions have the greatest distribution in total revenue. However, the West region has a handful of outliers that have the greatest total revenue. Local revenue seems to encompass about half of of the total revenue for all regions except for the West and South regions which displays two different peaks in local revenue. Both the Northeast and West have to distinct peaks in the total revenue, but these do not align with the local revenue which indicates that this increased revenue in a subsample of the data is due to some other data source.

Per Pupil spending is right skewed for all regions except for the Northeast which has two distinct peaks. The South has the greatest distribution, and the Northeast has the highest per pupil spending out of all the regions.

The Midewest has a normal distribution of Mean Income. The Northeast has two or three peaks in the distribution. The South and West have right skewed distribution, but the West has a few outliers that make it so and reflect the distribution in Total Revenue. The Mean Income distributions seems to reflect the Total Revenue distributions.

The Midwest and the South have left skewed distributions in percent passed, but the South has a smaller distribution than the Midwest. The Northeast and West have two peaks in their distribution which may have to do with the distributions in Total Revenue and Mean Income.

```
In [418]: schlev_data.groupby('DIVISION').describe()['TOTALREV']
```

```
Out[418]:                      count           mean            std       min        25%  \
          DIVISION
          East North Central   352.0  214171.250000  101786.889240   75340.0  138585.25
          East South Central   133.0  242520.699248  198579.933107   82192.0  124808.00
          Middle Atlantic       72.0  319763.944444  200601.410375  104154.0  172630.75
          Mountain              62.0  622308.774194  900829.537574   99323.0  147495.00
          Pacific              184.0  290883.788043  158512.325495   86163.0  166882.00
          South Atlantic       489.0  497946.122699  547684.153192   69946.0  135980.00
          West North Central   109.0  237846.146789  136706.316135   75706.0  140602.00
          West South Central    96.0  296675.729167  134198.770826  142420.0  204447.50

                                   50%        75%        max
          DIVISION
          East North Central  185300.5  263213.00   729047.0
          East South Central  180014.0  281434.00  1272594.0
```

```
Middle Atlantic     232968.0  533823.50   747268.0
Mountain            310804.5  546980.75  3359206.0
Pacific             253761.5  365781.75   815978.0
South Atlantic      266079.0  587566.00  2710577.0
West North Central  188700.0  297081.00   666255.0
West South Central  241862.0  373153.25   625708.0
```

```
In [419]: schlev_data.groupby('DIVISION').describe()['PCTLTOT']
```

```
Out[419]:                    count       mean        std   min     25%    50%     75%  \
DIVISION
East North Central  352.0  40.762216  16.080393   8.2  29.250  36.55  49.450
East South Central  133.0  39.492481  10.177996  22.1  30.200  38.60  48.300
Middle Atlantic      72.0  40.323611  27.263350   6.8  10.575  41.50  67.550
Mountain             62.0  29.838710  10.774490   8.7  21.850  29.35  34.275
Pacific             184.0  33.208696  17.328672  12.5  19.175  28.60  38.900
South Atlantic      489.0  47.168303  16.227049  18.6  36.400  43.10  56.100
West North Central  109.0  42.130275  12.918975  13.6  32.100  41.40  51.900
West South Central   96.0  41.522917  12.201566  21.4  32.225  41.80  48.200

                     max
DIVISION
East North Central  81.5
East South Central  59.3
Middle Atlantic     84.2
Mountain            53.7
Pacific             79.2
South Atlantic      93.3
West North Central  67.0
West South Central  74.6
```

```
In [420]: schlev_data.groupby('DIVISION').describe()['PPCSTOT']
```

```
Out[420]:                    count          mean          std      min       25%  \
DIVISION
East North Central  352.0  11015.306818  1834.783401   7374.0   9687.50
East South Central  133.0   8972.383459   964.950727   7129.0   8263.00
Middle Atlantic      72.0  17667.861111  3271.937499  12352.0  14780.75
Mountain             62.0   7485.596774  1340.608113   5195.0   6235.50
Pacific             184.0   9501.690217  1801.534394   7159.0   8208.25
South Atlantic      489.0   9545.044990  2412.638795   7485.0   8232.00
West North Central  109.0  10088.651376   892.492996   7525.0   9573.00
West South Central   96.0  10396.864583  1428.310910   8453.0   9535.00

                        50%       75%      max
DIVISION
East North Central  10652.0  12102.75  17327.0
East South Central   8822.0   9610.00  11147.0
Middle Atlantic     18104.5  20444.75  23328.0
```

```
Mountain             7380.0   8456.50  10653.0
Pacific              8996.5  10431.25  15596.0
South Atlantic       8723.0   9403.00  21974.0
West North Central  10133.0  10645.00  12601.0
West South Central  10176.5  10890.00  17588.0
```

```
In [421]: schlev_data.groupby('DIVISION').describe()['MEAN INCOME']
```

Out[421]:

DIVISION	count	mean	std	min	25%	\
East North Central	352.0	66949.903409	27003.830779	23527.0	50569.25	
East South Central	133.0	68116.639098	27384.033661	20840.0	55569.00	
Middle Atlantic	72.0	66188.833333	22804.326102	22871.0	48453.50	
Mountain	62.0	82642.709677	93088.592932	20292.0	63185.25	
Pacific	184.0	77214.940217	30082.104384	17760.0	60054.75	
South Atlantic	489.0	76772.089980	59877.332315	24335.0	55506.00	
West North Central	109.0	68946.376147	26286.667976	23692.0	53771.00	
West South Central	96.0	64083.864583	17485.204061	26345.0	57841.75	

DIVISION	50%	75%	max
East North Central	59566.0	77373.25	151262.0
East South Central	64013.0	76857.00	279092.0
Middle Atlantic	65018.0	82116.00	114096.0
Mountain	69775.5	75415.25	781796.0
Pacific	71544.0	89060.50	194371.0
South Atlantic	64904.0	76992.00	685559.0
West North Central	63781.0	79673.00	157915.0
West South Central	61649.5	66594.25	168031.0

```
In [422]: schlev_data.groupby('DIVISION').describe()['PCT_PASS']
```

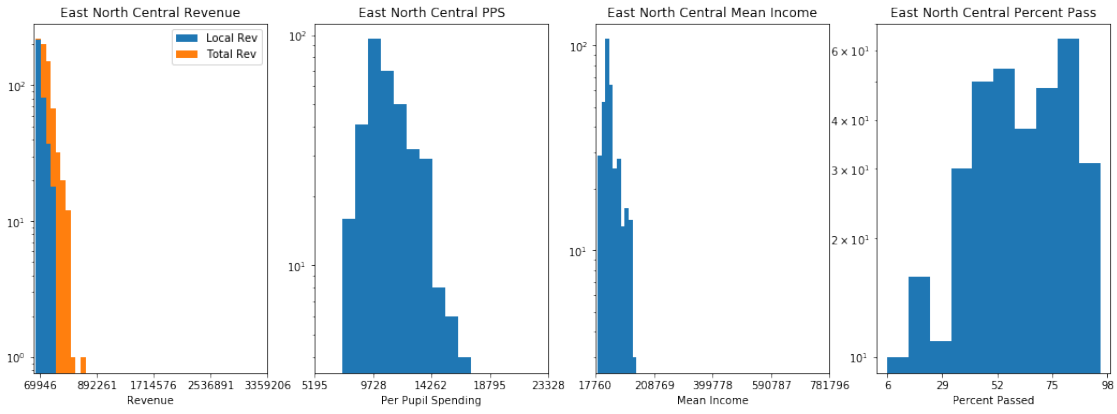
Out[422]:

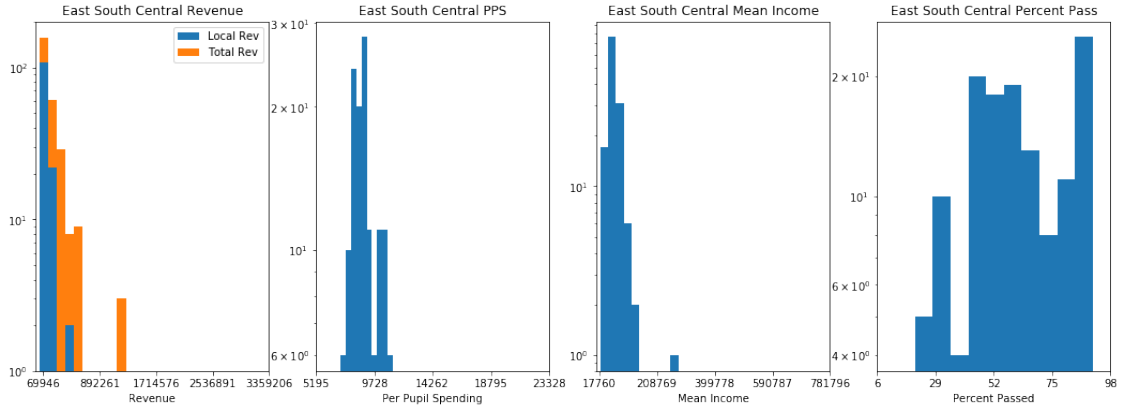
DIVISION	count	mean	std	min	25%	50%	75%	\
East North Central	352.0	60.051136	21.120134	6.0	47.00	61.00	78.0	
East South Central	133.0	60.687970	18.834668	21.0	47.00	59.00	78.0	
Middle Atlantic	72.0	53.000000	19.123026	19.0	36.00	56.50	68.0	
Mountain	62.0	54.725806	21.454618	12.0	38.25	59.00	70.0	
Pacific	184.0	51.931289	20.474376	15.0	30.00	54.75	69.5	
South Atlantic	489.0	63.386503	13.204411	25.0	55.00	62.00	72.0	
West North Central	109.0	65.316514	19.857905	11.0	57.00	69.00	77.0	
West South Central	96.0	72.781250	8.652597	49.0	68.00	75.00	79.0	

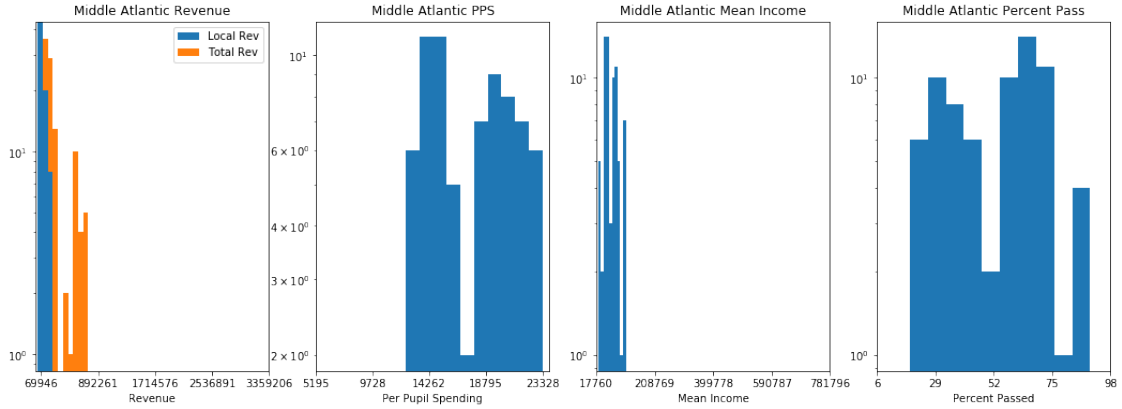
DIVISION	max
East North Central	95.0
East South Central	91.0
Middle Atlantic	90.0
Mountain	94.0

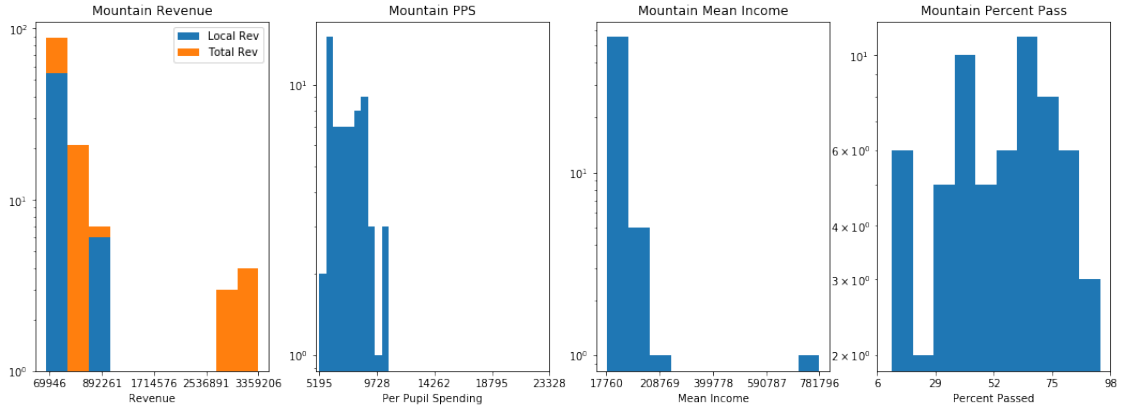
```
Pacific             92.0
South Atlantic      96.0
West North Central  98.0
West South Central  91.0
```

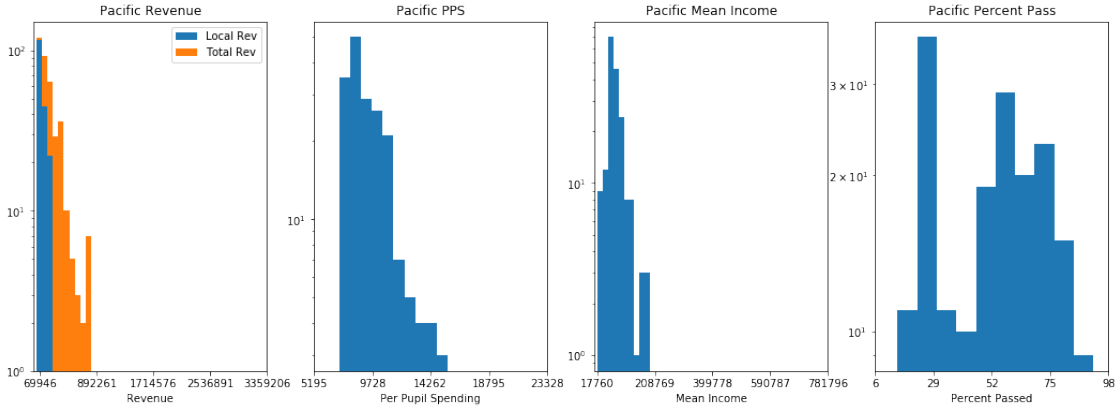
```
In [446]: for name, group in schlev_data.groupby(['DIVISION']):
              fig, axes = plt.subplots(ncols=4)
              fig.set_size_inches(18, 6)

              axes[0].hist(x=[group['TLOCREV'], group['TOTALREV']], log=True, stacked=True)
              axes[0].set_xticks(total_rev_ticks)
              axes[0].set_xlabel('Revenue')
              axes[0].legend(['Local Rev', 'Total Rev'])
              axes[0].set_title(f'{name} Revenue')

              axes[1].hist(x=group['PPCSTOT'], log=True)
              axes[1].set_xticks(pps_ticks)
              axes[1].set_xlabel('Per Pupil Spending')
              axes[1].set_title(f'{name} PPS')

              axes[2].hist(x=group['MEAN INCOME'], log=True)
              axes[2].set_xticks(mean_income_ticks)
              axes[2].set_xlabel('Mean Income')
              axes[2].set_title(f'{name} Mean Income')

              axes[3].hist(x=group['PCT_PASS'], log=True)
              axes[3].set_title(f'{name} Percent Pass')
              axes[3].set_xticks(pct_pass_ticks)
              axes[3].set_xlabel('Percent Passed')
```

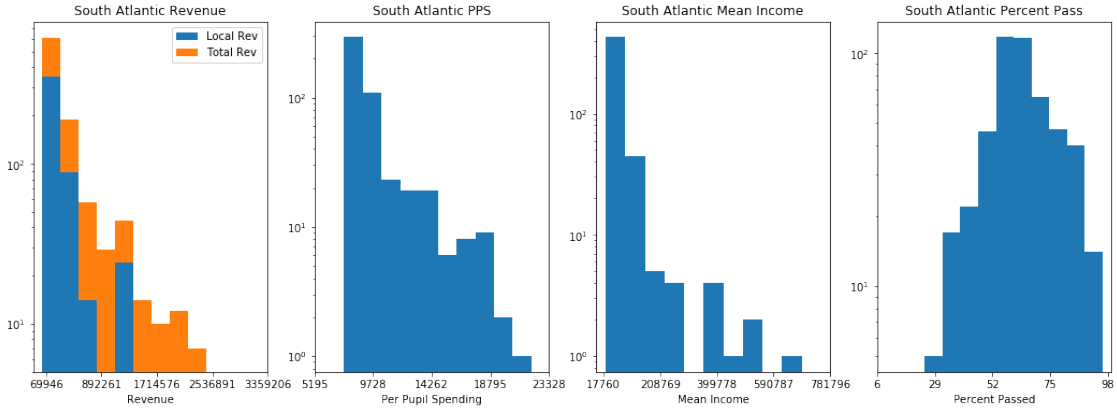


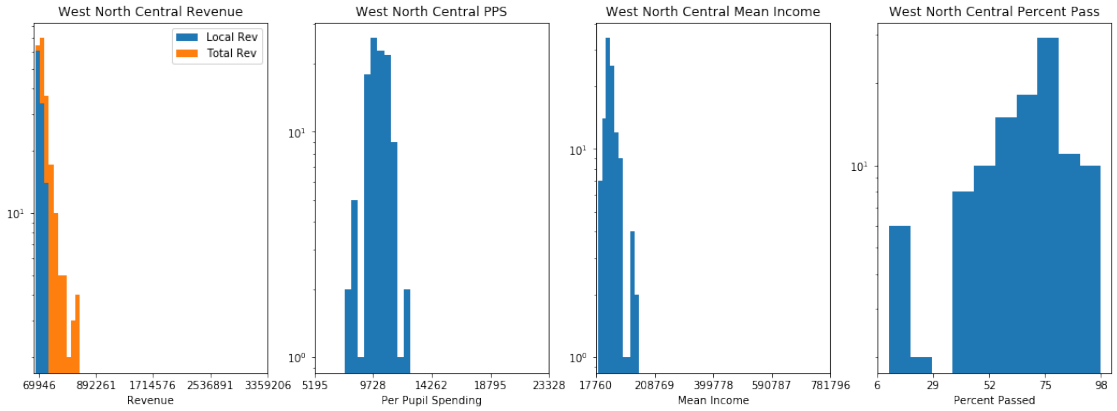

East South Central Revenue
Local Rev
Total Rev
Revenue
East South Central PPS
Per Pupil Spending
East South Central Mean Income
Mean Income
East South Central Percent Pass
Percent Passed

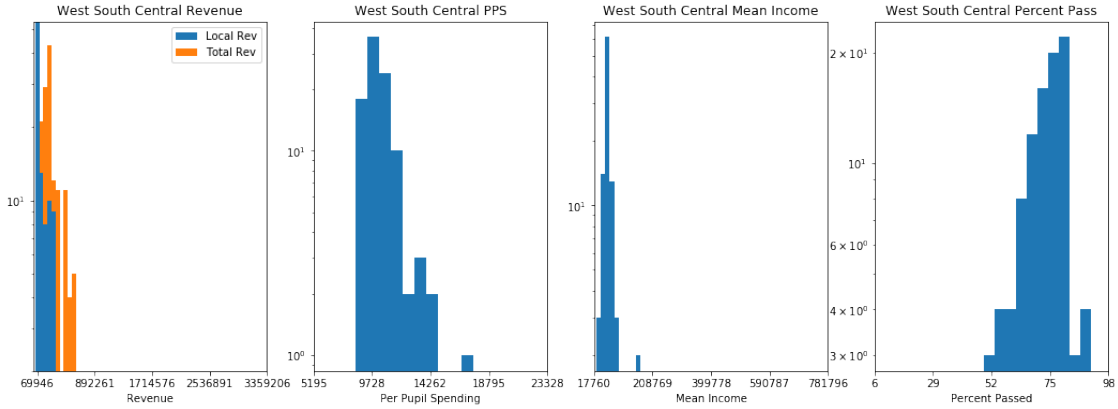

Middle Atlantic Revenue
Local Rev
Total Rev
Revenue
Middle Atlantic PPS
Per Pupil Spending
Middle Atlantic Mean Income
Mean Income
Middle Atlantic Percent Pass
Percent Passed


Mountain Revenue
Local Rev
Total Rev
Revenue
Mountain PPS
Per Pupil Spending
Mountain Mean Income
Mean Income
Mountain Percent Pass
Percent Passed


Pacific Revenue
Local Rev
Total Rev
69946 892261 1714576 2536891 3359206
Revenue
Pacific PPS
5195 9728 14262 18795 23328
Per Pupil Spending
Pacific Mean Income
17760 208769 399778 590787 781796
Mean Income
Pacific Percent Pass
6 29 52 75 98
Percent Passed

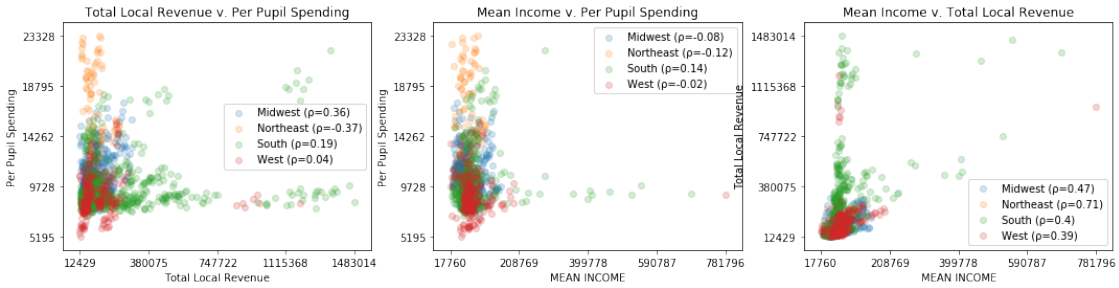

South Atlantic Revenue
Local Rev
Total Rev
69946 892261 1714576 2536891 3359206
Revenue
South Atlantic PPS
5195 9728 14262 18795 23328
Per Pupil Spending
South Atlantic Mean Income
17760 208769 399778 590787 781796
Mean Income
South Atlantic Percent Pass
6 29 52 75 98
Percent Passed


West North Central Revenue
Local Rev
Total Rev
69946 892261 1714576 2536891 3359206
Revenue
West North Central PPS
5195 9728 14262 18795 23328
Per Pupil Spending
West North Central Mean Income
17760 208769 399778 590787 781796
Mean Income
West North Central Percent Pass
6 29 52 75 98
Percent Passed




```
In [424]: local_rev = schlev_data['TLOCREV']
          min_rev = local_rev.min()
          max_rev = local_rev.max()
          local_rev_ticks = np.linspace(int(min_rev), int(max_rev), 5)

In [425]: region_data = schlev_data.groupby(['REGION'])
          fig, axes = plt.subplots(ncols=3)
          fig.set_size_inches(18, 4)
          for name, group in region_data:
              first_corr = round(group.corr().loc['TLOCREV', 'PPCSTOT'], 2)
              axes[0].scatter(x='TLOCREV', y='PPCSTOT', data=group, label=f'{name} (={first_co
              axes[0].set_xlabel('Total Local Revenue')
              axes[0].set_xticks(local_rev_ticks)
              axes[0].set_ylabel('Per Pupil Spending')
              axes[0].set_yticks(pps_ticks)
              axes[0].set_title('Total Local Revenue v. Per Pupil Spending')
              axes[0].legend()

              second_corr = round(group.corr().loc['MEAN INCOME', 'PPCSTOT'], 2)
              axes[1].scatter(x='MEAN INCOME', y='PPCSTOT', data=group, label=f'{name} (={seco
              axes[1].set_xlabel('MEAN INCOME')
              axes[1].set_xticks(mean_income_ticks)
              axes[1].set_ylabel('Per Pupil Spending')
              axes[1].set_yticks(pps_ticks)
              axes[1].set_title('Mean Income v. Per Pupil Spending')
              axes[1].legend()

              third_corr = round(group.corr().loc['MEAN INCOME', 'TLOCREV'], 2)
              axes[2].scatter(x='MEAN INCOME', y='TLOCREV', data=group, label=f'{name} (={thir
              axes[2].set_xlabel('MEAN INCOME')
              axes[2].set_xticks(mean_income_ticks)
              axes[2].set_ylabel('Total Local Revenue')
              axes[2].set_yticks(local_rev_ticks)
```

```
        axes[2].set_title('Mean Income v. Total Local Revenue')
        axes[2].legend()
```

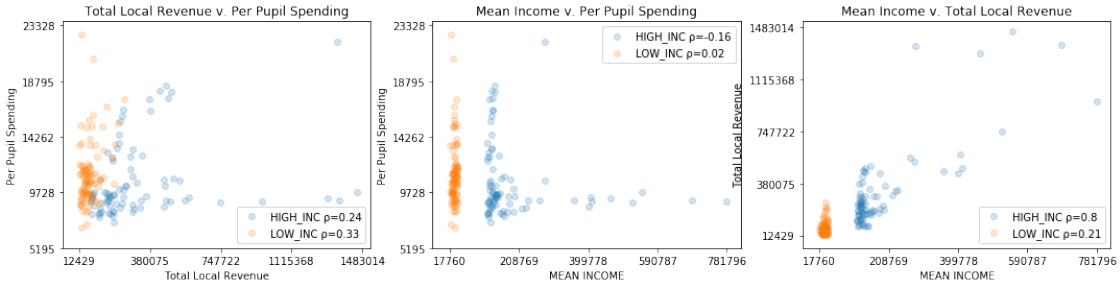


The strongest positive correlation is between Mean Income and Total Local Revenue for the Northeast. For the other regions Mean Income is somwheat positively correlated with Total Local Revenue, but not as strongly.

```
In [426]: schlev_data['INC_GRP'] = schlev_data['MEAN INCOME'].map(lambda x: 'LOW_INC' if x < 4
          income_data = schlev_data.loc[schlev_data['INC_GRP'] != 'MID_INC'].groupby('INC_GRP'
```

```
In [427]: # https://www.census.gov/topics/income-poverty/poverty/guidance/poverty-measures.htm
          # low income approximately $35000
          # https://money.usnews.com/money/personal-finance/family-finance/articles/where-do-i
          # low income $40100
          # upper income $120400
          fig, axes = plt.subplots(ncols=3)
          fig.set_size_inches(18, 4)
          for name, group in income_data:
              first_corr = round(group.corr().loc['TLOCREV', 'PPCSTOT'], 2)
              axes[0].scatter(x='TLOCREV', y='PPCSTOT', data=group, label=f'{name} ={first_cor
              axes[0].set_xlabel('Total Local Revenue')
              axes[0].set_xticks(local_rev_ticks)
              axes[0].set_ylabel('Per Pupil Spending')
              axes[0].set_yticks(pps_ticks)
              axes[0].set_title('Total Local Revenue v. Per Pupil Spending')
              axes[0].legend()

              second_corr = round(group.corr().loc['MEAN INCOME', 'PPCSTOT'], 2)
              axes[1].scatter(x='MEAN INCOME', y='PPCSTOT', data=group, label=f'{name} ={secon
              axes[1].set_xlabel('MEAN INCOME')
              axes[1].set_xticks(mean_income_ticks)
              axes[1].set_ylabel('Per Pupil Spending')
              axes[1].set_yticks(pps_ticks)
              axes[1].set_title('Mean Income v. Per Pupil Spending')
              axes[1].legend()

              third_corr = round(group.corr().loc['MEAN INCOME', 'TLOCREV'], 2)
```

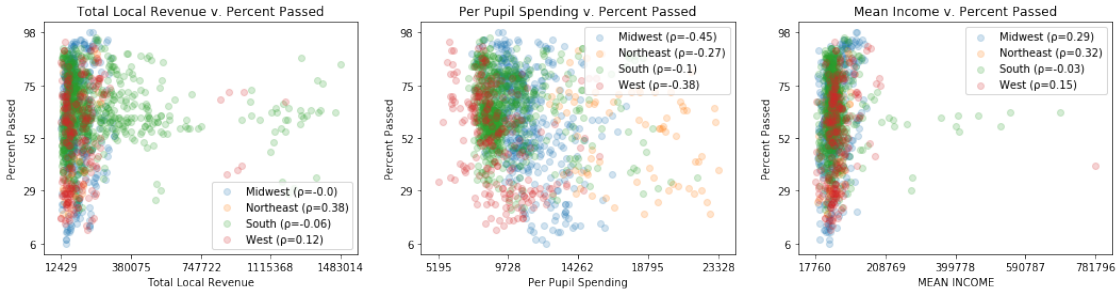
```
        axes[2].scatter(x='MEAN INCOME', y='TLOCREV', data=group, label=f'{name} ={third_
        axes[2].set_xlabel('MEAN INCOME')
        axes[2].set_xticks(mean_income_ticks)
        axes[2].set_ylabel('Total Local Revenue')
        axes[2].set_yticks(local_rev_ticks)
        axes[2].set_title('Mean Income v. Total Local Revenue')
        axes[2].legend()
```



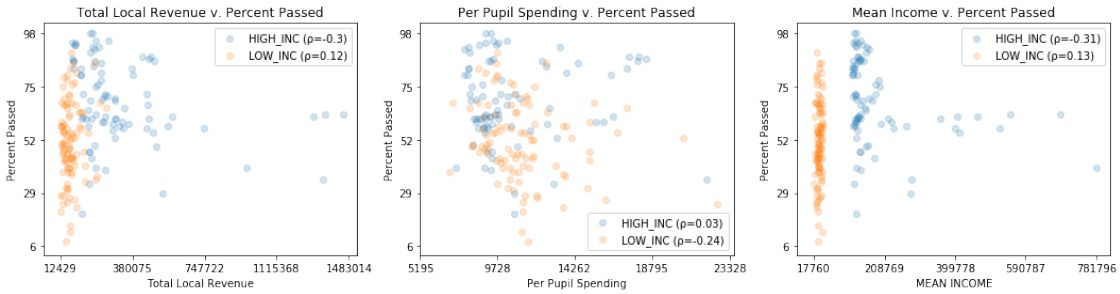
It seems that the previous correlation may be attributed to a difference between low and high income households. A high income household had a .8 positive correlation with total local revenue, but the correlation for low income household was nowhere near as close.

```
In [428]: region_data = schlev_data.groupby(['REGION'])
          fig, axes = plt.subplots(ncols=3)
          fig.set_size_inches(18, 4)
          for name, group in region_data:
              first_corr = round(group.corr().loc['TLOCREV', 'PCT_PASS'], 2)
              axes[0].scatter(x='TLOCREV', y='PCT_PASS', data=group, label=f'{name} (={first_c
              axes[0].set_xlabel('Total Local Revenue')
              axes[0].set_xticks(local_rev_ticks)
              axes[0].set_ylabel('Percent Passed')
              axes[0].set_yticks(pct_pass_ticks)
              axes[0].set_title('Total Local Revenue v. Percent Passed')
              axes[0].legend()

              second_corr = round(group.corr().loc['PPCSTOT', 'PCT_PASS'], 2)
              axes[1].scatter(x='PPCSTOT', y='PCT_PASS', data=group, label=f'{name} (={second_
              axes[1].set_xlabel('Per Pupil Spending')
              axes[1].set_xticks(pps_ticks)
              axes[1].set_ylabel('Percent Passed')
              axes[1].set_yticks(pct_pass_ticks)
              axes[1].set_title('Per Pupil Spending v. Percent Passed')
              axes[1].legend()

              third_corr = round(group.corr().loc['MEAN INCOME', 'PCT_PASS'], 2)
              axes[2].scatter(x='MEAN INCOME', y='PCT_PASS', data=group, label=f'{name} (={thi
              axes[2].set_xlabel('MEAN INCOME')
```

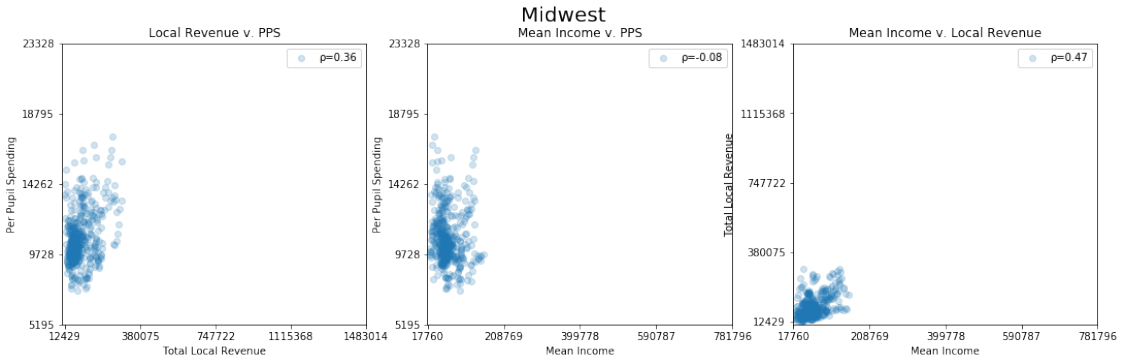
```
        axes[2].set_xticks(mean_income_ticks)
        axes[2].set_ylabel('Percent Passed')
        axes[2].set_yticks(pct_pass_ticks)
        axes[2].set_title('Mean Income v. Percent Passed')
        axes[2].legend()
```

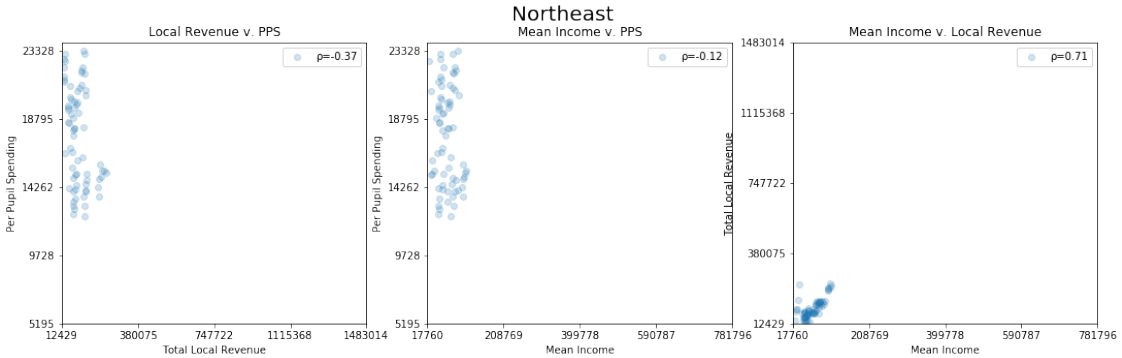


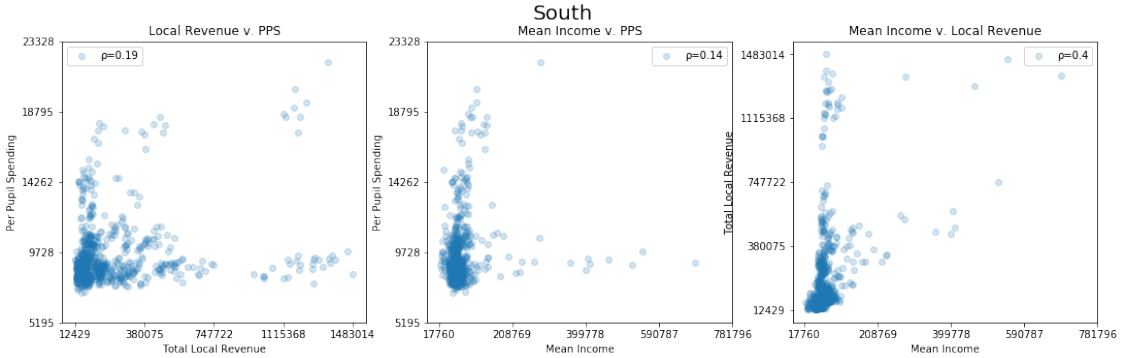
In [429]:
```
region_data = schlev_data.groupby(['REGION'])
fig, axes = plt.subplots(ncols=3)
fig.set_size_inches(18, 4)
for name, group in income_data:
    first_corr = round(group.corr().loc['TLOCREV', 'PCT_PASS'], 2)
    axes[0].scatter(x='TLOCREV', y='PCT_PASS', data=group, label=f'{name} (={first_c
    axes[0].set_xlabel('Total Local Revenue')
    axes[0].set_xticks(local_rev_ticks)
    axes[0].set_ylabel('Percent Passed')
    axes[0].set_yticks(pct_pass_ticks)
    axes[0].set_title('Total Local Revenue v. Percent Passed')
    axes[0].legend()

    second_corr = round(group.corr().loc['PPCSTOT', 'PCT_PASS'], 2)
    axes[1].scatter(x='PPCSTOT', y='PCT_PASS', data=group, label=f'{name} (={second_
    axes[1].set_xlabel('Per Pupil Spending')
    axes[1].set_xticks(pps_ticks)
    axes[1].set_ylabel('Percent Passed')
    axes[1].set_yticks(pct_pass_ticks)
    axes[1].set_title('Per Pupil Spending v. Percent Passed')
    axes[1].legend()

    third_corr = round(group.corr().loc['MEAN INCOME', 'PCT_PASS'], 2)
    axes[2].scatter(x='MEAN INCOME', y='PCT_PASS', data=group, label=f'{name} (={thi
    axes[2].set_xlabel('MEAN INCOME')
    axes[2].set_xticks(mean_income_ticks)
    axes[2].set_ylabel('Percent Passed')
    axes[2].set_yticks(pct_pass_ticks)
    axes[2].set_title('Mean Income v. Percent Passed')
    axes[2].legend()
```

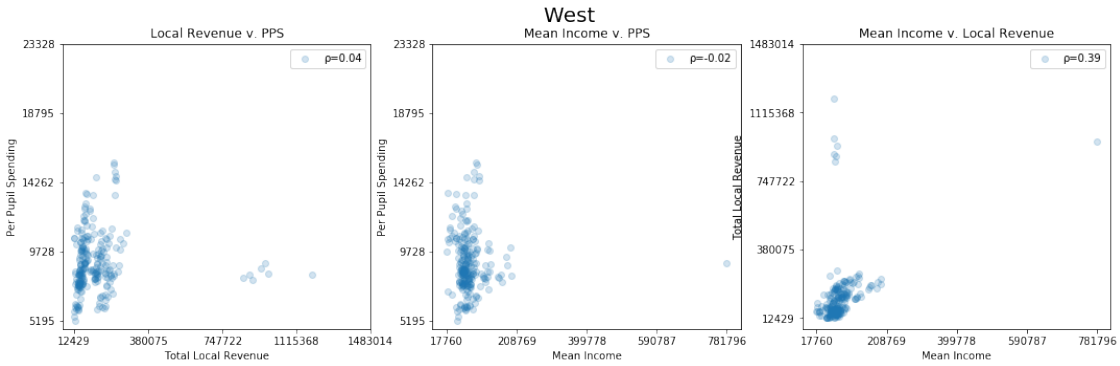



```
In [430]: for name, group in region_data:
              mean_income = group['MEAN INCOME']
              local_rev = group['TLOCREV']
              per_pupil_spending = group['PPCSTOT']

              fig, axes = plt.subplots(ncols=3, nrows=1)
              fig.set_size_inches(18, 5)
              fig.suptitle(name, fontsize=20)

              first_corr = round(group.corr().loc['TLOCREV', 'PPCSTOT'], 2)
              axes[0].scatter(x=local_rev, y=per_pupil_spending, alpha=0.2)
              axes[0].set_xlabel('Total Local Revenue')
              axes[0].set_xticks(local_rev_ticks)
              axes[0].set_ylabel('Per Pupil Spending')
              axes[0].set_yticks(pps_ticks)
              axes[0].set_title('Local Revenue v. PPS')
              axes[0].legend([f'={first_corr}'])

              second_corr = round(group.corr().loc['MEAN INCOME', 'PPCSTOT'], 2)
              axes[1].scatter(x=mean_income, y=per_pupil_spending, alpha=0.2)
              axes[1].set_xlabel('Mean Income')
              axes[1].set_xticks(mean_income_ticks)
              axes[1].set_ylabel('Per Pupil Spending')
              axes[1].set_yticks(pps_ticks)
              axes[1].set_title('Mean Income v. PPS')
              axes[1].legend([f'={second_corr}'])

              third_corr = round(group.corr().loc['MEAN INCOME', 'TLOCREV'], 2)
              axes[2].scatter(x=mean_income, y=local_rev, alpha=0.2)
              axes[2].set_xlabel('Mean Income')
              axes[2].set_xticks(mean_income_ticks)
              axes[2].set_ylabel('Total Local Revenue')
              axes[2].set_yticks(local_rev_ticks)
              axes[2].set_title('Mean Income v. Local Revenue')
              axes[2].legend([f'={third_corr}'])
```


Midwest
Local Revenue v. PPS
ρ=0.36
Per Pupil Spending
Total Local Revenue
Mean Income v. PPS
ρ=-0.08
Per Pupil Spending
Mean Income
Mean Income v. Local Revenue
ρ=0.47
Total Local Revenue
Mean Income

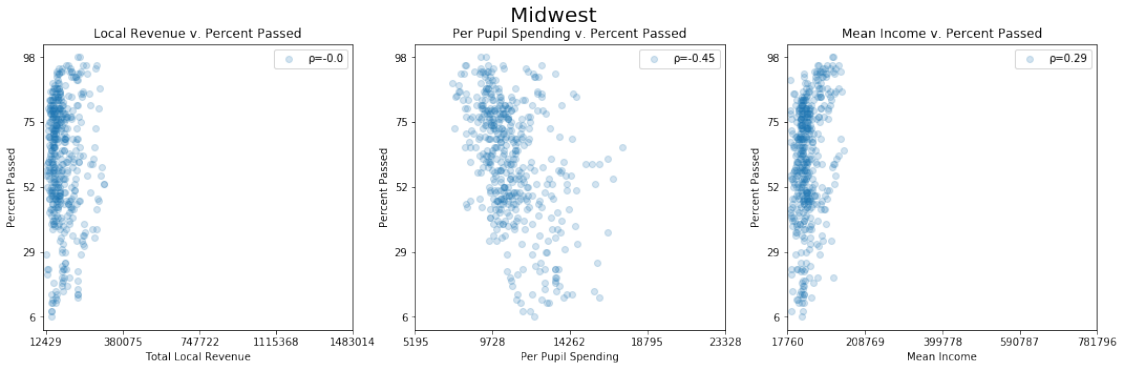

Northeast
Local Revenue v. PPS
ρ=-0.37
Per Pupil Spending
Total Local Revenue
Mean Income v. PPS
ρ=-0.12
Per Pupil Spending
Mean Income
Mean Income v. Local Revenue
ρ=0.71
Total Local Revenue
Mean Income

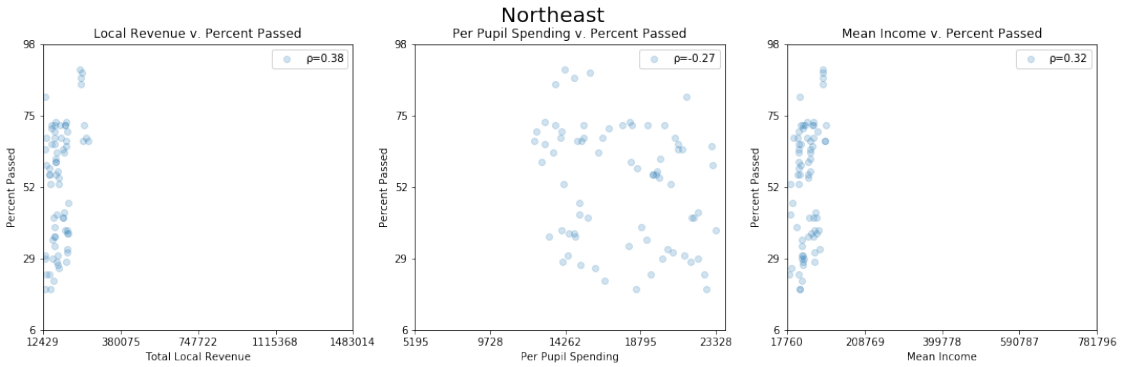

South
Local Revenue v. PPS
ρ=0.19
Per Pupil Spending
Total Local Revenue
Mean Income v. PPS
ρ=0.14
Per Pupil Spending
Mean Income
Mean Income v. Local Revenue
ρ=0.4
Total Local Revenue
Mean Income

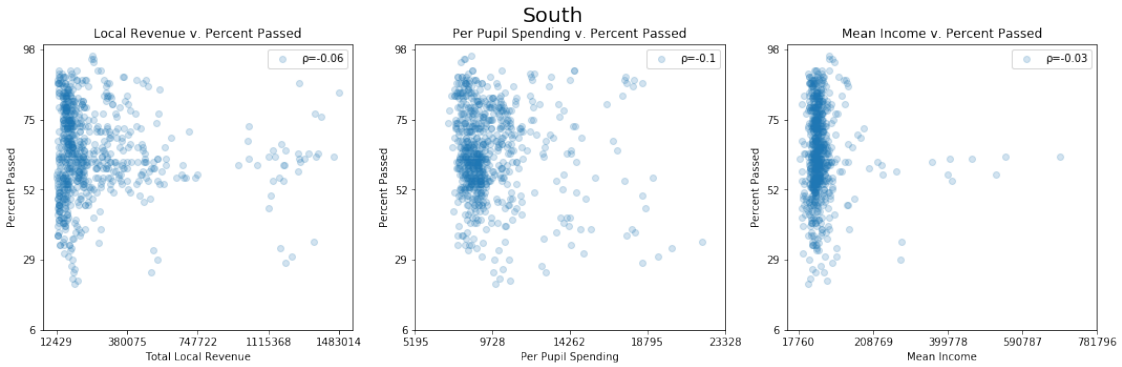


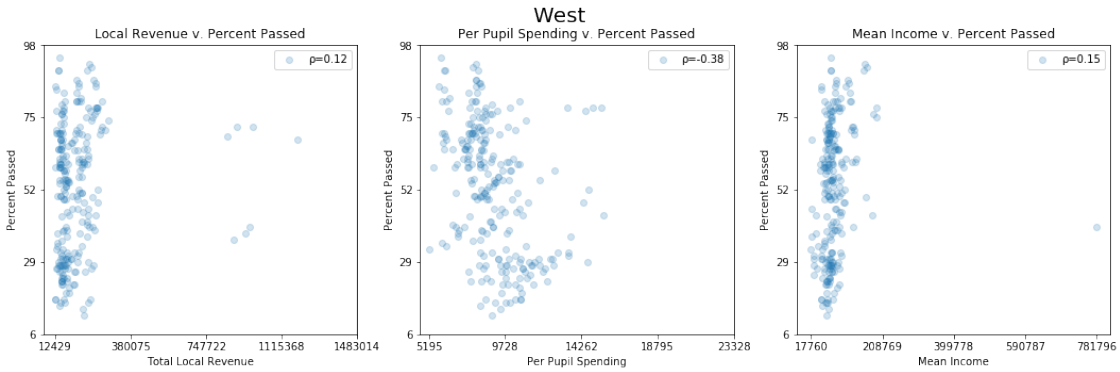

```
In [431]: for name, group in region_data:
              mean_income = group['MEAN INCOME']
              local_rev = group['TLOCREV']
              per_pupil_spending = group['PPCSTOT']
              percent_passed = group['PCT_PASS']

              fig, axes = plt.subplots(ncols=3, nrows=1)
              fig.set_size_inches(18, 5)
              fig.suptitle(name, fontsize=20)

              first_corr = round(group.corr().loc['TLOCREV', 'PCT_PASS'], 2)
              axes[0].scatter(x=local_rev, y=percent_passed, alpha=0.2)
              axes[0].set_xlabel('Total Local Revenue')
              axes[0].set_xticks(local_rev_ticks)
              axes[0].set_ylabel('Percent Passed')
              axes[0].set_yticks(pct_pass_ticks)
              axes[0].set_title('Local Revenue v. Percent Passed')
              axes[0].legend([f'={first_corr}'])

              second_corr = round(group.corr().loc['PPCSTOT', 'PCT_PASS'], 2)
              axes[1].scatter(x=per_pupil_spending, y=percent_passed, alpha=0.2)
              axes[1].set_xlabel('Per Pupil Spending')
              axes[1].set_xticks(pps_ticks)
              axes[1].set_ylabel('Percent Passed')
              axes[1].set_yticks(pct_pass_ticks)
              axes[1].set_title('Per Pupil Spending v. Percent Passed')
              axes[1].legend([f'={second_corr}'])

              third_corr = round(group.corr().loc['MEAN INCOME', 'PCT_PASS'], 2)
              axes[2].scatter(x=mean_income, y=percent_passed, alpha=0.2)
              axes[2].set_xlabel('Mean Income')
              axes[2].set_xticks(mean_income_ticks)
              axes[2].set_ylabel('Percent Passed')
              axes[2].set_yticks(pct_pass_ticks)
```

```
axes[2].set_title('Mean Income v. Percent Passed')
axes[2].legend([f'={third_corr}'])
```









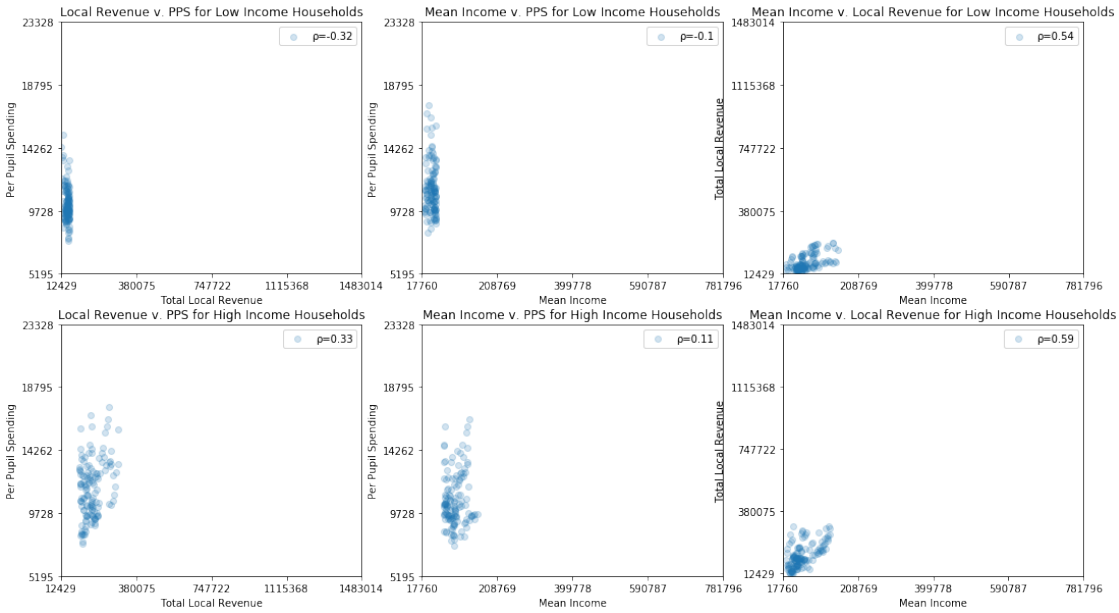
Per Pupil spending seems oddly slightly negatively correlated with Percent Passed rather than positvely correlated. There must be some other factor that is contributing to this.

```
In [432]: for name, group in region_data:
              low_quantile = .3
              high_quantile = .7

              mean_income = group['MEAN INCOME']
              min_income = mean_income.min()
              max_income = mean_income.max()
              low_income_qtl = mean_income.quantile(q=low_quantile)
              high_income_qtl = mean_income.quantile(q=high_quantile)
              low_income_grp = group[mean_income < low_income_qtl]
              high_income_grp = group[mean_income > high_income_qtl]

              local_rev = group['TLOCREV']
              min_rev = local_rev.min()
              max_rev = local_rev.max()
              low_rev_qtl = local_rev.quantile(q=low_quantile)
              high_rev_qtl = local_rev.quantile(q=high_quantile)
              low_rev_grp = group[local_rev < low_rev_qtl]
              high_rev_grp = group[local_rev > high_rev_qtl]

              per_pupil_spending = group['PPCSTOT']
              min_pps = per_pupil_spending.min()
              min_pps = per_pupil_spending.max()
              low_pps_qtl = per_pupil_spending.quantile(q=low_quantile)
              high_pps_qtl = per_pupil_spending.quantile(q=high_quantile)
              low_pps_grp = group[per_pupil_spending < low_pps_qtl]
              high_pps_grp = group[per_pupil_spending > high_pps_qtl]

              fig, axes = plt.subplots(ncols=3, nrows=2)
              fig.set_size_inches(18, 10)
              fig.suptitle(name, fontsize=20)
```

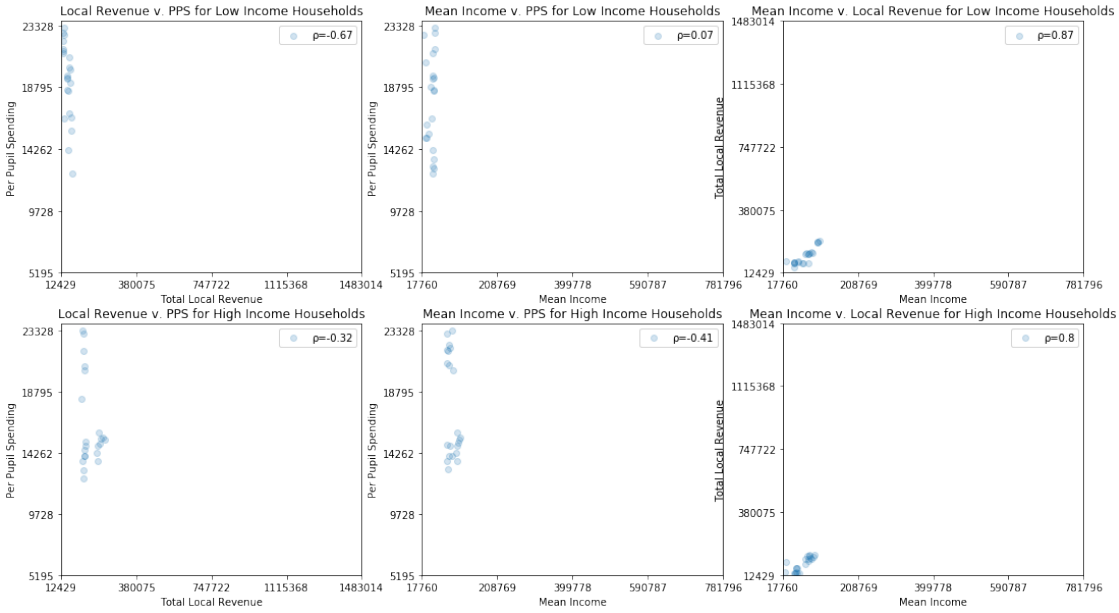
```
first_corr = round(low_rev_grp.corr().loc['TLOCREV', 'PPCSTOT'], 2)
axes[0][0].scatter(x=low_rev_grp['TLOCREV'], y=low_rev_grp['PPCSTOT'], alpha=0.2)
axes[0][0].set_xlabel('Total Local Revenue')
axes[0][0].set_xticks(local_rev_ticks)
axes[0][0].set_ylabel('Per Pupil Spending')
axes[0][0].set_yticks(pps_ticks)
axes[0][0].set_title('Local Revenue v. PPS for Low Income Households')
axes[0][0].legend([f'={first_corr}'])

second_corr = round(low_income_grp.corr().loc['MEAN INCOME', 'PPCSTOT'], 2)
axes[0][1].scatter(x=low_income_grp['MEAN INCOME'], y=low_income_grp['PPCSTOT'],
axes[0][1].set_xlabel('Mean Income')
axes[0][1].set_xticks(mean_income_ticks)
axes[0][1].set_ylabel('Per Pupil Spending')
axes[0][1].set_yticks(pps_ticks)
axes[0][1].set_title('Mean Income v. PPS for Low Income Households')
axes[0][1].legend([f'={second_corr}'])

third_corr = round(low_pps_grp.corr().loc['MEAN INCOME', 'TLOCREV'], 2)
axes[0][2].scatter(x=low_pps_grp['MEAN INCOME'], y=low_pps_grp['TLOCREV'], alpha=
axes[0][2].set_xlabel('Mean Income')
axes[0][2].set_xticks(mean_income_ticks)
axes[0][2].set_ylabel('Total Local Revenue')
axes[0][2].set_yticks(local_rev_ticks)
axes[0][2].set_title('Mean Income v. Local Revenue for Low Income Households')
axes[0][2].legend([f'={third_corr}'])

fourth_corr = round(high_rev_grp.corr().loc['TLOCREV', 'PPCSTOT'], 2)
axes[1][0].scatter(x=high_rev_grp['TLOCREV'], y=high_rev_grp['PPCSTOT'], alpha=0
axes[1][0].set_xlabel('Total Local Revenue')
axes[1][0].set_xticks(local_rev_ticks)
axes[1][0].set_ylabel('Per Pupil Spending')
axes[1][0].set_yticks(pps_ticks)
axes[1][0].set_title('Local Revenue v. PPS for High Income Households')
axes[1][0].legend([f'={fourth_corr}'])

fifth_corr = round(high_income_grp.corr().loc['MEAN INCOME', 'PPCSTOT'], 2)
axes[1][1].scatter(x=high_income_grp['MEAN INCOME'], y=high_income_grp['PPCSTOT']
axes[1][1].set_xlabel('Mean Income')
axes[1][1].set_xticks(mean_income_ticks)
axes[1][1].set_ylabel('Per Pupil Spending')
axes[1][1].set_yticks(pps_ticks)
axes[1][1].set_title('Mean Income v. PPS for High Income Households')
axes[1][1].legend([f'={fifth_corr}'])

sixth_corr = round(high_pps_grp.corr().loc['MEAN INCOME', 'TLOCREV'], 2)
axes[1][2].scatter(x=high_pps_grp['MEAN INCOME'], y=high_pps_grp['TLOCREV'], alp
axes[1][2].set_xlabel('Mean Income')
```

```
axes[1][2].set_xticks(mean_income_ticks)
axes[1][2].set_ylabel('Total Local Revenue')
axes[1][2].set_yticks(local_rev_ticks)
axes[1][2].set_title('Mean Income v. Local Revenue for High Income Households')
axes[1][2].legend([f'={sixth_corr}'])
```

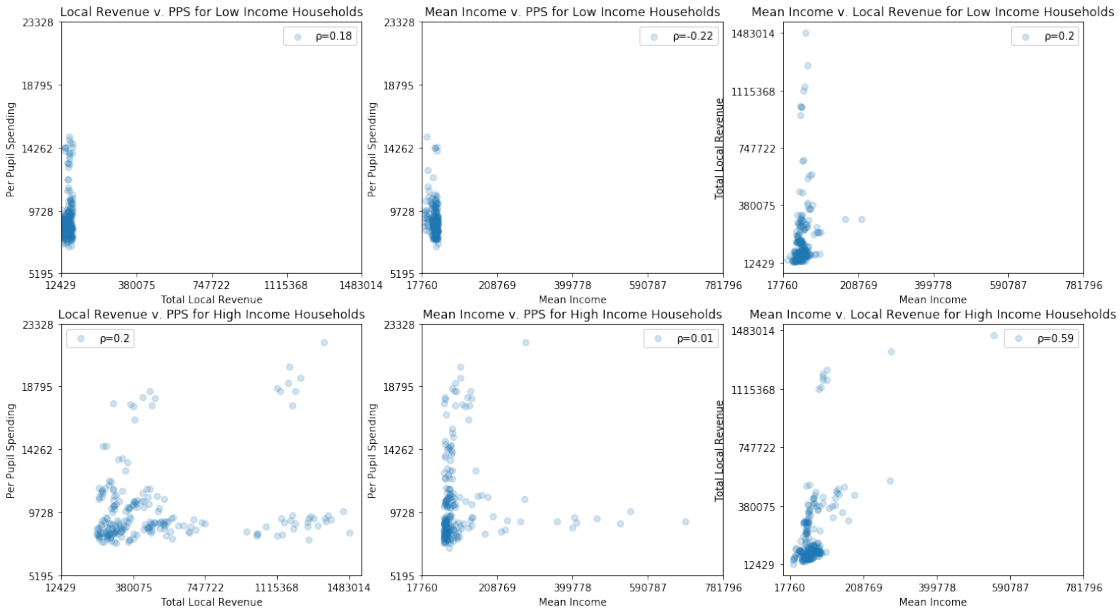
Midwest



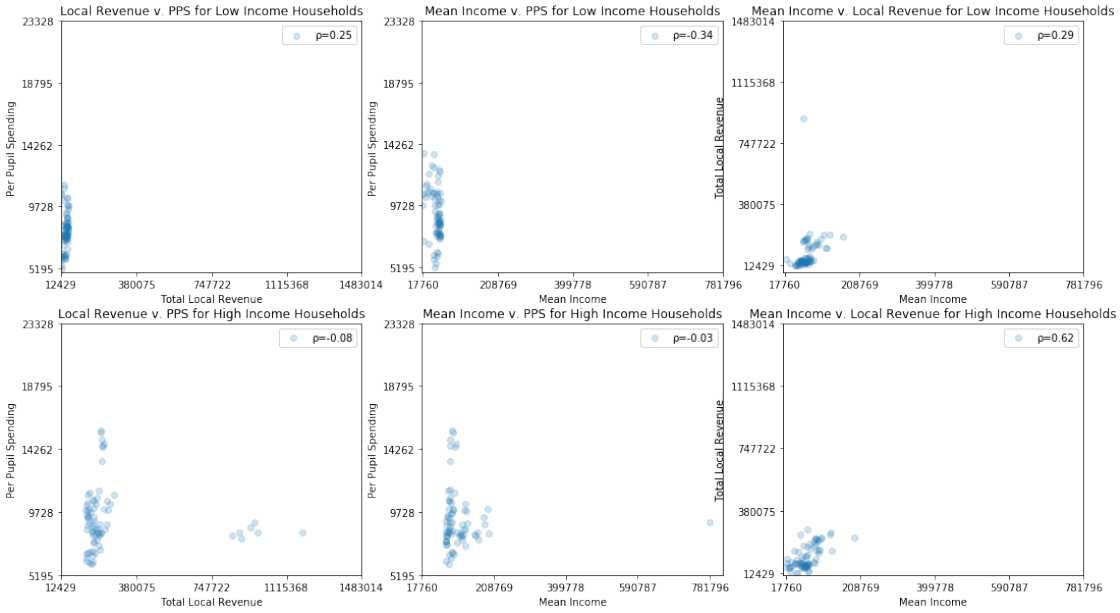
Northeast



South



West



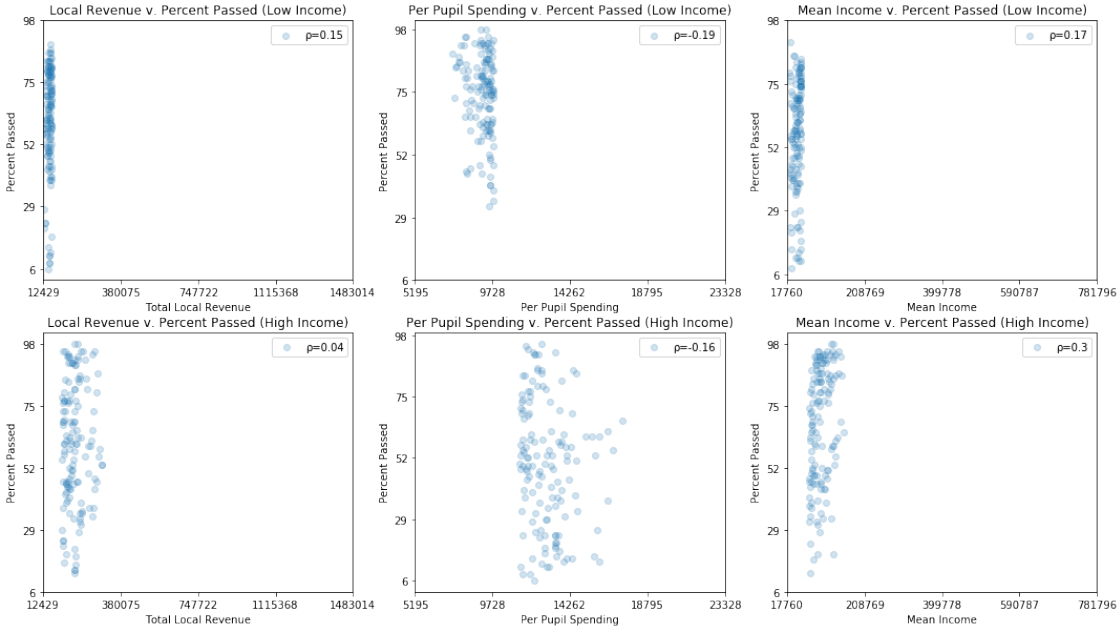
Mean Income and Local Revenue is somewhat positively correlated for low income households but strongly correlated for high income households in the South and West. The correlations

for low and high income households are practically equal and strongly positively correlated the Northeast and Midwest. This seems to indicate that the school districts in low income neighborhoods in South and West must get their revenue from other sources, possbily state and federal.

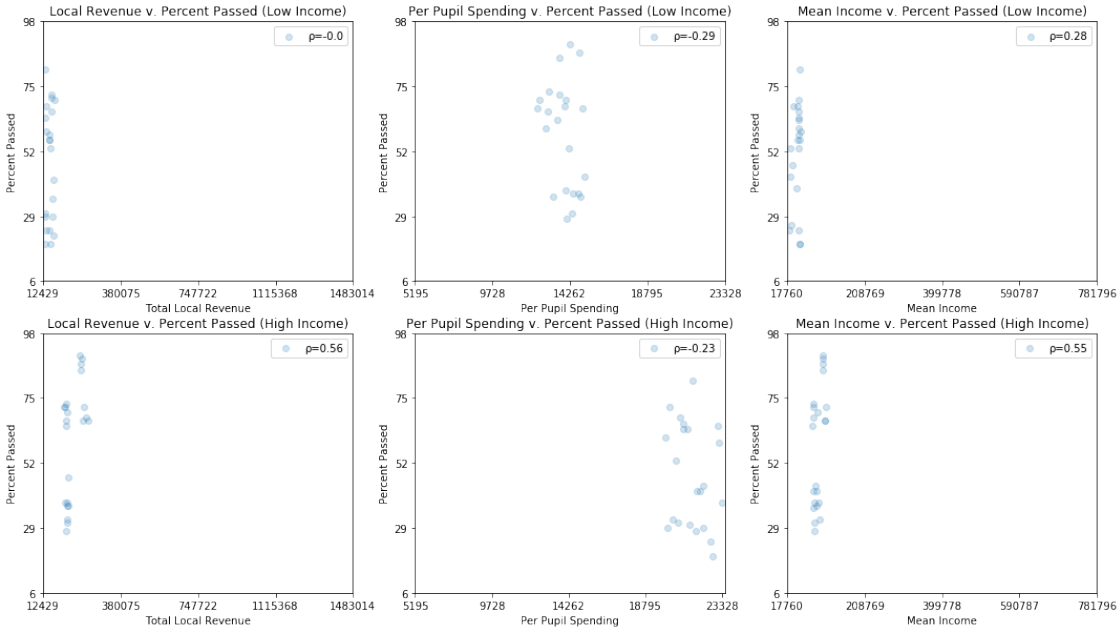
```
In [433]: for name, group in region_data:
              low_quantile = .3
              high_quantile = .7

              mean_income = group['MEAN INCOME']
              min_income = mean_income.min()
              max_income = mean_income.max()
              low_income_qtl = mean_income.quantile(q=low_quantile)
              high_income_qtl = mean_income.quantile(q=high_quantile)
              low_income_grp = group[mean_income < low_income_qtl]
              high_income_grp = group[mean_income > high_income_qtl]

              local_rev = group['TLOCREV']
              min_rev = local_rev.min()
              max_rev = local_rev.max()
              low_rev_qtl = local_rev.quantile(q=low_quantile)
              high_rev_qtl = local_rev.quantile(q=high_quantile)
              low_rev_grp = group[local_rev < low_rev_qtl]
              high_rev_grp = group[local_rev > high_rev_qtl]

              per_pupil_spending = group['PPCSTOT']
              min_pps = per_pupil_spending.min()
              min_pps = per_pupil_spending.max()
              low_pps_qtl = per_pupil_spending.quantile(q=low_quantile)
              high_pps_qtl = per_pupil_spending.quantile(q=high_quantile)
              low_pps_grp = group[per_pupil_spending < low_pps_qtl]
              high_pps_grp = group[per_pupil_spending > high_pps_qtl]

              fig, axes = plt.subplots(ncols=3, nrows=2)
              fig.set_size_inches(18, 10)
              fig.suptitle(name, fontsize=20)

              first_corr = round(low_rev_grp.corr().loc['TLOCREV', 'PCT_PASS'], 2)
              axes[0][0].scatter(x=low_rev_grp['TLOCREV'], y=low_rev_grp['PCT_PASS'], alpha=0.1
              axes[0][0].set_xlabel('Total Local Revenue')
              axes[0][0].set_xticks(local_rev_ticks)
              axes[0][0].set_ylabel('Percent Passed')
              axes[0][0].set_yticks(pct_pass_ticks)
              axes[0][0].set_title('Local Revenue v. Percent Passed (Low Income)')
              axes[0][0].legend([f'={first_corr}'])

              second_corr = round(low_pps_grp.corr().loc['PPCSTOT', 'PCT_PASS'], 2)
              axes[0][1].scatter(x=low_pps_grp['PPCSTOT'], y=low_pps_grp['PCT_PASS'], alpha=0.1
              axes[0][1].set_xlabel('Per Pupil Spending')
```

```
axes[0][1].set_xticks(pps_ticks)
axes[0][1].set_ylabel('Percent Passed')
axes[0][1].set_yticks(pct_pass_ticks)
axes[0][1].set_title('Per Pupil Spending v. Percent Passed (Low Income)')
axes[0][1].legend([f'={second_corr}'])

third_corr = round(low_income_grp.corr().loc['MEAN INCOME', 'PCT_PASS'], 2)
axes[0][2].scatter(x=low_income_grp['MEAN INCOME'], y=low_income_grp['PCT_PASS']
axes[0][2].set_xlabel('Mean Income')
axes[0][2].set_xticks(mean_income_ticks)
axes[0][2].set_ylabel('Percent Passed')
axes[0][2].set_yticks(pct_pass_ticks)
axes[0][2].set_title('Mean Income v. Percent Passed (Low Income)')
axes[0][2].legend([f'={third_corr}'])

fourth_corr = round(high_rev_grp.corr().loc['TLOCREV', 'PCT_PASS'], 2)
axes[1][0].scatter(x=high_rev_grp['TLOCREV'], y=high_rev_grp['PCT_PASS'], alpha=
axes[1][0].set_xlabel('Total Local Revenue')
axes[1][0].set_xticks(local_rev_ticks)
axes[1][0].set_ylabel('Percent Passed')
axes[1][0].set_yticks(pct_pass_ticks)
axes[1][0].set_title('Local Revenue v. Percent Passed (High Income)')
axes[1][0].legend([f'={fourth_corr}'])

fifth_corr = round(high_pps_grp.corr().loc['PPCSTOT', 'PCT_PASS'], 2)
axes[1][1].scatter(x=high_pps_grp['PPCSTOT'], y=high_pps_grp['PCT_PASS'], alpha=
axes[1][1].set_xlabel('Per Pupil Spending')
axes[1][1].set_xticks(pps_ticks)
axes[1][1].set_ylabel('Percent Passed')
axes[1][1].set_yticks(pct_pass_ticks)
axes[1][1].set_title('Per Pupil Spending v. Percent Passed (High Income)')
axes[1][1].legend([f'={fifth_corr}'])

sixth_corr = round(high_income_grp.corr().loc['MEAN INCOME', 'PCT_PASS'], 2)
axes[1][2].scatter(x=high_income_grp['MEAN INCOME'], y=high_income_grp['PCT_PASS
axes[1][2].set_xlabel('Mean Income')
axes[1][2].set_xticks(mean_income_ticks)
axes[1][2].set_ylabel('Percent Passed')
axes[1][2].set_yticks(pct_pass_ticks)
axes[1][2].set_title('Mean Income v. Percent Passed (High Income)')
axes[1][2].legend([f'={sixth_corr}'])
```

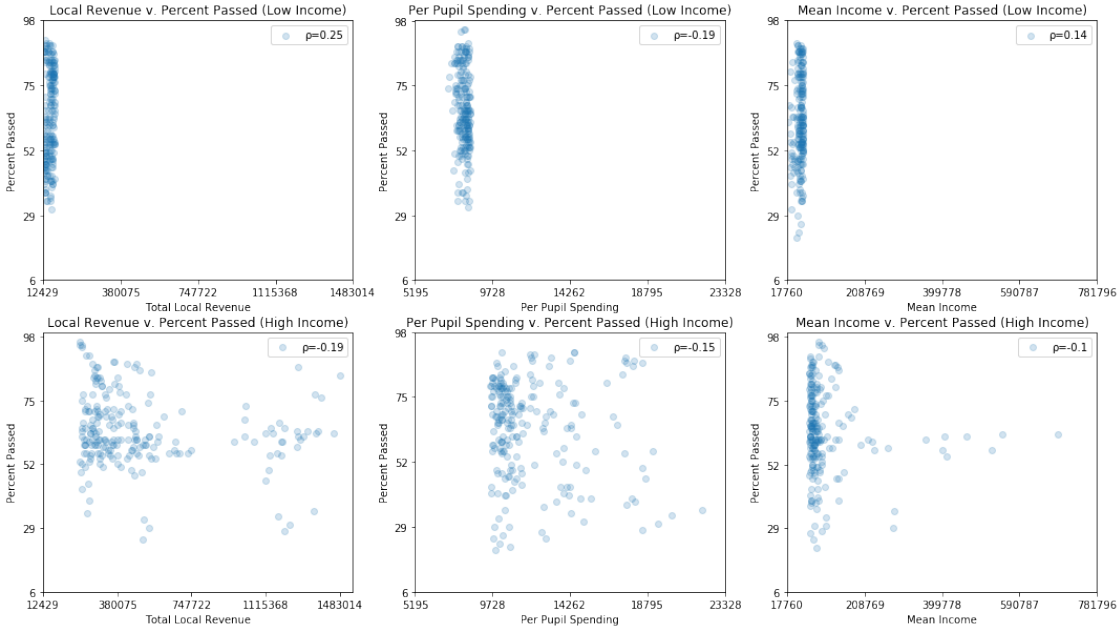
Midwest



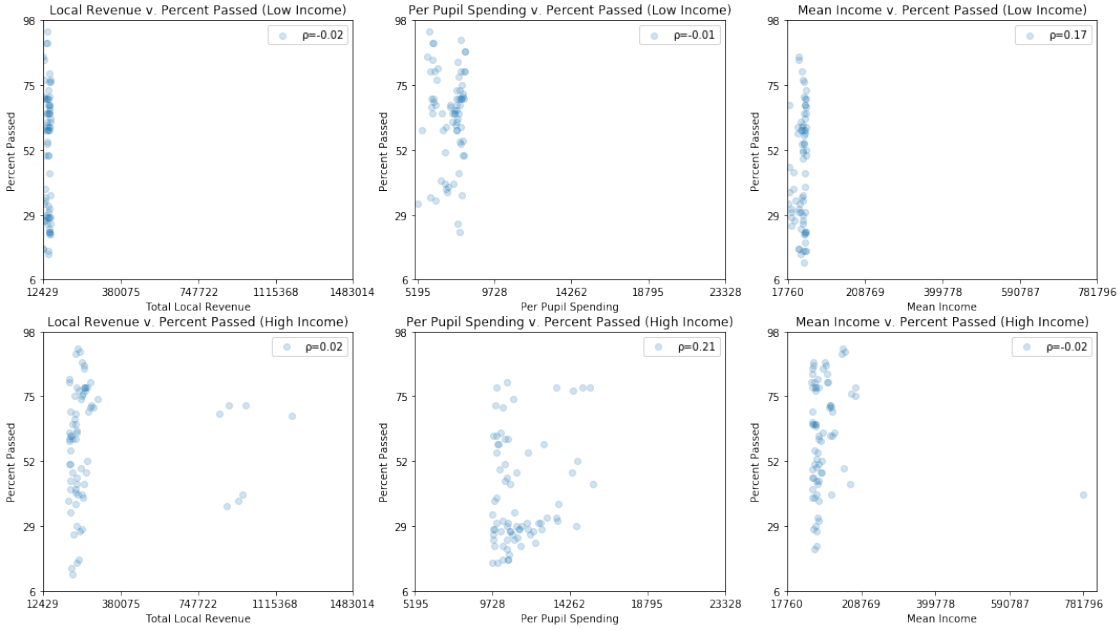
Northeast



South

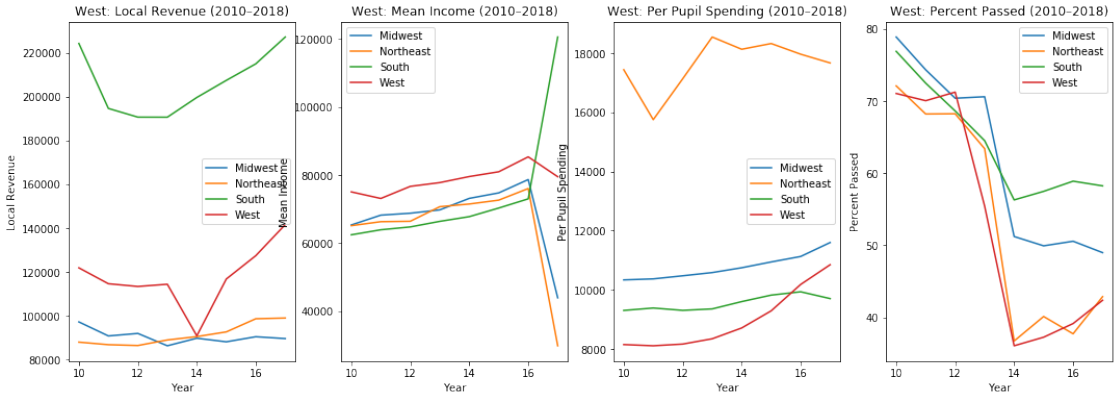


West



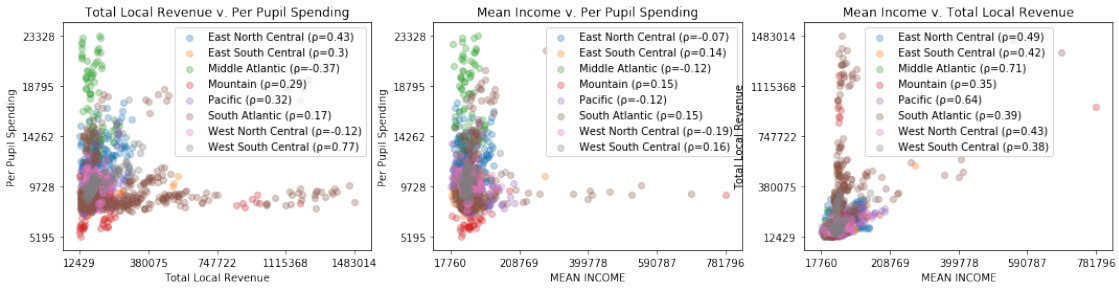

```
In [434]: fig, axes = plt.subplots(ncols=4)
          fig.set_size_inches(18, 6)
```

```
region_data_by_year = schlev_data.groupby(['REGION', 'YRDATA']).mean()
for region in region_data_by_year.index.levels[0]:
    year_data = region_data_by_year.xs(region)

    axes[0].plot(year_data.index.values, year_data['TLOCREV'], label=region)
    axes[0].set_xlabel('Year')
    axes[0].set_ylabel('Local Revenue')
    axes[0].set_title(f'{region}: Local Revenue (20102018)')
    axes[0].legend()

    axes[1].plot(year_data.index.values, year_data['MEAN INCOME'], label=region)
    axes[1].set_xlabel('Year')
    axes[1].set_ylabel('Mean Income')
    axes[1].set_title(f'{region}: Mean Income (20102018)')
    axes[1].legend()

    axes[2].plot(year_data.index.values, year_data['PPCSTOT'], label=region)
    axes[2].set_xlabel('Year')
    axes[2].set_ylabel('Per Pupil Spending')
    axes[2].set_title(f'{region}: Per Pupil Spending (20102018)')
    axes[2].legend()

    axes[3].plot(year_data.index.values, year_data['PCT_PASS'], label=region)
    axes[3].set_xlabel('Year')
    axes[3].set_ylabel('Percent Passed')
    axes[3].set_title(f'{region}: Percent Passed (20102018)')
    axes[3].legend()
```



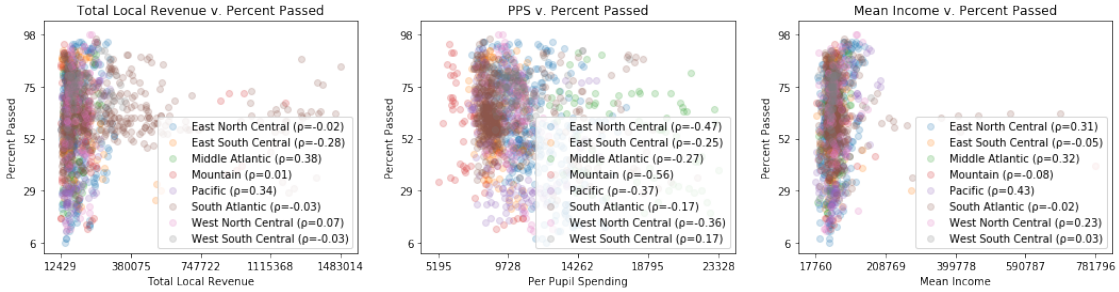
The South has by far the highest local revenue, but this may be due to the size of the area. The South seems to increase its per pupil spending dramatically in 2017. In the last few years the South also performs best out of the other regions in terms of percent passed. The Northeast has the highest per pupil spending of all the regions. The percent passed scores drop dramatically around 2014 this maybe due to some change in grading standards.

In [435]:
```
division_data = schlev_data.groupby(['DIVISION'])
fig, axes = plt.subplots(ncols=3)
fig.set_size_inches(18, 4)
for name, group in division_data:
    first_corr = round(group.corr().loc['TLOCREV', 'PPCSTOT'], 2)
    axes[0].scatter(x='TLOCREV', y='PPCSTOT', data=group, label=f'{name} (={first_co
    axes[0].set_xlabel('Total Local Revenue')
    axes[0].set_xticks(local_rev_ticks)
    axes[0].set_ylabel('Per Pupil Spending')
    axes[0].set_yticks(pps_ticks)
    axes[0].set_title('Total Local Revenue v. Per Pupil Spending')
    axes[0].legend()

    second_corr = round(group.corr().loc['MEAN INCOME', 'PPCSTOT'], 2)
    axes[1].scatter(x='MEAN INCOME', y='PPCSTOT', data=group, label=f'{name} (={seco
    axes[1].set_xlabel('MEAN INCOME')
    axes[1].set_xticks(mean_income_ticks)
    axes[1].set_ylabel('Per Pupil Spending')
    axes[1].set_yticks(pps_ticks)
    axes[1].set_title('Mean Income v. Per Pupil Spending')
    axes[1].legend()

    third_corr = round(group.corr().loc['MEAN INCOME', 'TLOCREV'], 2)
    axes[2].scatter(x='MEAN INCOME', y='TLOCREV', data=group, label=f'{name} (={thir
    axes[2].set_xlabel('MEAN INCOME')
    axes[2].set_xticks(mean_income_ticks)
    axes[2].set_ylabel('Total Local Revenue')
    axes[2].set_yticks(local_rev_ticks)
    axes[2].set_title('Mean Income v. Total Local Revenue')
    axes[2].legend()
```



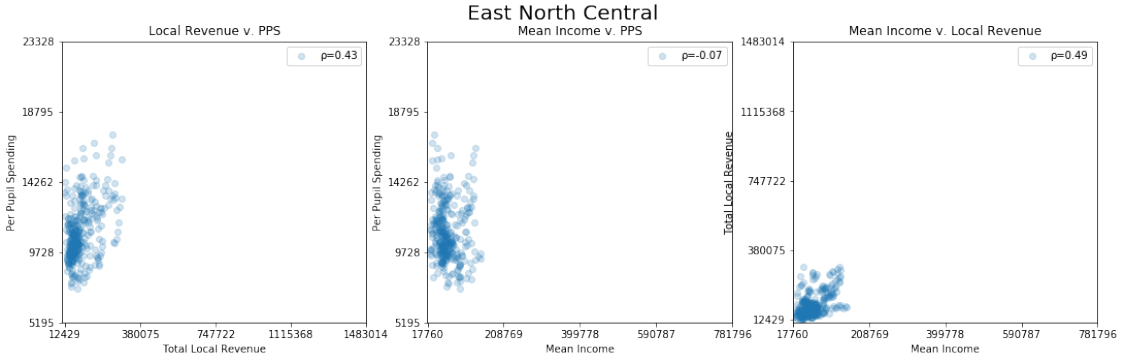
In [436]:
```
division_data = schlev_data.groupby(['DIVISION'])
fig, axes = plt.subplots(ncols=3)
fig.set_size_inches(18, 4)
for name, group in division_data:
    first_corr = round(group.corr().loc['TLOCREV', 'PCT_PASS'], 2)
```

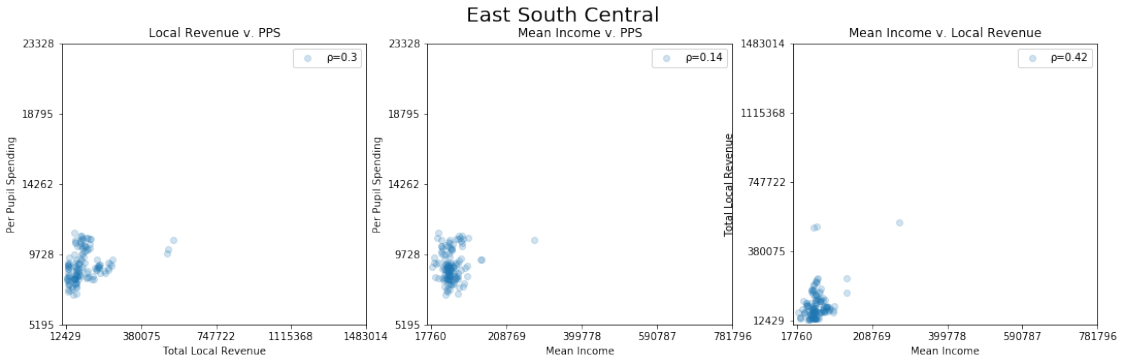
```
        axes[0].scatter(x='TLOCREV', y='PCT_PASS', data=group, label=f'{name} (={first_c
        axes[0].set_xlabel('Total Local Revenue')
        axes[0].set_xticks(local_rev_ticks)
        axes[0].set_ylabel('Percent Passed')
        axes[0].set_yticks(pct_pass_ticks)
        axes[0].set_title('Total Local Revenue v. Percent Passed')
        axes[0].legend()

        second_corr = round(group.corr().loc['PPCSTOT', 'PCT_PASS'], 2)
        axes[1].scatter(x='PPCSTOT', y='PCT_PASS', data=group, label=f'{name} (={second_
        axes[1].set_xlabel('Per Pupil Spending')
        axes[1].set_xticks(pps_ticks)
        axes[1].set_ylabel('Percent Passed')
        axes[1].set_yticks(pct_pass_ticks)
        axes[1].set_title('PPS v. Percent Passed')
        axes[1].legend()

        third_corr = round(group.corr().loc['MEAN INCOME', 'PCT_PASS'], 2)
        axes[2].scatter(x='MEAN INCOME', y='PCT_PASS', data=group, label=f'{name} (={thi
        axes[2].set_xlabel('Mean Income')
        axes[2].set_xticks(mean_income_ticks)
        axes[2].set_ylabel('Percent Passed')
        axes[2].set_yticks(pct_pass_ticks)
        axes[2].set_title('Mean Income v. Percent Passed')
        axes[2].legend()
```

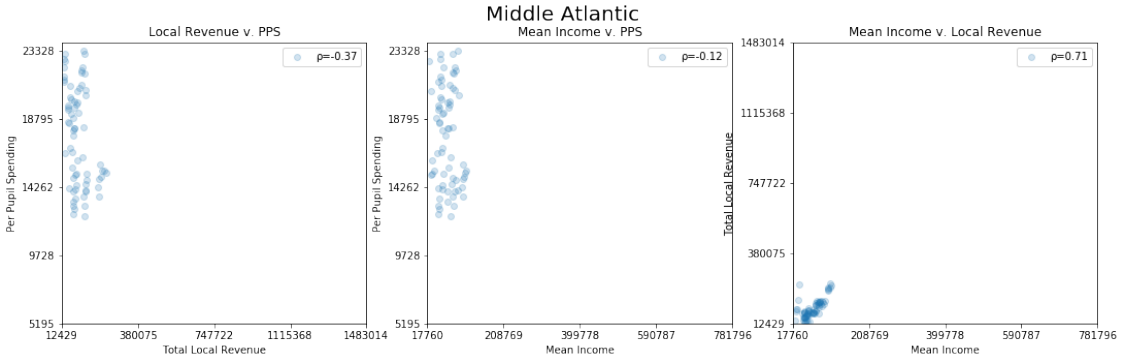


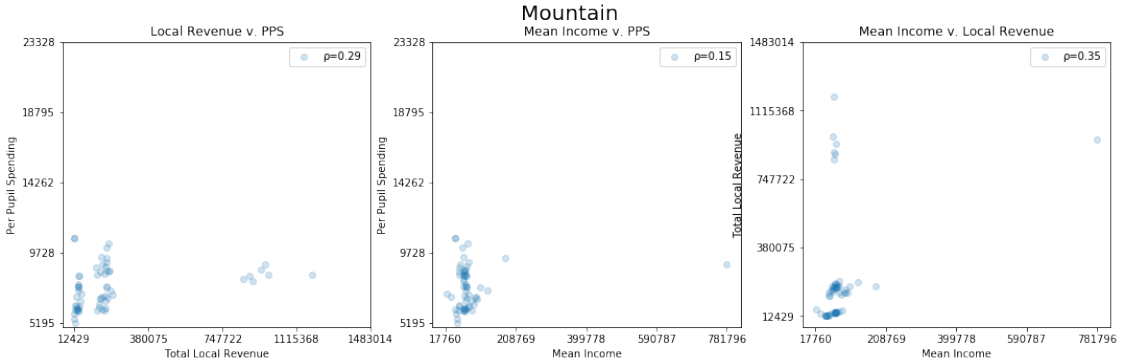
In [437]:
```
for name, group in division_data:
    mean_income = group['MEAN INCOME']
    local_rev = group['TLOCREV']
    per_pupil_spending = group['PPCSTOT']

    fig, axes = plt.subplots(ncols=3, nrows=1)
    fig.set_size_inches(18, 5)
    fig.suptitle(name, fontsize=20)

    first_corr = round(group.corr().loc['TLOCREV', 'PPCSTOT'], 2)
```

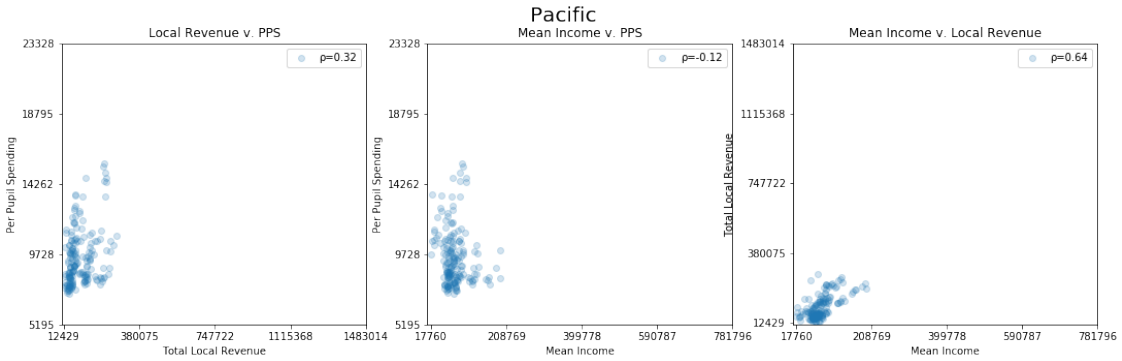
```
axes[0].scatter(x=local_rev, y=per_pupil_spending, alpha=0.2)
axes[0].set_xlabel('Total Local Revenue')
axes[0].set_xticks(local_rev_ticks)
axes[0].set_ylabel('Per Pupil Spending')
axes[0].set_yticks(pps_ticks)
axes[0].set_title('Local Revenue v. PPS')
axes[0].legend([f'={first_corr}'])

second_corr = round(group.corr().loc['MEAN INCOME', 'PPCSTOT'], 2)
axes[1].scatter(x=mean_income, y=per_pupil_spending, alpha=0.2)
axes[1].set_xlabel('Mean Income')
axes[1].set_xticks(mean_income_ticks)
axes[1].set_ylabel('Per Pupil Spending')
axes[1].set_yticks(pps_ticks)
axes[1].set_title('Mean Income v. PPS')
axes[1].legend([f'={second_corr}'])

third_corr = round(group.corr().loc['MEAN INCOME', 'TLOCREV'], 2)
axes[2].scatter(x=mean_income, y=local_rev, alpha=0.2)
axes[2].set_xlabel('Mean Income')
axes[2].set_xticks(mean_income_ticks)
axes[2].set_ylabel('Total Local Revenue')
axes[2].set_yticks(local_rev_ticks)
axes[2].set_title('Mean Income v. Local Revenue')
axes[2].legend([f'={third_corr}'])
```

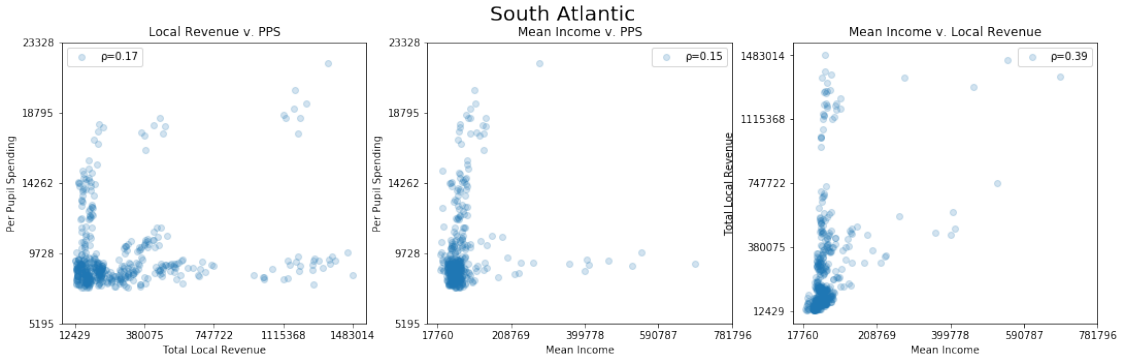


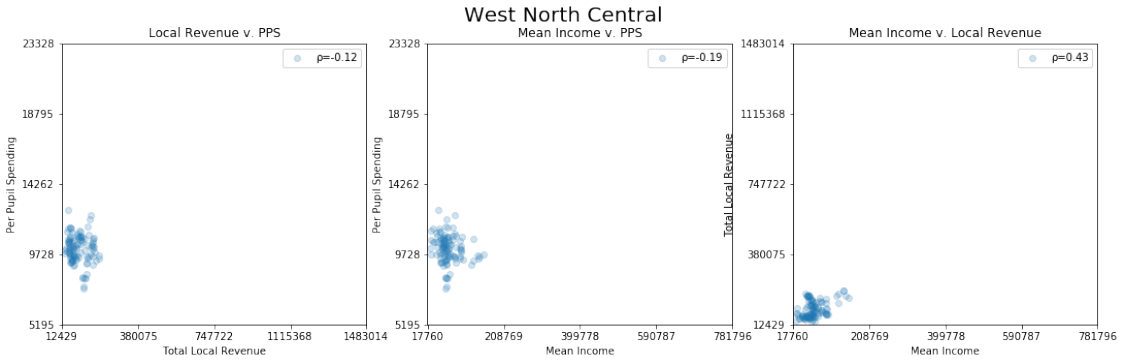

East South Central
Local Revenue v. PPS
ρ=0.3
Per Pupil Spending
Total Local Revenue
Mean Income v. PPS
ρ=0.14
Per Pupil Spending
Mean Income
Mean Income v. Local Revenue
ρ=0.42
Total Local Revenue
Mean Income

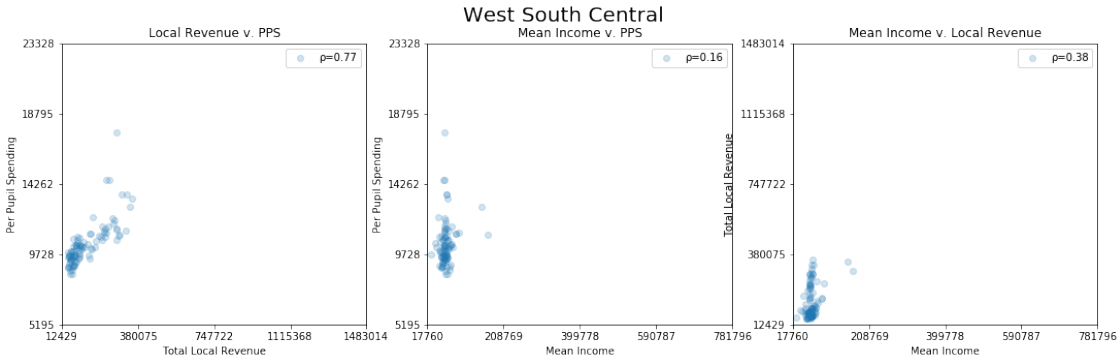

Middle Atlantic
Local Revenue v. PPS
ρ=-0.37
Per Pupil Spending
Total Local Revenue
Mean Income v. PPS
ρ=-0.12
Per Pupil Spending
Mean Income
Mean Income v. Local Revenue
ρ=0.71
Total Local Revenue
Mean Income


Mountain
Local Revenue v. PPS
ρ=0.29
Per Pupil Spending
Total Local Revenue
Mean Income v. PPS
ρ=0.15
Per Pupil Spending
Mean Income
Mean Income v. Local Revenue
ρ=0.35
Total Local Revenue
Mean Income


Pacific
Local Revenue v. PPS
ρ=0.32
Per Pupil Spending
Total Local Revenue
Mean Income v. PPS
ρ=-0.12
Per Pupil Spending
Mean Income
Mean Income v. Local Revenue
ρ=0.64
Total Local Revenue
Mean Income

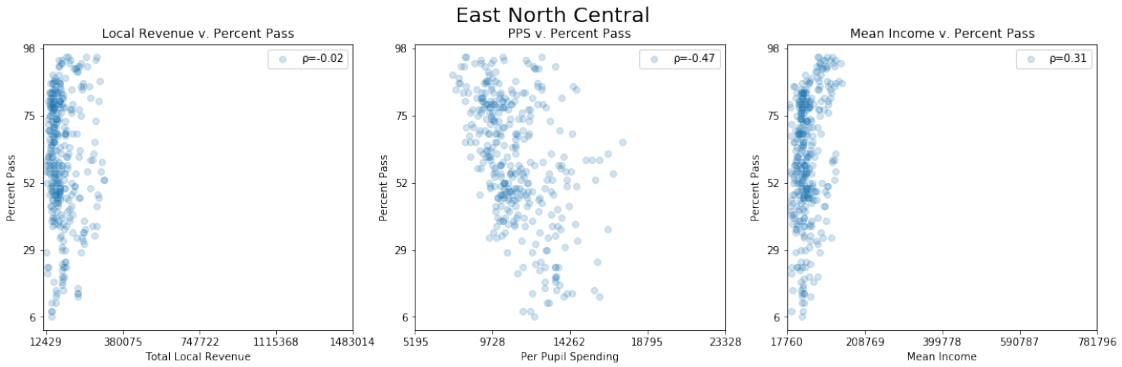

South Atlantic
Local Revenue v. PPS
ρ=0.17
Per Pupil Spending
Total Local Revenue
Mean Income v. PPS
ρ=0.15
Per Pupil Spending
Mean Income
Mean Income v. Local Revenue
ρ=0.39
Total Local Revenue
Mean Income

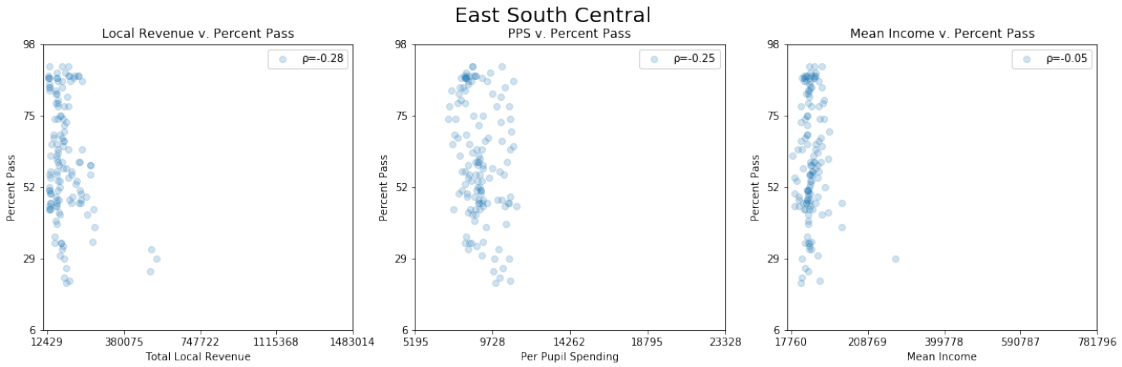

West North Central
Local Revenue v. PPS
ρ=-0.12
Per Pupil Spending
Total Local Revenue
Mean Income v. PPS
ρ=-0.19
Per Pupil Spending
Mean Income
Mean Income v. Local Revenue
ρ=0.43
Total Local Revenue
Mean Income

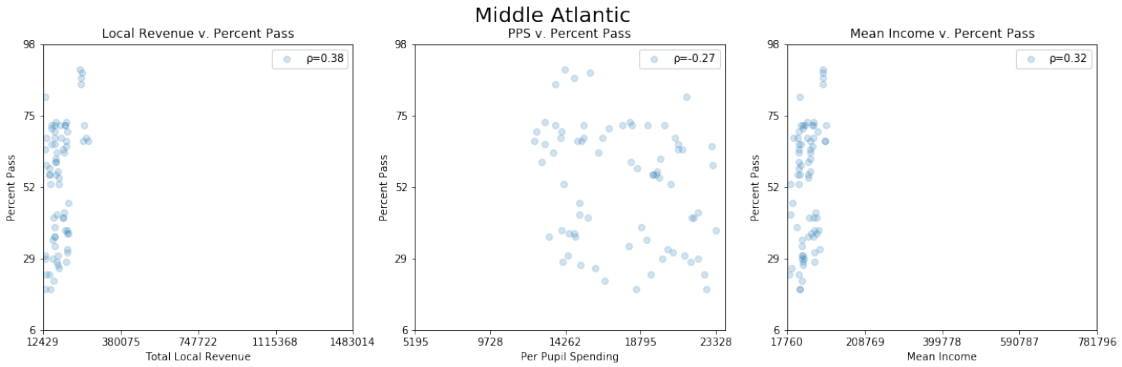


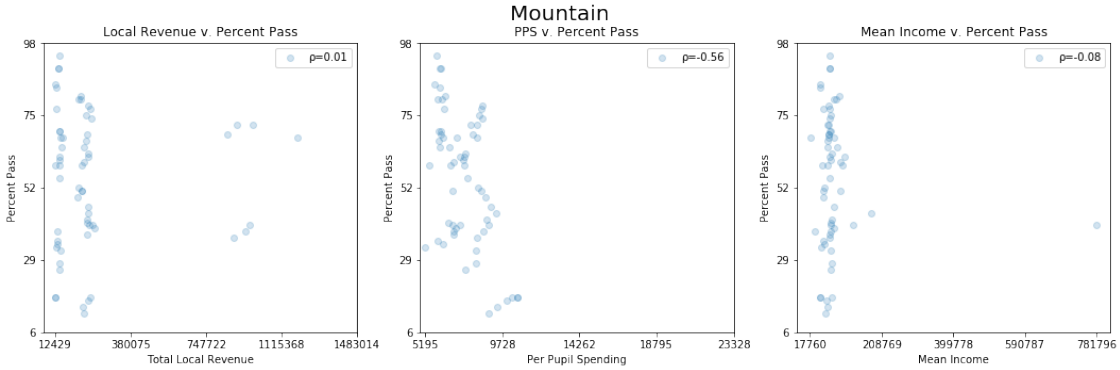

```
In [438]: for name, group in division_data:
              mean_income = group['MEAN INCOME']
              local_rev = group['TLOCREV']
              per_pupil_spending = group['PPCSTOT']
              pct_pass = group['PCT_PASS']

              fig, axes = plt.subplots(ncols=3, nrows=1)
              fig.set_size_inches(18, 5)
              fig.suptitle(name, fontsize=20)

              first_corr = round(group.corr().loc['TLOCREV', 'PCT_PASS'], 2)
              axes[0].scatter(x=local_rev, y=pct_pass, alpha=0.2)
              axes[0].set_xlabel('Total Local Revenue')
              axes[0].set_xticks(local_rev_ticks)
              axes[0].set_ylabel('Percent Pass')
              axes[0].set_yticks(pct_pass_ticks)
              axes[0].set_title('Local Revenue v. Percent Pass')
              axes[0].legend([f'={first_corr}'])

              second_corr = round(group.corr().loc['PPCSTOT', 'PCT_PASS'], 2)
              axes[1].scatter(x=per_pupil_spending, y=pct_pass, alpha=0.2)
              axes[1].set_xlabel('Per Pupil Spending')
              axes[1].set_xticks(pps_ticks)
              axes[1].set_ylabel('Percent Pass')
              axes[1].set_yticks(pct_pass_ticks)
              axes[1].set_title('PPS v. Percent Pass')
              axes[1].legend([f'={second_corr}'])

              third_corr = round(group.corr().loc['MEAN INCOME', 'PCT_PASS'], 2)
              axes[2].scatter(x=mean_income, y=pct_pass, alpha=0.2)
              axes[2].set_xlabel('Mean Income')
              axes[2].set_xticks(mean_income_ticks)
              axes[2].set_ylabel('Percent Pass')
              axes[2].set_yticks(pct_pass_ticks)
```

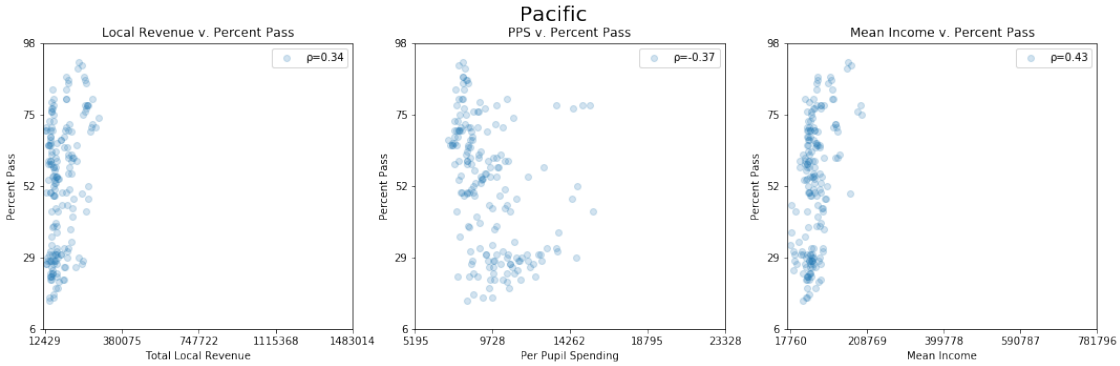
```
axes[2].set_title('Mean Income v. Percent Pass')
axes[2].legend([f'={third_corr}'])
```

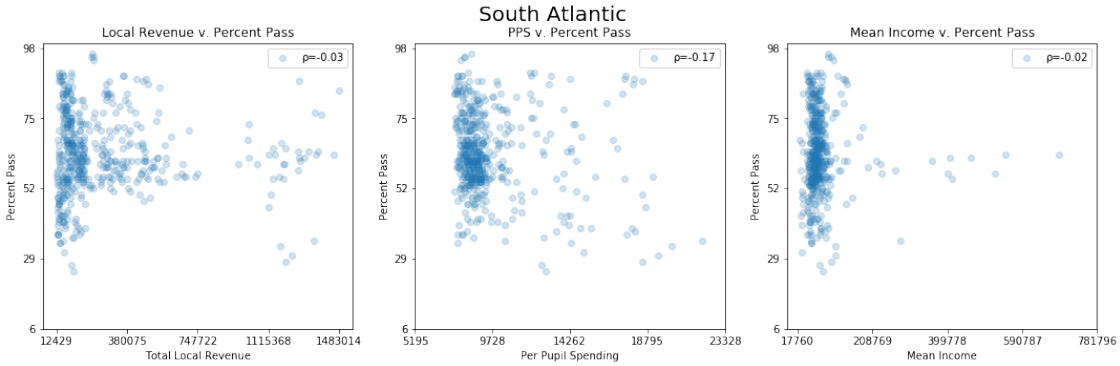


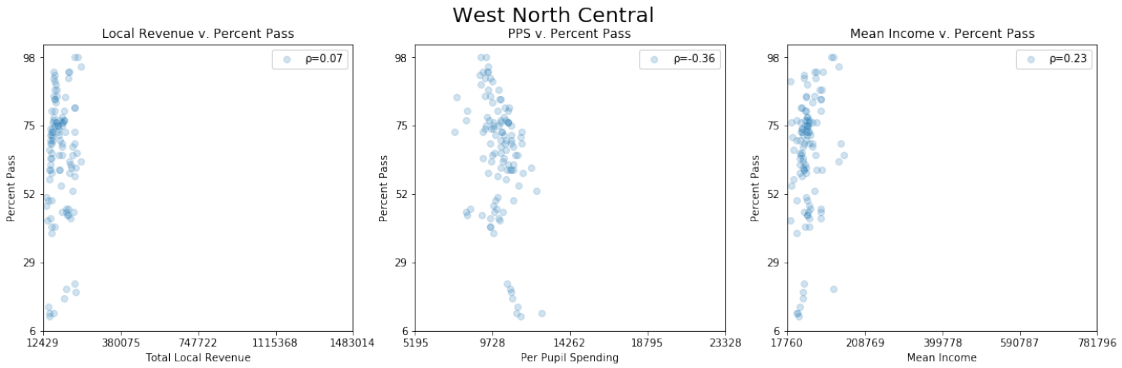


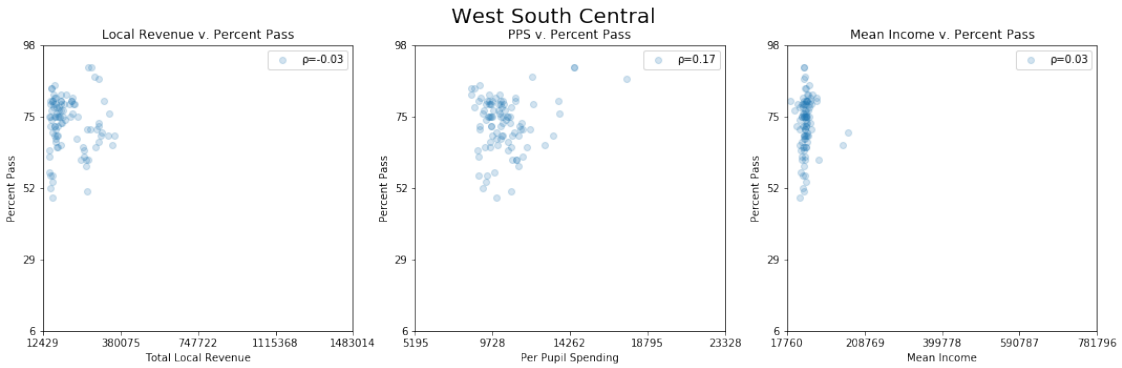



Mountain
Local Revenue v. Percent Pass
ρ=0.01
Percent Pass
Total Local Revenue
PPS v. Percent Pass
ρ=-0.56
Per Pupil Spending
Mean Income v. Percent Pass
ρ=-0.08
Mean Income


Pacific
Local Revenue v. Percent Pass
ρ=0.34
Percent Pass
Total Local Revenue
PPS v. Percent Pass
ρ=-0.37
Per Pupil Spending
Mean Income v. Percent Pass
ρ=0.43
Mean Income


South Atlantic
Local Revenue v. Percent Pass
ρ=-0.03
Percent Pass
Total Local Revenue
PPS v. Percent Pass
ρ=-0.17
Per Pupil Spending
Mean Income v. Percent Pass
ρ=-0.02
Mean Income



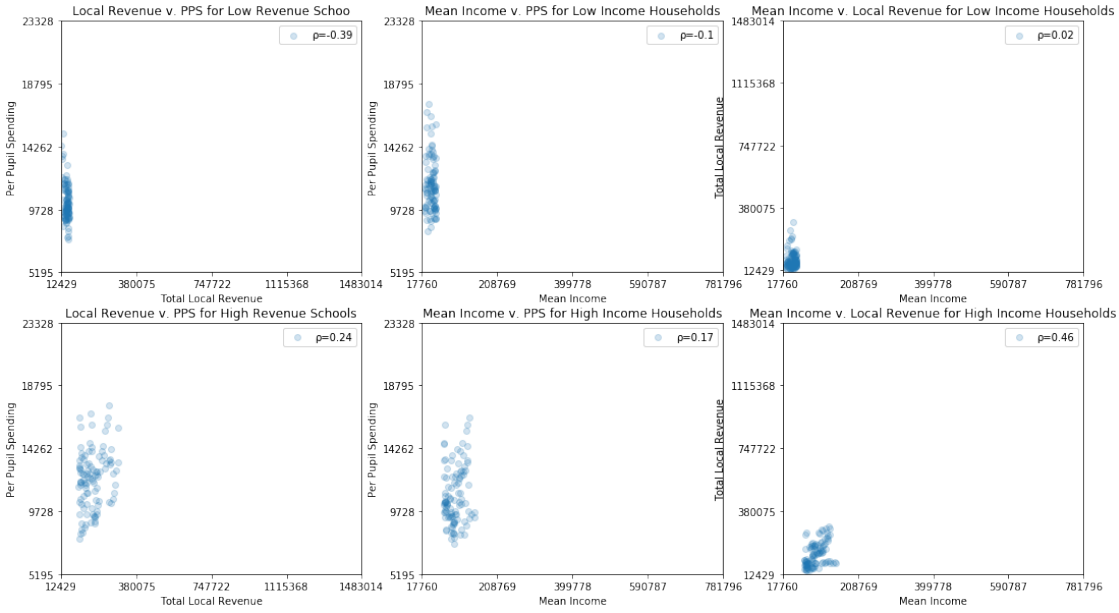



```
In [439]: for name, group in division_data:
              low_quantile = .3
              high_quantile = .7

              mean_income = group['MEAN INCOME']
              min_income = mean_income.min()
              max_income = mean_income.max()
              low_income_qtl = mean_income.quantile(q=low_quantile)
              high_income_qtl = mean_income.quantile(q=high_quantile)
              low_income_grp = group[mean_income < low_income_qtl]
              high_income_grp = group[mean_income > high_income_qtl]

              local_rev = group['TLOCREV']
              min_rev = local_rev.min()
              max_rev = local_rev.max()
              low_rev_qtl = local_rev.quantile(q=low_quantile)
              high_rev_qtl = local_rev.quantile(q=high_quantile)
              low_rev_grp = group[local_rev < low_rev_qtl]
              high_rev_grp = group[local_rev > high_rev_qtl]
```

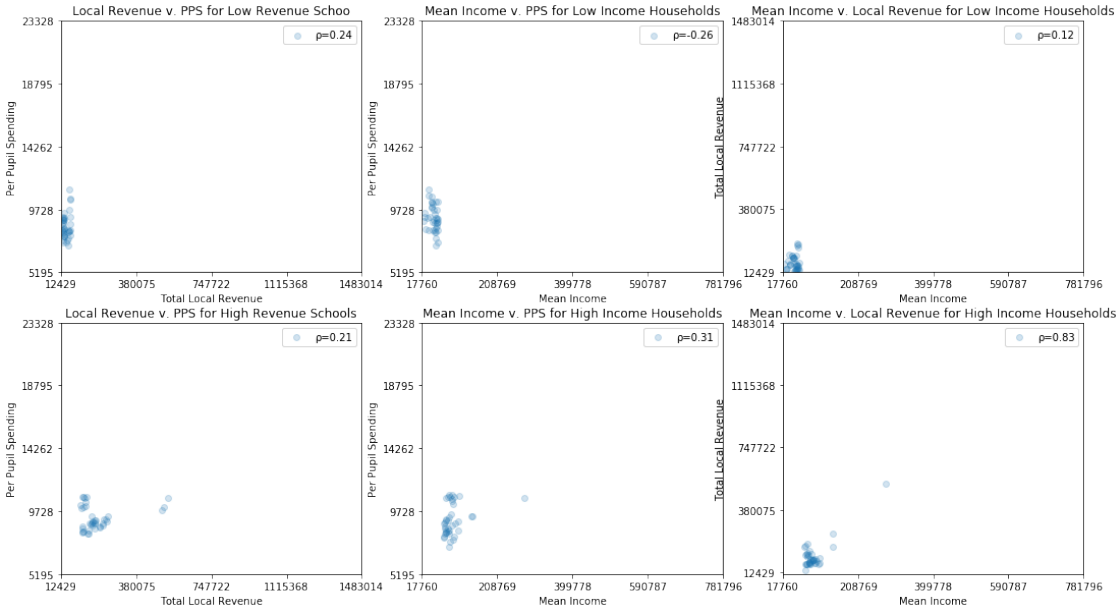
```
per_pupil_spending = group['PPCSTOT']
min_pps = per_pupil_spending.min()
max_pps = per_pupil_spending.max()
low_pps_qtl = per_pupil_spending.quantile(q=low_quantile)
high_pps_qtl = per_pupil_spending.quantile(q=high_quantile)
low_pps_grp = group[per_pupil_spending < low_pps_qtl]
high_pps_grp = group[per_pupil_spending > high_pps_qtl]

fig, axes = plt.subplots(ncols=3, nrows=2)
fig.set_size_inches(18, 10)
fig.suptitle(name, fontsize=20)

first_corr = round(low_rev_grp.corr().loc['TLOCREV', 'PPCSTOT'], 2)
axes[0][0].scatter(x=low_rev_grp['TLOCREV'], y=low_rev_grp['PPCSTOT'], alpha=0.2)
axes[0][0].set_xlabel('Total Local Revenue')
axes[0][0].set_xticks(local_rev_ticks)
axes[0][0].set_ylabel('Per Pupil Spending')
axes[0][0].set_yticks(pps_ticks)
axes[0][0].set_title('Local Revenue v. PPS for Low Revenue Schoo')
axes[0][0].legend([f'={first_corr}'])

second_corr = round(low_income_grp.corr().loc['MEAN INCOME', 'PPCSTOT'], 2)
axes[0][1].scatter(x=low_income_grp['MEAN INCOME'], y=low_income_grp['PPCSTOT'],
axes[0][1].set_xlabel('Mean Income')
axes[0][1].set_xticks(mean_income_ticks)
axes[0][1].set_ylabel('Per Pupil Spending')
axes[0][1].set_yticks(pps_ticks)
axes[0][1].set_title('Mean Income v. PPS for Low Income Households')
axes[0][1].legend([f'={second_corr}'])

third_corr = round(low_income_grp.corr().loc['MEAN INCOME', 'TLOCREV'], 2)
axes[0][2].scatter(x=low_income_grp['MEAN INCOME'], y=low_income_grp['TLOCREV'],
axes[0][2].set_xlabel('Mean Income')
axes[0][2].set_xticks(mean_income_ticks)
axes[0][2].set_ylabel('Total Local Revenue')
axes[0][2].set_yticks(local_rev_ticks)
axes[0][2].set_title('Mean Income v. Local Revenue for Low Income Households')
axes[0][2].legend([f'={third_corr}'])

fourth_corr = round(high_rev_grp.corr().loc['TLOCREV', 'PPCSTOT'], 2)
axes[1][0].scatter(x=high_rev_grp['TLOCREV'], y=high_rev_grp['PPCSTOT'], alpha=0
axes[1][0].set_xlabel('Total Local Revenue')
axes[1][0].set_xticks(local_rev_ticks)
axes[1][0].set_ylabel('Per Pupil Spending')
axes[1][0].set_yticks(pps_ticks)
axes[1][0].set_title('Local Revenue v. PPS for High Revenue Schools')
axes[1][0].legend([f'={fourth_corr}'])
```

```
fifth_corr = round(high_income_grp.corr().loc['MEAN INCOME', 'PPCSTOT'], 2)
axes[1][1].scatter(x=high_income_grp['MEAN INCOME'], y=high_income_grp['PPCSTOT']
axes[1][1].set_xlabel('Mean Income')
axes[1][1].set_xticks(mean_income_ticks)
axes[1][1].set_ylabel('Per Pupil Spending')
axes[1][1].set_yticks(pps_ticks)
axes[1][1].set_title('Mean Income v. PPS for High Income Households')
axes[1][1].legend([f'={fifth_corr}'])

sixth_corr = round(high_income_grp.corr().loc['MEAN INCOME', 'TLOCREV'], 2)
axes[1][2].scatter(x=high_income_grp['MEAN INCOME'], y=high_income_grp['TLOCREV']
axes[1][2].set_xlabel('Mean Income')
axes[1][2].set_xticks(mean_income_ticks)
axes[1][2].set_ylabel('Total Local Revenue')
axes[1][2].set_yticks(local_rev_ticks)
axes[1][2].set_title('Mean Income v. Local Revenue for High Income Households')
axes[1][2].legend([f'={sixth_corr}'])
```

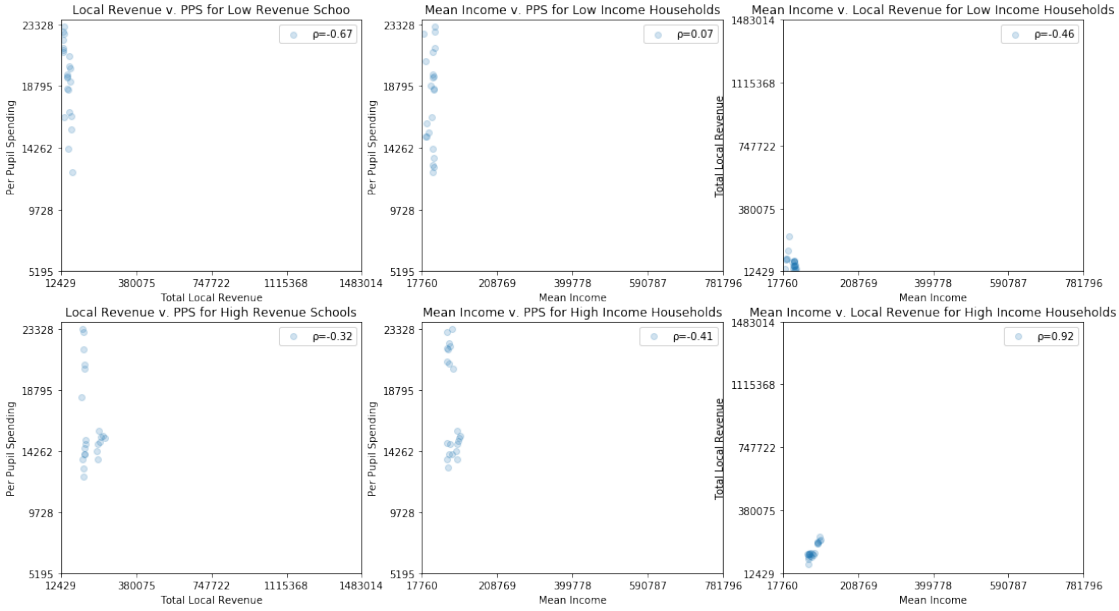
East North Central



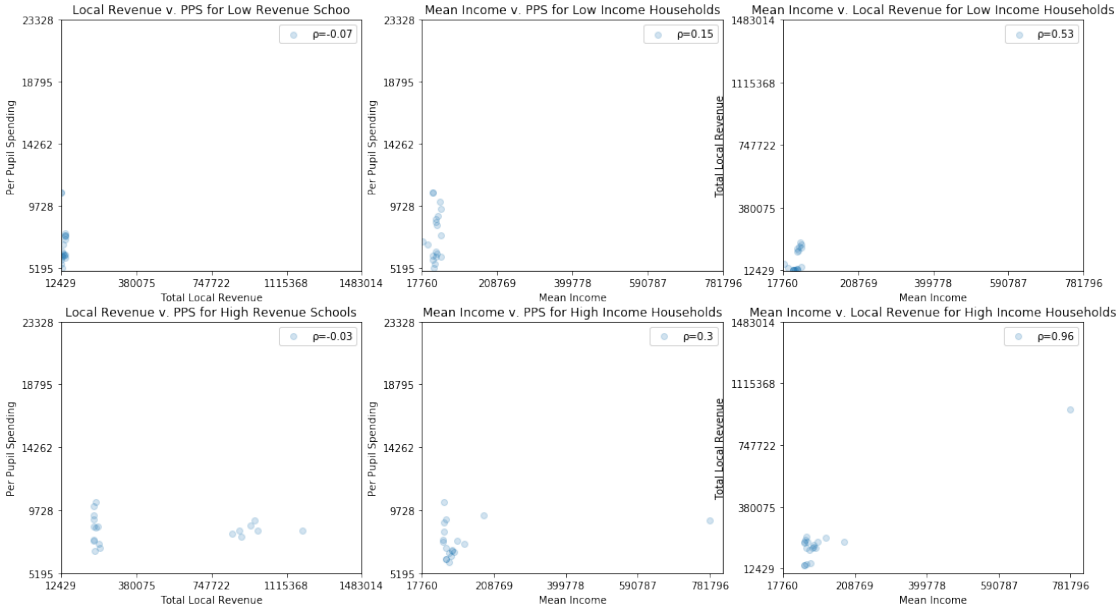
East South Central



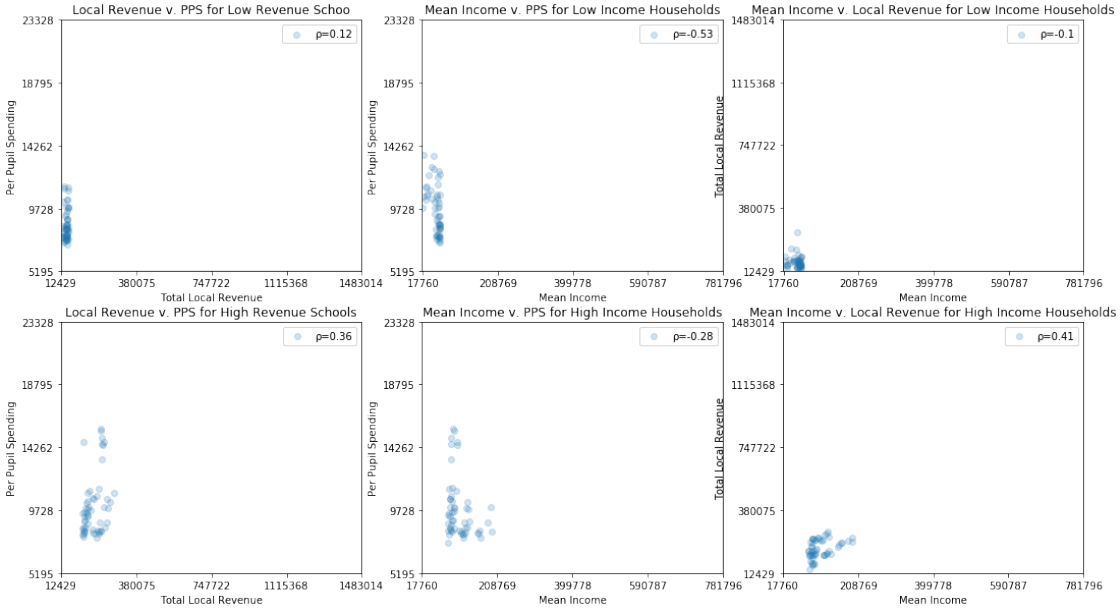
Middle Atlantic



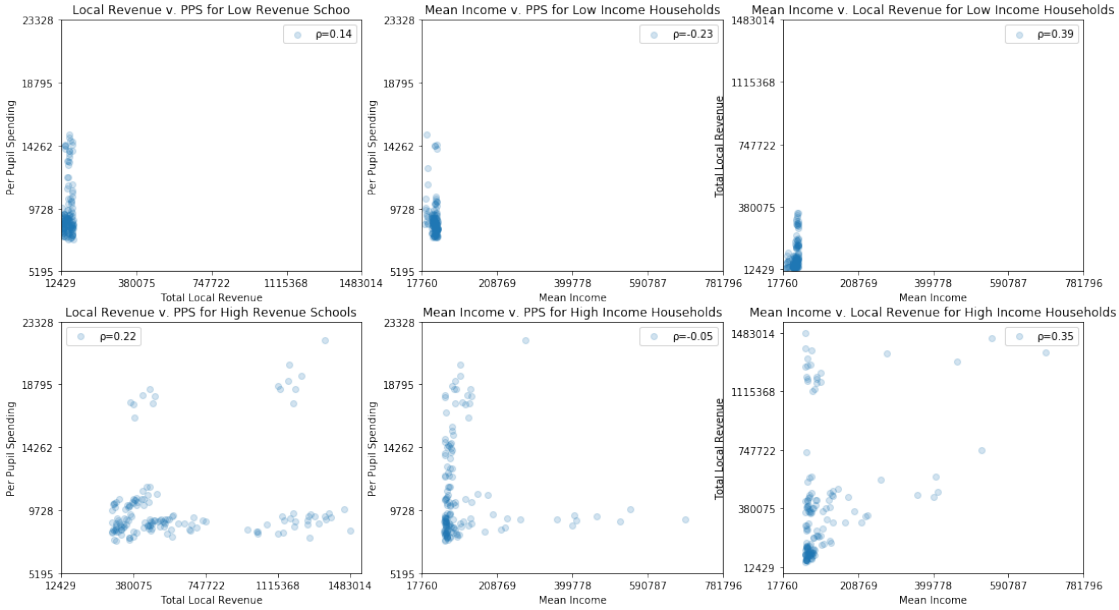
Mountain



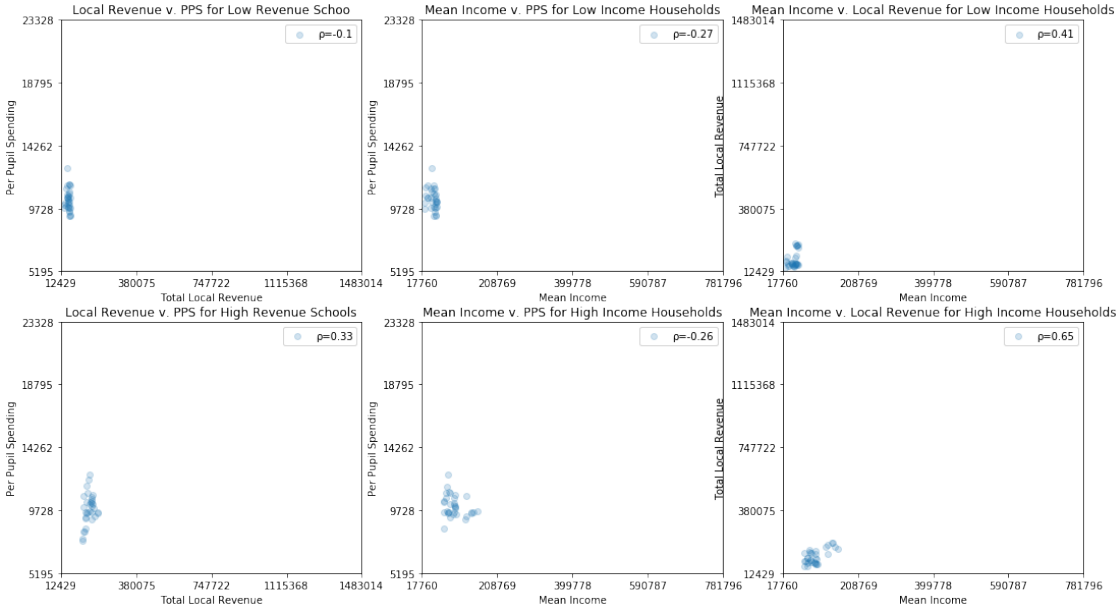
Pacific



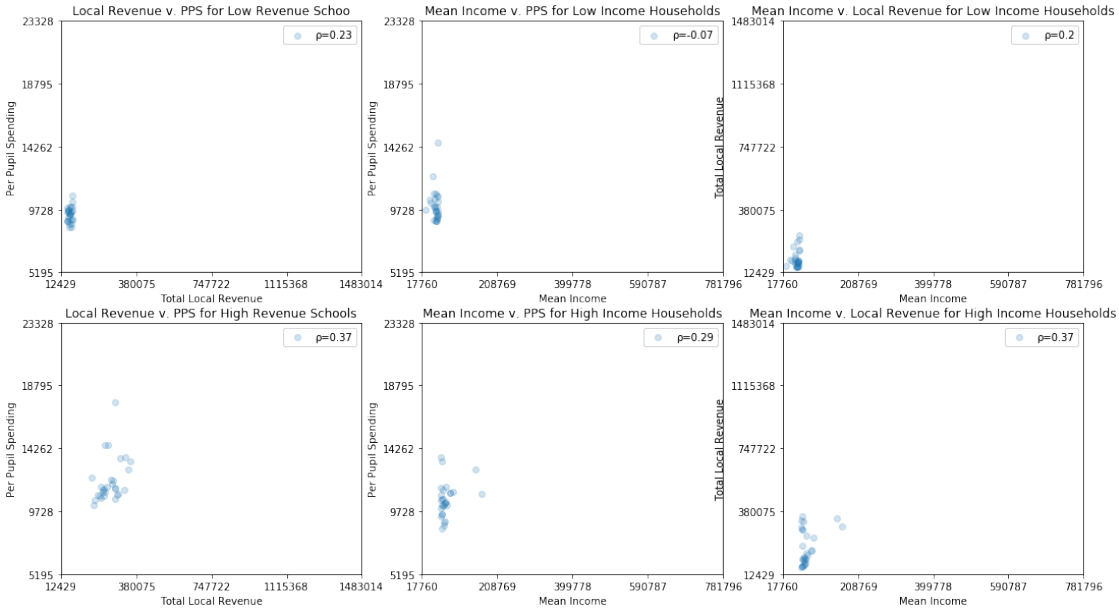
South Atlantic



West North Central



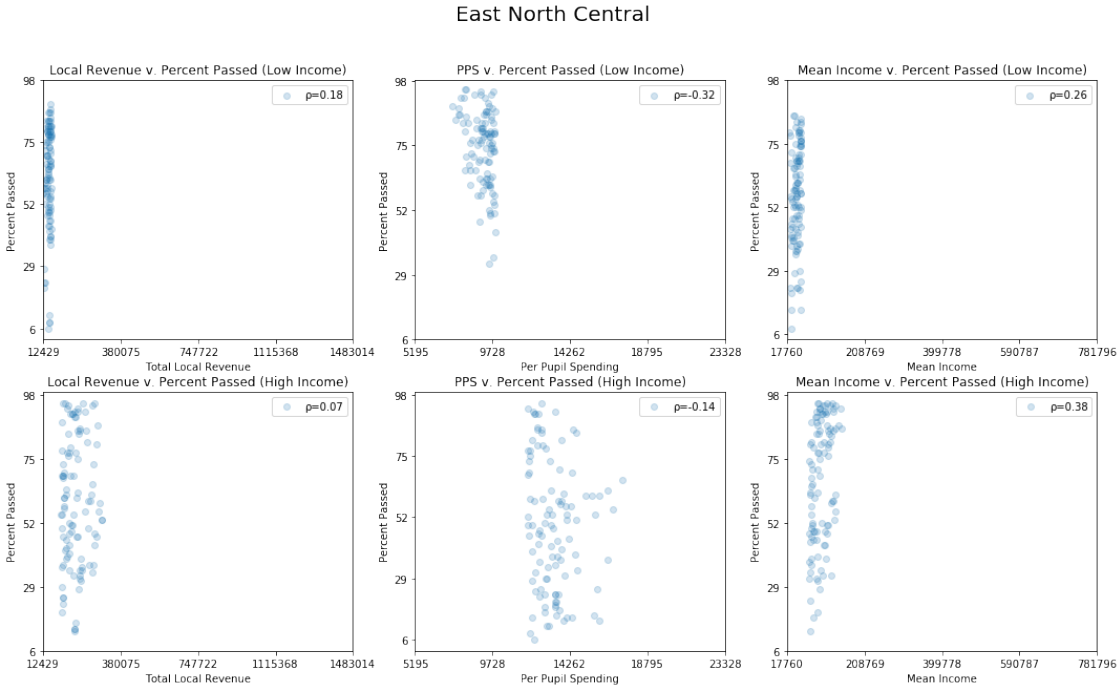
West South Central



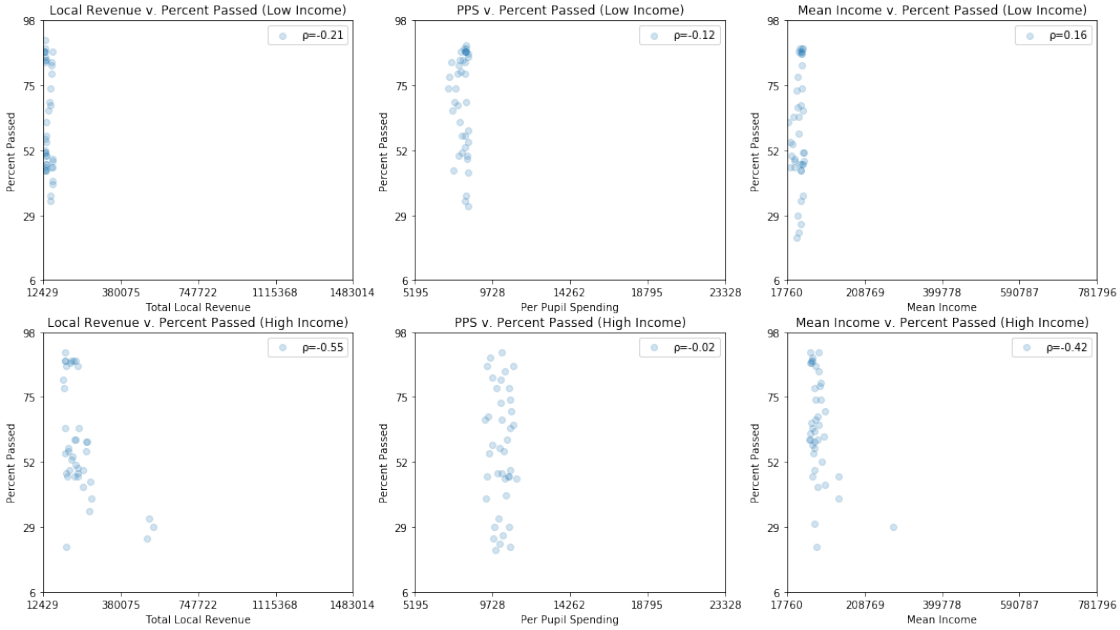

```
In [440]: for name, group in division_data:
              low_quantile = .3
              high_quantile = .7

              mean_income = group['MEAN INCOME']
              min_income = mean_income.min()
              max_income = mean_income.max()
              low_income_qtl = mean_income.quantile(q=low_quantile)
              high_income_qtl = mean_income.quantile(q=high_quantile)
              low_income_grp = group[mean_income < low_income_qtl]
              high_income_grp = group[mean_income > high_income_qtl]

              local_rev = group['TLOCREV']
              min_rev = local_rev.min()
              max_rev = local_rev.max()
              low_rev_qtl = local_rev.quantile(q=low_quantile)
              high_rev_qtl = local_rev.quantile(q=high_quantile)
              low_rev_grp = group[local_rev < low_rev_qtl]
              high_rev_grp = group[local_rev > high_rev_qtl]

              per_pupil_spending = group['PPCSTOT']
              min_pps = per_pupil_spending.min()
              max_pps = per_pupil_spending.max()
              low_pps_qtl = per_pupil_spending.quantile(q=low_quantile)
              high_pps_qtl = per_pupil_spending.quantile(q=high_quantile)
              low_pps_grp = group[per_pupil_spending < low_pps_qtl]
```

```
high_pps_grp = group[per_pupil_spending > high_pps_qtl]

fig, axes = plt.subplots(ncols=3, nrows=2)
fig.set_size_inches(18, 10)
fig.suptitle(name, fontsize=20)

first_corr = round(low_rev_grp.corr().loc['TLOCREV', 'PCT_PASS'], 2)
axes[0][0].scatter(x=low_rev_grp['TLOCREV'], y=low_rev_grp['PCT_PASS'], alpha=0.
axes[0][0].set_xlabel('Total Local Revenue')
axes[0][0].set_xticks(local_rev_ticks)
axes[0][0].set_ylabel('Percent Passed')
axes[0][0].set_yticks(pct_pass_ticks)
axes[0][0].set_title('Local Revenue v. Percent Passed (Low Income)')
axes[0][0].legend([f'={first_corr}'])

second_corr = round(low_pps_grp.corr().loc['PPCSTOT', 'PCT_PASS'], 2)
axes[0][1].scatter(x=low_pps_grp['PPCSTOT'], y=low_pps_grp['PCT_PASS'], alpha=0.
axes[0][1].set_xlabel('Per Pupil Spending')
axes[0][1].set_xticks(pps_ticks)
axes[0][1].set_ylabel('Percent Passed')
axes[0][1].set_yticks(pct_pass_ticks)
axes[0][1].set_title('PPS v. Percent Passed (Low Income)')
axes[0][1].legend([f'={second_corr}'])

third_corr = round(low_income_grp.corr().loc['MEAN INCOME', 'PCT_PASS'], 2)
axes[0][2].scatter(x=low_income_grp['MEAN INCOME'], y=low_income_grp['PCT_PASS']
axes[0][2].set_xlabel('Mean Income')
axes[0][2].set_xticks(mean_income_ticks)
axes[0][2].set_ylabel('Percent Passed')
axes[0][2].set_yticks(pct_pass_ticks)
axes[0][2].set_title('Mean Income v. Percent Passed (Low Income)')
axes[0][2].legend([f'={third_corr}'])

fourth_corr = round(high_rev_grp.corr().loc['TLOCREV', 'PCT_PASS'], 2)
axes[1][0].scatter(x=high_rev_grp['TLOCREV'], y=high_rev_grp['PCT_PASS'], alpha=
axes[1][0].set_xlabel('Total Local Revenue')
axes[1][0].set_xticks(local_rev_ticks)
axes[1][0].set_ylabel('Percent Passed')
axes[1][0].set_yticks(pct_pass_ticks)
axes[1][0].set_title('Local Revenue v. Percent Passed (High Income)')
axes[1][0].legend([f'={fourth_corr}'])

fifth_corr = round(high_pps_grp.corr().loc['PPCSTOT', 'PCT_PASS'], 2)
axes[1][1].scatter(x=high_pps_grp['PPCSTOT'], y=high_pps_grp['PCT_PASS'], alpha=
axes[1][1].set_xlabel('Per Pupil Spending')
axes[1][1].set_xticks(pps_ticks)
axes[1][1].set_ylabel('Percent Passed')
axes[1][1].set_yticks(pct_pass_ticks)
```

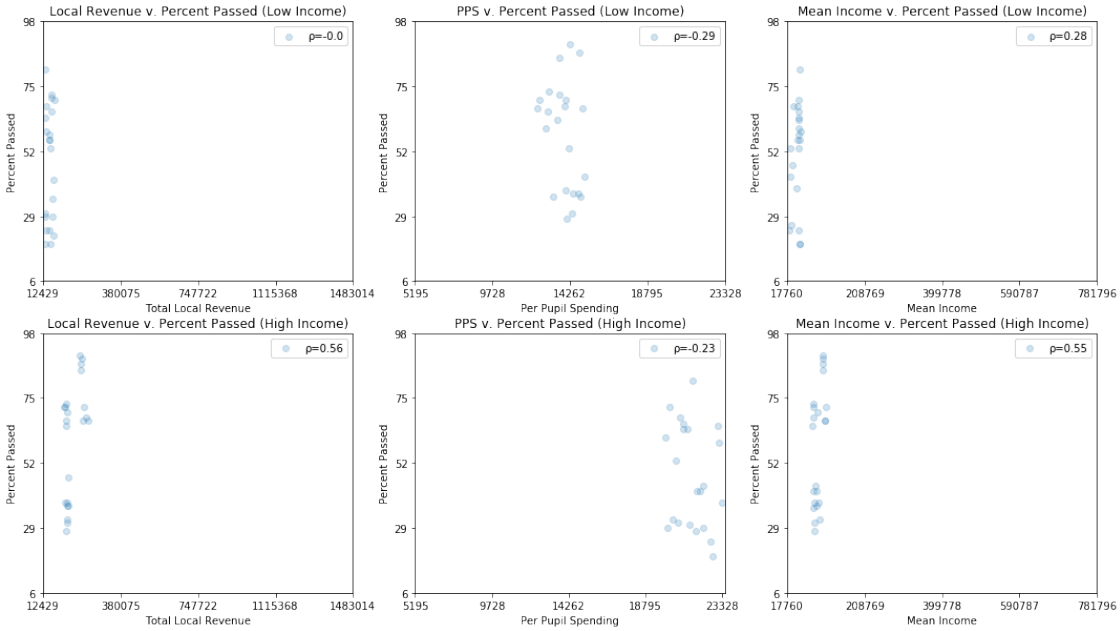
```
axes[1][1].set_title('PPS v. Percent Passed (High Income)')
axes[1][1].legend([f'={fifth_corr}'])

sixth_corr = round(high_income_grp.corr().loc['MEAN INCOME', 'PCT_PASS'], 2)
axes[1][2].scatter(x=high_income_grp['MEAN INCOME'], y=high_income_grp['PCT_PASS
axes[1][2].set_xlabel('Mean Income')
axes[1][2].set_xticks(mean_income_ticks)
axes[1][2].set_ylabel('Percent Passed')
axes[1][2].set_yticks(pct_pass_ticks)
axes[1][2].set_title('Mean Income v. Percent Passed (High Income)')
axes[1][2].legend([f'={sixth_corr}'])
```



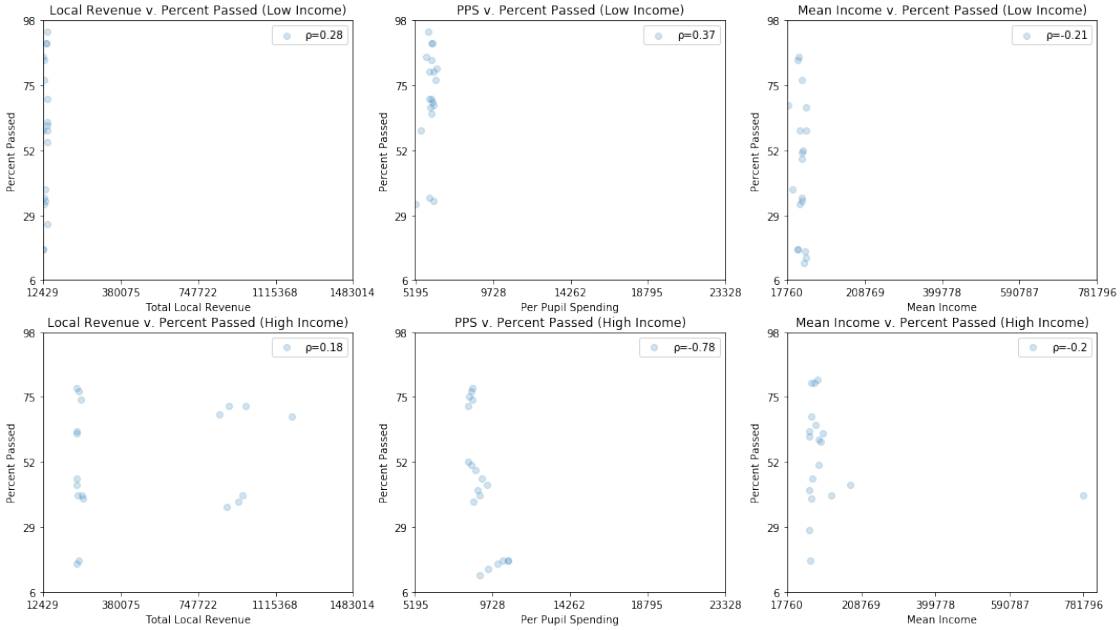
East South Central



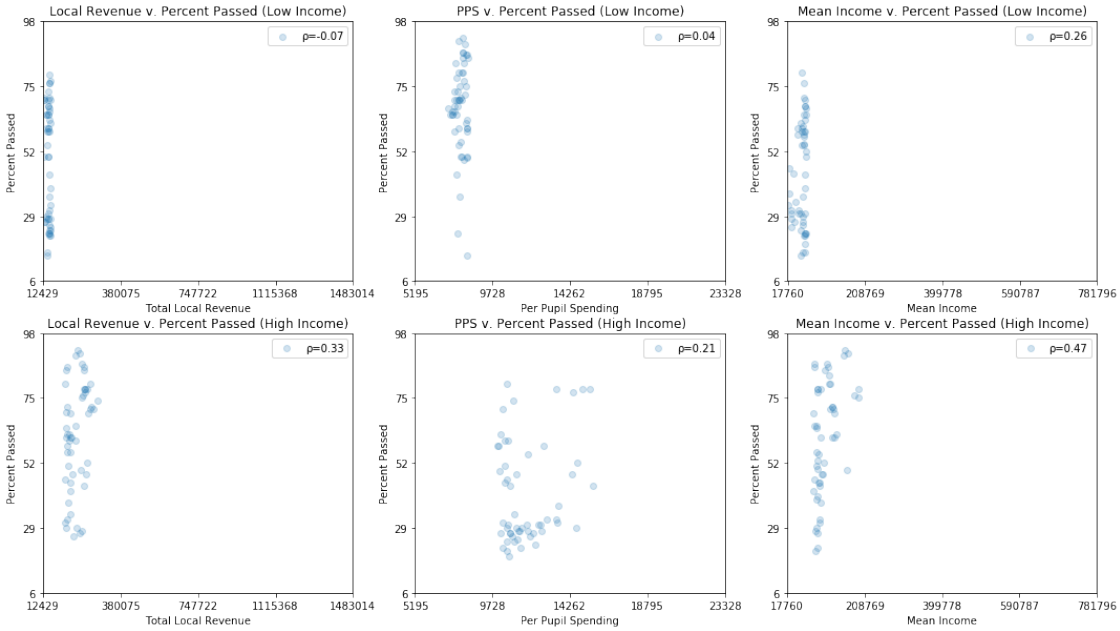
Middle Atlantic



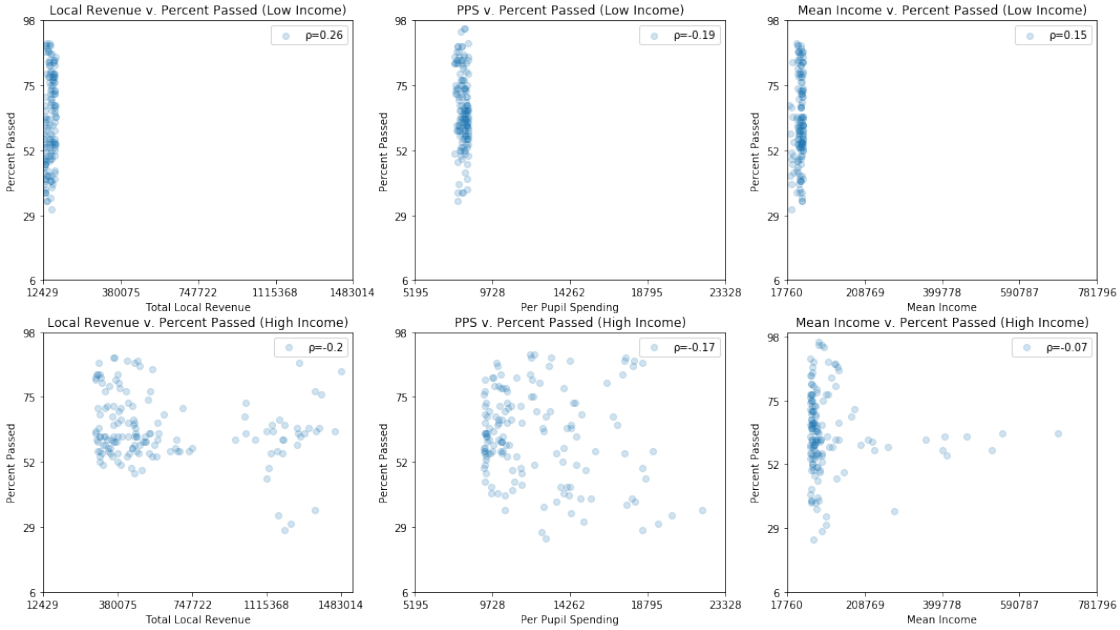
Mountain



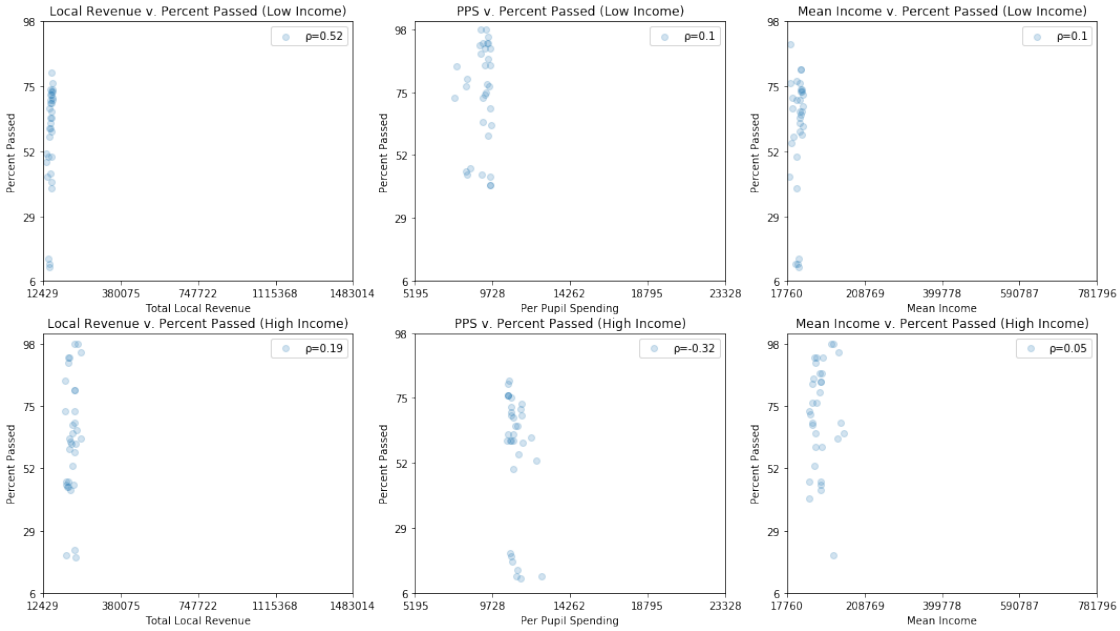
Pacific

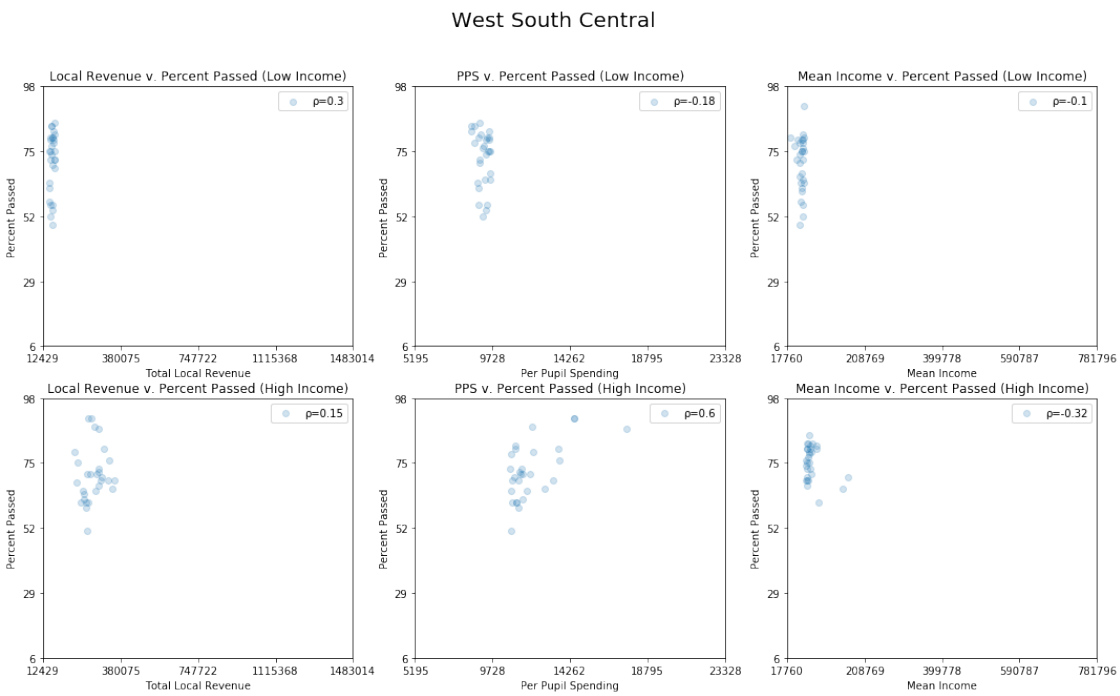


South Atlantic



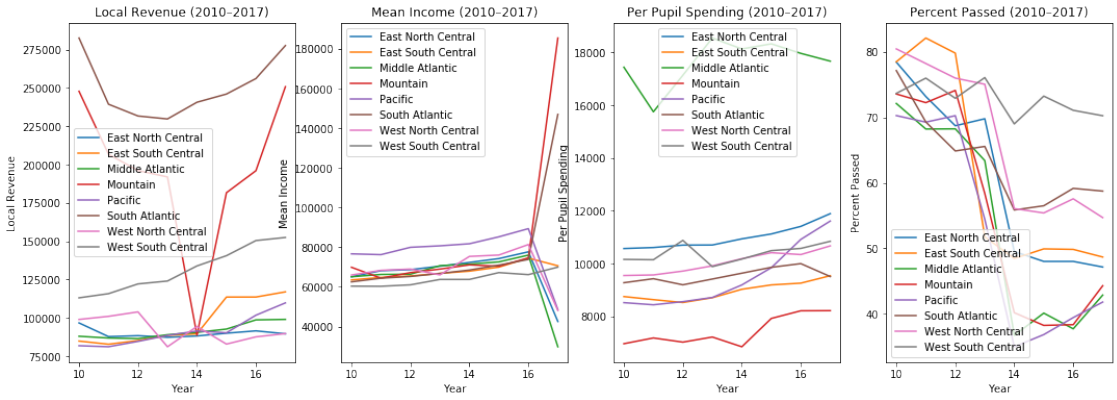
West North Central






```
In [441]: fig, axes = plt.subplots(ncols=4)
          fig.set_size_inches(18, 6)
          division_data_by_year = schlev_data.groupby(['DIVISION', 'YRDATA']).mean()
          for region in division_data_by_year.index.levels[0]:
              year_data = division_data_by_year.xs(region)

              axes[0].plot(year_data.index.values, year_data['TLOCREV'], label=region)
              axes[0].set_xlabel('Year')
              axes[0].set_ylabel('Local Revenue')
              axes[0].set_title('Local Revenue (20102017)')
              axes[0].legend()

              axes[1].plot(year_data.index.values, year_data['MEAN INCOME'], label=region)
              axes[1].set_xlabel('Year')
              axes[1].set_ylabel('Mean Income')
              axes[1].set_title('Mean Income (20102017)')
              axes[1].legend()

              axes[2].plot(year_data.index.values, year_data['PPCSTOT'], label=region)
              axes[2].set_xlabel('Year')
              axes[2].set_ylabel('Per Pupil Spending')
              axes[2].set_title('Per Pupil Spending (20102017)')
              axes[2].legend()

              axes[3].plot(year_data.index.values, year_data['PCT_PASS'], label=region)
```

```
axes[3].set_xlabel('Year')
axes[3].set_ylabel('Percent Passed')
axes[3].set_title('Percent Passed (20102017)')
axes[3].legend()
```



The South Atlantic has the high local revenue out of all the districts which probably caused the greater local revenue seen in the South region. The Middle Atlantic has the highest per pupil spending of all the districts, which accounts for the higher pps in the Northeast region.

There seem to be a few groups of districts peforming on a similar level on the scale of percent passed. The Mountain, Middle Atlantic, Pacific are performing worst than the other districts. The East North Central and East South Central are performing a bit better. South Atlantic and West North Central are performing a bit better than that—almost at 60 percent. The West South Central district is performing best with an about 75-percent passing rate.

Conclusion: We have not come to a solid conclusion about the data. Further analysis would be necessary to have any amount of certainy. For the purposes of the study, Mean Income, Total Local Revenue, and Per Pupil Spending were not string predictors of Percent Passed.

In order to create a clearer picture about what influences the "quality of education" in the United States we would need more time to dive down deeper into the data. With more time we could compare the West and Northeast, which were most similar, to the rest of the US. We could also dive down into the West South Central to try to learn why it has the highest scores over all. Finally we would want to do more research and conduct a further EDA with other factors that may be playing a role here.