pop_proj_tc_vs_census

March 20, 2018

1 Population projections: taxcalc vs Census

This compares population totals between taxcalc and Census projections for the following fields: * XTOT (total population) * nu05 (under 5) * nu13 (under 13) * n24 (children eligible for the Child Tax Credit, of which the primary condition is being under age 17) * nu18 (under 18) * n1820 (18-20) * n21 (21 or older)

Data: CPS | Tax years: 2014-2018 | Type: Static | Author: Max Ghenis | Date run: 2018-03-20

1.1 Setup

1.1.1 Imports

```
In [1]: import taxcalc as tc
        import pandas as pd
        import numpy as np
        import copy
        from bokeh.io import show, output_notebook
        import matplotlib as mpl
        import matplotlib.pyplot as plt
        from matplotlib.ticker import MaxNLocator
        import seaborn as sns
        # On Python 3.6 use "import urllib.request as url_lib".
        import urllib as url_lib

In [2]: tc.__version__

Out[2]: '0.17.0'
```

1.1.2 Settings

```
In [3]: sns.set_style('white')
        DPI = 300
        mpl.rc('savefig', dpi=DPI)
        mpl.rcParams['figure.dpi'] = DPI
        mpl.rcParams['figure.figsize'] = 6.4, 4.8  # Default.

In [4]: mpl.rcParams['font.sans-serif'] = 'Roboto'
        mpl.rcParams['font.family'] = 'sans-serif'
```

```
        # Set title text color to dark gray (https://material.io/color) not black.
        TITLE_COLOR = '#212121'
        mpl.rcParams['text.color'] = TITLE_COLOR

        # Axis titles and tick marks are medium gray.
        AXIS_COLOR = '#757575'
        mpl.rcParams['axes.labelcolor'] = AXIS_COLOR
        mpl.rcParams['xtick.color'] = AXIS_COLOR
        mpl.rcParams['ytick.color'] = AXIS_COLOR

        # Use Seaborn's default color palette.
        # https://stackoverflow.com/q/48958426/1840471 for reproducibility.
        sns.set_palette(sns.color_palette())
```

```
In [5]: # Show one decimal in tables.
        pd.set_option('precision', 2)
```

1.2 Data

1.2.1 taxcalc

```
In [6]: recs = tc.Records.cps_constructor()
        pol = tc.Policy()
```

Include age 5 and 13 to match current code (see https://github.com/open-source-economics/taxdata/issues/164).

```
In [7]: calc = tc.Calculator(records=recs, policy=tc.Policy(), verbose=False)
        tc_pop = pd.DataFrame()
        METRICS = pd.DataFrame(
            index=       ['XTOT', 'nu05', 'nu13', 'nu18', 'n1820', 'n21'],
            data={'min': [0     , 0     , 0     , 0     , 18     , 21   ],
                  'max': [100   , 5     , 13    , 17    , 20     , 100  ]})
        metric_cols = METRICS.index.tolist()
```

```
In [8]: for i in range(2014, 2028):  # 2027 is the last modelable year.
            calc.advance_to_year(i)
            calc.calc_all()
            calc_df = calc.dataframe(['s006'] + metric_cols)
            for col in metric_cols:
                tc_pop.loc[i, col] = (calc_df.s006 * calc_df[col]).sum()
```

```
In [9]: tc_pop_m = tc_pop / 1e6
```

1.2.2 Census projections

```
In [10]: census_raw = pd.read_csv('https://www2.census.gov/programs-surveys/popproj' +
                                  '/datasets/2017/2017-popproj/np2017_d1.csv')
```

```
In [11]: census = census_raw[(census_raw.SEX == 0) & (census_raw.ORIGIN == 0) &
                             (census_raw.RACE == 0)].drop(
             ['SEX', 'ORIGIN', 'RACE', 'TOTAL_POP'], axis=1).melt(
             id_vars='YEAR')
         census.columns = ['year', 'age', 'pop']
         census['age'] = census.age.str.replace('POP_', '').astype('int64')
         census = census[census.year < 2028]
```

1.3 Preprocessing

```
In [12]: censust = pd.DataFrame(index=range(2016, 2028))
         for i in metric_cols:
             tmp = census.loc[census.age.between(METRICS.loc[i, 'min'],
                                                 METRICS.loc[i, 'max']),
                              ['pop', 'year']].groupby('year').sum()
             tmp.columns = [i]
             censust = censust.merge(tmp, left_index=True, right_index=True)
```

```
In [13]: censust_m = censust / 1e6
         censust_m
```

Out[13]:

	XTOT	nu05	nu13	nu18	n1820	n21
2016	323.13	23.96	56.88	73.64	12.75	236.74
2017	325.49	24.02	56.95	73.68	12.76	239.04
2018	327.85	24.13	57.00	73.66	12.87	241.32
2019	330.21	24.26	57.07	73.72	12.92	243.57
2020	332.55	24.39	57.13	73.88	12.87	245.81
2021	334.89	24.52	57.17	74.03	12.76	248.10
2022	337.22	24.68	57.23	74.16	12.75	250.32
2023	339.52	24.78	57.41	74.29	12.82	252.41
2024	341.80	24.86	57.59	74.40	12.90	254.51
2025	344.06	24.93	57.76	74.48	12.97	256.61
2026	346.29	24.99	57.98	74.56	13.04	258.68
2027	348.48	25.03	58.19	74.77	12.97	260.74

```
In [14]: diff = pd.merge(censust_m, tc_pop_m, left_index=True, right_index=True)
         for i in metric_cols:
             diff[i] = diff[i + '_y'] / diff[i + '_x'] - 1
         diff[metric_cols]
```

Out[14]:

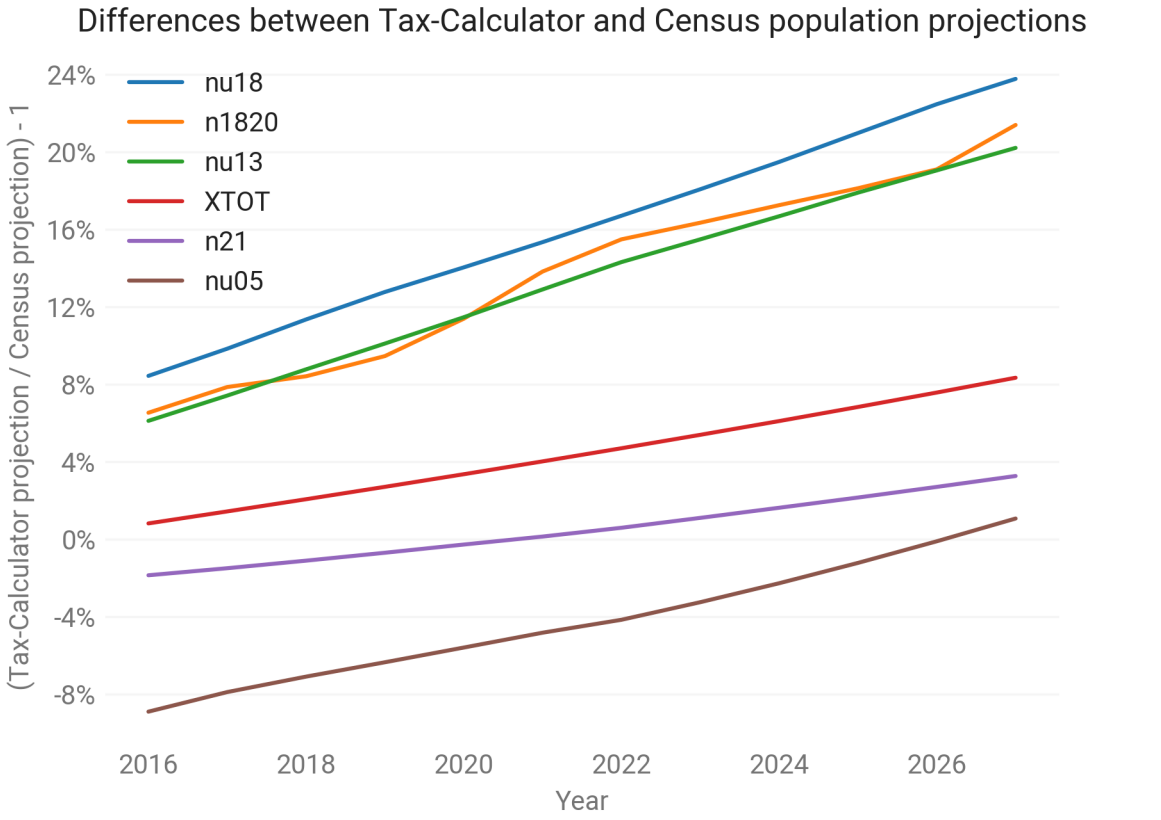
	XTOT	nu05	nu13	nu18	n1820	n21
2016	8.14e-03	-8.91e-02	0.06	0.08	0.07	-1.86e-02
2017	1.43e-02	-7.90e-02	0.07	0.10	0.08	-1.50e-02
2018	2.06e-02	-7.10e-02	0.09	0.11	0.08	-1.11e-02
2019	2.70e-02	-6.36e-02	0.10	0.13	0.09	-7.01e-03
2020	3.35e-02	-5.60e-02	0.11	0.14	0.11	-2.77e-03
2021	4.02e-02	-4.83e-02	0.13	0.15	0.14	1.35e-03
2022	4.70e-02	-4.16e-02	0.14	0.17	0.15	5.89e-03
2023	5.39e-02	-3.25e-02	0.15	0.18	0.16	1.10e-02

```
2024  6.10e-02 -2.28e-02  0.17  0.19   0.17  1.62e-02
2025  6.83e-02 -1.23e-02  0.18  0.21   0.18  2.15e-02
2026  7.57e-02 -1.09e-03  0.19  0.22   0.19  2.70e-02
2027  8.34e-02  1.07e-02  0.20  0.24   0.21  3.26e-02
```

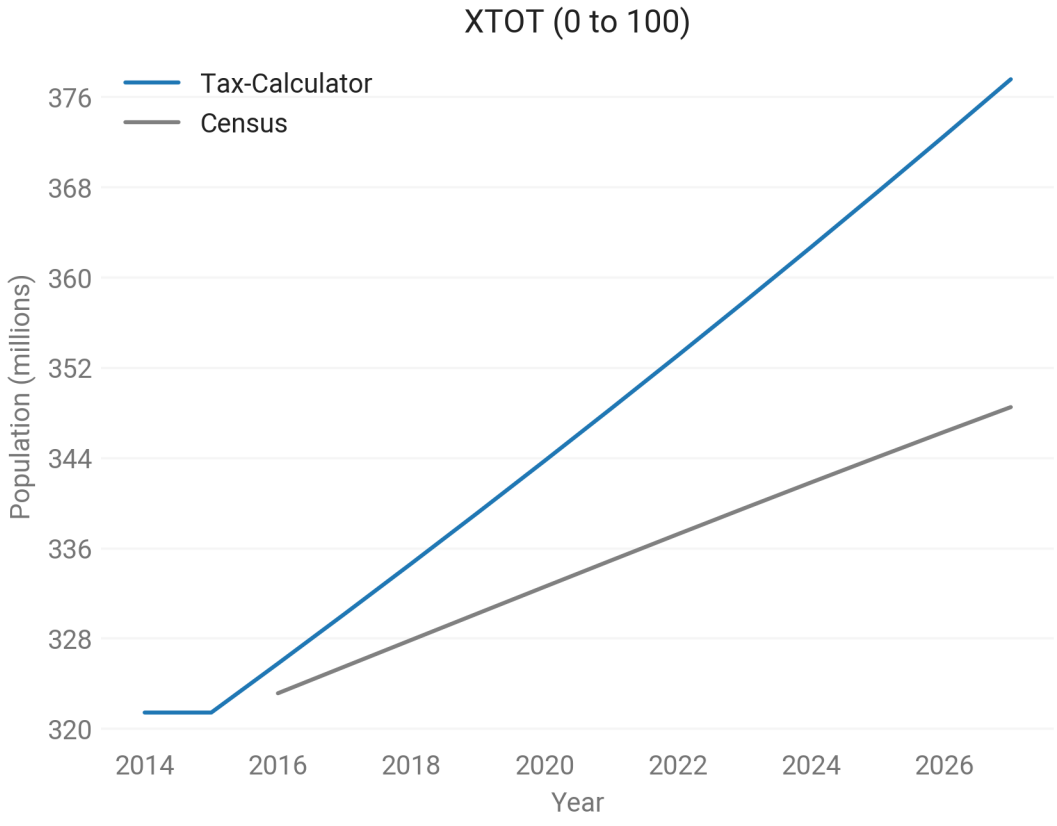
1.4 Plot

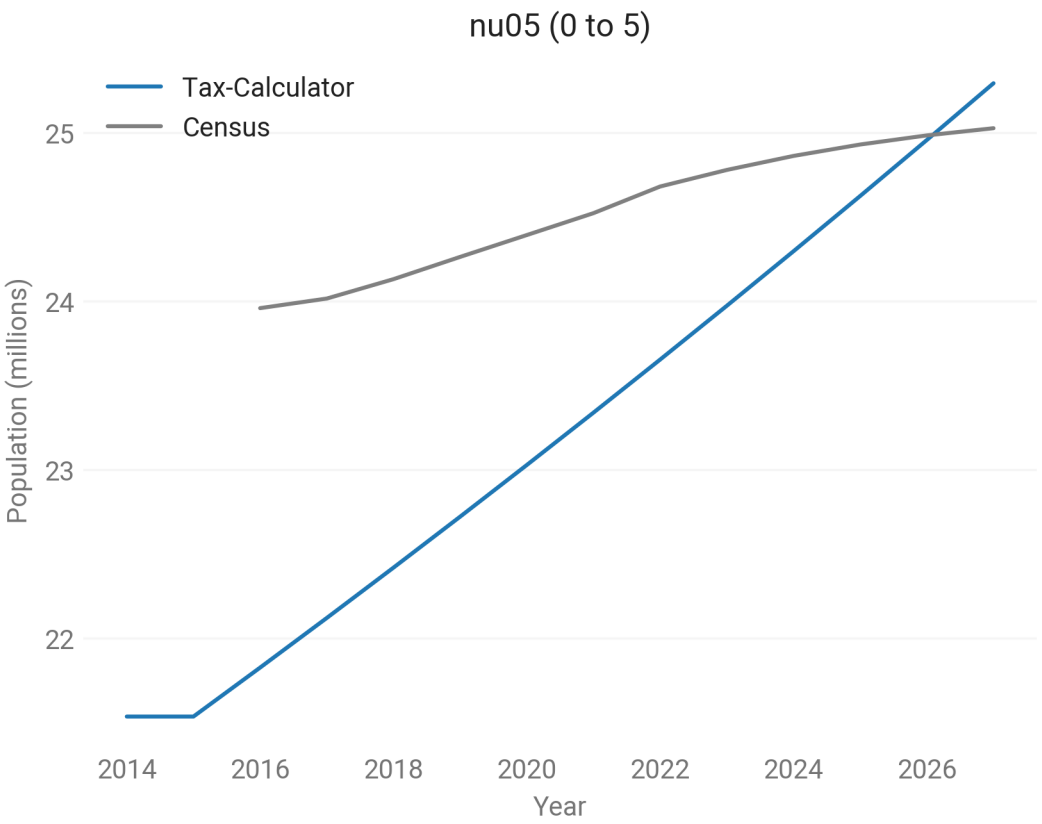
In [15]:
```
# Order from top to bottom to align with graph.
metric_cols_order = ['nu18', 'n1820', 'nu13', 'XTOT', 'n21', 'nu05']
```

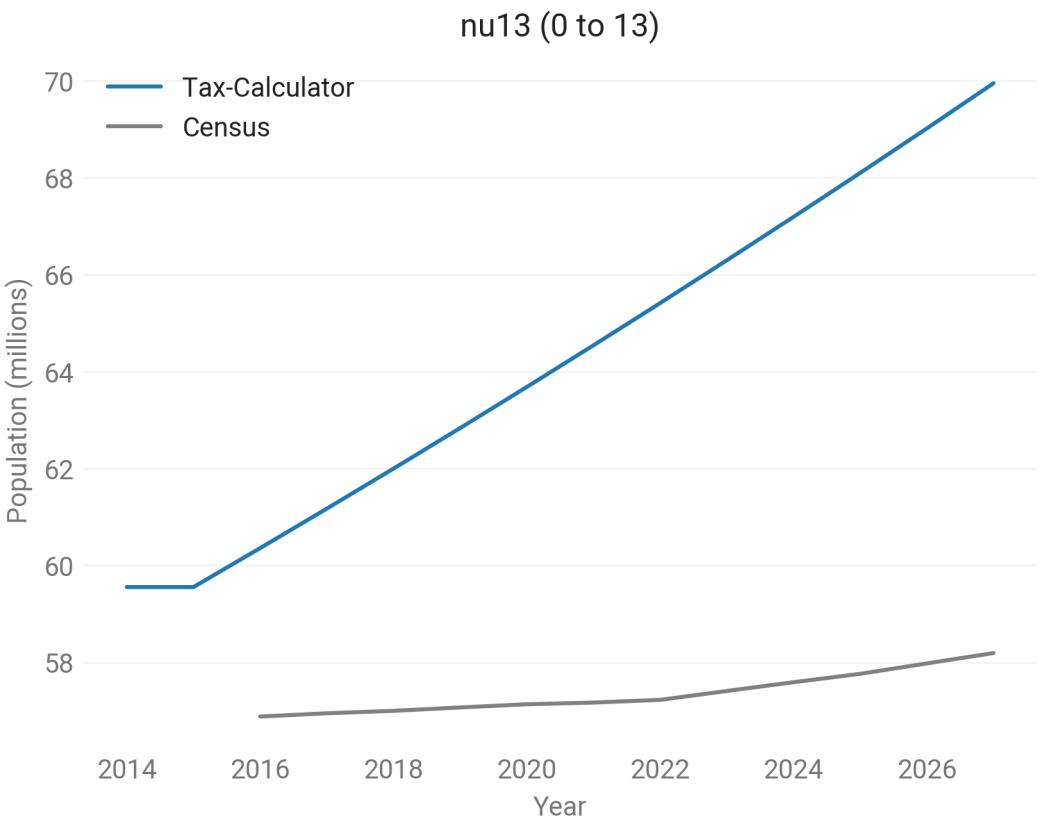
In [16]:
```
ax = diff[metric_cols_order].plot()
plt.legend(frameon=False)
sns.despine(left=True, bottom=True)
plt.title('Differences between Tax-Calculator and Census population' +
          ' projections')
ax.set(xlabel='Year',
       ylabel='(Tax-Calculator projection / Census projection) - 1')
ax.yaxis.set_major_locator(MaxNLocator(integer=True))
ax.xaxis.set_major_locator(MaxNLocator(integer=True))
ax.yaxis.set_major_formatter(mpl.ticker.FuncFormatter(
    lambda y, _: '{:.0%}'.format(y)))
ax.grid(color='#f5f5f5', axis='y')
plt.axhline(y=0, c='gray', linestyle='dashed', linewidth=0.3, zorder=-1)
plt.show()
```

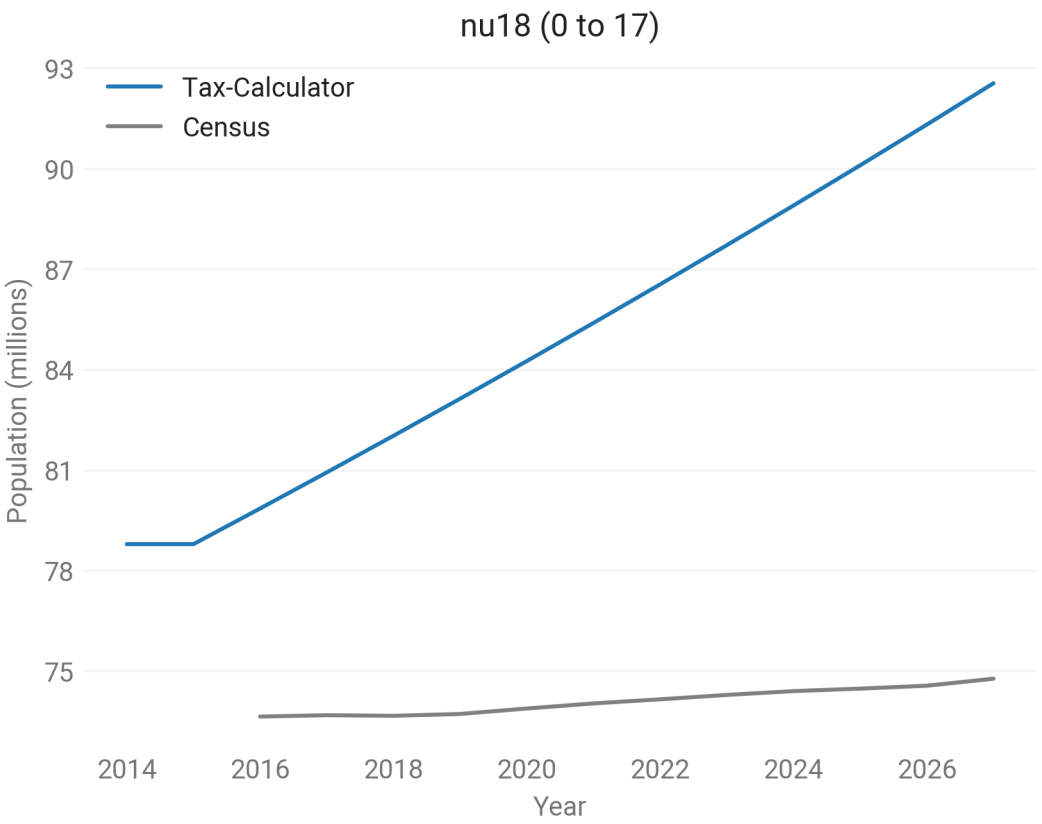


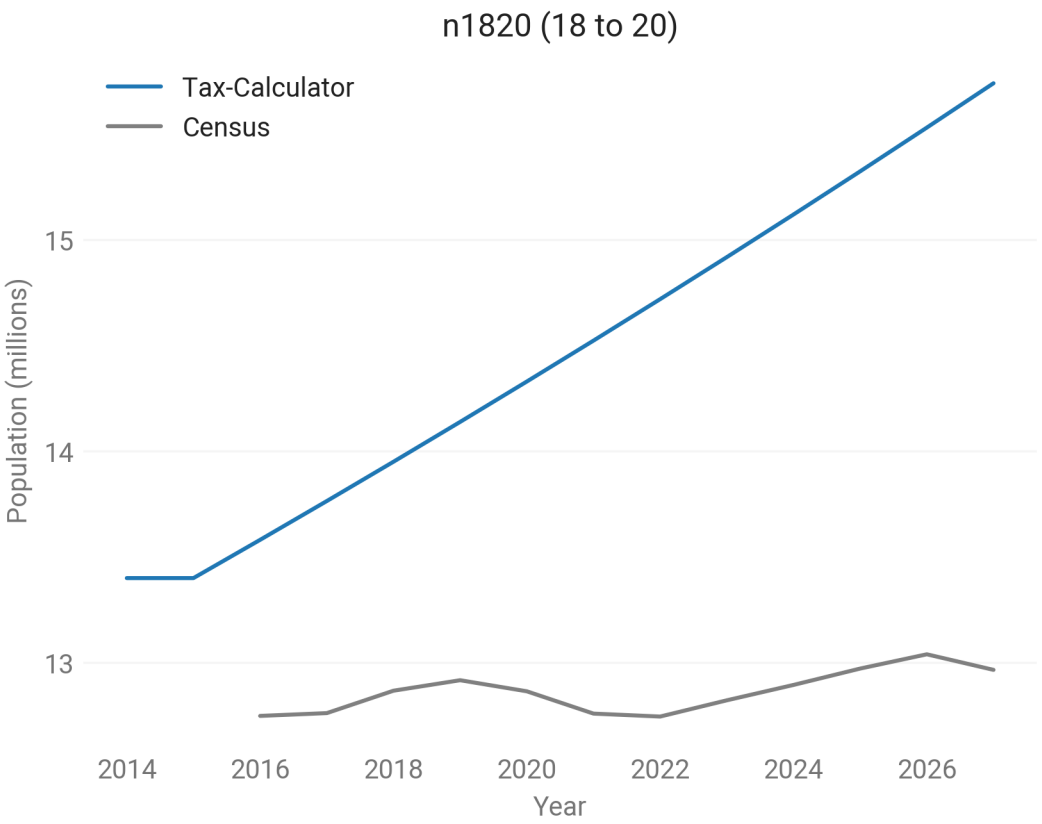
```
In [17]: for i in range(len(metric_cols)):
             col = metric_cols[i]
             ax = tc_pop_m[col].plot(label='Tax-Calculator')
             censust_m[col].plot(ax=ax, color='gray', label='Census')
             plt.legend(frameon=False)
             sns.despine(left=True, bottom=True)
             plt.title(col + ' (' + str(METRICS.loc[col, 'min']) + ' to ' +
                       str(METRICS.loc[col, 'max']) + ')')
             ax.set(xlabel='Year',
                    ylabel='Population (millions)')
             ax.yaxis.set_major_locator(MaxNLocator(integer=True))
             ax.xaxis.set_major_locator(MaxNLocator(integer=True))
             ax.grid(color='#f5f5f5', axis='y')
             plt.show()
```

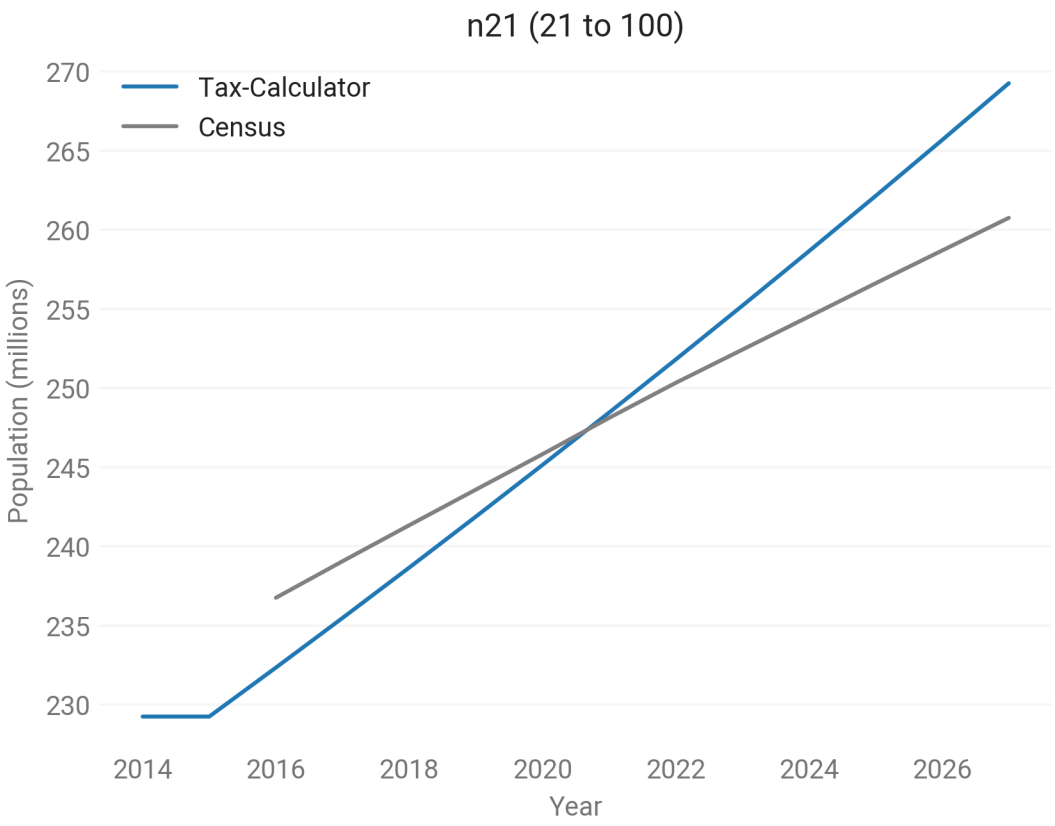



nu05 (0 to 5)
Tax-Calculator
Census
25
24
23
22
Population (millions)
2014
2016
2018
2020
2022
2024
2026
Year


nu13 (0 to 13)
Tax-Calculator
Census
70
68
66
64
62
60
58
Population (millions)
2014
2016
2018
2020
2022
2024
2026
Year


nu18 (0 to 17)
Tax-Calculator
Census
93
90
87
84
81
78
75
Population (millions)
2014
2016
2018
2020
2022
2024
2026
Year


n1820 (18 to 20)
Tax-Calculator
Census
Population (millions)
15
14
13
2014
2016
2018
2020
2022
2024
2026
Year


n21 (21 to 100)
Tax-Calculator
Census
270
265
260
255
250
245
240
235
230
Population (millions)
2014
2016
2018
2020
2022
2024
2026
Year