From: Council President's Office – Finance and Budget Team

Date: 9/6/2016

RE: Statistical Analysis (Regression) on Common Variables that Affect Credit Rating among Comparable Cities

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Summary

For the purpose of examining potential general correlations between certain city demographic and financial statistics, and credit scores, this document shows the results of a statistical regression analysis – which is a statistical process for determining the relationship between a dependent variable and several independent variables. *Dependent* variables are examined to see if their value is dependent on outside variables which are independent of one another.

The following analysis used each city's most recent Moody's rating as the dependent variable, and Working Age Population (2010 Census), Year Since Peak Population, Median Household Income (2010 Census), Population 18 and Under, and Average FY14/FY15 General Fund Balance as the independent variables. The Moody's ratings were given ordinal values of 1 (Aaa), 2 (Aa1-Aa3), 3 (A1-A3), 4 (Baa1-Baa3), 5 (Ba1-Ba3), and 6 (B1-B3; 10 equals less than Ca, or In Default). Since 1 represents a prime score, a negative variable represents a positive impact on a city's credit score.

The statistical (regression) analysis shows that Working Age Population, Years since Peak Population, and Under 18 Population, to have a statistically significant affect on credit rating. More specifically, the analysis found that **increases in the percentages of Working Age Population and Population Under 18 both had positive impacts on a city's credit score, and the more Years since Peak Population had a negative impact on a city's credit score (or the less time since Peak Population has a positive impact on credit score).** Household Median Income was very close to being considered statistically significant in the first analysis; when controlling for both Chicago and Detroit in the second analysis, this category (along with the three mentioned above) did return slightly statistically significant.

While Average General Fund Balance (FY14/FY15) did not result in a statistical significant relationship when combined with the variables above, there is **a statistically significant, positive correlation when running each city's Average FY14/FY15 Fund Balance directly against the relevant Credit Rating.** A chart showing these results can be found in the Appendix.

Chart 1: Cities used in Analysis

City	Moody's	Average Unrestricted General Fund Balance 2015/2014	Years Since Peak Population (as of 2010)	Working Age Population (2010 Census)	Median Household Income (City, Census Quickfacts)	Under 18 (2010 Census - %)
Boston, MA	Aaa	29.4%	80	72.8%	$54,485	16.8%
Atlanta, GA	Aa1	28.3%	40	70.8%	$46,439	9.8%
Phoenix, AZ	Aa1	25.2%	0	63.4%	$46,881	28.2%
San Francisco, CA	Aa1	29%	0	73.0%	$78,378	13.4%
Tampa, Fl	Aa1	17.4%	0	66.4%	$43,740	22.6%
Washington, DC	Aa1	13.7%	60	71.8%	$69,235	16.8%
Baltimore, MD	Aa2	19.4%	60	66.8%	$41,819	21.5%
Dallas, TX	Aa2	15.2%	0	64.7%	$43,359	26.5%
Los Angeles, CA	Aa2	19.4%	0	66.4%	$49,682	23.1%
New York, NY	Aa2	0.6%	0	66.3%	$52,737	21.6%
San Diego, CA	Aa2	18.6%	0	67.9%	$65,753	21.4%
Houston, TX	Aa3	13.0%	0	65.1%	$45,728	25.9%
Miami, Fl	Aa3	19.4%	0	65.6%	$30,858	18.4%
Milwaukee, WI	Aa3	18.5%	50	64.0%	$35,489	27.1%
Cleveland, OH	A1	8.5%	60	63.4%	$26,179	24.6%
Philadelphia, PA	A2	4.6%	60	65.4%	$37,460	22.5%
Chicago, IL	Ba1	5%	60	66.6%	$47,831	23.1%
Detroit, MI	B2	9.4%	60	61.8%	$26,095	26.7%

Increases in the percentage of Working Age Population and Under 18 populations were shown to have a positive impact on a city's Moody's credit score. In short, an increase in the working age population represents an increase in the number of working taxpayers, who contribute more to the tax base than those on fixed incomes. It is likely that cities with a working population and families maintain more consistent revenues, which positively impacts credit ratings.

An increase in the number of years since a city reached peak population had a negative impact on credit score. Population decline, which affected many older post-industrial cities, left cities with financial stressors that newer, growing cities have not yet had to deal with. A large portion of urban population decline can be attributed to the growth of inner-ring suburbs, which newer cities, especially in the Southwest, have been able to annex. The ability to annex suburbs has left some cities in a much better financial position than cities that were not able to. It is important to note that, however, Philadelphia has experienced population growth within the last decade, mostly attributable to millennials choosing to move to, or not leave, Philadelphia post-secondary graduation.

Controlling for Chicago and Detroit

The same categories as above (Working Age Population (2010 Census), Year Since Peak Population, and Population 18 and Under) were statistically significant when controlling for Chicago and Detroit (due to Chicago having an unusually high median household income relative to Credit Score and Detroit having just gone through bankruptcy). In fact, Median Household Income became statistically significant in this scenario, though it has a very small impact on credit ratings. By removing these two cities from the analysis, the regression became more statistically significant, with both R-squared values increasing and P-values decreasing to less than .05 (for relevant independent variables, which is very statistically significant). The first page of the appendix shows the summary output statistics, both with and without Chicago and Detroit included.

Conclusion and Other Scenarios

A few other statistical scenarios were ran to see if any other correlations could be concluded, including poverty rate, pension funding ratio, and other demographic or financial data points that may indicate a positive or negative correlation to credit score. While there may not be statistically significant conclusions that could be drawn based on these observations, it is important to note that these are just statistics and should not be used in a vacuum. There are many financial indicators, and other cities, that could be used in different scenarios to try to find a trend. There are also many variables that cannot necessarily be quantified. With that said, the purpose of this document was to provide a guide, or an example of some demographic statistics that do correlate with credit score, but not to provide definitive causation to what will improve credit scores.

Appendix

Chart 2a: Summary Statistics (including Chicago and Detroit)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.767327091
R Square	0.588790864
Adjusted R Square	0.417453724
Standard Error	0.915231249
Observations	18

ANOVA

	df	SS	MS	F	Significance F
Regression	5	14.39266556	2.878533	3.436446202	0.037024199
Residual	12	10.05177888	0.837648		
Total	17	24.44444444			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Credit Rating	51.72106307	21.4604598	2.410063	0.032908973	4.962737991	98.47938815	4.962737991	98.47938815
Average	-2.379003828	3.413863893	-0.696865	0.49916473	-9.817174268	5.059166611	-9.817174268	5.059166611
Years Since Peak Population	0.026715662	0.0108821	2.45501	0.030314069	0.003005602	0.050425721	0.003005602	0.050425721
Under 18 (2010 census%)	-22.58987538	12.23366399	-1.846534	0.08961188	-49.24473941	4.064988651	-49.24473941	4.064988651
Working Age Population (2010 census)	-72.47995977	32.08210715	-2.259202	0.043273151	-142.3808663	-2.579053188	-142.3808663	-2.579053188
Median Household Income (City, Census Quickfacts)	7.76107E-05	4.55182E-05	1.705047	0.11391335	-2.1565E-05	0.000176786	-2.1565E-05	0.000176786

Chart 2b: Summary Statistics (Controlling for/not including for Chicago and Detroit)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.83983
R Square	0.70532
Adjusted R Square	0.55797
Standard Error	0.29422
Observations	16.00000

ANOVA

	df	SS	MS	F	Significance F
Regression	5	2.071865167	0.414373	4.786926517	0.017100769
Residual	10	0.865634833	0.086563		
Total	15	2.9375			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Credit Rating	25.4727	7.6013	3.3511	0.0074	8.5360	42.4095	8.5360	42.4095
Fund Balance Average	-1.5922	1.1543	-1.3794	0.1979	-4.1642	0.9798	-4.1642	0.9798
Years Since Peak Population	0.0081	0.0040	2.0516	0.0673	-0.0007	0.0170	-0.0007	0.0170
Under 18 (2010 census%)	-12.0285	4.1542	-2.8955	0.0160	-21.2846	-2.7723	-21.2846	-2.7723
Working Age Population (2010 census)	-33.1370	11.3582	-2.9174	0.0154	-58.4447	-7.8293	-58.4447	-7.8293
Median Household Income (City, Census Quickfacts)	0.0000	0.0000	1.9661	0.0776	0.0000	0.0001	0.0000	0.0001

Chart 3: Demographics Chart of Cities used in Analysis

City	Moody's	Poverty Rate (Census 2014)	City Population (Census Quickfact Estimates)	Median Household Income (City, Census Quickfacts)	Years Since Peak Population	Under 18 (2010 census%)	Over 65 (2010 census%)	Working Age Population (2010 census)	Peak Population (Census)	Non-Hispanic White	Black	Hispanic or Latino	Asian	Other, Mixed Race
Atlanta, GA	Aa1	30%	463,878	$46,439	40	9.8%	19.4%	70.8%	1970	33.3%	54.0%	10.2%	5.1%	2.0%
Baltimore, MD	Aa2	23%	621,849	$41,819	60	21.5%	11.7%	66.8%	1950	29.6%	63.7%	4.2%	2.3%	1.9%
Boston, MA	Aaa	23%	667,137	$54,485	80	16.8%	10.4%	72.8%	1930	45.9%	22.4%	17.5%	9.0%	4.5%
Chicago, IL	Ba1	22%	2,720,546	$47,831	60	23.1%	10.3%	66.6%	1950	31.7%	32.0%	28.0%	5.0%	3.0%
Cleveland, OH	A1	39%	388,072	$26,179	60	24.6%	12.0%	63.4%	1950	33.4%	53.3%	10.0%	1.8%	4.5%
Dallas, TX	Aa2	24%	1,300,092	$43,359	0	26.5%	8.8%	64.7%	2010	28.8%	25.0%	42.4%	2.9%	0.9%
Detroit, MI	B2	39%	677,116	$26,095	60	26.7%	11.5%	61.8%	1950	7.8%	82.7%	6.8%	1.1%	5.6%
Houston, TX	Aa3	22%	2,296,224	$45,728	0	25.9%	9.0%	65.1%	2010	25.6%	25.3%	43.7%	6.0%	0.0%
Los Angeles, CA	Aa2	22%	3,971,883	$49,682	0	23.1%	10.5%	66.4%	2010	29.4%	9.8%	47.5%	10.7%	2.8%
Miami	Aa3	26%	441,003	$30,858	0	18.4%	16.0%	65.6%	2010	11.9%	19.2%	70.0%	1.0%	4.2%
Milwaukee, WI	Aa3	29%	600,155	$35,489	50	27.1%	8.9%	64.0%	1960	37.0%	40.0%	17.3%	3.5%	2.2%
New York, NY	Aa2	21%	8,550,405	$52,737	0	21.6%	12.1%	66.3%	2010	33.3%	25.1%	27.5%	11.8%	2.3%
Philadelphia, PA	A2	26%	1,567,442	$37,460	60	22.5%	12.1%	65.4%	1950	36.9%	44.1%	12.3%	6.3%	2.3%
Phoenix, AZ	Aa1	23%	1,563,025	$46,881	0	28.2%	8.4%	63.4%	2010	46.5%	6.5%	40.8%	3.2%	3.6%
San Diego, CA	Aa2	16%	1,394,929	$65,753	0	21.4%	10.7%	67.9%	2010	45.1%	6.7%	28.8%	15.9%	0.0%
San Francisco, CA	Aa1	12%	864,816	$78,378	0	13.4%	13.6%	73.0%	2010	41.9%	6.1%	15.1%	33.3%	0.5%
Tampa, Fl	AA1	22%	369,075	$43,740	0	22.6%	11.0%	66.4%	2010	46.3%	26.2%	23.1%	3.4%	1.0%
Washington, DC	Aa1	19%	672,228	$69,235	60	16.8%	11.4%	71.8%	1950	34.8%	50.7%	9.1%	3.5%	0.6%

Average General Fund Balance (FY14-FY15) vs. Credit Rating