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Structure of the Economy, Financial and Debt Positions, and State Credit Ratings: Evidence from Michigan and the Great Lakes Region

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Abstract

We examine the effects of sectoral dynamics in the economy, and financial and debt positions on state credit ratings in Michigan and the Great Lakes region. An in-depth study of Michigan and a subsequent comparison to other states in the region reveals that an overreliance on a single sector and/or a sub-sector has negative effects on state credit ratings. For Michigan, however, we find a positive and significant relationship between auto production and the credit ratings. Poor recent performance of the auto sector has been a major determinant of Michigan's current low credit rating. State financial and debt positions are also found to have significant effects on credit ratings. Whereas tax and debt burdens demonstrate an inverse relation with credit ratings, a strong tax base has a positive correlation.

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Introduction

The economy of Michigan is heavily reliant on the automobile industry, though this level of dependence has shrunk to about one-tenth of the gross state product (GSP). Auto production comprised about 16 percent of GSP in the 1970s, 13 percent in the 1980s, and just below 10 percent in the 1990s and 2000s. (See Figure 1 to compare the share of Michigan's auto industry in GSP to other states in the Great Lakes region: Illinois, Minnesota, Ohio, and Wisconsin.) Michigan's reliance on a single industry – one that had sustained massive losses even before the Great Recession of 2007-08 – only exacerbated the state's struggles. Michigan was the only state whose GSP growth was negative the three years preceding the latest recession (Bureau of Economic Analysis, Regional Economic Accounts).

In recent years, Michigan has had the highest unemployment rate in the United States, while the Detroit-Warren-Livonia metropolitan area has seen the highest unemployment rate among metropolitan areas. The overall poverty rate in Michigan in 2008 was 14.4 percent, which is significantly higher than in the rest of the Great Lakes region (12.2 percent), as well as the national average of 13.2 percent (U.S. Census Bureau, American Community Survey 2008, Table: R1701). Michigan's credit rating has deteriorated under these economic conditions. Standard & Poor's rating of the state fell from AAA in 2003 to AA+ in 2004, AA in 2005 and 2006, AA- in 2007 and 2008, and A+ in 2009. Similarly, Moody's lowered its rating from Aaa in 2002 to Aa3 in 2009.

The recession's impact on Michigan should not come as a big surprise, once the near-collapse of the U.S. auto industry is taken into account. During the recession of the late 1970s and early 1980s, Moody's credit ratings of the state fell from Aa2 in 1979 to A in 1980, and Baa1 in 1982. Conversely, during the period of overall economic growth in the late 1990s and early 2000s, especially the growth of the auto sector, the Moody's credit rating of the state increased from Aa2 in 1997 to Aa1 in 1998 and Aaa between 2000 and 2002. Given such oscillations, an obvious question to ask is whether the structure of the economy has anything to do with the credit ratings. If so, what is the magnitude of such an association? In this paper, we study how structural dependence and sectoral shifts in Michigan's economy shape the state credit rating. In order to examine Michigan in a wider context, we also compare it to the other neighboring states in the Great Lakes region as well as the national averages, along a spectrum of economic, fiscal, and debt management factors. To summarize, the paper studies sectoral dynamics in the economy, and analyzes financial and debt positions' associations with state credit ratings in Michigan and the Great Lakes region (the latter in a framework of panel data structure). We find that the credit rating of the State of Michigan is largely defined by the strength of its manufacturing sector, its auto industry in particular.

Literature Review

In order to reduce the borrowing costs for state and local governments, it is important for the state and municipal bond issuers to know the determinants of a good credit quality. In their attempts to identify the probabilities of default risk, or otherwise certify asset quality, investors rely on credit ratings issued by three major credit rating agencies: Moody's Investors Services, Standard & Poor's, and Fitch Investors Service. Johnson and Kriz (2002) define credit rating as "an independent and informed judgment … of the issuer's ability and willingness to make principal and interest payments on time and in full" (1).

Generally speaking, while the rating of a corporate or an asset-backed bond (including structured financial products) is assigned based on the risk of a loss, the rating of a municipal bond is based on an overall fiscal strength of the issuing government (Municipal Bond Fairness Act, retrieved on September 9, 2008). In contrast to corporate bonds, new municipal bonds receive the rating of an existing Government Obligation (GO) debt (i.e. municipality's credit rating) (Walker and Krueger, 2009).

Credit rating agencies gather and process a variety of financial, economic, administrative, and demographic information about debt issuers. Such information includes the evidence about municipality's current debt obligations, monetary base, political risks, unemployment rates, and other relevant factors. Based on this information they provide opinions on the issuer's probability of default.[1] A high credit rating indicates a high quality of an asset (a low probability of default), and vice versa. Table 1 indexes credit rating categories by three major credit rating agencies. AAA rating, for example, is the highest credit rating category, meaning that the bond issue has the lowest chance of default according to the credit rating agency's opinion.

A number of papers on state and municipal credit ratings have studied the factors that are important in achieving a more preferable credit score. Overall, research shows that states and localities with stronger and stable financial, demographic, and economic environments receive higher credit ratings than their counterparts. Thus, lower ratios of debt outstanding to total personal income (Uyar and Escarraz, 1995; Johnson and Kriz, 2002), higher per capita personal income (Liu and Thakor, 1984; Capeci, 1991; Uyar and Escarraz, 1995; Johnson and Kriz, 2005; Depken and LaFountain, 2006; Marlowe, 2007; and Krueger and Walker, 2008) and resilient population growth (Liu and Thakor, 1984; Capeci, 1991; Marlowe, 2007) have positive effects on state and local credit ratings. On the other hand, increases in the unemployment rate (Liu and Thakor, 1984; Johnson and Kriz, 2002 & 2005; Depken and LaFountain, 2006; Krueger and Walker, 2008), net direct debt burden of the state (gross debt of the state minus debt issued for or on behalf of the agencies of the state) (Liu and Thakor, 1984; Marlowe, 2007)[2], and per capita debt outstanding (Liu and Thakor, 1984; Uyar and Escarraz, 1995) are found to have an inverse association with state credit ratings.

Table 1. Rating Scale of the Major Credit Rating Agencies.

		Moody's	*Standard &*	*Fitch*
Investment Grade	Strongest	Aaa	AAA	AAA
	‘	Aa1	AA+	AA+
		Aa2	AA	AA
		Aa3	AA-	AA-
		A1	A+	A+
		A2	A	A
		A3	A-	A-
	∨	Baa1	BBB+	BBB+
		Baa2	BBB	BBB
Non-Investment Grade	∧	Ba1	BB+	BB+
		Ba2	BB	BB
		Ba3	BB-	BB-
		B1	B+	B+
		B2	B	B
		B3	B-	B-
		Caa1	CCC+	CCC+
		Caa2	CCC	CCC
		Caa3	CCC-	CCC-
	'	Ca	CC	CC
	Weakest	C	C	C

Source: The table is reprinted from Johnson, 2011

Johnson and Kriz (2002) find a strong correlation between credit ratings and fiscal institutions, such as balanced budget requirements, debt ceilings, and tax and expenditure limitations (TELs). Sohl et al (2008) hypothesize that a high number of funds or fund groups negatively contribute to state credit ratings. Depken and LaFountain (2006) and Krueger and Walker (2008) conclude that political factors –such as political corruption, political turnover, and the presence of a divided government – are important for state credit ratings. Finally, an idea that managerial performance is related to credit ratings was recently introduced and tested by Denison, Yan, and Zhao (2007). The authors find on a sample of school districts is Texas that managerial performance does affect districts' credit ratings.

In this study, in order to track the changes in credit quality and identify the factors that are strongly associated with the quality of Michigan's and neighboring states' debt, we employ a set of fiscal, economic and demographic variables that were found to be important for credit quality by other researchers. Specifically, we are interested in how the reliance of Michigan and neighboring states on manufacturing, especially the auto industry, has affected their credit qualities over the last three and a half decades. In the next section, we describe the overall economic, demographic, and fiscal situation in Michigan, particularly during the last decade. We compare Michigan to four states in the Great Lakes region including Illinois, Minnesota, Ohio, and Wisconsin.[3]

The Study of Michigan

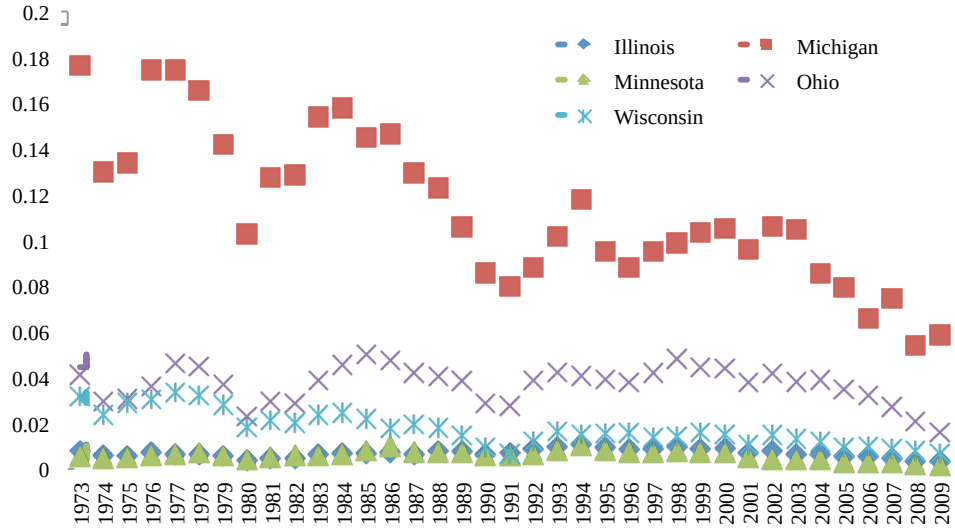
During the past decade, Michigan has endured its worst financial and economic crisis in more than fifty years (Michigan's Fiscal Future Report 349). The bankruptcy and government bailout of Chrysler and General Motors, two of America's "Big Three" auto manufacturers, epitomized the region's hard times. Credit market hardships, declining home values, and uncertainty about oil prices – all of which have a direct effect on the auto manufacturing sector – were emblematic of a nationwide economic downturn. Michigan faced another set of state-specific obstacles associated with its ailing auto industry, which had been such a vital aspect of the state's economy. The share of auto sector production in total GSP remained near 10 percent after 1989 (see Figure 2). It declined after 2004 but remains much higher than in the other states of the Great Lakes region. Not surprisingly, GSP growth rate variations in Michigan are directly related to similar fluctuations in the manufacturing sector, particularly to shifts in the auto industry.

One byproduct of the state's dependence on manufacturing has been a weakened real estate sector in cities where such industries were located. Detroit, Flint, and Dearborn are the most visible examples. A sustained out-migration from these urban centers has contributed to a dramatic decline in home property values and the number of new construction projects launched in Michigan. In 2006 Michigan ranked thirty-seventh (1.2 percent growth rate in construction projects compared to the U.S. average of 1.8) and in 2007 ranked forty-first by the percent of housing units built (2.1 percent compared with the U.S. average of 3.3 percent) (U.S. Census Bureau, *American Community Surveys,* 2007). The number of construction projects in the state also declined because of high homeowner and rental vacancy rates (U.S. Census Bureau, *American Community Surveys*: *Construction Summary Tables,* 2000 to 2007) and a more rapid decay in housing value than both in the region or the national average (U.S. Census Bureau). The median value of an owner-occupied house in Michigan was $18,200 below the national average in 2005; three years later, in 2008, that discrepancy had grown to $46,300 (U.S. Census Bureau, *American Community Surveys*: Median Housing Value of Owner-Occupied Housing Units Tables, 2005-2008).

This economic distress slowed per capita income growth, decreased expenditures on publicly subsidized goods and services, raised unemployment rates, and encouraged out-migration of the working-age population – especially young, educated professionals. Between 2000 and 2011 Michigan was the only state in the Great Lakes region that lost population. What is especially striking is that youth and working-age populations constitute the main groups that left the state (See Figure 3), which resulted in an overall aging of Michigan's population. The median population age increased from 35.3 years in 2000 to 38.0 years in 2008 (U.S. Census Bureau, *American Community Surveys*, 2005 to 2008). In 2006 the exodus of educated professionals[4] in Michigan was the highest in the Great Lakes region. For the past several years Michigan has been ranked fourth in the nation with respect to highest shares of households with pension income (21.6 percent in 2007) (U.S. Census Bureau, *American Community Surveys*, 2007). An aging population

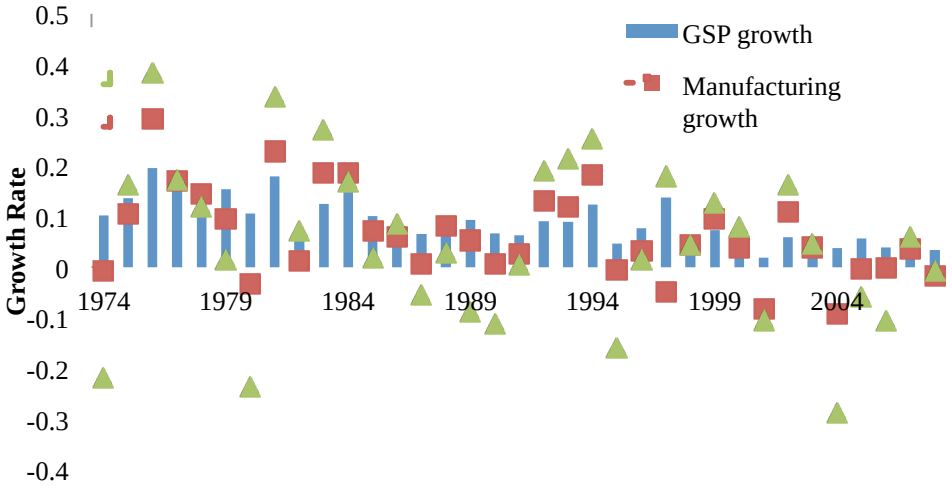
puts further strain on pension liabilities and medical and social welfare funds, which in turn inversely affects the fiscal health of the state.

Figure 1: Share of Automobile Production in the Gross State Products of Five States



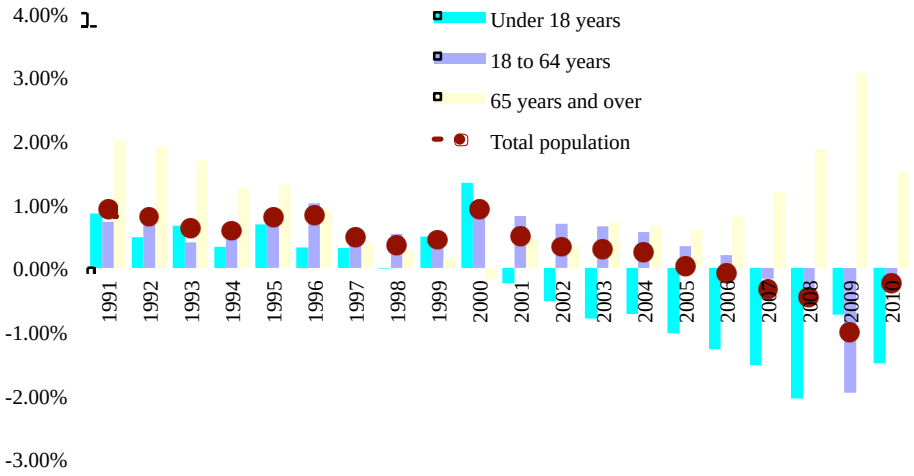
Source: Bureau of Economic Analysis; Data available from: http://www.bea.gov/regional/index.htm#gsp

Figure 2: Gross State Product Growth Rate, Growth Rate in Manufacturing and Automobile Production in Michigan



Source: Bureau of Economic Analysis; Data available from: http://www.bea.gov/regional/index.htm#gsp

Figure 3: Growth Rate of Population by Age Group in Michigan (in % to the previous year)



Source: U.S. Census Bureau; Data available from http://www.census.gov/popest/estimates.php

In February 2000 the unemployment rate in Michigan was the lowest since the Great Depression (3.2 percent). By 2009, it had climbed to 15.3 percent, the highest rate in the United States (See Figure 4). The Michigan Department of Labor and Economic Growth reported that Michigan lost 32,000 jobs per month in the first half of 2009. About 18,000 jobs a month were lost in the manufacturing sector alone "as the auto industry struggled with bankruptcy related restructuring" (Michigan Department of Labor and Economic Growth, 2008, 4). Not surprisingly, the unemployment rate in Detroit-Warren-Livonia metropolitan area, where a high percentage of the labor force has been employed in the auto sector, reached 17.7 percent in September 2009 (Bureau of Labor Statistics).

Figure 4: Annual Unemployment Rate in Michigan

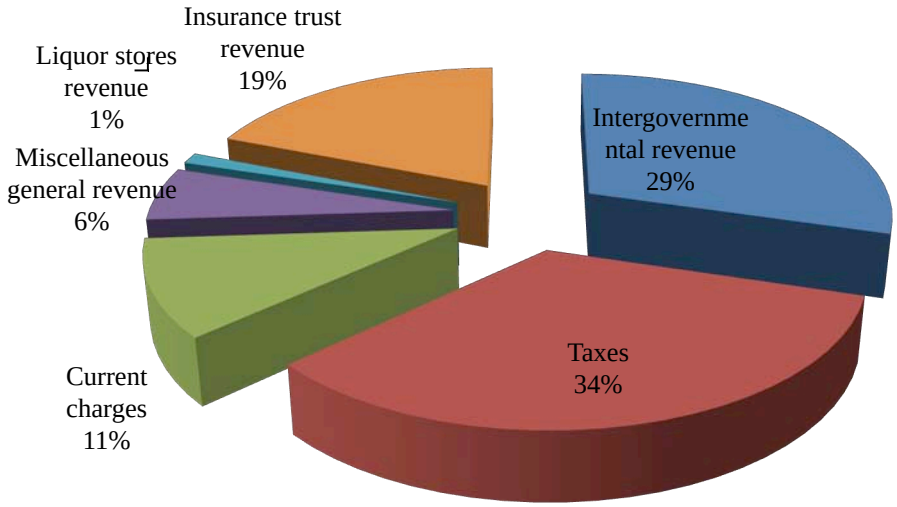
Source: Bureau of Labor Statistics; Data available from: http://www.bls.gov/lau/data.htm

Michigan's Fiscal Management Response

While the demographic and economic outlooks are grim, the fiscal situation in Michigan has remained quite strong. The state has a fairly diversified revenue base, and on average, Michigan's reliance on federal money is no greater than that of its neighbors or other states beyond the region. While taxes are the major source of revenue (37.8 percent in 2007), Michigan also derives revenues from the insurance trust fund (contributions from public employee retirement and social insurance systems, and net earnings on investments) and from intergovernmental transactions. Both categories contributed about 21 percent to total state revenues in 2007. Michigan tax revenues come from a variety of sources and consist of equal parts of elastic (the individual and corporate income taxes and the selective tax on motor fuels) and inelastic (general sales taxes, the selective tax on tobacco products, and property taxes) (See Figures 5 & 6). The real per capita tax burden has declined since 2000 while total real government expenditures have remained unchanged.

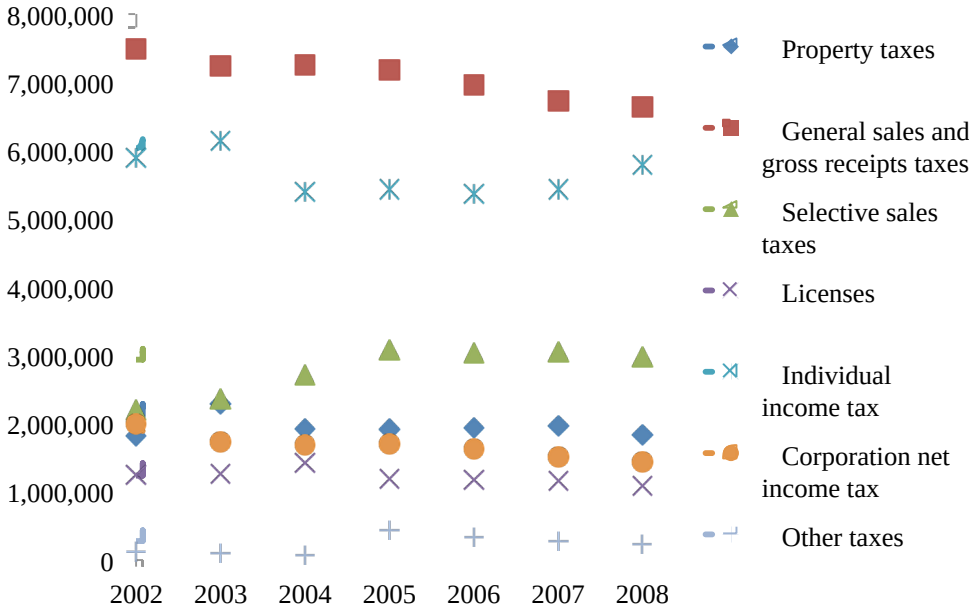
Of the other financial indicators, the share of unrestricted net assets to expenses also points to a worsening financial situation in the state. The ratio was negative mainly due to underfunding of long-term liabilities. Other than that, the government has a good fiscal position and major financial ratios are close to the U.S. medians. Debt burden is largely unchanged in the past decade in terms of per capita debt and debt to personal income share.

Figure 5: Michigan Revenues by Source in 2007



Source: U.S. Census Bureau, State Government Finance Data 2007; Data available from: http://www.census.gov/govs/www/financegen.html

Figure 6: Tax collections in Michigan (1 = $1,000), 2002-2007



Source: U.S. Census Bureau, State Government Finance Data 2007; Data available from: http://www.census.gov/govs/www/financegen.html

Table 2: Michigan CAFR Ratios 2005-2007

	2005			2006			2007		
	GA	**BTA**	**TPG**	**GA**	**BTA**	**TPG**	**GA**	**BTA**	**TPG**
Operating Revenues to Expenses	0.99	0.93	0.98	0.97	0.93	0.97	0.98	0.94	0.97
Current Assets to Current Liabilities	1.94	2.39	2.00	1.99	2.00	1.99	1.93	1.61	1.90
Unrestricted Net Assets to Expenses	-0.02	0.00	-0.02	-0.04	0.00	-0.04	-	0.00	-0.05
Unrestricted Net Assets to Total Net	-0.06	0.01	-0.05	-0.11	0.01	-0.10	-	0.01	-0.13
Changes in Net Assets to Total Net Assets	0.02	-0.30	0.00	-0.03	-0.43	-0.04	-	-0.73	-0.04
General Revenues to Operating Revenues	0.65	-0.23	0.58	0.66	-0.22	0.58	0.65	-0.23	0.57
Program Revenues to Operating Revenues	0.37	1.23	0.44	0.36	1.22	0.44	0.36	1.23	0.44
Charges for Services to Program	0.13	0.99	0.33	0.13	0.99	0.34	0.13	0.99	0.34
OperGrants and Cont. to ProgRev	0.82	0.01	0.63	0.81	0.01	0.61	0.83	0.01	0.62
CaprGrants and Cont. to ProgRev	0.06	0.00	0.04	0.05	0.00	0.04	0.04	0.00	0.03
Program Revenues to Expenses	0.36	1.15	0.43	0.35	1.14	0.42	0.36	1.15	0.43
BTA ProgRev / TPG Expenses	0.102			0.105			0.107		

Data and Methods

We utilize several data sources to construct the variables of interest. Credit ratings data are obtained from Standard & Poor's (S&P) and Moody's for the period of 1973-2007. Information on unemployment dynamics is collected from the Bureau of Labor Statistics (BLS) as well as relevant state employment agencies. Variables representing shares of manufacturing and the auto sector to GSP are collected from the Bureau of Economic Analysis (BEA) and the U.S. Census of State Government Finances and Tax Collections for the thirty-five years under our focus. These last two data sources also provide the figures for the state per capita incomes, per capita tax burden, state revenues, and debt outstanding. We estimate two models in the paper. The first equation estimates the associations of the explanatory variables with credit ratings only for Michigan. The second equation tests the relevant associations in a configuration of a panel data structure where the states of Illinois, Minnesota, Ohio, and Wisconsin further enhance our understanding of credit rating dynamics in Michigan and the Great Lakes region. We chose to compare Michigan to the other neighboring states to understand how our findings hold in the greater region that has experienced some of the same declines in the manufacturing sector. In either case, the underlying model is:

$$CRATE = f(UNEMP, rManfctGSP, rAutoGSP, rPCIncPCTaxB, rTaxTotRev, rDebtTotRev, SPLIT)$$

The response variable *CRATE* is constructed from the S&P and Moody's credit ratings of states. While there is a great deal of ratings changes for Michigan during the time frame under investigation, credit ratings for Ohio and Wisconsin are largely unchanged, with Illinois and Minnesota changing moderately. S&P's and Moody's sometimes issue credit ratings that split two different ratings levels. We introduced an indicator variable *SPLIT* into the models to account for this split. *CRATE* represents the higher score of the two credit ratings and is a five-

choice ordered outcome variable.[5] The reason for this five-choice truncation is that all of the state credit ratings are distributed between A+/A and AAA/Aaa with a peak around AA/Aa2.[6] Parallel odds probit and logit estimates employed in our paper (see tables 4-6) are by far the most popular econometric models used in equations with limited dependent variables, such as credit ratings (for example, Liu and Thakor, 1984; Capeci, 1991; Johnson and Kriz, 2002; Kriz, 2003; Johnson and Kriz, 2005; Denison, Yan, and Zhao, 2007).[7] Consequently, the associations of seven explanatory variables, including the dichotomous indicator for a split rating, with the outcome variable are estimated using the ordered logit and probit specifications.

UNEMP represents annual unemployment rates in the states of interest.[8] Unemployment rate is often found to be a strong proxy for the health of economic activity in any given region and has been found to have significant and negative effects on credit ratings by Liu and Thakor (1984), Johnson and Kriz (2002; 2005), Depken and LaFountain (2006), and Krueger and Walker (2008). *rManfctGSP* is an annual percentage share of the manufacturing sector of respective GSPs. Similarly, *rAutoGSP* is an annual percentage share of the automobile industry of that year's GSP. These two variables capture the shifts in the structure of the state economies for the past thirty-five years.

While we are not aware of empirical works on the association between the structure of the economy, as defined above, and state credit ratings, Zandi and Perna (1994) warn of potentially negative effects of the collapsing auto industry on municipal credit ratings. The expectation is that state credit ratings are negatively associated with overdependence on the auto industry. *rTaxTotRev* captures states' fiscal management practices. This variable is a percentage of tax revenues as a share of total state revenues. The approach is different from other similar studies, where the focus was rather on the share of "own-source revenues" to total state revenues. For example, Denison, Yan and Zhao (2007) completed estimates that test whether own-source revenues improve fiscal independence of school districts, which in turn may affect managerial factors as a function for school district credit ratings in Texas. Somewhat similarly, Johnson and Kriz (2005) use per capita own-source revenues as an instrument for fiscal independence in the evaluation of possible associations between fiscal institutions and credit ratings in the states. However, in our modification we focus on total revenues from taxes as a proxy for the states' abilities to meet their debt servicing needs. We expect that a larger share of the tax revenues in total state revenues will be associated with higher credit ratings.

Variable *rDebtTotRev* reflects the share of total debt outstanding as a share of total state revenues. This factor measures debt management practices within the states throughout the time period assessed. Other empirical studies included the ratios of debt outstanding to general revenues as a measure of long-run risk of return on investment. We focus our attention on total debt that includes both general obligation and revenue debt. We expect this variable to be negatively related to state credit ratings. Earlier findings of Uyar and Escarraz (1995), Depken and LaFountain (2006), and Krueger and Walker (2008) suggest that debt outstanding to

revenues inversely affects credit ratings. This implies that a higher long-term risk factor is associated with a lower municipal credit rating.

Table 2: Descriptive Statistics

Variable	Description	Mean	St. Dev.	Min	Max
Restricted Sample: Michigan					
CRATE	State credit rating	3.06	1.30	1	5
UNEMP	Unemployment rate	0.57	0.50	0	1
SPLIT	Indicator for credit ratings split	7.95	2.91	3.72	15.54
rManfctGSP	% of manufacturing sector to GSP	28.59	6.48	16.99	39.15
rAutoGSP	% of auto sector to GSP	11.68	3.24	6.11	17.63
rPCIncPCTaxB	% of per capita income to per capita tax burden	6.86	0.65	5.84	8.03
rTaxTotRev	% of total tax revenues to total own source revenues	47.04	4.31	37.81	54.24
rDebtTotRev	% of debt outstanding to total revenues	34.35	9.29	20.14	53.36
NOTE: For restricted sample, *CRATE* is a 5 choice outcome variable: AAA/Aaa = 5 (20%); AA+/Aa1 = 4 (9%); AA/Aa2 = 3 (46%); AA-/Aa3 = 2 (9%); A+/A = 1 (17%); T = 35.					
Panel Data for MI, IL, MN, OH, WI					
CRATE	State credit rating	3.73	1.11	1	5
UNEMP	Unemployment rate	0.34	0.47	0	1
SPLIT	Indicator for credit ratings split	6.32	2.36	2.74	15.54
rManfctGSP	% of manufacturing sector to GSP	24.52	6.47	12.51	39.15
rAutoGSP	% of auto sector to GSP	3.71	4.42	0.22	17.63
rPCIncPCTaxB	% of per capita income to per capita tax burden	6.72	1.20	4.39	8.89
rTaxTotRev	% of total tax revenues to total own source revenues	47.50	6.84	28.71	60.70
rDebtTotRev	% of debt outstanding to total revenues	40.11	14.82	20.14	105.10
NOTE: For restricted sample, *CRATE* is a 5 choice outcome variable: AAA/Aaa = 5 (35%); AA+/Aa1 = 4 (16%); AA/Aa2 = 3 (39%); AA-/Aa3 = 2 (6%); A+/A = 1 (3%); *N* = 175. SOURCES: *CRATE* - S&P and Moody's, *UNEMP* - BLS, all other variables from BEA and the US Census					

Finally, *rPCIncPCTaxB* is a share of per capita tax burden to per capita state incomes. This factor, also included in earlier credit rating studies by Depken and LaFountain (2006) and Krueger and Walker (2008), is important because greater burdens on the ability to pay have a negative effect on state credit ratings. Per capita income indicator is a proxy for reliability of revenue sources and the ability to collect higher tax revenues to finance future debt, given the current and historical levels of per capita tax burden.[9]

Results & Discussions

The results section consists of two parts. Part one interprets and reports the results from the ordered regression analysis for Michigan for thirty-five time periods (years).[10] Part two interprets the results from the panel analysis for five states in the Great Lakes region during the same time frame. In part one, we estimate ordered regression models for the effects of seven explanatory

variables on Michigan's credit ratings. All of the regressors in this credit rating model are found to be significant, statistically and substantively.[11] Generally, all of the hypothesized associations have the expected directions with the exception of variable *rAutoGSP,* which, contrary to our expectations, has a positive sign.

Unemployment Rates

Unemployment rates (*UNEMP*) appear to have a significant inverse effect on Michigan's credit ratings ($p = 0.012$). Thus, a 1 percent increase in unemployment rates is found to be associated with a factor change in odds of 0.28, all else constant (i.e. unemployment increases the odds of lower credit ratings vs. higher credit ratings by a factor of almost 3.60). In order to provide a more comprehensive picture, we plot the predicted values of credit ratings in Michigan across the range of observed unemployment rates with all other variables held at their mean values. In Figure 7, we can see that probabilities for ratings AAA/Aaa and AA+/Aa1 decrease with unemployment rates moving from about 3.5 percent to 8 percent. At 8 percent unemployment rate (a 'switching point' – the probability of moving from one rating notch to the next), the probability of having the top two credit rating categories is equal to zero. At the same time, with unemployment rates above 8 percent the probabilities for ratings AA-/Aa3 and/or A+/A increase substantively. The probabilities for ratings AA/Aa2 appear to peak at around 7.5 percent unemployment. The evidence is conclusive and the magnitude of the effect of the economy as measured by unemployment rates on credit ratings is substantive. This finding is expected and supports the findings in earlier literature.

Table 4: Model Estimates and Fit for *CRATE* (with robust standard errors), Restricted Sample

Variable	*Ordered Logit*	*Ordered Probit*
$SPLIT$	2.825 (2.47)*	1.713 (2.69)**
$UNEMP$	−1.280 (−2.50)*	−0.675 (−3.04)**
$rManfctGSP$	−1.186 (−3.93)***	−0.707 (−4.42)***
$rAutoGSP$	0.703 (2.29)*	0.413 (2.42)*
$rPCIncPCTaxB$	−4.305 (−2.54)*	−2.423 (−2.67)**
$rTaxTotRev$	0.569 (3.06)**	0.346 (3.83)***
$rDebtTotRev$	−0.321 (−3.28) **	−0.194 (−3.55)***
AIC	76.53	76.60
BIC	93.63	93.71
Likelihood Ratio X^2	43.70	43.62
ML (Cox-Snell) R^2	0.713	0.712
McKelvey and Zavoina's R^2	0.805	0.808
Cragg-Uhler's (Nagelkerke) R^2	0.759	0.758

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Manufacturing Sector

We observe that a larger share of manufacturing sector in a states' overall production (*rManfctGSP*) is associated with a lower state credit ratings. This relationship holds true for Michigan as well. *rManfctGSP* is inversely correlated with Michigan's credit ratings ($p = 0.001$). Thus, a 1 percent increase in manufacturing sector as a share of GSP is found to be associated with a factor change in odds of 0.31, all else constant (i.e. *rManfctGSP* increases the odds of lower credit ratings versus higher credit ratings by a factor of 3.27). Here too, we plot the predicted values of credit ratings in Michigan across the range of observed *rManfctGSP* with all other variables held at their mean values. Similar to conclusions for the first variable, in Figure 8, we can see that probabilities for ratings AAA/Aaa and AA+/Aa1 decrease with *rManfctGSP* approaching from 17 percent to 28 percent. At 28 percent, the probability of having the top two credit rating categories is equal to zero. Above 28 percent (a 'switching point' for manufacturing), the probabilities for ratings AA-/Aa3 and/or A+/A are found to increase substantively and symmetrically to decreases in the top two credit rating categories. The probabilities for ratings AA/Aa2 appear to be bound between 24 percent and 32 percent of *rManfctGSP*. The evidence is again rather conclusive and the magnitude of the effect of *rManfctGSP* on credit ratings is undisputable. It appears that economic diversity is an important factor for Michigan's credit ratings. Top two credit ratings are very reliant on manufacturing activities and this reliance may decline with increases in other sectors of the economy. We observe that when the share of the manufacturing sector exceeds one quarter of the economy (due to manufacturing expansion, failures in other sectors, or both), the ratings fall.

Automobile Industry

The share of auto sector to GSP (*rAutoGSP*), unlike the share of manufacturing (which includes auto sector), is found to have a positive effect on Michigan's credit ratings ($p = 0.022$). Thus, a 1 percent increase in automobile production sector as a share of GSP is found to be associated with a factor change in odds of 2.02 in credit ratings, all else constant. The plot of predicted values of credit ratings across the range of observed *rAutoGSP* with all other variables held at their mean values in Figure 9 reveals that probabilities for ratings AAA/Aaa and AA+/Aa1 increase when *rAutoGSP* ranges from about 12 percent to 18 percent. Below 12 percent, the probability of having the top two credit rating categories is equal to zero and the probabilities for ratings AA-/Aa3 and/or A+/A increase substantively. The probabilities for ratings AA/Aa2 have a perfectly bell-shaped distribution across the range of *rAutoGSP*. What may explain this divergence in expected versus observed effects of *rAutoGSP* on state credit ratings? The explanation may be quite simple: given the state's reliance on the auto industry, a stronger auto sector strengthens the state's credit ratings. Conversely, distress in the auto sector is rather strongly associated with lower credit ratings. A large percentage of auto industry in manufacturing sector of Michigan then makes the state's credit ratings highly dependent on this one industry, with other industries likely also dependent on auto production activities. The

problem of within sector diversification may not have been so pertinent if the auto industry was permanently strong, which has not been the case (see Figure 2).

Tax Burden

The share of per capita tax burden to per capita state income (*rPCIncPCTaxB*) has the strongest significant inverse effect on Michigan's credit ratings according to our estimates ($p = 0.011$). Thus, a 1 percent increase in the share of per capita tax burden to per capita state income is found to be associated with a factor change in odds of 0.01, all else constant. In other words, an increase in *rPCIncPCTaxB* improves the odds of lower credit ratings versus higher credit ratings by a factor of 74.03. Both an ability to raise tax revenues and whether that revenue source is overburdened are strongly correlated with credit ratings. In Figure 10 we find that top ratings AAA/Aaa and AA+/Aa1 appear to favor shares of per capita tax burden to per capita state income in the range of 5.8 percent to 6.8 percent. Any greater tax burden levels than that are found to increase the probabilities for ratings AA-/Aa3 and/or A+/A quite substantively. The probabilities of greater than 0.50 for ratings AA/Aa2 appear to be bound between 6.3 percent and 7.3 percent of *rPCIncPCTaxB*.

Tax Revenues

The share of tax revenues to total revenues (*rTaxTotRev*) is found to have a significant and positive effect on credit ratings ($p = 0.002$). As expected, a 1 percent increase in the share of tax revenues to total revenues increases credit ratings by a factor change in odds of 1.77, all other variables controlled for. Hence, in accordance with previous literature and our estimates, we may infer that a greater share of tax revenues to total revenues provides the revenue flexibility and independence that is positively viewed by the credit rating agencies. The plot of predicted values of credit ratings in Michigan across the range of observed *rTaxTotRev* with all other variables held at their mean values in Figure 11 shows that the probabilities for ratings AAA/Aaa and AA+/Aa1 increase with *rTaxTotRev* ranging above 47.5 percent. However, below 47.5 percent the probabilities for ratings AA-/Aa3 and/or A+/A are found to increase substantively and symmetrically to decreases in the top two credit rating categories. The probabilities for ratings AA/Aa2 appear to be bound between 44 percent and 52 percent of *rTaxTotRev*.

Figure 7: Multinomial Response Categories for Credit Rating for the Effect of Unemployment.

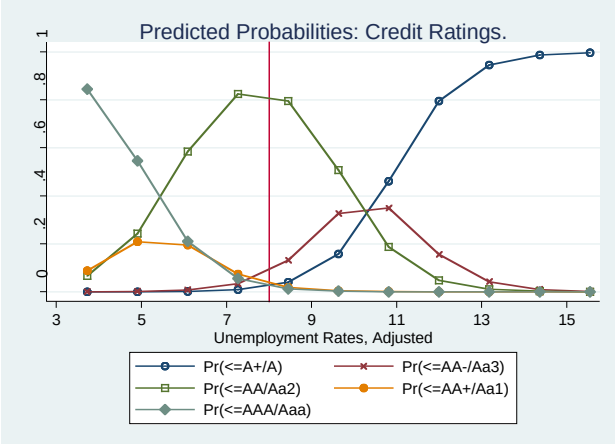


Figure 8: Multinomial Response Categories for Credit Rating f the Effect of Manufacturing Sector as Share of GSP.

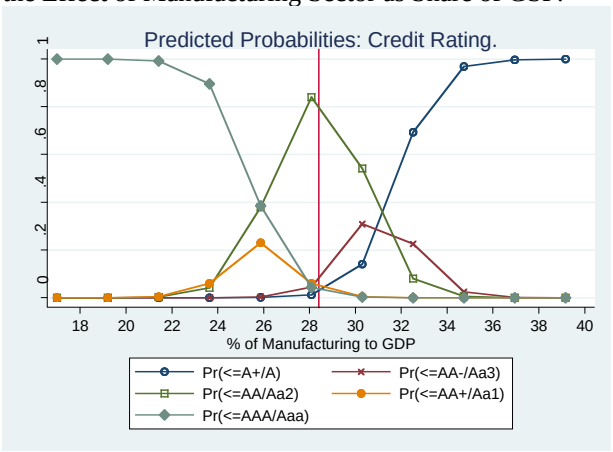


Figure 9: Multinomial Response Categories for Credit Rating for the Effect of Auto Sector as Share of GSP.

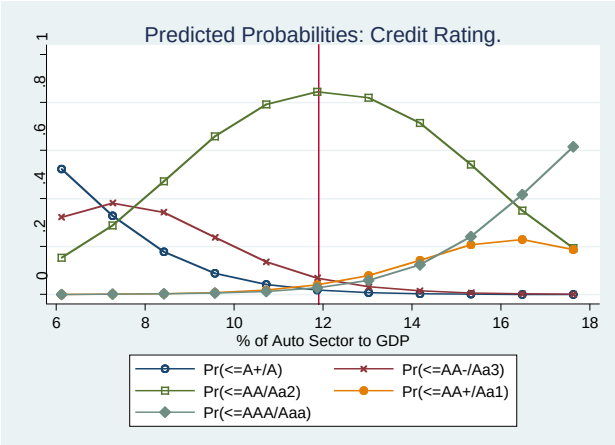


Figure 10: Multinomial Response Categories for Credit Rating for the Effect of Per Capita Tax Burden as Share of Per Capita Income

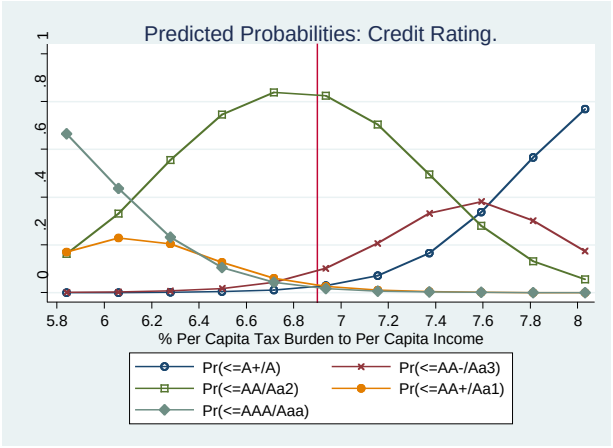


Figure 11: Multinomial Response Categories for Credit Rating for the Effect of Tax Revenue as Share of Total Own Source Revenue

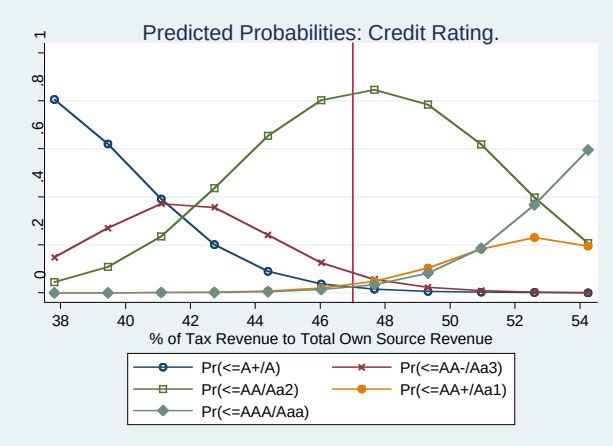
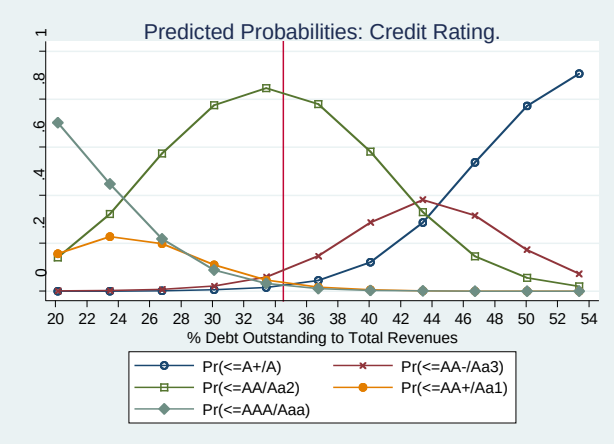


Figure 12: Multinomial Response Categories for Credit Rating for the Effect of Debt Outstanding as Share of Total Revenues



Debt Outstanding

The last variable (*rDebtTotRev*) – the share of total debt outstanding to total revenues – again is found to have a significant inverse effect on Michigan's credit ratings ($p = 0.001$). A 1 percent increase in *rDebtTotRev* is associated with a factor change in odds of 0.72, all else constant (i.e. *rDebtTotRev* increases the odds of lower credit ratings vs. higher credit ratings by a factor of 1.37). A look at the plot of predicted values of credit ratings in Michigan across the range of observed *rDebtTotRev* in Figure 12 with all other variables held at their mean values demonstrates that debt size greater than one-third of total revenues is very likely to increase the probabilities of AA-/Aa3 and/or A+/A rather significantly. A lighter debt burden, on the other hand, increases the probabilities for ratings AAA/Aaa and AA+/Aa1. The probabilities for ratings AA/Aa2 appear to be bound between 26 percent and 41 percent of *rDebtTotRev*. This result is as expected and confirms our initial hypothesis as to the association between the percentage of debt size to total revenues in Michigan and the state's credit ratings.

Finally, the variable *SPLIT* is found to be statistically significant. This, however, does not suggest that split ratings affect credit ratings. Due to the nature of the construct of the outcome variable, we must conclude that there is a significant difference in credit ratings assigned to Michigan by the two credit rating agencies – S&P and Moody's respectively.

Panel Data Analysis

We now analyze the effects of seven explanatory variables on state credit ratings for five states – Michigan, Illinois, Minnesota, Ohio, and Wisconsin (hereinafter the Great Lakes Region) – throughout 1973-2007. The panel data are strongly balanced where a two-level structure can be clearly identified – time periods of 1973-2007 are nested within the states. A quick review of the grand means and within and between variations reveals a diverse picture. While between variance is greater for variables *UNEMP* and *rManfcGSP*, within variance is greater for the

remaining variables. In order to achieve consistent and efficient estimates, we employ a random intercepts ordered logit (RIL), and random coefficients ordered logit (RCL) specifications for the effects of our explanatory variables on state credit ratings. These results are given in Table 5.[12]

Table 5: Model Estimates and Fit for *CRATE*, Panel Data Sample

Variable	*Ordered Logit Robust*	*Random Intercepts Ordered Logit (RIL)*	*Random Coefficients Ordered Logit (RCL)*
$SPLIT$	$-0.173\ (-0.36)$	$0.789\ (1.55)$	$0.920\ (1.61)$
$UNEMP$	$-0.395\ (-3.32)$***	$-0.414\ (-4.01)$***	$-0.417\ (-4.04)$***
$rManfctGSP$	$-0.135\ (-2.92)$**	$-0.243\ (-3.41)$***	-0.238***(-3.39)***
$rAutoGSP$	$-0.143\ (-2.10)$*	$-0.363\ (-2.37)$*	$-0.372\ (-2.36)$*
$rPCIncPCTaxB$	$-1.534\ (-6.10)$***	$-1.497\ (-2.98)$***	$-1.411\ (-2.76)$**
$rTaxTotRev$	$0.256\ (7.59)$***	$0.388\ (6.23)$***	$0.384\ (6.18)$***
$rDebtTotRev$	$-0.133\ (-7.85)$***	$-0.190\ (-6.17)$***	$-0.191\ (-6.28)$***
Fixed Effects $\alpha^{(1)}$	$-14.89\ (-5.88)$***	$-14.63\ (-3.12)$**	$-14.19\ (-3.01)$**
$\alpha^{(2)}$	$-13.49\ (-5.46)$***	$-13.03\ (-2.77)$**	$-12.57\ (-2.65)$**
$\alpha^{(3)}$	$-10.00\ (-4.35)$***	$-9.02\ (-1.92)$	$-8.56\ (-1.81)$
$\alpha^{(4)}$	$-8.77\ (-3.97)$***	$-7.73\ (-1.62)$	$-7.27\ (-1.54)$
Random Effects ψ_{11}	---	$1.758\ (2.09)$*	$1.703\ (3.96)$*
ψ_{12}	---	---	$0.000\ (0.00)$
ψ_{21}	---	---	$0.258\ (0.58)$
AIC	351.80	350.15	353.80
BIC	386.60	388.12	398.10
$-$Log-Likelihood	-164.90	-163.07	-162.89

The simplest method of estimating ordered logit models for group specific data is the specification with robust standard errors using the sandwich estimator. There is reason to believe that the observations and results may be correlated within states. However, conditional independence of outcomes within states given the covariates is a very strong assumption.[13] Therefore, two-level model specifications are needed to account for the state-specific random intercepts and/or random coefficients ordered logit models. To aid in our interpretation, we estimate the marginal effects of explanatory variables on outcome variables at their mean values. The results show that the expected directions for all of the explanatory variables hold rather well. Unemployment is found to have a negative association with state credit ratings, all else equal. A marginal increase of the unemployment rate from its mean value appears to pull the probabilities of credit ratings downwards by about 0.41 in both RIL and RCL models.[14] This revalidates that unemployment (here a proxy for economic health) is a rather important factor for credit ratings.

We find that the share of manufacturing to GSP has an inverse effect on the outcome variable, as predicted, with other variables held constant at average values. The marginal effect of this variable at its mean score is estimated to be -0.24 and -0.22 in RIL and RCL,

respectively. Thus from a regional perspective, both unemployment rates and larger shares of manufacturing sector in the economy appear to play adverse roles to credit ratings.

Table 6: Variable Marginal Effects on CRATE (All else fixed at means) Panel Data Sample

Variable	*RIL*		*RCL*		*X mean*
	dy/dx	*Std. Err.*	*dy/dx*	*Std. Err.*	
$UNEMP$	−0.414	0.103	−0.417	0.103	6.32
$rManfctGSP$	−0.243	0.071	−0.238	0.070	24.52
$rAutoGSP$	−0.363	0.153	−0.372	0.158	3.71
$rPCIncPCTaxB$	−1.496	0.502	−1.411	0.512	6.72
$rTaxTotRev$	0.388	0.062	0.384	0.062	47.47
$rDebtTotRev$	−0.190	0.031	−0.191	0.030	40.11

Furthermore, as initially hypothesized but not in line with the Michigan findings, a greater share of auto industry in the economy appears to be negatively correlated with credit ratings. The marginal negative effect of auto industry's size in GSP (in terms of percentages) is -0.36 in the RIL. Note that in the random intercepts ordered logit model we relax the assumption of conditional independence within states given the covariates by allowing the intercepts to be different. In the random coefficients ordered logit model we relax the assumptions even further and allow for the slopes to reflect individual differences both within states and trajectories between states. Hence, in the RCL model we let the slopes for the effect of *rAutoGSP* vary for each state (i.e. to model that the states differ in how their auto sectors affect their credit ratings). The marginal effects of the auto sector on state credit ratings are found to be -0.24 ($p < 0.05$). Recall that in Michigan's case auto industry was a positive factor due to the hefty role of auto industry in that state's economy, meaning that the successes in the auto industry tend to bring credit ratings structures up, while failures drag the ratings down. From a regional perspective, the data suggest that the credit rating firms view a strong reliance on a single sub-sector negatively.

In terms of sound fiscal management, and as was the case in the restricted sample, increases in per capita tax burden as a share of per capita income have the strongest magnitude of effect on our outcome variable. The effect of this variable on credit ratings is -1.5, and -1.4 for each unit increase above the mean, all else held constant in RIL and RCL specifications. Thus, both the restricted sample from Michigan and the panel data of the Great Lakes Region suggest the same outcome. Unlike all the variables above, the credit raters seem to look positively at greater levels of revenue flexibility measured as the percentage of total tax revenues in total revenues. Each unit increase in this factor above its mean is found to have a marginal positive effect of 0.38 on state credit ratings. The effect is significant and consistent with established literature on credit ratings. Finally, states with greater levels of debt burden (i.e. percentage of total debt outstanding to total revenues) are estimated to have lower ratings. The marginal effect of debt burden indicator is negative 0.19 above the mean of 40 percent, all else held constant.

Here again the findings are consistent with predicted expectations.

Concluding Remarks

Results in this study provide evidence that Michigan's credit rating is highly dependent on a single sub-industry, that of auto manufacturing. A poor performance of its auto sector was found to be a major determinant of Michigan's current low credit rating. For the state of Michigan and the Great Lakes Region, the key to higher credit ratings appears to be a complex yet clear enough path to establish. While the dynamics in a state's economy may be largely beyond the direct control of the state, it could "manage" its own credit rating by supporting policy initiatives for economic diversity.[15] Policies that divert the economic (and also political, social, and human) resources to a limited pool of sub-sectors and narrow industries may expose the states to risks in the long term. Managing incentives for sectoral diversification of the economy, within sector composition, and competition incentives would be a rather attractive path.

However, if managing the composition of the economy is an extremely complex initiative, the other alternatives could be more feasible in improving Michigan's credit rating. The findings suggest states (and their citizens) could manage their taste and demand for tax revenues. High tax burden appears to send a certain signal that is not well received by the credit rating agencies. This is not to say that tax or expenditure limitations (TELs) must be blindly institutionalized. There is an established literature clearly suggesting that certain tax limitations hurt state credit ratings and their borrowing costs (Johnson and Kriz, 2005; Denison, Hackbart, and Moody, 2006; Wagner, 2004). At the same time, a lower reliance on outside and 'insecure' revenues (i.e. greater levels of own source tax revenues) appears to send a strong signal of ability to pay. This is captured in the positive effects of increasing percentage of tax revenues to total revenues. Consequently, better uses of tax revenues, and perhaps also the stability of the tax instruments, are what the states could effectively manage. This should not be an uncontrollable task and we know that states can and do manage their tax choices. Finally, states can manage how much they borrow. Higher debt burdens do not appear to be particularly positive for credit ratings. Good debt management is found to be an effective and efficient practice of good housekeeping. Michigan appears to score well on this factor. Nevertheless, with unpredictable revenue sources, and revenue volatility due to economic exposure to a select few industries, Michigan may need to tap into municipal debt markets in the short term to build stability in the longer term.

In June 2011 Michigan's new governor, Rick Snyder, travelled to New York City along with several other government officials to meet with three major credit rating agencies and discuss how to improve Michigan's credit rating. Although the credit rating has not changed yet (except for the positive outlook issued by Fitch), such a trip might be an indicator that Michigan's senior officials are willing to undertake serious steps to improve the credibility of the state. One of the major tasks here was captured by *The Economist* and resonates well with our findings:

> The state's woes are abundant and familiar. Employment has fallen every year since 2000. Even as the carmakers recover, they will not resume their role as guarantors of middle-class prosperity. State leaders have struggles to respond to structural shifts. Unfortunately, rather than reform a collapsing revenue system, they have passed short-term fixes. Attempts to reinvent Michigan have moved fitfully. Grants for college students did little to encourage them to stay after graduation… [Michigan] must move beyond car making, do more to keep young people, to create a friendly business climate rather than court specific industries, and support entrepreneurship... (*The Economist*, January 29th, 2011).

Suggested Future Research

In the bigger picture, while the lessons of this study are easily applicable to the Great Lakes region, those who would apply these findings to other regions must use healthy caution. Yet, other research questions are easily extendable from this study. One direction would involve shifting the level of analysis to the national stage as a whole and attempt to understand how an over-reliance on one sector may shape state credit ratings. 'Big-item' sub-sectors such as tourism and entertainment in Florida and Nevada, natural resource extraction in Texas and Alaska, niche service sectors of California (technology) and New York (finance) are all subject to market volatility. An analysis could also be expanded toward the sub-state/municipal level. In particular, a study of Michigan counties may reveal that it is an economically diverse state, with some counties riding the waves of health and education service sector expansions. More importantly, future studies should survey how the economic, fiscal, and debt factors are related to aggregate state borrowing costs. After all, the state credit ratings are important inasmuch as they determine the debt service yields. It is possible that these factors have direct and indirect effects on state borrowing costs, which are important to know for state governments and their tax-paying citizens alike.

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[1] For more information about credit ratings and credit rating agencies, go to Standard and Poor's (S&P's) web site: http://img.en25.com/Web/StandardandPoors/SP_CreditRatingsGuide.pdf, http://img.en25.com/Web/StandardandPoors/On_The_Use_Of_Models.pdf, and other sources available at S&P's web site at no charge.

[2] Marlowe (2007) refers only to Net Direct GO Debt.

[3] Indiana excluded from the sample because the state issues bonds indirectly through an 'independent' finance authority.

[4] Also see Figure 3 for Michigan's population by educational attainment and Michigan Department of Labor and Economic Growth. "Michigan Economic and Workforce Indicators," *Bureau of Labor Market Information & Strategic Initiatives* (Summer 2008): 1-11.

[5] Johnson and Kriz (2002) use the same method for constructing credit ratings variable. See pages 6-10.

[6] In both equations (ordered logit/probit and panel ordered logit/probit), the response variable has sufficient distributions across all of the five outcome options; see Table 2 for descriptive statistics.

[7] The alternatives to logit and probit approaches that may be found in scholarly articles are the tobit and/or simultaneous equations model. Depken and LaFountain (2006) employ a tobit model to estimate average relative state bond ratings, which appears to be a suitable candidate for credit rating estimates with truncated limited dependent variables. Reiter and Zeibart (1991) use simultaneous equations approach for a credit rating problem. Simultaneous equations method is an appropriate approach when the research questions is to find out what the direction of causes and effects are, like the one asked by Reiter and Zeibart: "whether rating determine yields or whether both ratings and yields are determined by a concurrent set of economic and financial factors".

[8] Annual unemployment rates are averaged monthly figures as reported by the Bureau of Labor Statistics; available from http://www.bls.gov/data/#unemployment.

[9] Interestingly, values of per capita debt outstanding or per capita general revenue by themselves are often found insignificant and the sign of these variables changes from one paper to another; see Depken and LaFountain (2006, 75-85); Krueger and Walker (2008, 274-282); Liu and Thakor (1984, 344-352).

[10] In the first part, we must study individual characteristics of time series variables involved (See the discussion in Helmut Lutkepohl and Markus Kratzig (2004, 8-17)). In a time series framework there is a potential danger that individual variable regressors are correlated with the error terms; i.e. the assumption of homogeneity in errors may be violated. Such a violation may lead to imprecise coefficients and estimates of standard errors. Therefore, we start by testing whether the process is stationary; i.e. test for the stochastic process *CRATE's* time invariance in first and second moments. We do not find any traces of trending in our time series equation. None of the coefficients in the lagged terms are statistically significant. However, when we conduct the Durbin-Watson d-statistic test for autocorrelated errors, our results are inconclusive (with the estimated statistic falling between $dL < d = 1.94 < dU$). Hence, we resorted to more conservative tests for autocorrelation. For that purpose, we ran a Breusch-Godfrey LM test for autocorrelation and found no evidence that would reject the null hypothesis of no serial correlation ($\chi^2_{B-G} = 0.009$). Similarly, the test for autoregressive conditional heteroskedasticity found no ARCH effects ($\chi^2_{ARCH} = 0.386$). Moreover, the Phillips-Perron and the Dickey-Fuller tests for unit root both provide clear evidence of stationarity in the data. Consequently, we conclude that the stationary model provides an appropriate fit for the data and the most parsimonious interpretation of results.

[11] We have estimated ordered logit and ordered probit equations for credit ratings in Michigan. The conventional model fit statistics such as AIC, BIC, and/or LR-chi-squared do not signal of any preference to either of the equations. Both equations produced identical R^2: McFadden's R^2 = 0.44; Cox-Snell ML R^2 = 0.71; McKelvey and Zavoina's R^2 = 0.81; Cragg-Uhler's (Nagelkerke) R^2 = 0.76. Consequently, we will use results from both of the models interchangeably in our interpretations.

[12] We also estimated three ordered probit specifications of the model – clustered, random intercepts, and random coefficients. However, since the results were not significantly superior to the ordered logit versions, we do not report these results here for the reasons of brevity.

[13] See Rabe-Hesketh, Sophia and Anders Skrondal (2008) for a useful discussion on model selection in panel data structures.

[14] The results for five explanatory variables (i.e. excluding the dummy for split rating and *rAutoGSP*) are highly significant at $p < 0.01$. *rAutoGSP* is significant at $p < 0.05$.

[15] Having said this, we recognize that states can and do manage the pools of unemployed citizens. However, in a larger definition of the economy (beyond unemployment rates) economic factors may be considered exogenous.