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Does the Relationship Between Mortality and the Business Cycle Vary by the Level of Economic Development? Evidence from Mexico

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Abstract

We investigate the relationship between mortality and business cycles within Mexico, where development varies significantly. We exploit this variation by separately analyzing the top ten and bottom ten developed states. We find that while mortality is procyclical nationally and in the top ten states, it is countercyclical in the bottom ten. Further, we show that in the top ten states mortality due to noncommunicable conditions is procyclical, while in the bottom ten mortality due to noncommunicable conditions and infectious and parasitic diseases is countercyclical. This suggests that the relationship between mortality and business cycles may vary by level of development.

Key words: mortality, business cycles, development

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1. Introduction

The relationship between mortality and the business cycle has been the subject of an extensive literature. Most studies of developed countries find that mortality is procyclical,[1] in that mortality rates tend to increase (decrease) during periods of economic expansion (contraction). Conversely, studies of less developed countries report a wide range of results, from countercyclical to procyclical to no relationship.[2]

However, these papers generally estimate national average effects and ignore heterogeneity within the countries they analyze. As such, important intra-country differences that may affect the relationship between mortality and the business cycle are not considered.

Further, none of the existing papers have explicitly investigated whether the relationship between mortality and macroeconomic conditions varies by the level of development. Previous studies have generally analyzed either a single country or a group of countries at a similar stage of development.[3] Thus, the only insight regarding the effects of development that can be gained is from comparing existing papers. However, differences in variables, sample periods, and econometric specifications make comparing results across these papers problematic.

This paper addresses two primary questions. First, does the relationship between mortality and the business cycle vary within a country, specifically Mexico? Second, does the relationship between mortality and the business cycle vary by level of development?

Our paper potentially contributes to the existing literature in a number of dimensions. First, rather than taking only a national perspective, we investigate how the relationship between mortality and the business cycle varies within a country. As the level of development within Mexico is relatively heterogenous, our more nuanced analysis is potentially informative. Second, our analysis may provide insight into how the relationship between mortality and the business cycle varies by level of development. Not only is there a larger range of development within Mexico than in other countries in which data are available, but our analysis controls for potential confounding factors that vary across existing country-level studies. Such factors include data collection procedures, the sample period and

[1]Recent papers have found a procyclical relationship in the U.S. (Ruhm 2000 and Tapia Granados 2005a), Germany (Neumayer 2004), Spain (Tapia Granados 2005b), Japan (Tapia Granados 2008), in a group of five European countries (McAvinchey 1988), and for 23 developed countries within the Organization for Economic Cooperation and Development (OECD) (Gerdtham and Ruhm 2006). In contrast, Economou, Nikolaou and Theodossiou (2008) find a countercyclical relationship in the European Union.

[2]For example, see Abdala, Geldstein and Mychaszula (2000), Khang, Lynch and Kaplan (2005), Rios-Neto and Carvalho (1997), Ortega-Osona and Reher(1997), Bravo (1997), Palloni and Hill (1997), Lee (1997) and Cutler et al (2002).

[3]One exception is Palloni, Perez Brignoli, and Arias (2000), who analyze 19th and early 20th century data for several Latin American cities and countries.

the econometric specification. Further, the Mexican mortality data has been judged to be high quality by the World Health Organization (Mathers et al 2005). Third, we are able to gain insight into the effects of development by investigating the mortality rates for specific causes of death. Finally, our panel analysis potentially improves upon the methodologies employed in most existing studies of developing countries.

Our results indicate important contrasts exist within Mexico. While overall mortality appears to be procyclical for the entire country, the relationship diverges between the more and less developed states. In the more developed states the procyclical relationship is stronger than the national average, while in the less developed states overall mortality is countercyclical.

Further differences emerge when the mortality rate is limited to specific categories of death. For communicable, nutritional and reproductive conditions, the mortality rate is countercyclical in less developed states and is not related to changes in GDP per capita in more developed states. For noncommunicable conditions, the mortality rate is procyclical in the more developed states and countercyclical in the less developed states.

These differences are further explained by examining more disaggregated mortality rates. Generally, the mortality rate is countercyclical in less developed states for causes of death more commonly associated with lower levels of development, such as infectious and parasitic diseases, respiratory infections, and malnutrition. Conversely, there is no relationship for these causes in the more developed states. For causes of death more common in developed countries, such as cardiovascular diseases, diabetes, and cirrhosis, the mortality rate is procyclical in the more developed states and countercyclical in the less developed states.

Taken together, our results indicate that the relationship between mortality and the business cycle varies significantly within Mexico. This suggests that further studies of this relationship need to explore the possibility that national estimates mask important differences within the country.

Additionally, our analysis suggests that the relationship between mortality and fluctuations in the economy may vary by level of development. Given the contrast between the more developed and less developed states in Mexico, our findings are consistent with existing studies that find mortality is procyclical in more developed countries, especially for causes of death associated with behavioral choices. Conversely, in less developed states with limited resources, mortality is countercyclical, especially for causes that are associated with sanitation, nutrition and health resources. While our results are obviously specific to Mexico, they may provide insight into inter-country differences in the relationship between mortality and the business cycle.

Our paper is structured as follows. The next section contains background information regarding the differences between the more developed and less developed states in Mexico. The third section describes the data and econometric specification employed in our analysis. The next section details our results, while the final section concludes.

2. Heterogeneity within Mexico

In this section we describe the wide degree of heterogeneity across Mexican states. Through the use of the widely cited Human Development Index (HDI), we subset roughly two-thirds of the Mexican states into two groups which represent significantly different stages of development. We then describe differences between these two groups that can impact the relationship between mortality and the business cycle.

2.1. Differences in development

The HDI is a measure of development produced by the United Nations Development Programme (UNDP) since 1990. The index is composed of three indicators with equal weights: life expectancy, education and adjusted GDP per capita. The HDI values range from zero (the lowest level of development) to one (the highest level of development). According to the 2000 HDI values published by UNDP (2002), Mexico is ranked 54th and is considered a medium-high HDI country. However, this level of development is not distributed equally across the country. This unequal distribution has been an important historic characteristic of Mexico (Esquivel 2000, Fox 1983, Bassols 1978). According to state-level HDI data (CONAPO 2001), the most developed Mexican state in 2000 was the Federal District with an HDI similar to Solvenia and Malta, countries ranked 29th and 30th globally. The state with the lowest level of development was Chiapas, whose HDI was similar to that of Syria and South Africa (ranked 107th and 108th worldwide, respectively). In 2000, 14 of the 32 Mexican states had a high HDI (above 0.800) while the remaining 18 had a medium HDI (between 0.500 and 0.800).

In this paper, we take advantage of the significant differences in development across Mexican states to analyze the relationship between the business cycle and mortality at different stages of development. We differentiate development within Mexico by using state-level HDI values for the year 2000 from CONAPO (2001) and group the top ten states into a high-HDI group and the bottom ten into a low-HDI group. We choose the year 2000 since HDI calculations for this year are based on census data which tend to be more reliable.[4] The choice of ten states per group is driven by two main

[4]The use of HDI for the other available years does not change the states included in either group.

considerations. First, given our sample period and the number of explanatory variables, including ten states in each group allows us to have sufficient degrees of freedom for the econometric analysis. Second, the differences in development between the top and bottom ten states are significant. The average 2000 HDI in the top ten HDI states is 0.827 and is similar to the HDI in countries such as Uruguay or Bahamas, ranked 40th and 41th, respectively. By contrast, the average of 0.740 in the bottom ten HDI states is similar to the HDI values for Paraguay or Sri Lanka, ranked 89th and 90th, respectively. As Mexico has 32 states, the top and bottom ten states roughly correspond to the top third and bottom third of the states.

We use the HDI to differentiate levels of development for several reasons. First, it is frequently used in the literature as an indicator of development (for example, see Hajro and Joyce 2009, Abadie 2006 and Fischer 2003). Second, the state-level HDI computations from CONAPO (2001) use the same methodology as the UNDP, which allows for comparisons between Mexican states and other countries. Third, the other primary indicator of development available at the state level in Mexico is GDP per capita, which is highly correlated with HDI. In our data set, the use of GDP per capita rather than HDI changes only one state in the bottom ten HDI group and does not affect the top ten HDI group. Fourth, the top ten and bottom ten HDI states closely corresponds to the traditional patterns of regional development in Mexico (Esquivel 2000, Fox 1983, Bassols 1978).

[FIGURE 1 HERE]

Figure 1 shows the geographic location of the top ten and bottom ten HDI states. The top ten HDI states are primarily concentrated in the northern part of the country, with the exceptions of the Federal District and Aguascalientes in the center and Campeche and Quintana Roo in the southeast. All of the states in this group other than Quintana Roo have historically experienced the highest degrees of development in Mexico.[5] The bottom ten HDI states are concentrated in the south and center of the country and have been traditionally poor (Esquivel 2000, Fox 1983, Bassols 1978). The continuous area that includes Chiapas, Oaxaca, Guerrero and Veracruz corresponds to the least developed region of Mexico.

In addition to differences in HDI, these two groups also exhibit vastly different poverty levels. In 2000, the average percentage of population living in alimentary poverty was 13% in the top ten HDI

[5] Data from INEGI (2009) show that the inclusion of Quintana Roo in this group is due to economic activity associated with international and national tourism.

states and 38% in the bottom ten HDI states (CONEVAL 2000).[6]

Similarly, the difference in GDP per capita between the top ten and bottom ten HDI states is remarkable. During our sample period the average GDP per capita in the top ten states is roughly three times greater than in the bottom ten states. The dissimilarity in GDP per capita within Mexico is substantial even in comparison to other countries. For example, Messmacher (2000) shows that during the 1990's an interval of 188% around the mean GDP per capita includes 90% of the Mexican population. By contrast, the corresponding interval for the U.S. is 140%.

2.2. Differences in mortality

Mexico is experiencing an epidemiological transition characterized by an increase in the prevalence of chronic diseases, such as diabetes, cardiovascular diseases, high blood pressure and cancer, and a decrease in infectious diseases. This transition is reflected in changes in the top causes of death over time. In 1979, the top three mortality causes were intestinal infectious diseases (10.0%), infectious respiratory disease (9.9%) and cancer (3.9%) (Rivera-Dommarco et al 2001). In contrast, the top three causes in 2004 were heart disease (16.4%), diabetes (13.6%) and cancer (12.9%).

However, this process is not homogenous across the country. The states comprising the bottom HDI group are the least advanced in the epidemiological transition with larger shares of deaths related to undernutrition and infectious, maternal and perinatal diseases (Steven et al 2008). This difference in the stages of epidemiological transition between the two HDI groups is important as it may impact the relationship between overall and specific causes of mortality and the business cycle.

[FIGURE 2 HERE]

Figure 2 shows some evidence of the epidemiological transition at the national level and for our two HDI groups. While the chart uses crude mortality rates, we can roughly compare the rates across the two groups given that the population structures in the groups are similar.[7]

Panel A in Figure 2 displays the average overall mortality rates for all states and the average for the top ten and bottom ten HDI states during our sample period. The overall mortality rate in the bottom ten states is higher than the national average and the average in the top ten HDI states. As indicated in the other panels of Figure 2, the higher overall rate in the bottom ten states is driven by

[6] Alimentary poverty refers to the inability to buy a basket of basic food.

[7] For example, the median ages are 24 years and 22 years in the top ten and bottom ten HDI states, respectively. Similarly, in 2004 the percentage of population under five years is roughly 10% in both groups. In that same year, the percentage of population over 65 years old is 5.4% in the bottom ten states and 4.6% in the in the top ten states.

higher mortality rates for communicable, nutritional and reproductive conditions and injuries. Panels B and D show that despite a generalized decrease in the mortality rates of communicable diseases and injuries, the bottom ten HDI states still have rates higher than the national and the top ten HDI states. Panel C shows the increase in the noncommunicable diseases mortality rate nationally and for both HDI groups.

2.3. Differences in health care

The health care sector in Mexico is segmented according to income and work status. The quality of care varies widely across institutions, states, and even hospitals within the same institution (see SSA 2004b). Around 45% of the population has health care coverage from the social security system. Moreover, the Secretariat of Health (SSA) directly and through state governments provides limited health care for about 43% of the total population. The remaining 12% are not covered by any institution.

As in the case of HDI and mortality rates, national averages regarding health care coverage mask important differences between states. The average percentage of population covered by social security is 66% in the top ten HDI states and only 25% in the bottom ten HDI states (SSA 2004). Since the government has a greater role where social security coverage is low, the SSA covers a higher percentage of population in the bottom ten HDI states (approximately 44%) than in the top ten HDI states (approximately 24%). The percentage of the population without social security or SSA coverage in the bottom ten HDI states is roughly 31%, which is nearly three times the proportion in the top ten HDI states. In addition to these differences in coverage, the quality of services is higher in the top ten HDI states (see SSA 2004b). For example, in 2004 the number of doctors per 10,000 people and the number of qualified medical personnel available during birth were 50% and 25% higher, respectively, in the top ten HDI states than in the bottom ten HDI states (SSA 2005b). These differences are potentially important for our analysis because the relationship between mortality and the business cycles may be affected by the quality and quantity of health care present in each group. For example, some preventable causes of death may not be significantly affected during recessions when high quality health care is widely available.

2.4. Differences in international trade

The opening of the Mexican economy due to the implementation of the North American Free Trade Agreement (NAFTA) in 1994 is an important aspect of the 1993-2004 sample period. NAFTA significantly reduced tariffs between Mexico, the U.S. and Canada, increased foreign direct investment and trade and promoted regional economic integration (see Lustig 2001, Esquivel et al 2002 and Gasca 2002). Existing studies have found that the Mexican states were impacted unequally, with nearly all of the states in our top ten HDI group benefiting from NAFTA and few regions in the bottom ten states experiencing a sizeable benefit (Messmacher 2000, Esquivel et al 2002; Scott 2004; Baylis et al 2009; Sanchez-Reaza and Rodriguez-Pose 2002, Gasca 2002). The positive impact of NAFTA depended mainly on a set of preexisting conditions that are more common in the top ten HDI states: good infrastructure, proximity to the U.S., skilled and low-cost labor, possible economies of agglomeration and a strong integration to international markets (Gasca 2002, Scott 2004).

3. Data and Empirical Model

[TABLE 1 HERE]

Table 1 contains the summary statistics for the variables used in our analysis. The dependent variable in our analysis is the mortality rate (*mort*), which is calculated as the number of deaths in that state and year per 100,000 population. The mortality rates are constructed using mortality and population data from SSA (2007) and SSA (1993-2004a), respectively. The mortality rates for specific causes of death were computed at the three levels of disaggregation used by the WHO (2004). At the broadest level we obtain mortality rates for three categories: 1) communicable, nutritional and reproductive conditions[8]; 2) noncommunicable conditions; 3) injuries. The second level of disaggregation, which also follows the WHO (2004), is composed of several subcategories within the broader categories.[9] Finally, at the third level of disaggregation we selected specific causes of death where we find particularly interesting results. The mortality rates in Table 1 highlight the contrast in mortality between the top ten and bottom ten HDI states. Namely, the bottom ten HDI states trail the top ten states in the epidemiological transition and thus exhibit a higher incidence of communicable, nutritional and reproductive causes of death.

[FIGURE 3 HERE]

[FIGURE 4 HERE]

[8] Reproductive conditions include prenatal and congenital.

[9] As there a relatively large number of subcategories in WHO (2004), we analyze only those with the highest frequency.

The explanatory variable of interest is state GDP per capita (*gdpcap*) which is used to measure economic fluctuations of the state economy. It is computed using state-level GDP from INEGI (2008b) and the aforementioned population data from SSA (1993-2004a), and is measured in thousands of pesos at 1993 prices. The most significant shock to the Mexican economy during the sample period was the 1995 peso crisis. In that year GDP per capita decreased 6.4% nationally, 6.5% in the top ten HDI states and 4.5% in the bottom ten states. Nevertheless, the economy quickly recuperated after the crisis with an average yearly growth rate the next two years of 3.7% nationally and 4.7% and 3.3% in the top ten and bottom ten HDI states, respectively. Figures 3 and 4 show the annual percent change in GDP per capita for the top ten and bottom ten states, respectively. The graphs indicate for both groups that not only is there significant variation in GDP per capita growth in any given year, but that the ordering of the states also changes substantially throughout the sample period.

Previous studies for developed countries have used the unemployment rate as an alternative measure of the business cycle. However, there are a number of reasons why GDP per capita is a better measure of economic activity in Mexico. Negrete (2001) provides some background as to why the unemployment rate in Mexico, which averaged only 3% during the sample period, is a poor proxy for Mexican business cycles. First, in some areas (both rural and urban) of Mexico a significant portion of the population is always self-employed. During economic recessions, these individuals may experience lower earnings, but will not be considered unemployed. Second, Mexico has relatively flexible labor markets in which most of the adjustments to economic shocks come from changes in prices (wages) rather than quantities (employment).[10] Third, Mexico does not provide unemployment benefits, which makes it more likely that recently unemployed workers will turn to temporary work or self-employment and not be classified as unemployed. Fourth, some unemployed workers migrate to the U.S. during Mexican recessions, thus reducing the effect on the unemployment rate. Finally, in terms of the available data, state-level unemployment data are limited to the unemployment rate for the largest city in each state and thus do not reflect economic activity in other areas within the state.

We employ additional explanatory variables to control for other factors that may affect mortality. We use the percent of the population aged 0 to 4 (*%popunder5*) and the percent of the population aged 65 and older (*%popover65*) to control for the age of the population. In both HDI groups the percentage of population under five years is about 2.5 times greater than the percentage of population

[10]Negrete (2001) points out that the relatively low unemployment rates observed in Mexico reflect flexible labor markets. For example, the average unemployment rate during our sample period was 3.0% in Mexico while it was 7.0% for all of the OECD countries (INEGI 2008a and OECD 2008).

over 65. As mentioned in the previous section, the two HDI groups have similar population structures. We employ the illiteracy rate for those 15 years and older (*illiteracy*), obtained from SEP (2007), to control for the tendency of education to reduce mortality. This variable also captures the significant difference in education between the top ten and bottom ten HDI states, as illiteracy rates are three times higher in the bottom ten HDI states. Since women tend to care for vulnerable members of the household, we follow Cutler et al. (2002) and include the women's labor force participation rate (*wmparate*) obtained from INEGI (2008a). However, this last variable is unavailable for some of the observations in our data set.[11]

Mexico experiences important degrees of international migration outflows, which may increase mortality rates since international emigrants tend to be in relatively better health than the overall population (CONAPO 2005). Thus, we include net international migration flows *(intmig)* from CONAPO (2006) as a explanatory variable. Given that most of the Mexican international migration flows are with the U.S., CONAPO's (2006) international migration data are based on both Mexican and U.S. data sources.[12] Negative values in net international migration flows imply a net outflow of people from the state to abroad, mainly to the U.S. Table 1 indicates that the net international outflow of migrants in the bottom ten HDI states is on average more than 2.5 times greater than in the top ten HDI states. We do not explicitly consider interstate migration because the quality of these data is questionable.[13]

We also include indicators of the availability of health care resources. In particular, we consider resources in the public health care system as the majority of Mexicans receive their care from these institutions.[14] We include two measures of public health care: the per capita levels of public health spending and the number of doctors. We include both of these variables to capture different aspects of the public health care system. Public health spending is useful because it represents the total amount of public resources that are devoted to health care. However, it also includes expenditures that may not necessarily affect mortality in the short-term, such as administration, research and development, and physical and human capital investment. Thus, we also employ the number of doctors per capita

[11]Specifically, we are missing women's labor force participation data for three states in the top ten HDI group (Baja California Sur 1992-1995, Coahuila 2003-2004 and Quintana Roo 1992-1995) and for two states in the bottom ten HDI group (Hidalgo 1992-1996 and Tlaxcala 1992-1993.)

[12]In particular, CONAPO's (2006) net international migration flows are constructed using data from the Mexican census and population counting and the U.S. Census, Current Population Survey and American Community Survey.

[13]Interstate migration is not observable and estimates cannot be corroborated with actual data. Moreover, estimates produced by the Mexican government assumes a convergence of net interstate migration rates across states (CONAPO 2007b).

[14]In 2004, 71% of the people that receive health care in the top HDI states were treated by the public sector. This figure is 74% in the bottom HDI states (SSA 2005a).

because, while this variable only reflects one aspect of health care, it reflects resources that may directly affect immediate mortality. The number of doctors per 1000 residents *(doctors)* is constructed using the number of doctors in direct contact with patients from SSA (1993-2004b) and the population data from SSA (1993-2004a).[15] The state-level public health spending per 100 residents *(healthspend)* is computed using public health spending reported by SSA (2008) and is deflated at 1993 prices. Public health spending at the state level includes the spending of the social security system, as well as federal and state government spending in health care at the state level.[16] Doctors per capita and health spending per capita are 67% and 150% higher, respectively, in the top ten HDI states relative to the bottom ten HDI states.

The quality of the data is an important issue, especially in studies of developing countries. The mortality data come from the administrative records of death certificates. The Mexican mortality data are considered "high quality" by the WHO (see Mathers et al. 2005). By this measure the Mexican mortality data are of better quality than most of Western Europe (with exception of the U.K. and Ireland), Latin America (except Cuba and Venezuela), Asia (except Japan) and Africa. Since our analysis considers separate regressions for the top ten HDI states and bottom ten HDI states, we also perform an additional check on the quality of the mortality data for these states. In particular, the regression estimates could be biased if the mortality data quality varies with the business cycle. For example, during recessions a decrease in administrative resources could artificially decrease the number of registered deaths. Hence, we compare the number of expected deaths according to the population characteristics of each state, obtained from the life tables of CONAPO (2008), with the actual number of registered deaths. We find that the under or over registration of deaths does not vary with the economic cycle.

The population data are important as they are used to construct mortality rates, the per capita variables and the percentages of the population under 5 and over 65 years old. The population data are based on the Mexican census, population surveys, state- and national-level rates of migration, mortality and fertility (see CONAPO 2007).[17]

The coefficients are estimated via ordinary least squares. The natural log of the mortality rate is used as the dependent variable and the observations are weighted by the square root of the state

[15]We also use SSA (1993-2004a,b) to compute the number of nurses per capita and number of hospital beds per capita since they may also reflect the supply of health care in a given state. However, these measures were found to be highly collinear with the number of doctors per capita and are thus not included in the regressions.

[16]This variable does not include federal spending that cannot be attributable to any particular state, such as administrative expenses of the SSA and other federal health institutions.

[17]International migration data are constructed using Mexican and international sources.

population. The main estimating equation is:

$$\begin{aligned} ln(mort_{i,t}) =& \beta_0 + \beta_1 gdpcap_{i,t} + \beta_2 \%popunder5_{i,t} + \beta_3 \%popover65_{i,t} \\ &+ \beta_4 illiteracy_{i,t} + \beta_5 healthspend_{i,t} + \beta_6 doctors_{i,t} \\ &+ \beta_7 intmig_{i,t} + \beta_8 wmparate_{i,t} + \gamma_t + \eta_i + \epsilon_{i,t} \end{aligned} \tag{1}$$

where i indexes the state and t indexes the year. The γ_t terms are the year fixed effects, the η_i are the state year effects, and $\epsilon_{i,t}$ is the error term. The error terms are clustered at the state level to account for the possibility of correlated disturbances within each state.

An important econometric issue is how to best measure the relationship between the mortality rate and GDP per capita in light of the relatively large differences in development between the top ten and bottom ten HDI states. We choose to estimate regression 1 both for the entire sample as well as separately for each of the two HDI groups. Thus, in the results that follow, we report separate coefficient estimates for the full sample as well as for the top ten and bottom ten HDI states.

4. Results

This section describes the regression results from the model specified in Equation 1. The first subsection focuses on overall mortality and categories of death, the next subsection on subcategories of death, and the third subsection on specific causes of death. The fourth subsection considers lagged effects of GDP per capita on mortality, while the final subsection describes robustness checks to the main model.

4.1. Overall & by category

[TABLE 2 HERE]

Table 2 details the regression results in which the dependent variables are the overall morality rate and the mortality rates for categories of death. The table reports the coefficients on GDP per capita and the associated standard errors from the various specifications. The rows of the table correspond to the type of mortality rate used in the regression. The three sets of columns indicate whether the full sample is used or whether the sample is subset for those states that were either in the top ten or bottom ten HDI states.

The results in Table 2 indicate that overall mortality is procyclical nationally[18], as has been found in previous studies of developed countries. However, there is a large degree of heterogeneity across states. Specifically, while mortality is procyclical in the top ten HDI states it is countercyclical in the bottom ten HDI states. Further, while in the top ten HDI states the procyclical association appears to be driven mainly through noncommunicable conditions, in the bottom ten HDI states the countercyclical association is present for both communicable, nutritional and reproductive and noncommunicable conditions.

The coefficients in the table represent the effect of a one thousand peso increase in GDP per capita on the mortality rate. For the full sample, a one thousand peso increase in GDP per capita is associated with a 0.9% increase in the overall mortality rate. This coefficient is statistically significant at the 11% significance level and its positive sign indicates that across all states overall mortality is procyclical. The corresponding elasticity is 0.12,[19] which indicates that a one percent increase in GDP per capita is associated with a 0.12% increase in the mortality rate. The estimates indicate that the effect on the male mortality rate is nearly twice as large as for the female mortality rate.

The heterogeneity across states becomes evident when the sample is subset into the top ten and bottom ten HDI states. The estimates for the top ten HDI states indicate that overall mortality is procyclical, while the negative and statistically significant estimate in the bottom ten HDI states suggests that mortality is countercyclical. The estimates from these two sample subsets correspond to elasticities of roughly the same magnitude (0.25). While in the top ten states there is little difference between the estimates by gender, in the bottom ten states the coefficient estimate from the female mortality rate regression is 50% larger than the estimate in the male mortality rate regression.

For the communicable, nutritional and reproductive category, there does not appear to be a relationship for all states or for the top ten HDI states. However, in the bottom ten HDI states we find that mortality is countercyclical. The corresponding elasticity estimate for the regressions on this subset that include both males and females is roughly -0.56.

The results change when we analyze the mortality rate for noncommunicable conditions. While there does not appear to be a relationship for all states, for the top ten states the mortality rate is

[18]This result initially appears to contradict the finding by Cutler et al (2002) of a countercyclical relationship. However, the difference-in-difference approach employed by Cutler et al (2002) assumes that the mortality rate for males aged 30 - 44 is relatively unaffected by the economic crises that they study. As described in Gonzalez and Quast (2009), the countercyclical association that they find for the very young and very old may instead be due to a procyclical association for their control group.

[19]The elasticity is calculated by multiplying the coefficient estimate by the sample mean of GDP per capita, which for the full sample is 13.6.

procyclical. Conversely, for the bottom ten states the relationship is countercyclical. The magnitudes of the elasticities for the top ten states are roughly 33% larger than those in the bottom ten states (0.32 and -0.23, respectively).

Finally, while the injury mortality rate estimates for all states are relatively large and positive, they are not statistically significant. Further, none of the estimates for the top ten or bottom ten HDI states are statistically significant.

While our results are specific to Mexico during our sample period, the results are consistent with a scenario in which the relationship between mortality and the business cycle differs by the level of development. For instance, the lack of a relationship for the communicable, nutritional and reproductive category in the top ten HDI states may be due to the presence of better living conditions, nutrition and health care resources that reduce the risk of this type of mortality as described in Section 2. Thus, economic fluctuations in these states may have little impact on this type of mortality. Conversely, the countercyclical relationship in the bottom ten HDI states for this category may reflect that increases in income allow residents to afford improved health care, nutrition and living conditions. These investments may reduce the risk of death in these states from causes in this category.

The contrast in the relationship between GDP per capita and the mortality rate for noncommunicable conditions between the top ten and bottom ten HDI states is also potentially intuitive. In the more developed top ten HDI states, increases in income may lead to behavioral choices, such as increases in eating, increased alcohol consumption, and reduced exercise, that are associated with noncommunicable mortality. By contrast, the countercyclical relationship in the bottom ten HDI states may reflect that the aforementioned potential negative health consequences from increases in income are outweighed by the improved affordability of better nutrition, sanitation and health care.

While these results based on broad categories of mortality provide important insight into the relationship between business cycles and mortality, they are of limited use in determining the channels driving individual behavior. Therefore, the next two subsections examine more disaggregated data to gain additional insight as to what these channels may be.

4.2. By subcategory

[TABLE 3 HERE]

Table 3 extends the above analysis by examining the relationship between GDP per capita and selected mortality subcategories. The results in this table suggest that the countercyclical association for communicable, nutritional and reproductive category in the bottom ten HDI states is largely driven by infectious and parasitic diseases and respiratory infections. Further, the procyclical association in the top ten HDI states for noncommunicable conditions appears to be due in large part to cardiovascular disease, diabetes and digestive diseases. For the bottom ten HDI states, the countercyclical association for noncommunicable conditions appears to stem mainly from cardiovascular diseases and other noncommunicable conditions. Finally, there is a strong procyclical association for unintentional injuries, especially among the bottom ten HDI states.

Table 3 is consistent with the category-level results in Table 2, in that all but one of the communicable, nutritional and reproductive estimates for all states and the top ten HDI states are statistically insignificant. However, in the bottom ten HDI states there is a relatively strong countercyclical association for the mortality rate for infectious and parasitic diseases. The elasticity for the female respiratory infection mortality rate regressions for the bottom ten HDI states is -1.08.

Conversely, there is a procyclical association in the top ten HDI states for noncommunicable conditions. The three coefficient estimates for cardiovascular disease are roughly twice as large as the estimates based on all states. In contrast, the mortality rate is countercyclical in the bottom ten HDI states. For type 2 diabetes, there is virtually no association between GDP per capita and the mortality rate for all states and for the bottom ten HDI states. For the top ten HDI states, the mortality rate is procyclical.

In regards to injuries, the estimates for the unintentional subcategory are relatively small and statistically insignificant. However, the results for intentional injuries are quite different. For all states and the bottom ten HDI states, the procyclical relationship is relatively large and highly statistically significant with elasticities greater than 1.0.

The findings in Table **??** provide further insight into the channels by which changes in GDP per capita may affect mortality and how these channels vary across Mexico. The countercyclical relationship in the bottom ten HDI states for the infectious and parasitic diseases and respiratory infections mortality rates may reflect that individuals in these states have a relatively poor initial health status and have limited resources and are able to obtain better health care during expansions. Further, the lack of a statistically significant relationship for the top ten HDI states may indicate that individuals from these states face a lower income constraint to purchase health care.

The positive associations in the top ten HDI states for type 2 diabetes and cardiovascular disease may indicate that individuals in these states tend to engage in riskier behavior during economic expansions. For instance, they may consume too many calories, exercise less or work more hours when incomes rise. Alternatively, in the bottom ten HDI states, rising incomes may allow individuals to afford health care that reduces mortality from cardiovascular disease.

The next section investigates selected specific causes of death to continue our assessment of the possible channels through which business cycles may affect mortality.

4.3. By specific cause of death

[TABLE 4 HERE]

The top section of Table 4 shows the results for several causes of death in the infectious and parasitic diseases category. For tuberculosis, there is a countercyclical relationship, especially among women, in the bottom ten HDI states. The results also suggest a strong, negative association between GDP per capita and the HIV/AIDS mortality rate for the bottom ten HDI states. Like tuberculosis, treatment of HIV/AIDS is costly and it is probable that individuals in the bottom ten HDI states are more able to afford the treatments during economic expansions. Our results are consistent with Sanders and Sambo (1991), who note that economic recessions promote the spread of HIV/AIDS in Africa directly by increasing the at-risk population and indirectly through decreases in health care provision.

The mortality rates for protein-energy malnutrition and ischaemic heart disease are countercyclical in the bottom ten HDI states. For protein-energy malnutrition, this result may be due to individuals having an improved ability to afford nutritious food during expansions. Similarly, during expansions individuals in the bottom ten HDI states may be able to afford better health care and treat the conditions that contribute to ischaemic heart disease.

A different pattern is present for cirrhosis of the liver. The procyclical relationship in the top ten HDI states is consistent with previous studies of developed countries.[20] As noted in these papers, this finding may be due to increased alcohol consumption during economic expansions. This relationship may not be present in the bottom ten HDI states as individuals in these states have less disposable income to spend on nonessential items such as alcohol.

While in all states there is a statistically significant positive association between GDP per capita and the mortality rate for road traffic accidents, the relationship is much stronger in the bottom ten

[20]Ruhm (2000) and Gerdtahm and Ruhm (2006) find that the mortality rate for liver disease is procyclical in the U.S. and O.E.C.D., respectively.

HDI states. This result may be due to poor transportation infrastructure and a larger number of relatively inexperienced drivers in these states.

The suicide mortality rate is procyclical across all samples. The corresponding elasticities for the male mortality rate are roughly similar in the top ten and bottom ten HDI states (1.3 versus 1.4). There is virtually no association with the female mortality rate in the top ten HDI states, while in the bottom ten HDI states the elasticity is 2.2. [21]

Finally, the homicide mortality rate is procyclical. There is not a statistically significant association in the top ten HDI states, which is roughly consistent with previous studies of the U.S.[22] However, in the bottom ten HDI states there is a procyclical association, especially among males.

4.4. Lagged effects

A potentially important consideration is that changes in GDP per capita may affect mortality rates with a lag. For instance, if individual increase their caloric intake in response to an increase in income, some of the potential negative effects of this behavior may not affect the mortality rate for a number of years. To account for this possibility, regressions were estimated in which two lagged values of GDP per capita were included as explanatory variables.[23] Generally, these results are consistent with the contemporaneous model in overall mortality is procyclical in the top ten HDI states and countercyclical in the bottom HDI states. Further, our findings regarding mortality categories are also largely unaffected by the inclusion of lagged effects.

The inclusion of the lagged values of GDP per capita does not significantly affect the effects for any of the three categories in the top ten HDI states. However, in the bottom ten states the countercyclical effect for the communicable, nutritional and reproductive category is larger than in the contemporaneous model, while the effect on noncommunicable diseases is smaller. A possible explanation for this dichotomy is that for communicable diseases increases in income can be spent on health care and improved nutrition which provide positive benefits on health over time. Conversely, increases in income may lead to changes in behavior that have detrimental effects on long-term health, specifically through noncommunicable conditions.

[21] Results from previous studies have shown that the relationship between the suicide mortality and business cycles varies across countries. For example, see Ruhm 2000, Tapia Granados 2005b, Hintikka, Saarinen and Viinamakis 1999, and Neumeyer 2004.

[22] For example, see Levitt (2004) does not find a relationship between recessions and violent crime.

[23] Two years was chosen, somewhat arbitrarily, based on the competing concerns of allowing for as long of a delayed effect as possible and preserving degrees of freedom for inference. Given the relatively short length of our panel, the inclusion of two lags was judged to be the preferred option. However, by including these lags, two of the twelve years of the original sample period are lost. Further, the two years that are dropped (1993 and 1994) roughly coincide with the initial implementation of NAFTA and an economic crisis.

Caution is warranted in comparing the results from the lagged model to the results from the instantaneous model. The exclusion of two of the twelve years in the sample period limits the ability of assigning differences solely to lagged effects. Also, it is possible that the effects of GDP per capita persist beyond the two years that are included in the model.

4.5. Robustness checks

This section describes the results of several tests as to the validity of our results. The tests were performed for the mortality rates for all causes and each category and the mortality rate for both genders was used as the dependent variable.

We performed a falsification test, in which we tested whether changes in GDP per capita are associated with past changes in the mortality rate. Changes in current GDP per capita should not be associated with past changes in the mortality rate. However, if a statistically significant relationship exists, it may indicate the presence of serial correlation (Bertrand, Duflo, and Mullainathan 2004). However, in our twelve test regressions, the relationship was never significant at the 5% significance level and was significant once at the 10% significance level.

Even though the Mexican unemployment rate data is not well suited to measure business cycles, it could explain a significant portion of the variation in mortality. Therefore we include the unemployment rate as an explanatory variable in some of our regressions. In the twelve test regressions the coefficients on GDP per capita were virtually unchanged and the unemployment rate was not economically or statistically significant.

As noted above, one of the primary reasons that we subset the states is that it is likely the coefficients on the control variables vary significantly across these groups. An alternative to this approach is to use the full sample and include polynomial terms of GDP per capita, thus allowing for the relationship between mortality and the business cycle to vary by GDP per capita. When we implement this approach, the results are generally similar to those described above, in that the mortality rate becomes less procyclical as GDP per capita increases.

Finally, we test the robustness of the econometric model by estimating the regressions using the level (rather than log) of the mortality rate. The results are consistent with our original model.

5. Conclusion

In this paper we explore the relationship between mortality and the business cycle by level of development using data for Mexico. While we confirm the findings of Gonzalez and Quast (2009) that nationally mortality is procyclical, we also find that the relationship varies significantly within the country. In the more developed states, the relationship is also procyclical and slightly stronger than the national average. In contrast, in the less developed states mortality is countercyclical.

While our results are specific to Mexico, they may be generalizable to countries that are at levels of development similar to those observed in Mexican states. Given the wide range of development across Mexican states, our results may apply to a considerable range of countries. Specifically, our finding of a procyclical relationship in the more developed Mexican states is consistent with earlier studies that find a procyclical relationship in developed countries. While there has been a lack of consensus in studies of developing countries, the countercyclical relationship that we find in the less developed states may indicate that mortality is countercyclical in countries at medium levels of development.[24]

We also find important differences in the relationship between specific types of mortality and the business cycle for states at different stages of development. In the less developed states the mortality rates for infectious diseases, nutritional deficiencies and noncommunicable conditions are countercyclical. By contrast, in the more developed states there is no relationship for the mortality rates for infectious diseases and nutritional deficiencies, while the mortality rate for noncommunicable conditions is procyclical. If our results are generalizable, these patterns may be present in countries at similar levels of development.

However, our analysis has several limitations. First, our estimates are based on aggregate, state-level data. If available, individual-level data would potentially provide more precise information regarding the channels through which income affects mortality. Second, our analysis is based on a single country. Thus, we are somewhat limited in our ability to generalize our findings regarding the effects of development to other countries. Finally, our analysis would be strengthened if we could extend our sample period to capture additional periods of economic fluctuations.

[24]The term medium is taken from the UNDP classification based on HDI.

Table 1: Summary statistics

Variable	All states (n=374) Mean	All states (n=374) SD	Top ten states (n=114) Mean	Top ten states (n=114) SD	Bottom ten states (n=116) Mean	Bottom ten states (n=116) SD
Death rate per 100,000 population						
Overall	443.7	54.8	437.8	71.0	454.7	54.0
By gender						
Female	382.9	57.0	373.5	72.9	397.3	53.2
Male	504.8	58.2	501.2	77.5	513.3	56.8
By category						
Communicable, nutritional and reproductive	57.1	19.5	48.0	9.4	70.8	24.4
Noncommunicable conditions	314.8	49.7	322.6	65.3	304.6	47.7
Injuries	59.1	12.6	57.6	14.2	62.1	11.1
By subcategory						
Communicable, nutritional and reproductive						
Infectious & parasitic diseases	22.0	7.9	20.3	4.5	25.4	11.7
Perinatal conditions	16.3	6.0	16.2	3.9	18.4	6.7
Respiratory infections	16.2	7.4	14.0	5.4	20.0	8.9
Nutritional deficiencies	13.6	6.3	8.9	2.6	19.0	6.9
Maternal conditions	1.0	0.4	0.8	0.3	1.3	0.4
Noncommunicable conditions						
Cardiovascular diseases	102.0	21.4	108.3	27.2	93.4	17.7
Malignant neoplasms	43.6	8.3	46.6	9.0	38.9	6.2
Diabetes mellitus	42.0	12.4	44.4	14.7	39.6	13.0
Digestive diseases	38.5	11.0	34.5	8.5	43.2	11.7
Respiratory diseases	23.7	5.2	23.3	5.9	23.1	5.6
Neuropsychiatric disorders	11.7	3.1	10.2	2.2	13.9	3.4
Other neoplasms	11.2	2.2	12.3	2.5	10.2	1.9
Nutritional/endocrine disorders	5.7	1.6	6.1	1.8	5.4	1.7
Other	36.3	5.6	36.7	6.2	36.6	6.2
Injuries						
Unintentional	41.1	7.1	41.1	8.6	41.7	5.1
Intentional	28.6	14.5	15.1	6.3	16.2	10.2
By selected specific causes of death						
Tuberculosis	4.4	2.2	4.3	2.1	4.5	2.8
HIV/AIDS	3.9	2.1	4.8	2.7	3.1	1.6
Protein-energy malnutrition	9.7	4.4	6.6	2.0	13.3	5.0
Ischaemic heart disease	44.2	14.7	53.7	16.5	32.8	8.3
Cirrhosis of the liver	21.8	9.6	18.0	5.4	25.7	11.4
Road traffic accidents	15.3	4.5	15.2	4.8	13.8	4.8
Suicides	4.0	1.9	5.1	1.8	2.6	0.8
Violence	12.1	8.1	10.0	5.7	13.6	10.3
Explanatory variables						
GDP per capita[1]	13.6	6.4	21.3	5.7	7.9	1.4
% of population under 5 years old	11.2	1.2	10.8	1.2	11.8	1.2
% of population aged 65 and over	4.5	0.8	4.2	0.9	4.7	0.7
Women's labor participation rate	39.4	3.9	38.2	3.0	39.6	4.6
Number of doctors per 1000 residents	1.2	0.4	1.5	0.5	0.9	0.1
Govt healthcare spending per 100 residents[1]	0.7	0.5	0.5	0.2	0.2	0.1
Illiteracy rate	9.6	5.6	5.1	2.7	15.5	5.4
Intl net migration inflow rate	-0.6	0.5	-0.3	0.5	-0.8	0.5

[1] Thousand pesos per capita at 1993 prices.

Table 2: Coefficient on GDP per capita for overall mortality & mortality categories

	All states			Top ten states			Bottom ten states		
Category	All	Male	Female	All	Male	Female	All	Male	Female
All causes	.009	.010*	.006	.013**	.012*	.013**	-.030*	-.023	-.036*
	(.005)	(.006)	(.005)	(.005)	(.005)	(.005)	(.015)	(.015)	(.017)
Communicable, nutritional and reproductive	-.001	-.005	.004	.004	.004	.003	-.071**	-.081**	-.061*
	(.012)	(.015)	(.011)	(.016)	(.022)	(.014)	(.030)	(.035)	(.029)
Noncommun. conditions	.004	.004	.006	.015***	.013**	.017***	-.029*	-.026*	-.029*
	(.004)	(.004)	(.004)	(.004)	(.005)	(.004)	(.013)	(.014)	(.014)
Injuries	.017	.017	.011	.002	-.002	.003	.015	.015	.015
	(.011)	(.011)	(.012)	(.012)	(.014)	(.013)	(.015)	(.018)	(.061)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The dependent variable for both columns is the logarithm of the mortality rate per 100,000 population. The additional explanatory variables are listed in the ”Explanatory variables” in Table 1. The sample sizes are 374 for the all states estimates, 114 for the top ten HDI states and 116 for the bottom ten HDI states. State and year fixed effects are included and the observations are weighted by the square root of the state population. The errors are clustered by state.

Table 3: Coefficient on GDP per capita for mortality subcategories

	All states			Top ten states			Bottom ten states		
Subcategory	All	Male	Female	All	Male	Female	All	Male	Female
<u>Communicable, nutritional and reproductive</u>									
Infectious & parasitic diseases	.002	-.001	.010	.021	.021	.021	-.093**	-.092**	-.087*
	(.017)	(.019)	(.017)	(.021)	(.022)	(.024)	(.033)	(.031)	(.039)
Perinatal conditions	.001	-.005	.004	.003	-.003	.005	-.047	-.036	-.056
	(.016)	(.016)	(.016)	(.015)	(.022)	(.013)	(.054)	(.057)	(.053)
Respiratory infections	-.024	-.022	-.024	-.022	-.023	-.025	-.122*	-.109	-.137*
	(.020)	(.024)	(.020)	(.032)	(.042)	(.024)	(.060)	(.066)	(.063)
Nutritional deficiencies	.020	.012	.027*	.005	-.006	.015	-.008	-.036	.019
	(.012)	(.013)	(.014)	(.019)	(.018)	(.027)	(.031)	(.049)	(.026)
Maternal conditions	na	na	-.013	na	na	-.027	na	na	-.030
	na	na	(.027)	na	na	(.044)	na	na	(.057)
<u>Noncommunicable conditions</u>									
Cardiovas. diseases	.005	.0002	.010	.011	.006	.019***	-.036**	-.043**	-.027
	(.006)	(.006)	(.007)	(.007)	(.009)	(.005)	(.015)	(.015)	(.015)
Malignant neoplasms	-.008	-.008	-.008	-.010	-.006	-.016**	-.030	-.037	-.025
	(.005)	(.006)	(.006)	(.006)	(.008)	(.006)	(.020)	(.021)	(.021)
Diabetes mellitus	.005	.005	.006	.031**	.025	.035***	.006	.022	-.004
	(.009)	(.010)	(.009)	(.010)	(.015)	(.010)	(.023)	(.020)	(.025)
Digestive diseases	.026**	.029**	.019**	.036**	.036**	.030*	-.025	-.017	-.033
	(.011)	(.013)	(.009)	(.013)	(.015)	(.016)	(.015)	(.011)	(.020)
Respiratory diseases	-.010	-.010	-.010	.011	.020	-.0004	-.063	-.073	-.051
	(.013)	(.011)	(.017)	(.016)	(.017)	(.023)	(.039)	(.045)	(.034)
Neuropsych. disorders	-.0006	-.004	-.0004	.023**	.020	.027	-.054	-.044	-.074
	(.010)	(.010)	(.014)	(.010)	(.013)	(.018)	(.041)	(.047)	(.043)
Other neoplasms	.014*	.005	.024**	.029**	.002	.057***	-.014	-.008	-.018
	(.008)	(.007)	(.011)	(.011)	(.016)	(.012)	(.021)	(.031)	(.021)
Nutritional/ endocrine disorders	.0001	.006	-.006	-.013	.002	-.035	-.029	-.019	-.036
	(.016)	(.019)	(.019)	(.023)	(.033)	(.024)	(.031)	(.042)	(.031)
Other	.0001	-.0002	.001	.017	.013	.019*	-.053*	-.041	-.063*
	(.008)	(.009)	(.008)	(.012)	(.017)	(.010)	(.025)	(.024)	(.028)
<u>Injuries</u>									
Unintentional	.009	.011	.017	.008	.010	.006	.014	.033	.075
	(.009)	(.008)	(.011)	(.014)	(.014)	(.016)	(.019)	(.021)	(.043)
Intentional	.079***	.076***	.088**	.031	.023	.041	.139***	.148***	.126
	(.023)	(.023)	(.030)	(.029)	(.033)	(.027)	(.042)	(.045)	(.083)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; na - not applicable

The dependent variable for both columns is the logarithm of the mortality rate per 100,000 population. The additional explanatory variables are listed in the "Explanatory variables" in Table 1. The sample sizes are 374 for the all states estimates, 114 for the top ten HDI states and 116 for the bottom ten HDI states. State and year fixed effects are included and the observations are weighted by the square root of the state population. The errors are clustered by state.

Table 4: Coefficient on GDP per capita for mortality selected specific causes of death

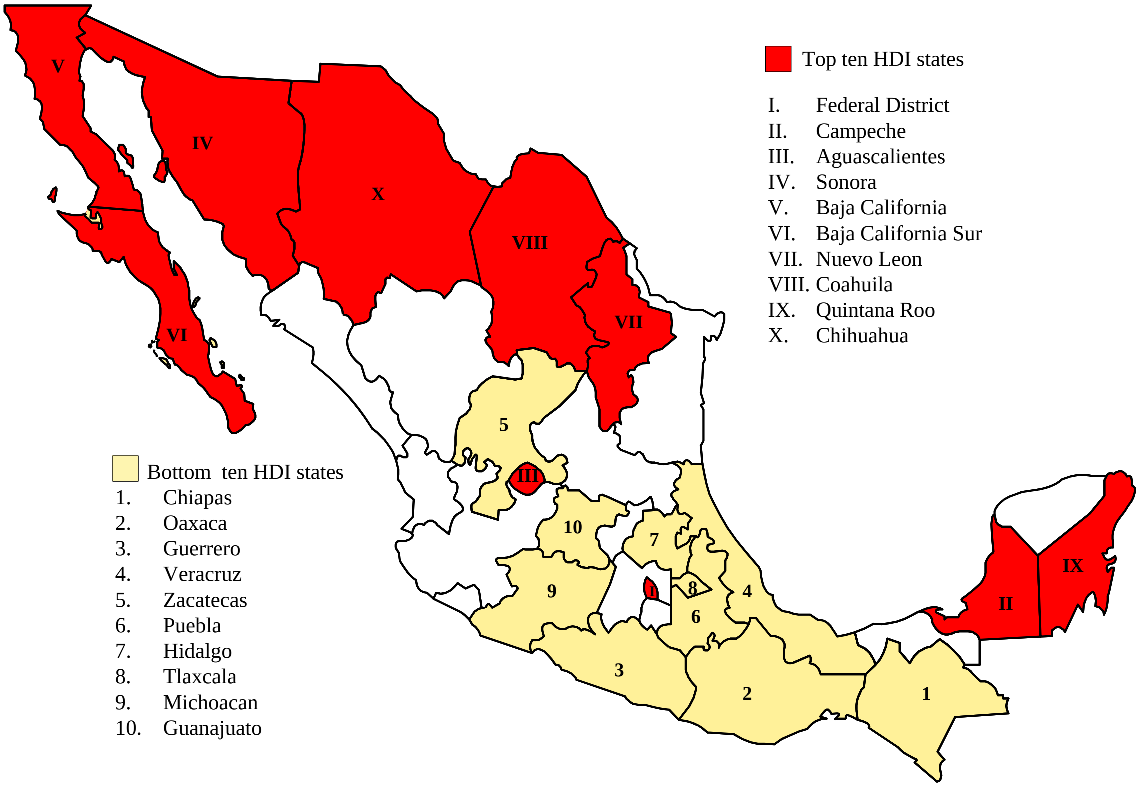
Cause of death	All states: All	All states: Male	All states: Female	Top ten states: All	Top ten states: Male	Top ten states: Female	Bottom ten states: All	Bottom ten states: Male	Bottom ten states: Female
Infectious & parasitic diseases									
Tuberculosis	.001	-.004	.015	.027	.037	.014	-.116**	-.114	-.112*
	(.025)	(.027)	(.024)	(.028)	(.035)	(.027)	(.063)	(.071)	(.058)
HIV/AIDS[1]	-.023	-.030	.029	.010	-.007	.101	-.239**	-.213**	-.330*
	(.040)	(.040)	(.054)	(.039)	(.041)	(.060)	(.102)	(.092)	(.163)
Nutritional deficiencies									
Protein-energy malnutrition	.004	-.005	.012	-.0004	-.009	.009	-.075**	-.090**	-.059*
	(.014)	(.014)	(.015)	(.019)	(.021)	(.024)	(.024)	(.040)	(.028)
Cardiovascular disease									
Ischaemic heart disease	.007	.001	.016	.009	.0009	.021	-.064**	-.053	-.076**
	(.010)	(.010)	(.013)	(.011)	(.014)	(.013)	(.028)	(.033)	(.030)
Digestive diseases									
Cirrhosis of the liver	.033*	.036*	.023	.057**	.052*	.060**	-.038	-.027	-.053
	(.019)	(.020)	(.020)	(.022)	(.024)	(.024)	(.023)	(.023)	(.045)
Unintentional injuries									
Road traffic accidents	.039**	.042**	.031	.033	.031	.036	.210*	.217*	.184
	(.019)	(.020)	(.018)	(.020)	(.018)	(.028)	(.102)	(.099)	(.107)
Intentional injuries									
Suicides	.061***	.064***	.052	.061**	.060*	.010	.179**	.174***	.284*
	(.022)	(.022)	(.043)	(.022)	(.027)	(.045)	(.102)	(.043)	(.152)
Violence	.034*	.026	.066**	-.015	-.031	.040	.096*	.104*	.079
	(.018)	(.018)	(.027)	(.033)	(.035)	(.039)	(.046)	(.046)	(.103)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

[1] There were no female deaths from HIV/AIDS in 10 state-years in the full sample, three state-years in the top ten HDI states, and one state-year in the bottom ten HDI states. As the dependent variable is the log of the mortality rate, the dependent variable would be undefined for these state-years. To circumvent this problem, one death is added to all state-years (for both genders) before calculating the HIV/AIDS mortality rate.

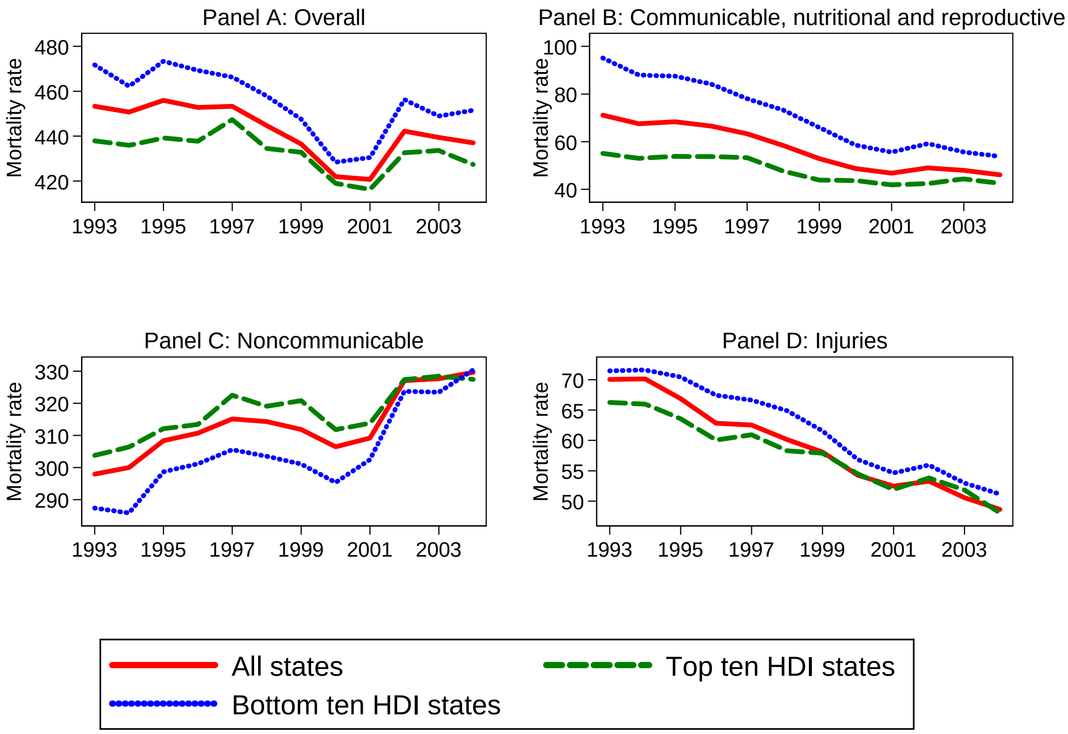
The dependent variable for both columns is the logarithm of the mortality rate per 100,000 population. The additional explanatory variables are listed in the "Explanatory variables" in Table 1. The sample sizes are 374 for the all states estimates, 114 for the top ten HDI states and 116 for the bottom ten HDI states. State and year fixed effects are included and the observations are weighted by the square root of the state population. The errors are clustered by state.

Figure 1: Mexican states in the high and low-HDI groups



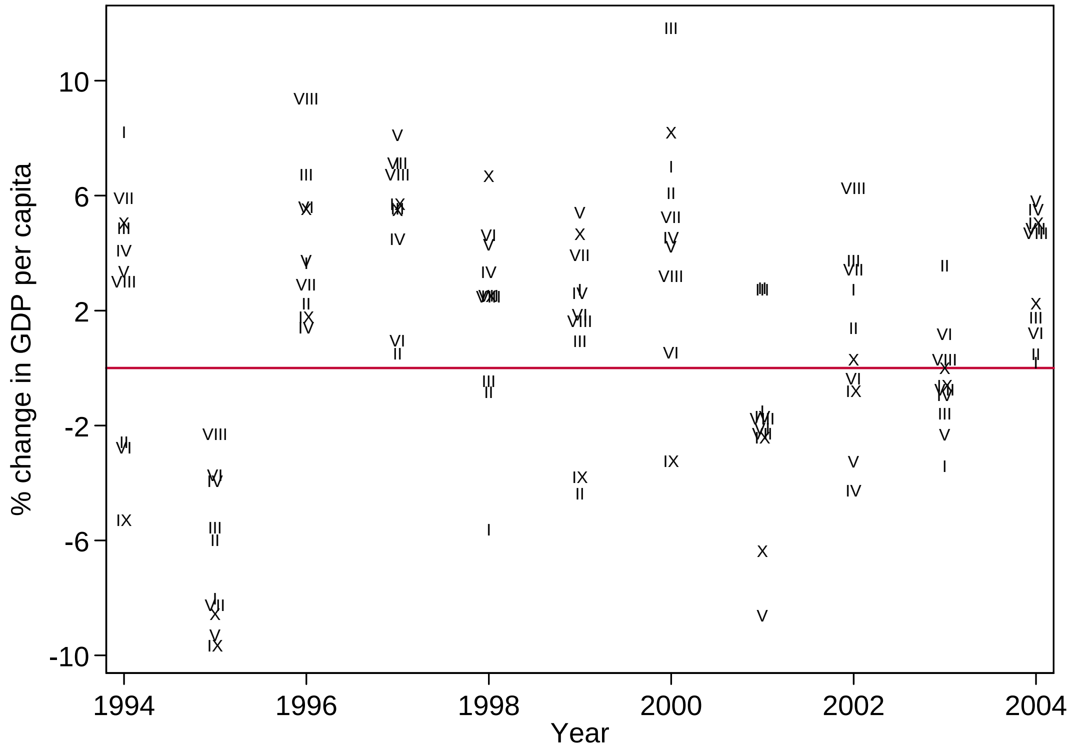
Source: Authors' own using data from CONAPO (2001).

Figure 2: Mortality rates, all states and HDI subsets, 1993-2004.



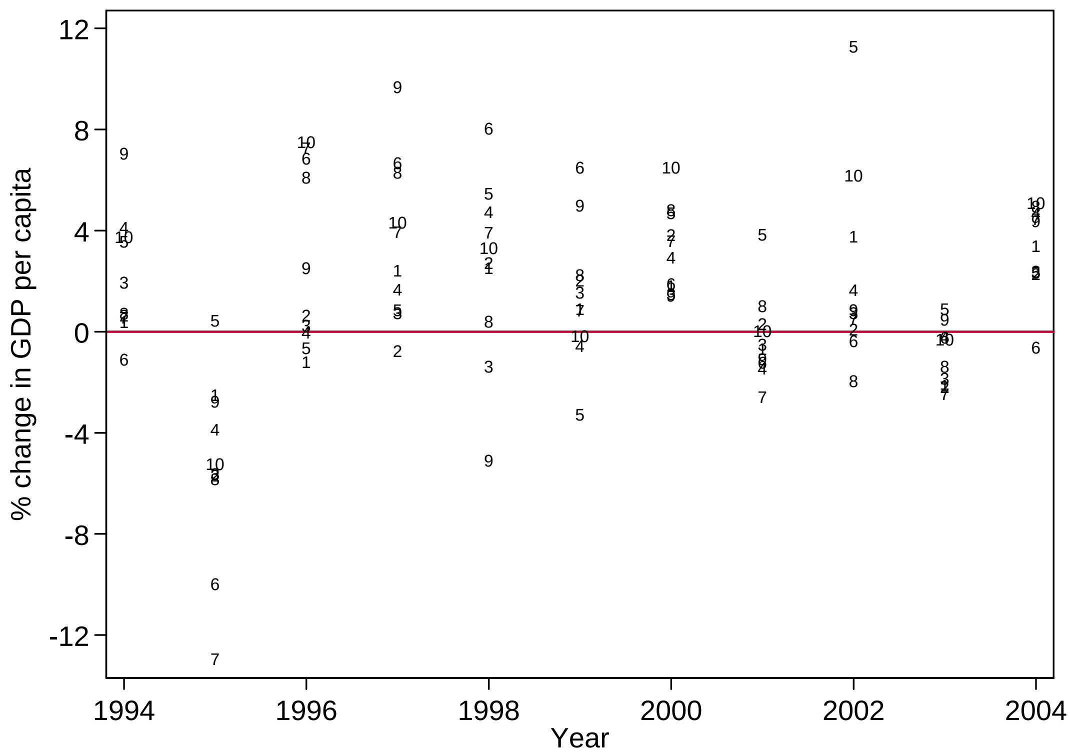
Sources: SSA (2007) and SSA (1993-2004a).

Figure 3: Percent change in GDP per capita, top ten HDI states, 1994-2004.



Symbols correspond to those used in Figure 1.
Sources: SSA (2007) and SSA (1993-2004a).

Figure 4: Percent change in GDP per capita, bottom ten HDI states, 1994-2004.



Symbols correspond to those used in Figure 1.
Sources: SSA (2007) and SSA (1993-2004a).

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