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An City-Level Analysis of Mortality and the Business Cycle across Racial and Ethnic Groups

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This paper employs U.S. metropolitan data to investigate the relationship between mortality rate and the business cycle. We utilize mortality and employment data that are specific to a given city, year and race/ethnic group. The analysis improves upon the existing literature by analyzing the relationship for specific racial and ethnic groups and by allowing the relationship to vary according to the level of economic activity in that metropolitan area. We find that while overall mortality is procyclical at the median value of the employment rate, it is countercyclical at lower values and more strongly procyclical at higher values. Our estimates also suggest that while this pattern is present for whites and Hispanics, there is no discernible relationship between mortality and the employment rate for blacks. Our analysis of specific causes of death suggest additional differences across racial and ethnic groups

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1. Introduction

The relationship between the business cycle and mortality is the subject of a substantial literature. Recent studies of the U.S. and other developed countries have generally found that mortality rates are procyclical, in that economic expansions (contractions) are associated with increases (decreases) in mortality rates (e.g., Ruhm, 2000; Tapia Granados, 2005a; Neumayer, 2004; McAvinchey, 1998; Tapia Granados, 2005b; Fontenla, Gonzalez, and Quast, 2010). However, most of these studies do not consider two important factors that may affect this relationship. First, they ignore differences within populations and estimate average effects across racial and ethnic groups. This is a potentially important omission since some studies have found important differences across racial groups in terms of health care utilization (Currie and Thomas, 1995; Zheng and Zimmer, 2009) and impacts of the business cycle (Freeman, 1973; Bradbury, 2000). Second, existing papers typically assume a linear relationship between mortality rates and economic activity. Yet, the effects of fluctuations in the economy on mortality may vary with the level of economic activity.

In this paper we investigate whether changes in the business cycle have differential effects across races and ethnicities in the U.S. We employ a panel of race- and ethnic-specific mortality and employment rates of U.S. Primary Metropolitan Statistical Areas (PMSAs) and Metropolitan Statistical Areas (MSAs) for 1999 through 2006. We use mortality rates for all causes and specific causes of death and control for other factors that may influence mortality rates, such as the supply of health care and governmental transfer payments. We allow for a quadratic relationship between mortality and employment rate[1] by including the squared value of the employment measure by race/ethnicity as an explanatory variable.

We extend the analysis in Fontenla, Gonzalez, and Quast (2010) in several important aspects. First, we employ data measured at the MSA level rather than the county level. This allows us to: i) use employment data specific to race and ethnicity, ii) prevent spatial correlation of variables across contiguous counties as the MSAs in our sample are not adjacent to each other, and iii) avoid noisy mortality rates due to few deaths of relatively rare causes in less-populated counties. Second, we analyze specific causes of death in addition to overall mortality. Finally, we allow for differing effects based on economic conditions in the MSA by including a quadratic employment term and calculating the marginal effect at the 5^{th} and 95^{th} percentiles of employment.

We find that overall mortality is procyclical at the median value of the employment rate, which is consistent with Fontenla, Gonzalez, and Quast (2010). However, we also find that the relationship varies with the employment rate. Specifically, at low employment levels mortality is countercyclical while at high levels the procyclical relationship is stronger than at the median employment rate. This pattern holds for all races, whites, and Hispanics but not for blacks.

We also find interesting results when investigating mortality rates for specific causes of death. For instance, the suicide mortality rate is countercyclical at high employment levels for whites and Hispanics. Conversely, for blacks there is no measureable relationship between the mortality rate for any specific cause of death and the employment rate.

[1] The employment rate is the number of employed divided by the working-age population. This variable is sometimes referred to as the employment-to-population ratio.
[2] The PMSAs and MSAs in our sample are referred to below as (P)MSAs.

2. Data and Empirical Specification

Our sample covers 1999 – 2006 and includes the fifty PMSAs and MSAs in the U.S. for which employment data by race/ethnicity are available.[2] Table 1 describes the mortality rates used. They are the age-adjusted rates per 100,000 people and are taken from the *Compressed Mortality Database* published by the U.S. Centers for Disease Control (CDC). The rates for all causes and eight specific causes of death are obtained by race/ethnicity (white, black, Hispanic).[3]

The explanatory variable of interest is the employment rate by race/ethnicity. While previous studies typically use the unemployment rate, the employment rate is arguably a better measure as it is based on the total number of working age individuals rather than only those actively seeking employment. Further, Clark and Summers (1982) argue that it is a better measure for groups who move frequently in and out of employment. It is reported by race/ethnicity and is taken from publications by the U.S. Bureau of Labor Statistics entitled, *Geographic Profile of Employment and Unemployment*. There is almost complete coverage for all races and whites, with some gaps for blacks and Hispanics. Of the 400 possible observations, black employment data are missing for 76 observations and Hispanic data are missing for 133 observations.

Additional control variables are used in the regressions. To control for health care resources, the number of active non-federal doctors and hospital beds per capita are employed. These data come from the *Area Resource File* published by U.S. Department of Health and Human Services. Also, the per-capita level of federal transfer payments is taken from the *Regional Economic Information System* database published by the U.S. Department of Commerce. Migration patterns may affect mortality rates due to common characteristics of individuals moving into or out of an (P)MSA. Thus, both the domestic and international migration rates are obtained from *Population Estimates Program* (PEP) of the U.S. Census. Finally, from the PEP we use the percent of the total population of the specific race/ethnicity featured in the regression to control for any racial or ethnic peer effects on mortality.[4]

Following earlier papers, we model the mortality rate as a logarithmic function of the explanatory variables. The resulting estimation equation is:

$$\begin{aligned}\log\left(mort_{i,t,r}\right) = {} & \beta_0 + \beta_1 * (employ\ rate)_{i,t,r} + \beta_2 * (employ\ rate^2)_{i,t,r} + \beta_3 * (\#docs)_{i,t} \\ & + \beta_4 * (\#beds)_{i,t} + \beta_5 * (trnsf\ pmts)_{i,t} + \beta_6 * (dom\ mig\ rate)_{i,t} \\ & + \beta_7 * (intl\ mig\ rate)_{i,t} + \beta_8 * \%hispanic_{i,t} + \gamma_i + \delta_t + \varepsilon_{i,t}\end{aligned} \tag{1}$$

where *i* represents the (P)MSA, *t* the year and *r* the race/ethnicity. Consequently, γ_i are the (P)MSA fixed effects and δ_t are the year fixed effects. Thus, the mortality and employment rates are specific to a given MSA, year and race/ethnic group. Equation (1) is estimated for each possible combination of cause of death and race/ethnicity, resulting in 36 regressions. The

[2] The PMSAs and MSAs in our sample are referred to below as (P)MSAs.
[3] Observations for which the CDC classified the mortality rate as "unreliable" are not included in the analysis. This designation is assigned when the number of deaths is less than 20 and accounts for roughly 15% of all of the mortality rates across all causes, and races/ethnicities in the sample. The regression estimates when those rates are included are similar to those reported below and are available from the authors upon request.
[4] In the regressions where all races and ethnicities are included, this variable is omitted.

observations are weighted by the number of individuals in the relevant racial/ethnic category in that (P)MSA and are clustered by (P)MSA to allow for correlated error terms.

3. Results

3.1 Overall mortality

Table 2 contains the marginal effects estimates for the regressions where the dependent variable is the overall mortality rate and the explanatory variable is the employment rate.[5] We calculate the marginal effect as the estimated percentage change in the mortality rate associated with a one percentage point increase in the employment rate. The marginal effect is calculated at the 5th percentile, 50th percentile, and 95th percentile of the employment rate for that race/ethnicity. An additional column is included in the table that contains the absolute value of the difference of the marginal effect estimates at the 5th and 95th percentiles.[6]

For instance, the estimate of 0.0010 for all races implies that a 1 percentage point increase in the employment rate for all races is associated with a 0.1% increase in the overall mortality rate for all races at the median value of the employment rate. This translates to an increase of 0.8 deaths per 100,000 of population. While this estimate is not statistically significant, it is consistent with the prior procyclical findings. However, the two adjacent values indicate that this relationship varies with the employment rate. At the 5th percentile the relationship is countercyclical while at the 95th percentile mortality is procyclical and roughly three times the magnitude at the median value. The fourth column in the first row indicates that the difference between the marginal effect estimates at the 5th and 95th percentile is statistically different from zero at a 5% significance level. This pattern holds for the all races/ethnicities estimates.

Interesting contrasts emerge when comparing the results across races. While the estimates for whites are similar to those for all races/ethnicities, the results for blacks generally follow the opposite pattern: procyclical at low employment rates and countercyclical at high values. The results for Hispanic follow the patterns for whites and all races/ethnicities but the magnitudes are significantly greater at the 5th and 95th percentiles. At the 5th percentile, a one percentage point increase in the employment rate is associated with a decrease in roughly 2 deaths per 100,000, while at the 95th percentile the same change is associated with an increase of over 3 deaths per 100,000.

3.2 By cause of death

Table 3 presents the regression results by specific cause of death. The pattern of results for cardiovascular deaths for whites and all races follows that of overall mortality, in that mortality is countercyclical at low levels of the employment rate and procyclical at high levels. However, the magnitudes are significantly larger at all three values of the employment rate. The liver

[5] Given our quadratic specification, we report the marginal effects rather than the coefficient estimates to more readily assess the effects of changes in the employment rate on the mortality rate.

[6] The statistical significance of the absolute difference between the two estimated marginal effects is based on a Wald test in which the p-value is estimated via the delta method.

mortality rate for Hispanics ranges from countercyclical to procyclical as the employment rate increases.

Like prior studies of the U.S., we find that the motor vehicle mortality rate is procyclical for all races. However, the estimates for suicides also suggest interesting differences across races and ethnicities. For whites and all races, the suicide mortality rate is countercyclical. While the estimates for blacks are generally statistically insignificant, the results for Hispanics indicate that this mortality rate ranges from procyclical to countercyclical as the employment rate increases. Further, the Hispanics estimates are of a significantly greater magnitude than for whites and blacks.

4. Discussion

This study investigates whether the relationship between the business cycle and mortality varies by race/ethnicity and the level of economic activity at the MSA-level. We utilize mortality and employment data by race/ethnicity and analyze the relationship changes at the 5^{th}, 50^{th}, and 95^{th} percentile of the employment rate for that race/ethnicity.

We find that for whites and Hispanics the overall mortality rate varies from countercyclical to procyclical as the employment rates for these groups increase. For blacks, we generally find no relationship. In our analyses of specific causes of death, we find significant differences by race/ethnicity.

Ruhm (2000), Tapia (2005a, 2005b) among others attribute some of the procyclical nature of mortality to an increase in risky behavior by individuals under economic expansions such as higher alcohol and tobacco consumption, more strenuous working hours, more driving, reduced sleep and lower time for health promoting activities (such as exercise and doctor visits). Moreover, the increased road traffic and industrial activity during economic expansions lead to higher pollution exposure and mortality. Therefore our results suggest that riskier behavior and higher pollution exposure under economic expansions may take place mostly in the more prosperous cities and be more predominant for Hispanics and whites.

Taken together, our findings suggest the impact of fluctuations in economic activity on mortality rates in U.S. MSAs may differ significantly by race/ethnicity and by the level of local economic activity. As such, the results in existing studies that do not account for these factors may not hold for important segments of the population. However, the aggregate nature of the data does not allow for an in-depth analysis as to why the relationship differs in the ways discussed above.

There are interesting potential extensions to this study. As the data become available, extending the sample period may allow for more precise estimates of the long-term relationship between the business cycle and mortality. Further, individual-level data could potentially uncover differences in the mechanisms by which business cycles influence mortality.

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Table I. Mortality summary statistics

	Mean	Std dev
All causes		
All	814.1	104.7
White	804.4	84.5
Black	1072.8	131.9
Hispanic	549.4	133.3
Cardiovascular		
All	300.2	50.7
White	296.7	46.6
Black	396.0	70.1
Hispanic	195.2	60.7
Homicides		
All	6.8	3.7
White	2.9	1.1
Black	24.9	10.2
Hispanic	8.3	3.7
Liver		
All	11.7	2.4
White	11.3	2.1
Black	13.1	3.9
Hispanic	18.1	5.8
Motor vehicle accidents		
All	10.6	3.3
White	10.4	3.4
Black	12.9	4.0
Hispanic	13.1	4.6
Neoplasms		
All	192.7	23.2
White	194.8	18.7
Black	241.4	38.4
Hispanic	120.0	24.6
Other accidents		
All	18.4	6.7
White	19.4	7.1
Black	21.8	9.3
Hispanic	14.3	5.0
Pneumonia		
All	21.8	8.3
White	22.0	8.4
Black	24.1	11.5
Hispanic	18.8	6.6
Suicides		
All	9.9	2.7
White	11.8	3.2
Black	5.8	1.9
Hispanic	5.9	2.3

Table II. Marginal effect estimates from regressions – Overall mortality

	Percentile of employment rate at which marginal effect is estimated			
Race/ethnicity	5th percentile	50th percentile	95th percentile	Difference[1] between 5th & 95th percentiles
All	-0.0009	0.0010	0.0029**	0.0038**
	(0.54)	(0.32)	(0.02)	(0.04)
Whites	-0.0013	0.0007	0.0025*	0.0038*
	(0.39)	(0.39)	(0.05)	(0.09)
Blacks	0.0002	-0.0005	-0.0010	0.0012
	(0.93)	(0.50)	(0.48)	(0.69)
Hispanics	-0.0040	0.0011	0.0060	0.0100*
	(0.13)	(0.60)	(0.16)	(0.08)

Notes: *** significant at 1%; ** significant at 5%; * significant at 10%. The marginal effect is the estimated percentage change in the mortality rate associated with a percentage point increase in the employment rate. The estimated marginal effect is reported as the top number in each cell and the associated p-value is the bottom number.

[1] The difference is the absolute difference between the marginal effects. The p-value is based on the delta method.

Table III. Marginal effect estimates from regressions – By cause of death (page one of two)

Cause of death/ Race/ethnicity	5th percentile	50th percentile	95th percentile	Difference[1] Between 5th & 95th percentiles
Cardiovascular				
All	-0.0028**	0.0023**	0.0076***	0.0104***
	(0.02)	(0.03)	(0.00)	(0.00)
Whites	-0.0023	0.0021**	0.0063***	0.0086**
	(0.24)	(0.03)	(0.01)	(0.02)
Blacks	-0.0015	0.0003	0.0019	0.0034
	(0.58)	(0.77)	(0.41)	(0.45)
Hispanics	-0.0004	-0.0017	-0.0028	0.0024
	(0.93)	(0.75)	(0.82)	(0.88)
Homicides				
All	0.0026	0.0024	0.0023	0.0003
	(0.73)	(0.73)	(0.84)	(0.98)
Whites	0.0131	0.0029	-0.0067	0.0198
	(0.27)	(0.70)	(0.61)	(0.32)
Blacks	-0.0040	-0.0008	0.0020	0.0060
	(0.71)	(0.86)	(0.82)	(0.73)
Hispanics	0.0111	0.0068	0.0027	0.0084
	(0.45)	(0.67)	(0.92)	(0.78)
Liver				
All	0.0031	-0.0011	-0.0056	0.0087
	(0.73)	(0.82)	(0.41)	(0.49)
Whites	-0.0011	-0.0024	-0.0035	0.0024
	(0.90)	(0.57)	(0.62)	(0.84)
Blacks	0.0036	0.0010	-0.0013	0.0049
	(0.73)	(0.83)	(0.87)	(0.76)
Hispanics	-0.016	0.0036	0.0219	0.0379**
	(0.13)	(0.65)	(0.11)	(0.04)
Motor				
All	0.0109*	0.0159***	0.0211***	0.0102
	(0.09)	(0.00)	(0.00)	(0.33)
Whites	0.0073	0.0105***	0.0136**	0.0063
	(0.24)	(0.01)	(0.05)	(0.53)
Blacks	0.0154	0.0081	0.0017	0.0137
	(0.24)	(0.14)	(0.89)	(0.54)
Hispanics	0.0067	0.0090	0.0111	0.0044
	(0.43)	(0.18)	(0.33)	(0.78)

Table III. Marginal effect estimates from regressions – By cause of death (page two of two)

Cause of death/ Race/ethnicity	5th percentile	50th percentile	95th percentile	Difference[1] Between 5th & 95th percentiles
Neoplasms				
All	-0.0010	0.0001	0.0013	0.0023
	(0.37)	(0.90)	(0.40)	(0.25)
Whites	0.0002	0.0007	0.0012	0.0010
	(0.91)	(0.36)	(0.39)	(0.66)
Blacks	-0.0013	-0.0013	-0.0012	0.0001
	(0.47)	(0.31)	(0.63)	(0.97)
Hispanics	0.0002	-0.0070*	-0.0137	0.0139
	(0.95)	(0.09)	(0.17)	(0.27)
Other accidents				
All	-0.0108*	0.0020	0.0154	0.0262**
	(0.09)	(0.78)	(0.17)	(0.02)
Whites	-0.0157	-0.0013	0.0122	0.0279
	(0.21)	(0.85)	(0.25)	(0.13)
Blacks	-0.0013	-0.0046	-0.0075	0.0062
	(0.86)	(0.29)	(0.39)	(0.65)
Hispanics	-0.0405**	-0.0002	0.0375*	0.0780**
	(0.02)	(0.98)	(0.07)	(0.02)
Pneumonia				
All	0.0033	0.0114*	0.0200	0.0167
	(0.56)	(0.06)	(0.11)	(0.26)
Whites	0.0043	0.0090	0.0135	0.0092
	(0.61)	(0.12)	(0.24)	(0.58)
Blacks	0.0049	-0.0004	-0.0051	0.0100
	(0.70)	(0.94)	(0.66)	(0.65)
Hispanics	0.0320	-0.0015	-0.0328	0.0648*
	(0.100)	(0.90)	(0.18)	(0.08)
Suicides				
All	-0.0022	-0.0052	-0.0083	0.0061
	(0.47)	(0.14)	(0.26)	(0.48)
Whites	-0.0057	-0.0064*	-0.0069	0.0012
	(0.37)	(0.08)	(0.39)	(0.93)
Blacks	0.0052	0.0012	-0.0023	0.0075
	(0.76)	(0.88)	(0.91)	(0.82)
Hispanics	0.0535**	-0.0049	-0.0596	0.1131**
	(0.03)	(0.79)	(0.11)	(0.03)

Notes: *** significant at 1%; ** significant at 5%; * significant at 10%. The marginal effect is the estimated percentage change in the mortality rate associated with a percentage point increase in the employment rate. The estimated marginal effect is reported as the top number in each cell and the associated p-value is the bottom number.

[1]The difference is the absolute difference between the marginal effects. The p-value is based on the delta method.