IMPACT OF ECONOMIC CRISES ON MORTALITY: THE CASE OF MEXICO*

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Resumen: Se analiza el impacto de las crisis económicas en la mortalidad en México. La identificación de este efecto es difícil porque el PIB puede ser una función de la salud. Para resolver dicho problema de endogeneidad proponemos el uso de dos tipos de variables instrumentales del PIB a nivel estado. Nuestros resultados sugieren que una caída del uno por ciento del PIB provocaría un aumento del 0.5 por ciento en la tasa de mortalidad. Los niños y adultos mayores constituyen los grupos más vulnerables. Los resultados implican que la crisis de 2008 devolvió a México a los niveles de mortalidad infantil de 2001, revirtiendo su progreso para alcanzar las Metas del Milenio.

Abstract: We analyze the impact of economic crises on mortality in Mexico. Identification of that effect is difficult because the GDP itself may be a function of health. In order to solve for endogeneity, we propose the use of two sets of instrumental variables at the state level. Our findings suggest that a one percent decrease in GDP would lead to an increase of 0.5 percent of the mortality rates. Children and the elderly constitute the most vulnerable groups. The findings imply that the 2008 crisis sent us back to 2001 infant mortality levels, reversing Mexico's progress to attain that MDG.

Clasificación JEL/JEL Classification: E32, I10, O11, O54

Palabras clave/keywords: ciclo económico, crisis económica, mortalidad, Metas del Milenio, México, business cycle, economic crisis, MDG*s*

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1. Introduction

Given the current depression of the global economy, questions have been raised as to what the consequences will be for the well-being on people all around the world. Of particular concern are the effects of this recession on developing countries, and whether the progress towards the achievement of the Millennium Development Goals will be slowed down, stalled or even reversed (United Nations, 2009). According to the International Monetary Fund (IMF, 2009), as a result of Mexico's interlinkanges with the American economy Mexico has been particularly harshly hit by the current recession. The Mexican economy contracted by 6.5 percent during 2009. Such a contraction in growth could certainly have dire effects on the attainment of the MDGs in Mexico. In this paper, our objective is to estimate the effect of the business cycle on health. Our indicators of health will be centered on mortality, which is an extreme bad outcome of ill health. We will use Mexico's past experience to draw conclusions on the effect of the current global financial crisis on mortality rates, especially infant mortality rates and mortality rates due to ill nutrition.

The effect of the business cycle on health is still largely debated in the literature. If health is a normal good, the theory would predict that health deteriorates during economic downturns and improves during the upturns. However, ever since the work of Ruhm (2000), who found that the mortality rates are procyclical in the United States, there is a large debate on what the effect of the business cycle is. According to Ruhm's explanation, the production of health also requires time on the part of the individual. Hence when the opportunity cost of time decreases (i.e. during spells of unemployment or shrinking real wages), health should improve. As a consequence, health improves during economic downturns.[1] In the light of these results, Ruhm concludes that policymakers who exercise countercyclical expenditures on health may be misallocating their resources. These same results have been found in other developed nations.[2] However, we can hypothesize that the effect of the business cycle is going to be different in the case of developing countries. For instance, most of the developing world lacks the unemployment insurance that is available in developed nations. As a result, people in developing countries often

[1] This result was also found in Granados (2005a) using a different methodology and data from another period.

[2] For Spain see Granados (2005b); for the OECD countries see Gerdtham and Ruhm (2006); for Germany refer to Neumayer (2004).

turn to self-employment in order to obtain an income during a recession. This means that during the recessions they do not suddenly find themselves with additional time to produce health; they just have less income. Therefore, mortality may behave countercyclically in these countries.

There is a growing literature looking at the pro- or counter- cyclicality of mortality in different countries.[3] In this paper, we will focus on the case of Mexico. The case of Mexico is interesting because it shares characteristics of an industrialized and a developing nation. As such, Mexico is currently undergoing an epidemiological transition in which chronic diseases (such as heart disease, diabetes and cancer) are becoming more prevalent than infectious diseases. Mexico's health system is characterized as fragmented and segmented: half of the population remained uninsured until the advent of *Seguro Popular* in 2003 (Frenk, 2006; Frenk *et al.*, 2003; Knaul and Frenk, 2005). Hence, most out-of-pocket health expenditures were undertaken by the uninsured population, often resulting in catastrophic expenditures (Frenk, 2006; Torres and Knaul, 2003). Moreover, the literature has found that in a climate of economic distress, households cut back on the consumption of durables and on human capital investments, including those related to health (Attanasio and Szekely, 2004; and McKenzie, 2003 and 2006). Thus, the conditions of the Mexican social protection system do not seem to offer the necessary means to shield the population's health from large negative shocks.

The literature in the Mexican case offers two contradicting estimations on the effect of the business cycle on mortality. First, Cutler *et al.* (2002) conclude that mortality rates follow a countercyclical pattern in Mexico, especially for infants and the elderly. Using data on mortality rates from the Ministry of Health, they find that mortality rates either increase, or decrease less rapidly during the crisis periods in the 1980s and 1990s. More formally, they implement a difference-in-differences model where the treated groups are infants and the elderly, and the control group (or the group unaffected by the crisis) is composed by males between 30 and 44 years of age. They find that during the 1995 peso crisis infant mortality increased by 6.9 percentage points, whereas that of the elderly increased by 5 to 6 percentage points depending on the age group. These estimates imply that during the 1994-1995 crisis there were 7 000 additional

[3] For a survey of the literature please refer to Ferreira and Schady (2008). Baird, Friedman, and Schady (2007) performed an analysis using data from the Demographic and Health Surveys for several developing countries and find that mortality rates are countercyclical.

infant deaths, and 20 000 additional deaths for the elderly. However, we think the health effects are overestimated in this paper. The mortality of the control group -males between 30 and 44 years of age-exhibited a procyclical behavior: in general, mortality declined faster during crisis periods than in non-crisis periods; so it is not true that this group was unaffected by the crisis.

In contrast, Gonzales and Quast (2009) found that mortality rates in Mexico are procyclical. Their analysis is a straightforward application of Ruhm's (2000) methodology. The novelty of Ruhm's approach was the use of panel data at the state level, which allowed him to control for state and year fixed effects. Gonzales and Quast also used annual panel data from Mexico's vital statistics, and ran a regression where the explanatory variable is GDP per capita. They also controlled for some time-variant state level characteristics such as: mean education; age composition of the population; and, in addition to Ruhm's control variables, public health resources, and the extent of internal and international migration. An inherent problem with this approach is that the methodology only exploits a very limited variation. Ruhm justifies the use of year fixed effects arguing that they control for changes in the health culture, technological changes in the production of health and other sorts of phenomenon that are common to all states in any given year. However, this will also eliminate the national average effect of the recessions on mortality, which is something we are interested on knowing. Moreover, it is not clear that this methodology corrects for the endogeneity of GDP: it is very possible that other unobservable factors affect both GDP and mortality giving rise to a spurious correlation between the two.

In order to solve for the endogeneity of the GDP, in this paper we propose the use of two sets of instrumental variables for the GDP. These instruments exploit the variation in the economic shocks across states during the 1995 and 2000 crises. Given the nature of these crises,[4] the manufacturing sector was the most affected during both recessions. Our instruments will exploit this fact, and thus will instrument the share of the manufacturing sector using two different variables: the states' share of the manufacturing sector in 1985, and

[4] The 1995 peso crisis was triggered by the inability to sustain the exchange rate *vis à vis* the dollar. As a result, the peso was devalued. This event significantly affected the industries whose production hinged on imported inputs. In contrast, the 2000 crisis was a consequence of the United States' recession. Hence, the industries that exported to the US were the most affected. We will exploit this vulnerability of the manufacturing sector during both crises to create our instruments.

the distance from the states' capitals to the closest US port of entry. We will show that these two variables are correlated with GDP and argue that they are not necessarily correlated with mortality rates. In order to introduce time variation into our instruments, and in the spirit of Angrist and Kugler (2003), we will interact those two variables with period dummies defining the precrisis, 1995 crisis, the intercrisis, and the 2000 crisis periods. In this way, our instruments will be related to the size of the state's economy and will track the business cycle.

We use data from death registries of administrative records of the vital statistics. As opposed to Gonzales and Quast (2009), we use this data to estimate monthly death rates and we will only control for state and month fixed effects, and a time trend. The analysis will cover the period from 1993 to 2006, given the availability of the state GDP data. Our results are in line with those of Cutler *et al.* (2002) and indicate that mortality rates in Mexico are countercyclical: more people die when there is economic distress. However, our estimates are much more conservative than those in Cutler *et al.* (2002), suggesting that they were indeed overestimating the effect of the crisis. According to our findings, a one percent decrease in economic activity would lead to an increase of 0.5 percent of the mortality rates, which imply around 2 400 additional deaths in the country. The most vulnerable group during the economic crises was the children, whose mortality rates increase 1.5 and 2.3 percent for females and males, respectively. However, in absolute numbers the elderly are the most affected group. Our results imply around a thousand additional elderly deaths, although the elderly mortality rates increase only by around 0.35 percent. It seems thus very important to create instruments that shield the children and the elderly from negative economic shocks. On the bright side, we did not find any significant differences in the business cycle effect between males and females, so there does not seem to be any discrimination against women during periods of economic distress. Regarding the MDGs, the current crisis definitely implied a setback, sending us back to 2001 infant mortality levels. However, if the IMF forecasts for 2010 and 2011 are met (IMF, 2010);[5] our findings suggest that Mexico would only need to grow by 1.36 percent in total between 2012 and 2015 in order to attain this particular MDG.

The rest of the paper is organized as follows. Section 2 describes the data sources used in the analysis. Section 3 outlays the empirical

[5] Mexican analysts seem to believe that this is a rather optimistic outlook.

strategy and section 4 presents the findings of this paper and some robustness checks. Section 5 concludes and explains the implications of our results for the attainment of the MDGs.

2. Data

The data used in this paper comes from various sources. Our health indicators are going to be given by mortality rates, which are the extreme bad outcome of ill health. The mortality data used to calculate those rates comes from the administrative death records from the *Secretaría de Salud* (Ministry of Health).[6] This data has the information on all the deaths that occurred from 1985 to 2007. We have information on the exact month and year of death, gender, age (in hours, day, months or years), cause of death,[7] schooling level, marital status, rural/urban location, and the state and municipality of residence of the deceased. We kept the cases with a valid month and year of death, and further restricted the data to those individuals whose usual residence was in Mexico.[8] From this data, we counted the monthly deaths corresponding to the following groups by gender and state: neonatal deaths (a month or less of age); infant deaths (a year or less of age); child deaths (5 years or less of age); child deaths due to nutritional deficiencies;[9] maternal deaths;[10] total deaths due

[6] According to Mathers *et al.* (2005), the Mexican vital statistics are said to be of high quality in terms of their completeness and their coverage of the causes of death. For instance, the quality of the Mexican mortality data is said to be as good as United States data and is better than German mortality data.

[7] The causes of death are coded using the International Statistical Classification of Diseases and Related Health Problems (ICD). Mexico used the 9th revision from 1985 to 1999, and has used the 10th revision since 2000.

[8] From 1985 to 1988 we are unable to exclude foreigners. However, those represent only between 0.19 and 0.28 percent of the data. Furthermore, once we merge the other data, we will only keep the data since 1993, so this will not be an issue in our estimations.

[9] The codes related to a deficient nutrition are 260-269 (nutritional deficiencies), 278 (obesity and other hyperalimentation), and 280-281 (nutritional anemias) in the 9th revision (ICD9), and D50-D53 (nutritional anemia) and E20-E68 (malnutrition, other nutritional deficiencies, and obesity and other hyperalimentation) in the 10th revision (ICD10).

[10] The codes related to maternal death, or more specifically, complications of the pregnancy, childbirth and puerperium, are 630-676 in the ICD9, or O00-O99 in the ICD10.

to nutritional deficiencies; total deaths of people aged 13-20, 21-44, 44-64 and 65 or more years; and total deaths.

The mortality rates should be defined relative to the population at risk. *In the case of neonatal, infant, child and maternal deaths, the mortality rates are defined by the ratio of deaths to live births in each group in thousands.* The live births data comes from the administrative birth records of the vital statistics, and these were also obtained by gender for each state and year.[11] The national series of the neonatal, infant, child, and maternal mortality rates are presented in figure 1. The shaded areas represent the 1995 and 2000 crises periods. The figure shows that for children aged less than 5 years old, mortality rates increased or the decreasing trend slowed down during crises years. This is particularly evident for the mortality rates due to nutritional deficiencies:[12] there is a peak for both males and females during the crises years, and during the 2000 crisis the peak is higher for girls than for boys. The series for maternal mortality rates seem to be rather noisy; hence the results regarding maternal mortality should be taken with caution.

The rest of the mortality rates (total deaths due to nutritional deficiencies and people over 12 years old) were defined as the ratio of deaths in each group to each group's population in hundred thousands. The population data comes from the *Instituto Nacional de Estadís-*

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[11] A problem with the data is that not every child is registered the year in which he or she was born. The baby can be registered in subsequent years; for example, some mothers register their child until she enters school or when she dies, given that the birth certificate is required in both instances. The latter cause of late registration would be of particular concern for us, since it would introduce a mechanical relationship between the number of births and the number of deaths rendering our measure of the mortality rate useless. We propose the following solution for this problem. We observed that after 10 years of the birth date, the amount of children being registered is minimal (see figure A1 in appendix). Hence we took the average share of children registered in the year they were born by state from 1992 to 1994 by state. Then, we adjusted the number of children registered in the year they were born by the reciprocal of that share to get the total amount of children born every year. The final series of births by state are pictured in figure A2 in appendix.

[12] The most common measures of nutritional status in the literature are height-for-age, the body mass index, and z-cores for height and weight. Due to the lack of state-representative nutritional data in Mexico, we decided to use mortality due to nutritional deficiencies, since this is a well defined category in the ICD codes. The use of this measure is rather new in the literature dealing with the effect of business cycles on nutritional status.

tica y Geografía (INEGI), the National Statistical Office.[13] In order to estimate the yearly time series of population for each age group, we assumed that the population growth rate was constant between surveys, and then estimated the missing values accordingly.[14] The rest of the national mortality-rate time series are presented in figure 2. There are no apparent effects of the crisis for people between 13 and 64 years of age. However, we do observe increases in mortality among the elderly. Given the evident effects for children and the elderly, it is very possible that during economic distress the household reallocates resources from the less productive members (children and elders) to the more productive members of the household (people between 13 and 64 years old).[15]

Our Gross Domestic Product (GDP) measures come from INEGI. Annual GDP at the national level can be found starting 1980, whereas GDP at the state level is available every five years from 1970 to 1985, and then annually from 1993 to 2006. Since our analysis will be at the state level, we will mostly use the state GDP data. In this paper we will define an economic crisis as a significant decline in the economic activity, as measured by the GDP, which lasted two or more consecutive quarters. In some cases, the crisis period will be defined by a dummy variable. The beginning of the crisis is defined by the first year of economic contraction. The end of the crisis will be given by the year in which the economy reaches pre-crisis GDP levels. As shown in figure 3, the Mexican economy has gone through several periods of economic crisis during the past three decades. Figure 3 presents the logarithm of the GDP and the log of the GDP per capita in Mexico from 1980 to 2009. As we can see and according to our definition, there are five episodes of economic distress in Mexico during this period,

[13] There are no available yearly time series of population by gender for each of the age groups that we defined.

[14] The exception to this "in between surveys" rule is the state of Chiapas. Chiapas' estimated population using the INEGI's 1995 *Conteo de población* was too low as compared to 1990 and 2000. Our intuition is that the Zapatista guerilla that started on 1994 prevented INEGI from entering the Zapatista region in 1995, thus producing misleading estimates of Chiapas' population. In the case of Chiapas, we assumed a constant population growth between 1990 and 2000, and filled the gaps in the 1990s time series using this growth rate.

[15] An extreme result of this reallocation of resources is found in Miguel (2005). He found that cases of witch killing, in particular of female elders, increase when there are negative economic shocks, as measured by rainfall. Miguel argues that families expel or kill their witches in order to protect the nutritional status of the more productive household members.

which started on: 1982:I, 1985:IV, 1995:I, 2000:IV, and 2008:III. It is important to stress that these crises varied in depth and duration, and hence the potential effects on social indicators may be very different. For instance, during the 1995 crisis the economy contracted almost 5% in the first quarter and more than 6% in the second quarter. It took 2 years to return to the pre-1995 GDP level. In contrast, the 2000 crisis exhibited smaller decreases in GDP (at its trough the economy contracted by 0.506%), but it took 10 quarters to reach the pre-crisis GDP level. In this paper we will only focus on the effects of the 1995 and 2000 crises on mortality rates, due in part to the availability of data. According to analysts, the current crisis shares characteristics of both the 1995 and 2000 crises: it has been deep and the recovery is going to be long.

As we briefly mentioned in our introduction, our empirical strategy will rely on instrumental variables. One of these instruments is partly constituted by the distance from the state capital to the closest United States' port of entry. These data comes from the Atlas at infoplease.com.[16] The minimization of the distance was done over the top 25 ports of entry from Mexico to the US, which were defined according to the volume of US-Mexico trade that enters through each of these ports. The data on the trade volume entering through each port was obtained from the Bureau of Transportation Statistics, North American Transborder Freight Data.[17] Since the data was not available for a pre-crisis year, the ranking of the ports of entry was made as of 2005, which is a non-crisis period, and thus we implicitly assumed that the volume of trade is highly correlated over time.

As part of our analysis, we will control for some time-varying state characteristics, such as the educational composition of the state, the mean education of mothers, public health expenditures, and interstate and international emigration rates. The state education data comes from the INEGI. In order to create yearly time series, we also assumed that education increased at a constant rate in between surveys. The education measures are: the proportion of people over 25 years of age with secondary, high school, or college education, and the mean education of females over 25 of age. The public expenditures and emigration rates data come from the Basic Demographic Indicators at the *Consejo Nacional de Población* (Conapo), National Population Council.

Our final data set will cover the period from 1993 to 2006. Table

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[16] http://www.infoplease.com/atlas/calculate-distance.html

[17] http://www.bts.gov/programs/international/transborder/TBDR_QA.html

1 presents the summary statistics of the state level data that we will use in the empirical analysis below. According to these statistics, the mortality rates of females are always lower than the mortality rates of males, and the mortality rate gender gap seems to increase with age. The only exception to this pattern is the child mortality due to a deficient nutrition, though the difference in means is not significant (test not shown). During the period, more men were born than females. This difference seems to be compensated over time due to the higher male mortality rates: there are more females than males for all other age groups in the table.

3. Empirical Strategy

The objective of this paper is to untangle the effect of the business cycle on mortality rates for different age groups and causes of death. Thus, the estimating equation would have the following form:

$$Y_{jmt}^{k} = \alpha^{k} + \beta^{k} \log\left(GDP_{jt}\right) + \delta_{j}^{k} + \delta_{m}^{k} + \varepsilon_{jt}^{k} \tag{1}$$

where Y_{jmt}^{k} is the mortality rate for group k in state j in during month m in year t; GDP_{jt} is the state j's GDP in year t; δ_{j}^{k} is a state fixed effect; and δ_{m}^{k} is a vector of monthly dummies. We introduce the state fixed effects in order to control for any state level time-invariant characteristic. The monthly dummies will control for the observed seasonality in mortality rates, especially those of infants.

A particular concern in the literature has been the fact that both GDP and mortality rates follow a natural trend: GDP has increased over time, whereas mortality (especially that of infants) has tended to decrease. As a result, if we estimate equation 1 as it is, we will very possibly find that there is a negative correlation between GDP and mortality in time series data. The literature has proposed two different ways to solve for this issue. First, Ruhm (2000) proposed the use of year fixed effects in annual series of mortality and GDP in the United States. According to Ruhm, these fixed effects will control for advances in health technology, and changes in the health culture or preferences for health. However, the use of these year fixed effects implies that we will only use the variation on top of the annual national average for each state. If the crisis had a significant effect on this annual average national mortality, we will be losing a very important component of the effect of the business cycle on our outcome variable. The second strategy is to directly control for the trend (Baird, Friedman and Schady, 2007). We will follow this latter strategy in order to avoid the problems from using year fixed effects.[18] Specifically, we will use only a linear trend, which we will assume will be good enough to control for such technological and cultural changes. The equation of interest thus becomes:

$$Y^k_{jmt} = \alpha^k + \beta^k \log\left(GDP_{jt}\right) + \delta^k_j + \delta^k_m + \theta^k t + \varepsilon^k_{jt} \qquad (2)$$

where t is controlling for the annual trend.

We have yet another concern regarding the estimation of equation (2) by OLS. Individual level literature has often found that wealthier people are healthier. There is still a large debate on the direction of the causality in this relationship. Some authors argue that wealthier people are able to afford health-improving goods, and higher quality health services; thus making wealthier people healthier (Cutler, Deaton and Lleras Muney, 2006; Pritchett and Summers, 1996; Smith, 1999). However, another strand of the literature argues that healthier people are more productive and, in general, more able to work; thus making healthier people wealthier (Smith, 1999; Strauss and Thomas, 1998). Hence, the literature indicates that there might be an endogeneity problem in the estimation of equation 2 implying that β^k_{OLS} would be biased upwards, since in the aggregate wealthier states would be also healthier.

In order to solve for the endogeneity problem, we propose the use of two different sets of instrumental variables (henceforth referred to as IV in the text): *1*) the share of manufacturing on the state GDP in 1985, $M_{j,1985}$, interacted with period dummies; and *2*) the distance of the state capital to the closest US port of entry interacted, D_j, interacted with period dummies. The idea behind these instruments is to exploit the fact that the manufacturing sector was the hardest hit during the 1995 and 2000 crises. The correlation between the 1985 share of manufacturing and the prevailing share of manufacturing is evident. As for the distance to the United States border, Hanson (1997, 1998) establishes that the location of the manufacturing sector in Mexico is heavily clustered close to the US border and around

[18] If there were a large national shock in a given year, this trend would not take that variation away. We will thus be able to use this national level variation in our estimation, and relate it to the business cycle.

the Mexico City belt, especially following the North American Free Trade Agreement (NAFTA). Figure 4 shows the GDP against the share of manufacturing in 1985 (Panel A) and the distance to the closest US port of entry (Panel B). Each dot in the scatter plot is a state-year observation. These two variables induce cross-state variation in our sets of instruments. As the figure shows, those states which had a large share of manufacturing in 1985 (or were closer to the US ports of entry) have a higher GDP in the period of interest. Since each vertical set of dots represents a state, the figure also shows that there is wide variation in the GDP across states and within states across time.

Following Angrist and Kugler (2003), the time variance in the instruments comes from the interactions with period dummies. These period dummies are given by: the pre-crisis period (1995-1996) C_t^1, inter-crises period (1997-1999) C_t^2, 2000 crisis period (2000-2004) C_t^3, and the post-crisis period (2005-2007) C_t^4.[19] These period dummies thus track the business cycle closely. Our sets of instruments will explore whether there are breaks from the general time trend in the mortality rates over the business cycle within the states.

The first-stage equations in each case will thus be given by:

$$\log(GDP_{jt}) = \pi_0 + \sum_{p=1}^{3} \pi_p M_{j,1985} \times C_t^p + \mu_j + \pi_4 t + u_{jt} \qquad (3)$$

or

$$\log(GDP_{jt}) = \gamma_0 + \sum_{p=1}^{3} \gamma_p D_j \times C_t^p + \varphi_j + \gamma_4 t + \nu_{jt} \qquad (4)$$

The identification assumptions are that the instruments are relevant (i.e. correlated with the state GDP); and that the instruments are uncorrelated with the error term in equation (2). In our empirical implementation all the regressions will be weighted by the square root of the state's population, and the standard errors are going to be clustered at the state level. The next section presents our estimation results.

[19] This later period will be omitted to avoid multicollinearity.

4. Empirical Results

Table 2 presents the coefficients of the first-stage regressions in equations (3) and (4). Column 1 presents the results with the logarithm of GDP as the dependent variable and the set of instruments with the share of manufacturing in 1985. Since the reference period is 2005-2007, all the coefficients have a negative sign. However, the coefficient on the interaction with the 1995 crisis dummy is the largest in absolute terms reflecting the sharp decrease in GDP experienced during that period. The coefficient on the 2000 crisis is not significant, possibly reflecting the fact that this recession was not very deep, and that the post-recession period did not exhibit large growth rates either. Column 2 presents the results using the set of instruments with the logarithm of the distance to the closest US port of entry. As expected, all the coefficients are of the opposite sign as compared to those in column 1. The coefficients show that those states farther away from the US experienced a smaller decrease in economic activity during the 1995 and 2000 crises as compared to the states closer to the border. We also estimated the regressions using the logarithm of the GDP per capita. The results remain more or less the same as in the case of GDP. The F-statistic for the joint significance of the instruments is large enough for us to conclude that our sets of instruments are strong.[20] The instruments seem to be a little more powerful when using the logarithm of GDP, so our analysis will focus on this case.

The main results of this paper are presented in table 3. The table presents each coefficient β^k for each of the groups of interest. The first two columns in the table contain the resulting coefficients from OLS estimation. Most of the OLS coefficients are not significant, the exception being those for elder mortality and total mortality. Our IV estimates are generally larger in magnitude than the OLS coefficients, suggesting that we were in fact underestimating the effect of mortality.

A concern with our results is that although the signs of the effects are in general maintained across IV specifications, the magnitude of the coefficients differs. According to our first set of instruments (those that use the share of manufacturing in the state in 1985, columns 3 and 4), neonatal, infant, maternal, elder and total mortality behave countercyclically. That is, as the GDP decreases, mortality for these groups increases. For the rest of the groups of interest, we did not

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20 In the presence of one endogenous variable (GDP), Stock, Yogo, and Center (2002) suggest a critical value of 16.85 in order to reject the null hypothesis that the instruments are weak -see also Murray (2006). Our F-statistics are well above that critical value.

find any significant effect of GDP on mortality. In addition, we did not find any indication that females fared worse during recessions than males. Quite the opposite, we find that the effect is in general larger for males, but it is a well known fact that male mortality is higher than female mortality at all ages. When we use distance to the US to instrument, we find that infant, "nutritional-child", elder, and total mortality behave countercyclically. In this case however, we do find a procyclical effect on the mortality of young adults (people between 21 and 44 years of age). The results using the logarithm of GDP per capita are shown in table A1 in appendix; they look very similar as when using the log of GDP. In what follows, we will try to overcome the issue arising from the difference between the estimates of the two sets of instruments.

Even though our results should be exercised with caution, we would like to provide the reader with an interpretation of our estimates. If we take, for instance, the results for infant deaths in column 3 and 4, our results imply that a one percent decrease in the GDP would lead on average to 0.021 and 0.028 additional female and male infant deaths per thousand live births per month, respectively. These results imply an increase of about 1.73 and 1.84 percent on the female and male infant mortality rates, respectively. The child mortality rate due to a deficient nutrition is the most affected by the business cycle: a one percent decrease in the GDP induces a 2 to 4 percent increase in this particular mortality rate. The most affected group is that of children aged less than 5 years old, followed by pregnant women, whose mortality rate increases around 1.3 percent.

We are still concerned that the estimation of equation 2 by 2SLS will possibly produce a biased effect of GDP on health due to omitted variables. An important omitted variable could be the education level of people in state j. More educated people are healthier on average and they are also more productive; the omission of education would thus bias our results downwards. This will also be the case if having higher GDP leads to having better health services and, hence, lower mortality. Another important omission from our model is the fact that different states exhibit different emigration rates. The literature on the effect of emigration on health has found that both migration and remittances are positively correlated to the health status of those left behind (Hildebrandt and McKenzie, 2005; López-Córdova, 2004; Kanaiaupuni and Donato, 1999). These omissions are going to be particularly troublesome for us if these omitted variables are correlated with our instruments. If education and public expenditure levels are highly correlated over time, then these variables are going to be correlated with the share of manufacturing in 1985 as well. Similarly, there is some evidence that international emigration is correlated with distance to the US, though not very strongly.

In order to overcome this omitted variable issues and following Gonzales and Quast (2009), we will control for the following variables in our 2SLS model: *1*) the share of the population with secondary, high school, and college education, or more, in the state; *2*) total public health expenditures per capita; and *3*) the interstate and international emigration rates. Our estimating model thus becomes:

$$Y_{jmt}^{k} = \alpha^{k} + \beta^{k} \log\left(GDP_{jt}\right) + \gamma^{k} X_{jt} + \delta_{j}^{k} + \delta_{m}^{k} + \theta^{k} t + \varepsilon_{jt}^{k} \qquad (5)$$

where X_{jt} is a vector of time-variant state characteristics which includes the variables just mentioned. The first stage equations should be modified accordingly.

Table 5 presents the first-stage regressions when we control for these variables. The introduction of those variables diminished the power of our instruments -in particular those that use distance to the US, but the F-statistics remain relatively high. Table 6 has the coefficients on $\log(GDP_{jt})$ of our 2SLS model. These IV estimates are higher than those in table 3. Controlling for the variables mentioned above only strengthened our results, and corrected for many of the differences that existed between the estimates of the two sets of instruments. These will be our preferred specifications. These results imply that mortality behaves counter cyclically for almost all groups. These estimates in fact point to a marginally significant negative coefficient on maternal mortality (see column 3 in the table). Using the estimates in table 6 we estimated the effect of the business cycle on mortality in percentages (see table 7). In general, children less than 5 years of age are the most affected during the business cycle. According to those estimates, a one percent decrease in GPD would induce an increase of around 1.6 percent in infant mortality. The child mortality rate due to nutritional deficiencies is the one that increases the most, by between 5.6 and 7 percent. The mortality rate due to nutritional deficiencies of all the population also exhibits an increase of around 1.2 percent. Such results speak badly of the ability of the household to shield the nutritional status of its members. Maternal mortality rates increase around 1.3 percent, though the effect is only marginally significant (but robust to the inclusion of additional control variables). Finally, the other group that is harshly hit by the crises is the elderly; their mortality rate increases by approximately 0.5 percent. Although this effect might seem small, one has to consider that this is the group with the highest mortality rate, so that in absolute numbers more elders than children die due to a recession.

4.1 *Robustness Checks*

The literature has shown that the mother's level of education is instrumental for the health outcomes of children and maternal health (Currie and Moretti, 2003; Cutler, Deaton and Lleras-Muney, 2006). For this reason we added an additional control to our specification in equation (5): the states' mean education of females over 25 years of age. Table 8 presents the coefficient estimates. Our main results do not change much with the addition of this variable.

One could be concerned with whether states farther away from the US have a different weather. In particular, these states may exhibit much more rainfall and warmer weather than the states in the center or the north. If weather is somehow correlated with death rates, then states farther away from the border may exhibit higher mortality rates, and hence our instrument would be rendered irrelevant. We are confident that the introduction of state fixed effects will control for these weather differences.

Finally, our first stage equations in the previous tables show that the instrument is mostly working through the effect of the 1995 Mexican peso crisis. In order to shed light on this, we split the sample in two periods: 1993-1998, and 1998-2006. Using these separate samples we proceeded with a 2SLS analysis in which our instruments are only given by the interaction of the crisis dummy of the period, and either the share of manufacturing in 1985 or the distance to the closest US port of entry. The first stages of this analysis are shown in table 9. As expected, the instruments are only relevant for the 1995 peso crisis. It seems that the 2000 crisis was not big enough to be captured by our first-stage estimation. Table 10 shows the 2SLS results when we restrict the estimation to the 1995 crisis period (1993-1998). The sign and the magnitude of the estimates are robust to the exclusion of the 2000 crisis period, suggesting that our results are indeed being identified with the 1995 crisis. However, many of the coefficients are now statistically insignificant or only marginally significant (infant mortality, for instance), mostly as a result of the reduction in our sample size. Interestingly, the results for child mortality due to malnutrition, elderly mortality, and total mortality are very robust to the sample restriction.

Though we do not show all the following results we also did the estimations: *1*) using the logarithm of the mortality rate as a dependent variable; *2*) using the logarithm of GDP per capita as an explanatory variable (see tables A1 to A4 in appendix A); and *3*) aggregating the mortality data for a quarter, half year, and year. None of these changes produced any significant difference in our results. We are confident that after controlling for time-variant state characteristics, our results are very robust.

5. Conclusions and Implications for the MDGs

This paper presented a new method to estimate the effect of the business cycle on mortality rates in Mexico. Previous literature has attempted to identify this effect, but we have made our case on why we do not believe those estimates are accurate. We propose the use of two different sets of instrumental variables and then perform a time series analysis with state level data. We found that for most age groups, the mortality rates exhibits a countercyclical behavior. Our estimates suggest that a one percent decrease in economic activity would lead to almost 2 400 additional deaths in the country. The most vulnerable groups during the economic crises were infants and the elderly. Given our results, a one percent contraction in the economy would result in 640 additional infant deaths and around 960 additional elderly deaths. It is very important to stress that mortality due to malnutrition increases during crisis periods: we found that 30 additional children die with a one percent decrease in GNP, and that in total there are 160 additional deaths due to malnutrition. It seems thus very important to create instruments that shield the children and the elderly from negative economic shocks.

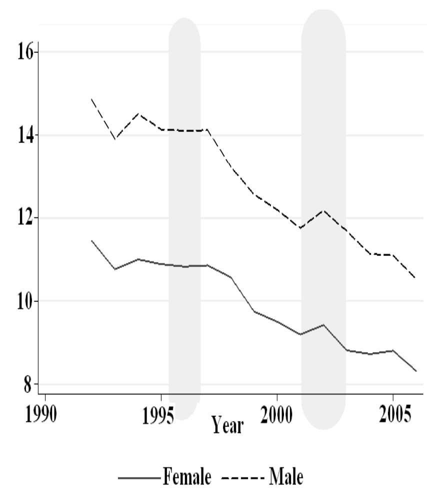
The topic is of particular importance given that the current global financial crisis has hit Mexico harshly. The application of our results in the current context deserves a note of caution. Given that most of the effect captured in our analysis comes from the effect of the 1995 peso crisis, an extension of our results to the current economic crisis would necessarily imply that the conditions now are similar to those in 1995. The latter is not necessarily true. The 1995 peso crisis was characterized by high inflation, high interest rates, and lack of credit in the financial sector. The 2008 crisis shares none of those characteristics; the two crises are only similar in the sharp decline in economic activity and the high unemployment rates. Given the drop in real wages and the sharp increase in interest rates, it seems that the microeconomic effects of the 1995 crisis were felt by the population at large. In contrast, the current crisis has not really been felt by those who have managed to keep their jobs. In consequence, any inference drawn from the results in this paper must be taken with caution.

Another important distinction between the 1995 and the 2008 crises refers to the role of remittances. During the 1995 crisis, households continued to receive remittances from international migrants given that the world economy, and in particular the United States, was experiencing an economic boom. These remittances allowed migrants' households to hedge against the negative shock. In contrast, the current crisis is global, and thus the inflow of remittances experienced a sharp decrease. As a result, households which were more dependent on remittances as an income source will be much more exposed to the effects of the negative macroeconomic shock in the current crisis than in 1995. Given the evidence in the literature, this cut back in remittances will deteriorate the health status of the migrants' dependents even more.

Notwithstanding, we consider it important to analyze the implications of our results for the 2008 crisis. The Mexican economy contracted by 6.5 percent during 2009. Such a contraction would lead to an increase of 3.5 and 2.7 of the female and male mortality rates, respectively. According to our estimates and using the 2006 population at risk, the results imply that there were 9 000 additional deaths in the country, around 600 of those deaths due to deficient nutrition, and 105 of these deaths a consequence of children's malnutrition in particular. Although these numbers seem to be small relative to the total population, Lindeboom, Van den Berg, and Portrait (2006) provide evidence that harsh macroeconomic conditions during childhood result in higher probabilities of dying at younger ages. Hence, our estimates represent only a short-run effect of the business cycle on mortality. Future research should also focus on the long-run effects of negative macroeconomic shocks on mortality, and on the specific causes of death.

As for infant mortality, our findings imply that a 6.5 contraction would induce 3.55 additional infant deaths per thousand live births. According to Conapo's Basic Demographic Information forecasts, Mexico was well on the path towards reducing infant mortality by two thirds between 1990 and 2015. In 2008, infant mortality was 15.2 deaths per thousand live births. The crisis will in fact increase this number to 18.75 (this is the infant mortality level Mexico had between 2000 and 2001). Fortunately, and if the IMF forecasts are correct (IMF, 2010), this setback was not enough to deter Mexico from attaining the MDG. If the economy does grow 4.7 percent in 2010 and 4 percent in 2011 as the IMF predicts (IMF, 2010), the Mexican economy would need to grow only 1.36 percent in total between 2012 and 2015 to attain the goal. Of course this conclusion hinges on the assumption that the Mexican economy will in fact sustain such a large and sustained rebound after the crisis.

Figure 1
Child, Infant, and Maternal Mortality Rates
A. Neonatal



B. Infant

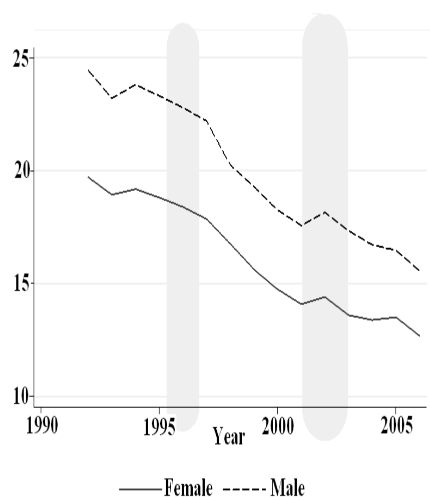
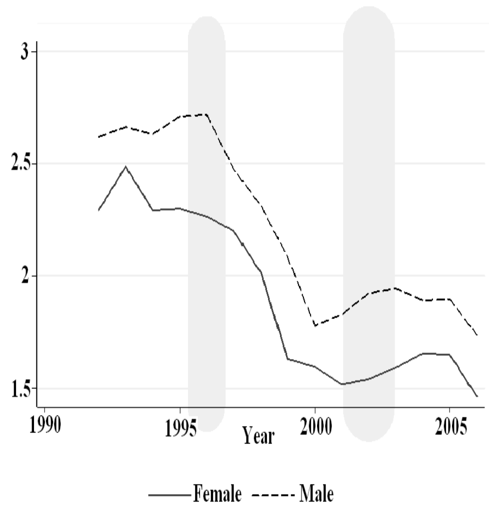
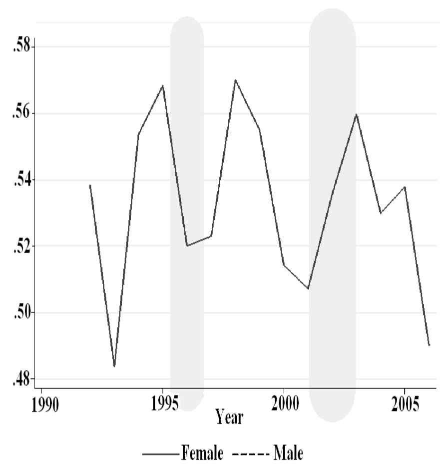


Figure 1
(*continued*)
C. Child



D. Child due to deficient nutrition

Figure 1
(*continued*)
E. Maternal



Note: Mortality rates are defined as deaths per thousand live births.
Source: Author's estimations using data from INEGI and *Secretaría de Salud*.

Figure 2
Adult Mortality Rates
A. Age: 13-20

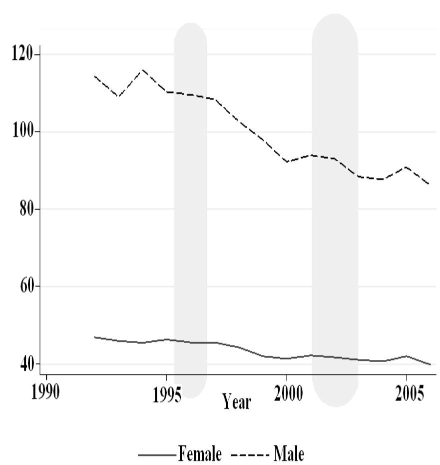
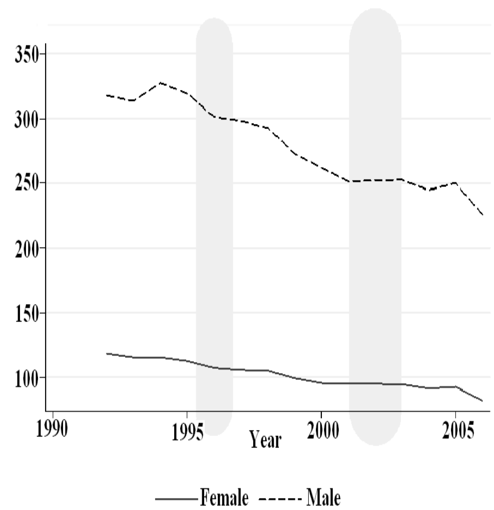


Figure 2
(*continued*)
B. Age: 21-44



C. Age: 45-64

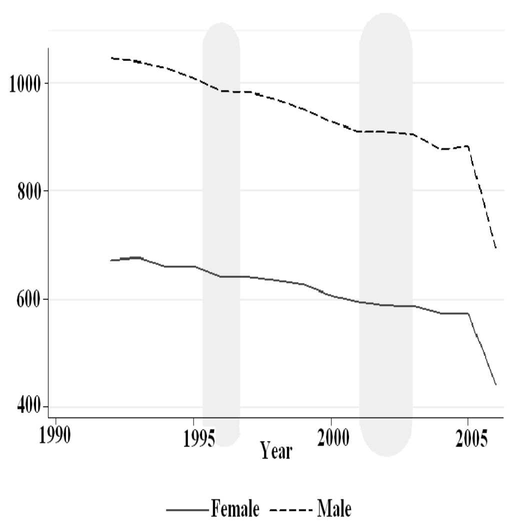


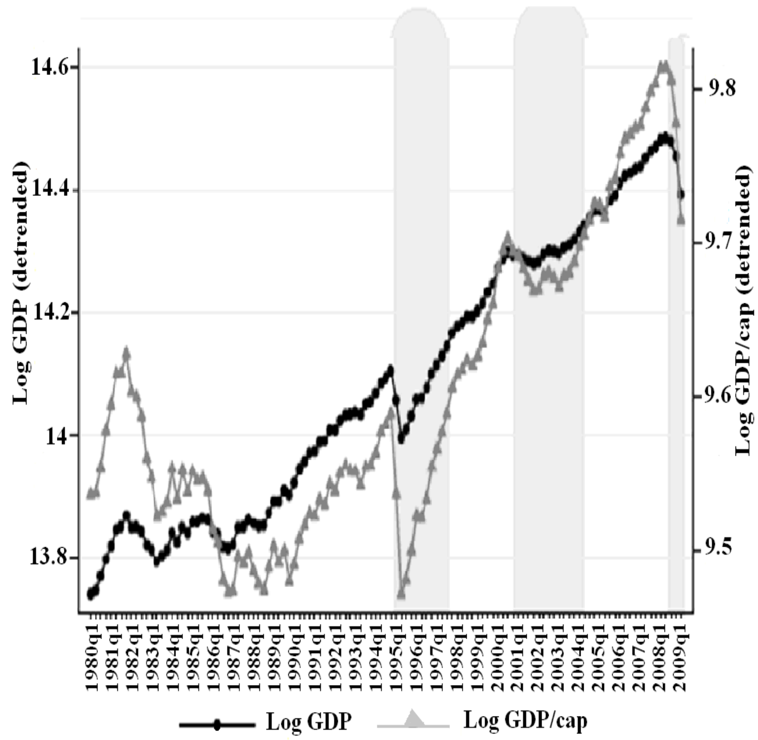
Figure 2
(*continued*)
D. Age: 65 or more

E. Total

Note: Mortality rates are defined as deaths per hundred thousands of the group's population. Source: Author's estimations using data from INEGI and *Secretaría de Salud*.

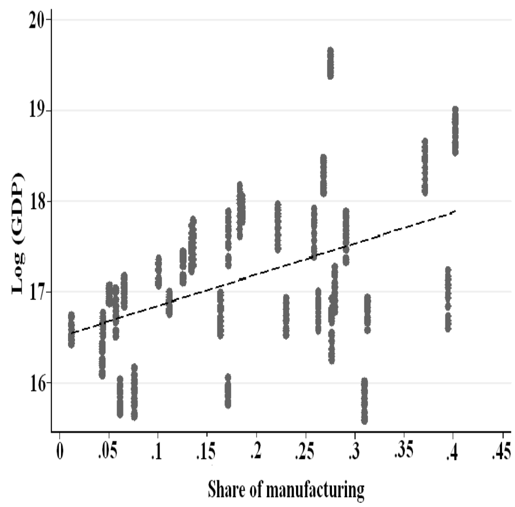
Figure 3

Mexican Economic Crises

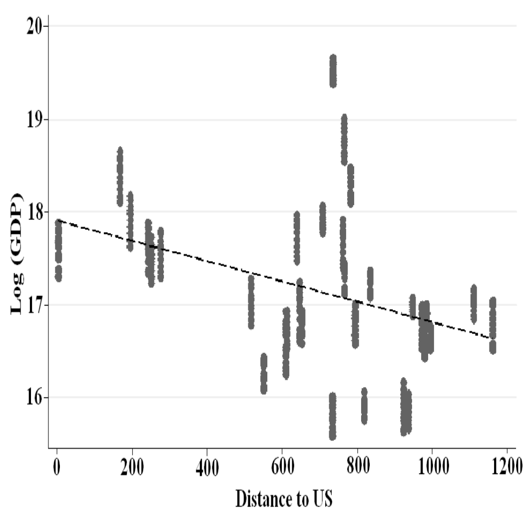


Note: GDP quarterly data was obtained from Statistical Office (INEGI). GDP data was detrended in 1993 prices (MXP millions). The series changed in 2008:I. Hence, we used information from 1980:I to 2007:IV and then we used the new series in 2003 prices in order to obtain growth rates for 2008 and 2009. We apply these growth rates to the original series to obtain the series 1980-2009. Population for the period 1990-2009 was obtained from Conapo. In order to obtain population for the period 1980-1989, we use a constant growth rate using 1980 population data from the Statistical Office.

Figure 4
Correlation with GDP
A. Share of manufacturing in 1985



B. Distance to US port of entry



Source: See data sources in section 2.

Table 1

Summary Statistics of State Level Data

	Mean		*S.D.*	
Logarithm of GDP	17.1554		0.8582	
Logarithm of GDP per capita	2.5857		0.4446	
Share of manufact. in 1985	0.1889		0.1095	
Log of distance to US port	6.3089		1.0111	
	Males		*Females*	
	Mean	*S.D.*	*Mean*	*S.D.*
Mortality rates:				
Neonatal[a]	0.9852	0.4138	0.7585	0.3368
Infant[a]	1.5157	0.6697	1.2139	0.5513
Child[a]	0.1785	0.1108	0.1483	0.1042
Child due to deficient nutrition[a]	0.0166	0.0305	0.0170	0.0314
Maternal[a]			0.0409	0.0344
Age: 13-20[b]	8.2028	3.0812	3.4405	1.7409
Age: 21-44[b]	22.6063	6.0524	8.1242	2.3686
Age: 44-64[b]	74.8904	15.7308	49.1738	10.6960
Age: 65+[b]	364.4717	75.3766	328.6394	69.9825
Due to deficient nutrition[b]	0.9944	0.5799	0.9902	0.5976
Total[b]	43.3245	7.3446	31.8858	6.5144
Population at risk:				
Births ('000s)	38.6615	30.8439	37.4572	30.0443
Age: 13-20 (hundred'000s)	2.5141	2.1115	2.5921	2.1808
Age: 21-44 (hundred'000s)	4.9557	4.5527	5.5203	5.0911
Age: 44-64 (hundred'000s)	1.9086	1.7314	2.0731	1.9575
Age: 65+ (hundred'000s)	0.7447	0.5992	0.8526	0.7725
Population (hundred '000s)	14.5876	12.4654	15.3729	13.3427

Notes: [a]Mortality rates are defined as deaths per thousand live births; [b]Mortality rates are defined as deaths per hundred thousand of the group's population. Source: Author's estimations using data from INEGI and death records from the Ministry of Health.

Table 2
First-stage Regression Coefficients

	log (GDP)		*log (GDP pc)*	
	(1)	(2)	(3)	(4)
Precrisis x share of manuf.'85	-0.2382 (0.1474)		-0.1859 (0.1983)	
1995 crisis x share of manuf.'85	-0.4737** (0.1184)		-0.5293** (0.1659)	
Intercrisis x share of manuf.'85	-0.1531 (0.0884)		-0.2769* (0.1189)	
2000 crisis x share of manuf.'85	-0.0460 (0.0499)		-0.1318 (0.0657)	
Precrisis x distance to US port		0.0179* (0.0067)		0.0306** (0.0057)
1995 crisis x distance to US port		0.0049 (0.0056)		0.0120* (0.0054)
Intercrisis x distance to US port		0.0097* (0.0040)		0.0124** (0.0044)
2000 crisis x distance to US port		0.0059** (0.0021)		0.0056** (0.0016)
R-squared	0.998	0.997	0.982	0.982
Significance of instruments: F-stat.	61.08	29.10	55.35	48.34
Observations	448	448	448	448

Notes: Clustered standard errors at the state level in parentheses. Additional control variables: State fixed effects, month fixed effects, and a time trend. *$p<0.05$, **$p<0.01$

Table 3

Effects of GDP on mortality rates by groups of interest

Coeff. on log (GDP)	OLS Female (1)	OLS Male (2)	IV w/share' 85 Female (3)	IV w/share' 85 Male (4)	IV w/distance Female (5)	IV w/distance Male (6)
Neonatal[a]	-.3365	-.5175*	-1.0708**	-1.5607**	-.3135	-.4214
	(.2010)	(.2500)	(.3186)	(.3724)	(.2240)	(.3000)
Infant[a]	-.5918	-.7887	-2.1064**	-2.7957**	-.7192*	-.9568*
	(.3589)	(.4163)	(.7001)	(.7959)	(.3584)	(.4570)
Child due nut. def[a]	.0068	.0110	-.0414	-.0544	-.0703**	-.0772**
	(.0226)	(.0223)	(.0292)	(.0323)	(.0266)	(.0277)
Child[a]	.0190	-.0432	-.1440	-.2992*	-.1397	-.2448**
	(.0681)	(.0689)	(.1079)	(.1209)	(.0805)	(.0748)
Maternal[a]	-.0001		-.0540*		.0147	
	(.0202)		(.0259)		(.0252)	
Nutritional[b]	.2755	.0669	-.1288	-.3381	-.3135	-.4981
	(.3741)	(.3527)	(.4889)	(.4463)	(.3259)	(.3919)
Age: 13-20[b]	.4329	.9278	-.0068	2.2665	-1.0024	-2.4744
	(.7851)	(1.2453)	(.8147)	(1.8421)	(1.0580)	(2.0220)
Age: 21-44[b]	.4876	4.4751	-.4495	-4.8485	2.6716*	-4.2144
	(1.3687)	(3.4309)	(1.8269)	(4.9843)	(1.2917)	(3.0676)
Age: 45-64[b]	-3.3610	5.5515	-.3057	-3.7752	-2.5790	10.4477
	(3.9905)	(6.6256)	(5.6185)	(11.5144)	(5.1738)	(8.0024)
Age: 65+[b]	93.4637**	-110.7826**	-102.0333**	-107.2582**	-169.5389**	-163.5062**
	(21.6886)	(27.4220)	(22.6945)	(23.9805)	(24.4157)	(31.1500)
Total[b]	-10.2743**	-11.6221**	-11.4901**	-14.9396**	-10.3175**	-12.0186**
	(2.6576)	(3.3663)	(3.2324)	(4.6292)	(1.8624)	(3.6229)
Observ.	5376	5376	5376	5376	5376	5376

Notes: Clustered standard errors at the state level in parentheses. Additional control variables: State fixed effects, month fixed effects, and a time trend. [a]Mortality rates are defined as deaths per thousand live births. [b]Mortality rates are defined as deaths per hundred thousand of the group's population. *$p<0.05$, **$p<0.01$

Table 4
Population at Risk in 2006

Group	*Females*	*Males*
Births[a]	1144.7780	1193.524
Age: 13-20[b]	87.1926	86.2504
Age: 21-44[b]	215.1697	189.4476
Age: 44-64[b]	102.4348	91.6285
Age: 65+[b]	39.2998	33.8397
Population[b]	571.4045	534.0058

Notes: [a]in thousands, [b]in hundred thousands.
Source: Author's estimations using data from INEGI.

Table 5
First-stage Regression Coefficients
(with additional time-varying state controls)

	log (GDP)		*log (GDP pc)*	
	(1)	(2)	(3)	(4)
Precrisis x share of manuf.'85	-0.1079 (0.1435)		-0.0475 (0.1522)	
1995 crisis x share of manuf.'85	-0.4064** (0.1272)		-0.4253** (0.1424)	
Intercrisis x share of manuf.'85	-0.0980 (0.0905)		-0.1738 (0.1021)	
2000 crisis x share of manuf.'85	-0.0045 (0.0521)		-0.0256 (0.0587)	
Precrisis x distance to US port		0.0098 (0.0068)		0.0172** (0.0048)
1995 crisis x distance to US port		-0.0048 (0.0054)		-0.0003 (0.0052)
Intercrisis x distance to US port		0.0022 (0.0039)		0.0041 (0.0042)

Table 5
(*continued*)

	log (GDP)		*log (GDP pc)*	
	(1)	(2)	(3)	(4)
2000 crisis x distance to US port		0.0022 (0.0021)		0.0034* (0.0014)
R-squared	.998	.998	.987	.987
Significance of instruments: F-stat	32.93	23.13	32.99	30.62
Observations	448	448	448	448

Notes: Clustered standard errors at the state level in parentheses. Additional control variables: State fixed effects, month fixed effects, time trend, state's educational composition, health expenditures per capita, interstate migration rate, and international migration rate; *p<0.05, **p<0.01

Table 6
Effects of GDP on Mortality Rates by Groups of Interest
(with additional time-varying state controls)

Coeff. on log (GDP)	OLS		IV w/share' 85		IV w/distance	
	Female (1)	Male (2)	Female (3)	Male (4)	Female (5)	Male (6)
Neonatal[a]	-.3489 (.2491)	-.5500 (.3166)	-.8149** (.2608)	-1.2237** (.3250)	-.3648 (.2290)	-.5667* (.2846)
Infant[a]	-.7210 (.4988)	-.9718 (.5585)	-1.9748** (.5223)	-2.5765** (.6097)	-1.1726** (.4068)	-1.4375** (.4806)
Child due nut. def[a]	-.0369 (.0192)	-.0239 (.0146)	-.0957** (.0221)	-.1073** (.0285)	-.1165** (.0290)	-.1168** (.0292)
Child[a]	-.0687 (.0648)	-.1242 (.0702)	-.2463** (.0941)	-.4107** (.1061)	-.2329** (.0698)	-.3579** (.0859)
Maternal[a]	-.0103 (.0232)		-.0531* (.0282)		-.0185 (.0281)	
Nutritional[b]	-.4395 (.2824)	-.5926 (.3097)	-1.1386** (.3877)	-1.2992** (.4225)	-1.2484** (.4014)	-1.2436** (.4278)

Table 6
(continued)

Coeff. on log (GDP)	OLS Female (1)	OLS Male (2)	IV w/share' 85 Female (3)	IV w/share' 85 Male (4)	IV w/distance Female (5)	IV w/distance Male (6)
Age: 13-20[b]	-.5275	.2649	-1.1685*	1.1575	-2.3135**	-3.4844
	(.6408)	(1.4172)	(.5949)	(2.0567)	(.8077)	(2.1709)
Age: 21-44[b]	-.8557	.3144	-3.0440*	-7.8821*	-1.0869	-9.7285*
	(1.2307)	(2.8113)	(1.4742)	(3.5105)	(1.3516)	(3.8705)
Age: 45-64[b]	4.2852	13.9485	.2297	.2579	-.6903	6.7268
	(3.8720)	(7.7914)	(4.5708)	(8.4988)	(5.5039)	(9.1326)
Age: 65+[b]	-69.1177*	-70.3216*	-120.9804**	-96.6703**	-142.4011**	-129.0441**
	(25.4467)	(28.0011)	(26.8680)	(33.4629)	(34.1861)	(40.1436)
Total[b]	-11.0861**	-12.2270**	-17.5111**	-18.4205**	-16.7874**	-18.1448**
	(2.4847)	(3.2530)	(2.4425)	(3.4818)	(1.9320)	(3.4333)
Observ.	5376	5376	5376	5376	5376	5376

Notes: Clustered standard errors at the state level in parentheses. Additional control variables: State fixed effects, month fixed effects, time trend, state's educational composition, health expenditures per capita, interstate migration rate, and international migration rate; [a]Mortality rates are defined as deaths per thousand live births. [b]Mortality rates are defined as deaths per hundred thousand of the group's population. *p<0.05, **p<0.01

Table 7
Percentage Change in Mortality Rates
Given a 1% Contraction of GDP

Group	*IV w/share' 85*		*IV w/distance*	
	Female	*Male*	*Female*	*Male*
Neonatal	1.0744**	1.2421**	0.4810	0.5752*
Infant	1.6268**	1.6999**	0.9655**	0.9484**
Child due to nutritional deficiencies	5.6187**	6.4638**	6.8399**	7.0361**
Child	1.6609**	2.3010**	1.5706**	2.0052**
Maternal	1.2981^{+}		0.4523	

Table 7

(*continued*)

Group	*IV w/share' 85*		*IV w/distance*	
	Female	*Male*	*Female*	*Male*
Nutritional	1.1499**	1.3065**	1.2608**	1.2506**
Age: 13-20	0.3396*	-0.1411	0.6724**	0.4248
Age: 21-44	0.3747*	0.3487*	0.1338	0.4303**
Age: 45-64	-0.0047	-0.0034	0.0140	-0.0898
Age: 65+	0.3681**	0.2652**	0.4333**	0.3541**
Total	0.5492**	0.4252**	0.5265**	0.4188**

Notes: The effects were estimated according to the coefficients in table 6. *p<0.05, **p<0.01, $^{+}$p<0.1. These *p*-values correspond to those from the coefficients in table 6.

Table 8

Effects of GDP on Mortality Rates by Groups of Interest
(with additional time-varying state controls and female mean education)

Coeff. on log (GDP)	OLS		IV w/share' 85		IV w/distance	
	Female (1)	Male (2)	Female (3)	Male (4)	Female (5)	Male (6)
Neonatal[a]	-.3386	-.5389	-.8136**	-1.2264**	-.3920	-.6031*
	(.2515)	(.3210)	(.2689)	(.3365)	(.2336)	(.2862)
Infant[a]	-.6707	-.9196	-1.9172**	-2.5238**	-1.1596**	-1.4227**
	(.4958)	(.5572)	(.5279)	(.6209)	(.4121)	(.4839)
Child due nut. def[a]	-.0346	-.0223	-.0937**	-.1063**	-.1168**	-.1154**
	(.0190)	(.0148)	(.0218)	(.0288)	(.0296)	(.0296)
Child[a]	-.0505	-.1098	-.2205*	-.3902**	-.2118**	-.3378**
	(.0644)	(.0688)	(.0930)	(.1048)	(.0728)	(.0857)

Table 8
(continued)

Coeff. on log (GDP)	OLS Female (1)	OLS Male (2)	IV w/share' 85 Female (3)	IV w/share' 85 Male (4)	IV w/distance Female (5)	IV w/distance Male (6)
Maternal[a]	-.0097		-.0538		-.0216	
	(.0229)		(.0284)		(.0279)	
Observ.	5376	5376	5376	5376	5376	5376

Notes: Clustered standard errors at the state level in parentheses. Additional control variables: State fixed effects, month fixed effects, time trend, state's educational composition, state's mean female education, health expenditures per capita, interstate migration rate, and international migration rate; [a]Mortality rates are defined as deaths per thousand live births. [b]Mortality rates are defined as deaths per hundred thousand of the group's population. *p < 0.05, **p < 0.01.

Table 9
First-stage Regression Coefficients by Crisis Period

	log (GDP)		*log (GDP pc)*	
	(1)	(2)	(3)	(4)
1995 crisis period				
crisis x share of manuf.'85	-.2108**		-.2386**	
	(.0207)		(.0204)	
crisis x distance to US port		-.0069**		-.0080**
		(.0012)		(.0013)
R-squared	.999	.999	.996	.995
Observations	448	448	448	448
2000 crisis period				
crisis x share of manuf.'85	.0100		.0343	
	(.0167)		(.0197)	
crisis x distance to US port		.0005		.0011
		(.0006)		(.0014)
R-squared	.999	.999	.988	.988
Observations	448	448	448	448

Notes: Clustered stand. errors at the state level in parentheses. *p < 0.05, **p < 0.01

Table 10
Effects of GDP on Mortality Rates by Groups of Interest During the 1995 Crisis

Coeff. on log (GDP)	OLS Female (1)	OLS Male (2)	IV w/share' 85 Female (3)	IV w/share' 85 Male (4)	IV w/distance Female (5)	IV w/distance Male (6)
Neonatal[a]	-.2279	-.3430	-.3659	-.6998	-.5740	-1.1123
	(.2427)	(.2880)	(.4318)	(.5784)	(.5822)	(.7450)
Infant[a]	-.5432	-.7463	-1.1294	-1.7587	-1.5765	-2.2444
	(.4664)	(.5182)	(.6699)	(.9051)	(.8708)	(1.2155)
Child due nut. def[a]	-.0393	-.0347	-.0796*	-.1121**	-.1083**	-.1188**
	(.0224)	(.0183)	(.0327)	(.0374)	(.0346)	(.0465)
Child[a]	-.1019	-.0244	-.1863	-.2873*	-.1296	-.3239*
	(.0835)	(.0800)	(.1082)	(.1243)	(.1476)	(.1561)
Maternal[a]	-.0670*		-.1017*		-.1085*	
	(.0277)		(.0479)		(.0532)	
Nutritional[b]	-.0485	-.4243	-.7385	-.6010	-1.8959**	-1.1457
	(.2680)	(.2832)	(.5600)	(.5101)	(.7012)	(.7584)
Age: 13-20[b]	0.8058	3.0921	1.1172	3.4566	-1.3921	-0.3911
	(1.2934)	(2.1081)	(1.5834)	(2.9121)	(2.1096)	(3.9132)
Age: 21-44[b]	-0.6529	4.9095	-1.0070	-1.5013	-0.5264	-8.7727
	(0.9491)	(2.9942)	(1.9075)	(3.6226)	(2.3272)	(7.0455)
Age: 45-64[b]	-4.6046	11.0868	-3.5180	17.3867	3.2547	10.7331
	(3.6343)	(8.5744)	(9.3222)	(10.2411)	(10.5216)	(17.4880)
Age: 65+[b]	-52.8018*	-35.5000	-122.6396**	-87.1472**	-153.9564**	-99.1395*
	(25.2146)	(22.4631)	(46.7944)	(31.1604)	(58.1113)	(48.2262)
Total[b]	-6.5796**	-3.2060	-8.5688**	-6.0937	-11.5219**	-13.1143*
	(2.3899)	(2.8290)	(2.4642)	(3.2870)	(3.5468)	(6.6255)
Observ.	2304	2304	2304	2304	2304	2304

Notes: Clustered standard errors at the state level in parentheses. Additional control variables: State fixed effects, month fixed effects, time trend, state's educational composition, state's mean female education, health expenditures per capita, interstate migration rate, and international migration rate; [a]Mortality rates are defined as deaths per thousand live births. [b]Mortality rates are defined as deaths per hundred thousand of the group's population. *$p < 0.05$, **$p < 0.01$.

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Appendix of tables

Table A1
Effects of GDP on Mortality Rates by Groups of Interest

Coeff. on log (GDP per capita)	OLS		IV w/share' 85		IV w/distance	
	Female	Male	Female	Male	Female	Male
	(1)	(2)	(3)	(4)	(5)	(6)
Neonatal[a]	-.1922	-.2371	-.9012**	-1.2737**	-.1966	-.2213
	(.1233)	(.1554)	(.2795)	(.3446)	(.1745)	(.2275)
Infant[a]	-.1553	-.2118	-1.4153**	-1.9559**	-.0121	-.0678
	(.2196)	(.2561)	(.5230)	(.6324)	(.2561)	(.3048)
Child due nut. def[a]	.0141	.0118	-.0447	-.0537*	-.0354	-.0345
	(.0128)	(.0125)	(.0241)	(.0270)	(.0189)	(.0194)
Child[a]	.0596	.0207	-.0317	-.1851	.0463	-.0290
	(.0392)	(.0417)	(.0745)	(.0955)	(.0570)	(.0412)
Maternal[a]	-.0078		-.0563*		.0070	
	(.0103)		(.0231)		(.0193)	
Nutritio-nal[b]	.0607	.0024	-.5502	-.4490	-.1943	-.1473
	(.2154)	(.1974)	(.3745)	(.3398)	(.2572)	(.2853)
Age: 13-20[b]	.3813	1.4239	.0368	2.4771	-.0096	-.1076
	(.5943)	(.8188)	(.7295)	(1.3105)	(.8849)	(1.5606)
Age: 21-44[b]	.4109	2.3963	.6256	-.7528	3.7847**	3.8811
	(.8282)	(1.9410)	(1.2816)	(3.3879)	(1.0140)	(2.3699)
Age: 45-64[b]	-14.6222**	-15.2982**	-11.3876*	-13.5364	-19.8312**	-10.6357
	(2.4501)	(3.6444)	(4.8558)	(8.1070)	(4.6122)	(7.3458)
Age: 65+[b]	-120.4067**	-125.3970**	-128.9232**	-116.5796**	-150.7160**	-140.2950**
	(18.4705)	(20.6071)	(19.3756)	(17.3823)	(31.1804)	(32.2596)
Total[b]	-6.9273**	-7.0770**	-8.1164**	-8.3569**	-3.6634	-1.6135
	(2.2143)	(2.5436)	(2.5984)	(3.1852)	(2.1483)	(3.1851)
Observ.	5376	5376	5376	5376	5376	5376

Notes: Clustered standard errors at the state level in parentheses. The regressions included state and monthly dummies, and a linear time trend. [a]Mortality rates are defined as deaths per thousand live births. [b]Mortality rates are defined as deaths per hundred thousand of the group's population. *$p < 0.05$, **$p < 0.01$.

Table A2

Effects of GDP on Mortality Rates by Groups of Interest
(with additional time-varying state controls)

Coeff. on log (GDP per capita)	OLS		IV w/share' 85		IV w/distance	
	Female	Male	Female	Male	Female	Male
	(1)	(2)	(3)	(4)	(5)	(6)
Neonatal[a]	-0.2129	-0.2430	-0.7933**	-1.1229**	-.3996	-.5348*
	(.1563)	(.1953)	(.2560)	(.3222)	(.2151)	(.2668)
Infant[a]	-.3160	-.3719	-1.7081**	-2.1893**	-.9962**	-1.1456*
	(.3122)	(.3467)	(.5013)	(.6016)	(.3773)	(.4460)
Child due nut. def[a]	-.0100	-.0088	-.0868**	-.0997**	-.0985**	-.0970**
	(.0134)	(.0102)	(.0230)	(.0283)	(.0296)	(.0294)
Child[a]	.0097	-.0161	-.1859*	-.3350**	-.1734*	-.2635**
	(.0449)	(.0501)	(.0868)	(.1076)	(.0685)	(.0851)
Maternal[a]	-.0072		-.0537*		-.0124	
	(.0104)		(.0255)		(.0248)	
Nutritional[b]	-.2617	-.3071	-1.1875**	-1.1658**	-1.0004**	-.9352*
	(.1741)	(.1977)	(.3599)	(.3814)	(.3650)	(.3730)
Age: 13-20[b]	-.3223	.5876	-1.0091	.7202	-1.8761*	-3.4160
	(.5642)	(1.0519)	(.5169)	(1.7827)	(.7789)	(2.1374)
Age: 21-44[b]	-.1631	-.3427	-2.3126	-6.6473*	-.0072	-7.8015*
	(.8148)	(2.0517)	(1.2287)	(3.0691)	(1.3723)	(3.9450)
Age: 45-64[b]	-1.5077	.3582	-4.5149	-2.8878	-5.9981	2.4392
	(2.5051)	(5.4900)	(4.2827)	(7.7054)	(6.0383)	(9.0229)
Age: 65+[b]	-66.5980**	-65.4001**	-126.2161**	-105.4089**	-133.4537**	-124.7529**
	(17.4688)	(19.8701)	(20.1459)	(24.3067)	(36.9287)	(37.2103)
Total[b]	-6.5094**	-7.1613*	-15.7966**	-15.8509**	-14.0641**	-14.8686**
	(2.3683)	(2.9322)	(2.5222)	(3.2443)	(2.2836)	(3.7431)
Observ.	5376	5376	5376	5376	5376	5376

Notes: Clustered standard errors at the state level in parentheses. Additional control variables: State fixed effects, month fixed effects, time trend, state's educational composition, health expenditures per capita, interstate migration rate, and international migration rate; [a]Mortality rates are defined as deaths per thousand live births. [b]Mortality rates are defined as deaths per hundred thousand of the group's population. *$p<0.05$, **$p<0.01$

Table A3

Effects of GDP on Mortality Rates by Groups of Interest (with additional time-varying state controls and female mean education)

Coeff. on log (GDP per capita)	OLS		IV w/share' 85		IV w/distance	
	Female	Male	Female	Male	Female	Male
	(1)	(2)	(3)	(4)	(5)	(6)
Neonatal[a]	-0.2078	-0.2367	-0.7919**	-1.1208**	-0.4275*	-0.5701*
	(0.1550)	(0.1932)	(0.2568)	(0.3226)	(0.2165)	(0.2653)
Infant[a]	-0.2926	-0.3469	-1.6810**	-2.1604**	-1.0207**	-1.1698**
	(0.3068)	(0.3397)	(0.4951)	(0.5947)	(0.3848)	(0.4499)
Child due nut. def[a]	-0.0089	-0.0081	-0.0861**	-0.0988**	-0.0995**	-0.0959**
	(0.0132)	(0.0104)	(0.0226)	(0.0282)	(0.0303)	(0.0299)
Child[a]	0.0176	-0.0095	-0.1777*	-0.3256**	-0.1703*	-0.2569**
	(0.0456)	(0.0493)	(0.0854)	(0.1055)	(0.0749)	(0.0863)
Maternal[a]	-0.0069		-0.0541*		-0.0153	
	(0.0104)		(0.0255)		(0.0252)	
Observ.	5376	5376	5376	5376	5376	5376

Notes: Clustered standard errors at the state level in parentheses. Additional control variables: State fixed effects, month fixed effects, time trend, state's educational composition, state's mean female education, health expenditures per capita, interstate migration rate, and international migration rate; [a]Mortality rates are defined as deaths per thousand live births. [b]Mortality rates are defined as deaths per hundred thousand of the group's population. *$p < 0.05$, **$p < 0.01$.

Table A4

Effects of GDP on Mortality Rates by Groups of Interest During the 1995 Crisis

Coeff. on log (GDP per capita)	OLS		IV w/share' 85		IV w/distance	
	Female	Male	Female	Male	Female	Male
	(1)	(2)	(3)	(4)	(5)	(6)
Neonatal[a]	-0.2220	-0.3127	-0.3233	-0.6182	-0.4924	-0.9540
	(0.2332)	(0.2940)	(0.3794)	(0.4999)	(0.4895)	(0.6111)
Infant[a]	-0.5051	-0.7114	-0.9977	-1.5536*	-1.3522	-1.9251
	(0.3977)	(0.4860)	(0.5826)	(0.7713)	(0.7204)	(0.9838)

Table A4
(*continued*)

Coeff. on log (GDP per capita)	OLS		IV w/share' 85		IV w/distance	
	Female	Male	Female	Male	Female	Male
	(1)	(2)	(3)	(4)	(5)	(6)
Child due nut. def[a]	-.0562*	-.0451*	-.0703*	-.0991**	-.0929**	-.1019**
	(.0226)	(.0173)	(.0281)	(.0324)	(.0282)	(.0393)
Child[a]	-.0943	-.0062	-.1646	-.2538*	-.1112	-.2778*
	(.0673)	(.0735)	(.0952)	(.1099)	(.1265)	(.1307)
Maternal[a]	-.0521		-.0898*		-.0931*	
	(.0266)		(.0418)		(.0452)	
Nutritio-nal[b]	-.1791	-.6078	-.6524	-.5309	-1.6262**	-.9827
	(.2793)	(.3367)	(.4874)	(.4425)	(.5698)	(.6325)
Age: 13-20[b]	.1626	2.6902	.9869	3.0536	-1.1941	-.3354
	(1.1009)	(1.8934)	(1.4172)	(2.5343)	(1.7994)	(3.3555)
Age: 21-44[b]	-1.5002	3.6873	-.8896	-1.3263	-.4515	-7.5247
	(.7731)	(2.9889)	(1.6764)	(3.1851)	(1.9859)	(5.8263)
Age: 45-64[b]	-2.7052	4.2791	-3.1079	15.3596	2.7917	9.2062
	(3.7182)	(6.6836)	(8.2267)	(9.2962)	(9.0508)	(15.2561)
Age: 65+[b]	-38.2040	-30.5932	-108.3408**	-76.9865**	-132.0546**	-85.0359*
	(21.6267)	(21.5523)	(40.8761)	(27.4701)	(50.9890)	(40.6837)
Total[b]	-5.2860**	-2.7379	-7.5698**	-5.3832	-9.8828**	-11.2487*
	(1.8109)	(2.2368)	(2.0948)	(2.8121)	(2.9972)	(5.3614)
Observ.	2304	2304	2304	2304	2304	2304

Notes: Clustered standard errors at the state level in parentheses. Additional control variables: State fixed effects, month fixed effects, time trend, state's educational composition, state's mean female education, health expenditures per capita, interstate migration rate, and international migration rate; [a]Mortality rates are defined as deaths per thousand live births. [b]Mortality rates are defined as deaths per hundred thousand of the group's population. *$p < 0.05$, **$p < 0.01$.