

Impact of Economic Crises on Mortality: The Case of Mexico

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October 30, 2009

Abstract

Given the current depression of the global economy, questions have been raised on what the consequences will be for the wellbeing 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 (UN, 2009). In this paper, we take a look at the consequences of previous crises in the Mexican economy to draw conclusions on the possible effects that the current global financial crisis will have on infant, maternal and elderly mortality. The identification of the effect of the business cycle on health is difficult because the Gross Domestic Product itself may be a function of health. Previous analyses have not successfully tackled this endogeneity issues. In order to solve for endogeneity and in the spirit of Angrist and Kugler (2003), we propose the use of two sets of instruments at the state level: the share of manufacturing in 1985 and distance to the closest US port of entry, both interacted with period dummies that define the business cycle. Our findings 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. In terms of the MDGs, the current crisis would definitely imply a reverse towards the attainment of the infant mortality goal, sending us back to 2003 infant mortality levels. Given the IMF forecasts for 2009 and 2010, and our findings, Mexico would need to grow 7.72 percent between 2011 and 2015 in order to attain this particular MDG. It seems thus very important to create instruments that shield the children and the elderly from negative economic shocks.

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1 Introduction

Given the current depression of the global economy, questions have been raised on what the consequences will be for the wellbeing 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 (UN, 2009). According to the International Monetary Fund (IMF), as a result of Mexico's interlinkages with the American economy Mexico has been particularly harshly hit by the current recession. The IMF predict that the Mexican economy will contract by 3.7 percent during 2009, and that it will only grow by one percent during 2010 (IMF, 2009). Such a contraction, and slowdown in growth could certainly have dire effects towards 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 around 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. So, 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 turn to self-employment in order to get an income.

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

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

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.

There is a growing literature looking at the pro- or counter-cyclicity of mortality in different countries.³ In this paper, we will focus in 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 for being fragmented and segmented, where 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 of the 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). In consequence, 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 that 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 1994-5 crisis there were 7,000 additional 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

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

behavior: in general, mortality decline 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. Gonzalez 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 using the year fixed effects arguing that they control for changes in the health culture, technological changes in the production of health and other sorts of phenomenae 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 both 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 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.

⁴The 1995 peso crisis was triggered by the inability to sustain the exchange rate *vis à vis* the dollar. As a result, the peso was devaluated. This 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.

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 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. We did not find any significant differences in the business cycle effect between males and females. In terms of the MDGs, the current crisis would definitely imply a reverse towards the attainment of the infant mortality goal, sending us back to 2003 infant mortality levels. Given the IMF forecasts for 2009 and 2010, and our findings, Mexico would need to grow 7.72 percent between 2011 and 2015 in order to attain this particular MDG. It seems thus very important to create instruments that shield the children and the elderly from negative economic shocks.

The rest of the paper is organized as follows. Section 2 describes the data sources used in the analysis. Section 3 outlays the empirical strategy and Section 4 presents the findings of this paper and some robustness checks. Section 5 concludes and explains the implications of our results towards 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 Mexican vital

statistics.⁵ 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,⁶ 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.⁷ 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;⁸ maternal deaths;⁹ total deaths due 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 death cases in each group over live births 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.¹⁰ 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

⁵According 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 Mexican mortality data is said to have as good quality as the United States, and it is better than German mortality data.

⁶The 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.

⁷From 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.

⁸The 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).

⁹The 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.

¹⁰ A problem with the data is that not every child is registered in the year when 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 birthdate, the amount of children being registered is minimal (see Figure A-1 in Appendix A). 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 A-2 in Appendix A.

years. This is particularly evident for the mortality rates due to nutritional deficiencies:¹¹ there is a tip for both males and females during the crises years, and during the 2000 crisis the tip 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 death cases in each group over each group's population in hundred thousands. In this case the population data was estimated from the 1990 and 2000 Census of Population and the 1995 and 2005 *Conteos de Población* from the *Instituto Nacional de Estadística y Geografía* (INEGI— the national statistical office).¹² 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.¹³ The rest of the national time series of the mortality rates 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 for the elderly. Given the apparent 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).¹⁴

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 latter GDP data. In this paper we will define an economic crisis as a significant decline in the economic activity, as measured by the GDP, that lasted two or more consecutive quarters. In some cases, the crisis period will be defined by a dummy variable. The beginning of

¹¹The most common measures of nutritional status in the literature are height-for-age, the body mass index, and z-scores 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 sort of novel in the literature of nutritional status.

¹²There are no available yearly time series of population by gender and for each of the age groups that we defined.

¹³The exception to this "in between surveys" rule is the state of Chiapas. Chiapas' estimated population using the 1995 *Conteo de Población* was too low as compared to 1990 and 2000. Our intuition is that the *Zapatista* guerilla that started in 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.

¹⁴A possibly extreme result of this reallocation of resources is that 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.

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, which started on: 1982:I, 1985:IV, 1995:I, 2000:IV, and 2008:III. It is important to stress that these crises varied on their 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 get back to the pre-1995 GDP level. In contrast, the 2000 crisis was characterized for exhibiting smaller decreases in the 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. However, according to the analysts, the current crisis shares characteristics of both: 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.¹⁵ 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 port. The data on the trade volume entering through each port was obtained from the Bureau of Transportation Statistics, North American Transborder Freight Data.¹⁶ Since the data was not available for a precrisis year, the ranking of the ports of entry was made as of 2005, which is a non-crisis period, and we 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 censuses and *conteos*. In order to create yearly time series, we also assumed that education increased

¹⁵<http://www.infoplease.com/atlas/calculate-distance.html>

¹⁶http://www.bts.gov/programs/international/transborder/TBDR_QA.html.

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 health expenditures and emigration rates data come from the Basic Demographic Indicators at the *Consejo Nacional de Población* (CONAPO - National Population Council).

Our final dataset will cover the period from 1993 to 2006. Table 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 be 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 disentangle 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:

$$Y_{jmt}^k = \alpha^k + \beta^k \log(GDP_{jt}) + \delta_j^k + \delta_m^k + \varepsilon_{jt}^k, \quad (1)$$

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 to

year fixed effects in a annual series of mortality and GDP in the United States. According to Ruhm, these fixed effects will control for advances in the 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 *et al*, 2007). We will follow this latter strategy in order to avoid the problems from using year fixed effects.¹⁷ More specifically, we will only use a linear trend, which we will assume will be enough to control for such technological and cultural changes. The equation of interest thus becomes:

$$Y_{jmt}^k = \alpha^k + \beta^k \log(GDP_{jt}) + \delta_j^k + \delta_m^k + \theta t + \varepsilon_{jt}^k, \quad (2)$$

where t is controlling for the annual trend.

We still have another concern with regards to 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 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_{OLS}^k 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: (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 , with period dummies. The idea behind these instruments is to exploit the fact that the manufacturing sector was the most affected during the 1995 and 2000 crises. The correlation

¹⁷If there were a large national shock in a given year, this trend would not take that variation away. We will thus be enabled to use this national level variation in our estimation, and relate it to the business cycle.

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 the Mexico City belt, especially after 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^2 , inter-crisis period (1997-1999) C_t^3 , 2000 crisis period (2000-2004) C_t^4 , and the post-crisis period (2005-2007) C_t^5 .¹⁸ These period dummies thus track the business cycle closely. Our sets of instruments will explore whether there are within state breaks from the general time trend in the mortality rates over the business cycle.

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

$$\log(GDP_{jt}) = \pi_0 + \sum_{p=1}^4 \pi_p M_{j,1985} \cdot C_t^p + \mu_j + \pi_5 t + u_{jt} \quad (3)$$

or

$$\log(GDP_{jt}) = \gamma_0 + \sum_{p=1}^4 \gamma_p D_j \cdot C_t^p + \eta_j + \gamma_5 t + \nu_{jt} \quad (4)$$

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.

¹⁸This 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 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.¹⁹ 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 just presents each coefficient β^k for each of the groups of interest. The first two Columns in the Table have the resulting coefficients from OLS estimation. Most of the OLS coefficients are not significant, the exception being 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

¹⁹In the presence of one endogenous variable (GDP), Stock et al. (2002) suggest a critical value of 16.85 in order to reject the null hypothesis that the instruments are weak (Murray, 2006). Our F-statistics are well above that critical value.

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 A-1 in Appendix A; they look very similar as when using the log of GDP instead. In what follows, we will try to overcome the issue arising from the difference in the estimates from 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. Using the population at risk as of 2006 (see Table 4), our results imply that a one percent decrease in GDP in 2006 would produce 288 and 396 additional female and male infant deaths during the year, respectively. These results also point to 15 additional maternal deaths per one percent decrease in the GDP. Similarly, a one percent decrease in GDP would produce 480 and 420 additional female and male elder deaths during the year, respectively.

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 & Donato, 1999). These kind of 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 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:

$$Y_{jmt}^k = \alpha^k + \beta^k \log(GDP_{jt}) + \gamma X_{jt} + \delta_j^k + \delta_m^k + \theta t + \varepsilon_{jt}^k, \quad (5)$$

where X_{jt} is a vector of time-variant state characteristics containing 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 $\log(\text{GDP})$ 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 specification. These results imply that mortality behaves countercyclically for almost all groups. These estimates in fact point to a marginally significant negative coefficient on maternal mortality (see Column 3 in the Table). According to the coefficients in Columns 3 and 4 of Table 6, and using the population at risk as of 2006, we estimated the total amount of additional deaths that a 1 percent decrease in GDP would produce. For instance, a 1 percent drop in GDP would lead to almost 2,400 additional deaths in Mexico (see our estimates in Table 7).

4.1 Robustness Checks

The literature has found that the mother's education is instrumental on the health outcomes of children and maternal health (Currie and Moretti, 2003; Cutler, Deaton and Lleras-Muney, 2006). For these 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 equation in the previous tables show that the instrument is mostly working through the effect of the 1995 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 is 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 of 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 as an explanatory variable (see Tables A-1-A-4 in Appendix A); and (3) aggregating the mortality data to the quarter, half year, and year. None of these changes produced any significance difference in our results. We are confident that after controlling for time-variant state characteristics, our results are 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 had 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 out that the mortality due to malnutrition increases during crisis periods: we found that 30 additional children die, and 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 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 difference between the 1995 and the 2008 crisis 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 a 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 now be much more exposed to the effects of the negative macroeconomic shock than in 1995. Given the evidence in the literature, this cut back in remittances will deteriorate the health status of the migrants' dependents.

Notwithstanding, we consider it important to analyze the implications of our results for the 2008 crisis. The IMF estimates that the Mexican economy will contract by 3.7 percent during 2009 and it will only grow by one percent in 2010 (MF, 2009). According to our estimates and using the 2006 population at risk, such a contraction would entail almost 9,000 additional deaths in the country, around 600 of those deaths would be due to a deficient nutrition, and 105 deaths would be due to malnutrition of children specifically. Although these numbers seem to be small relative to the total population, Van den Berg et al. (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 3.7 contraction would induce 2.0207 additional infant deaths per live birth. According to CONAPO's Basic Demographic Information forecasts, Mexico was well on the path towards reducing infant mortality by $\frac{2}{3}$ 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 17.22 (this is the infant mortality level we had in 2003). If the economy does grow by one percent in 2010, infant mortality will decrease by 0.54156 during that year. Mexico would thus need to grow 7.72 percent between 2011 and 2015 in order to attain the infant mortality MDG.

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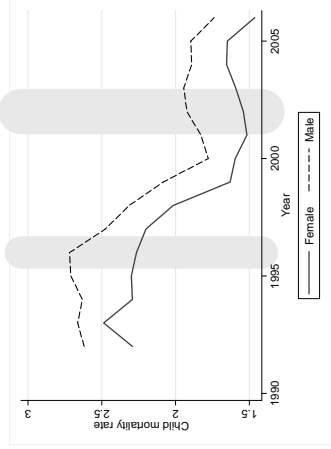
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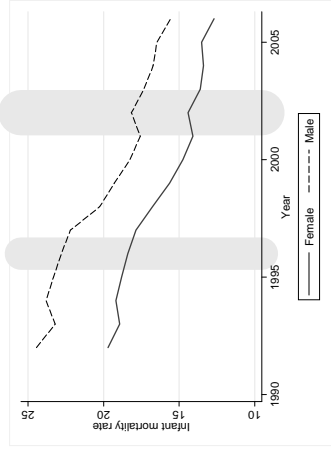
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Figure 1: Mortality rates

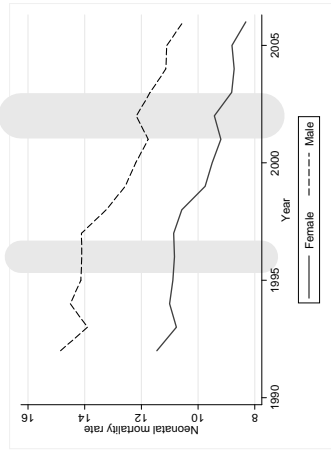
C. Child



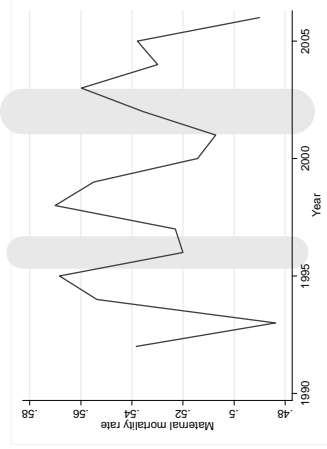
B. Infant



A. Neonatal



E. Maternal



D. Child due to deficient nutrition

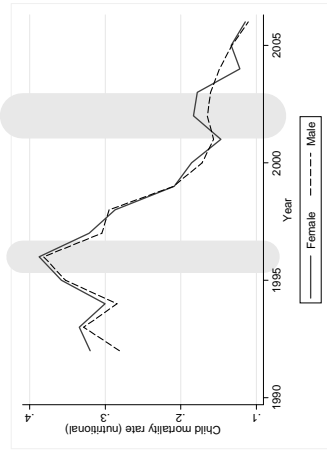
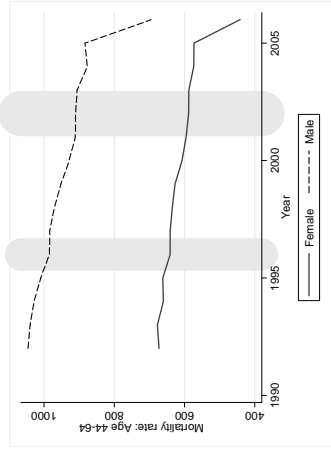
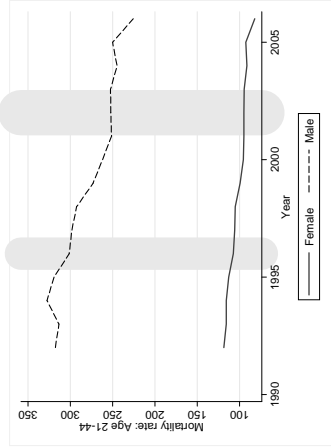


Figure 2: Mortality rates

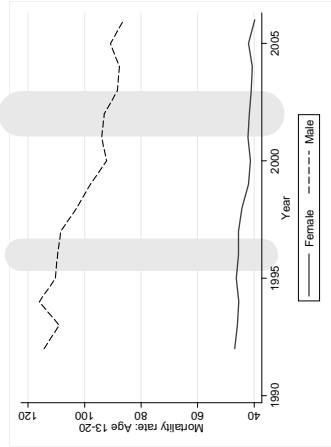
C. Ages 45-64



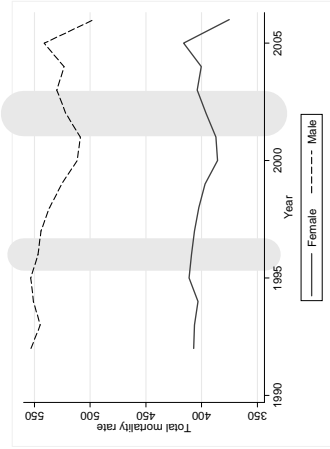
B. Ages 21-44



A. Ages 13-20



E. Total



D. Ages 65 or more

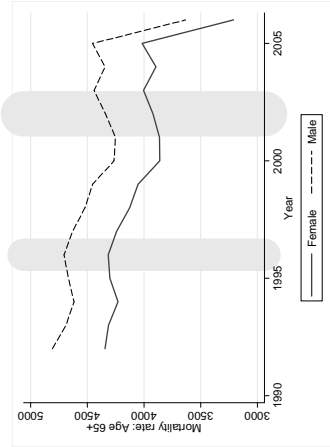
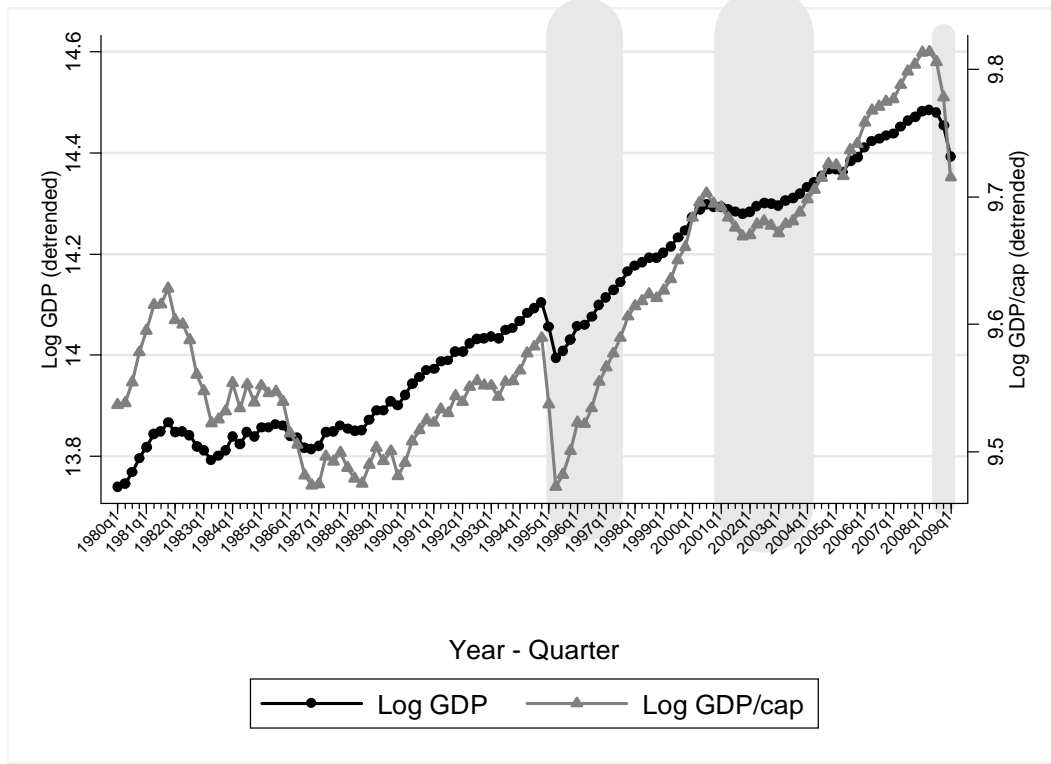


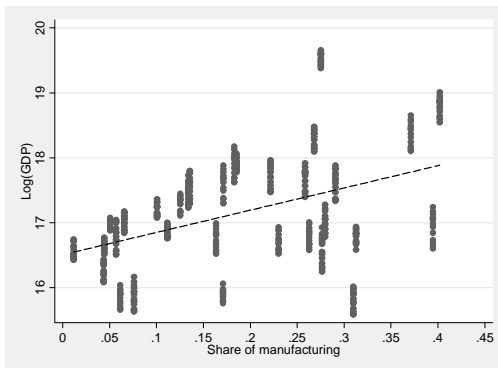
Figure 3: Mexican Economic Crises



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-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

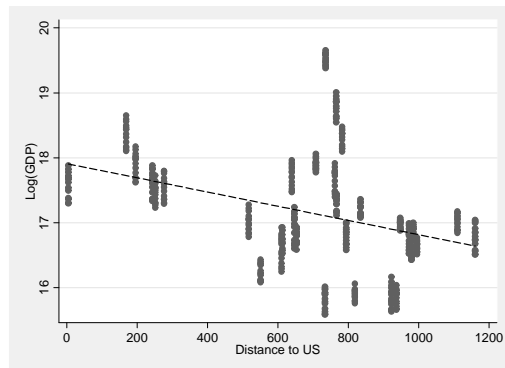


Table 1: Summary statistics of state level data

	Mean		S.D.	
Logarithm of GDP	17.1554		0.8582	
Logarithm of GDP per capita	2.5857		0.4446	
Share of manufacturing 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	0.9852	0.4138	0.7585	0.3368
Infant	1.5157	0.6697	1.2139	0.5513
Child	0.1785	0.1108	0.1483	0.1042
Child due to deficient nutrition	0.0166	0.0305	0.0170	0.0314
Maternal			0.0409	0.0344
Age: 13-20	8.2028	3.0812	3.4405	1.7409
Age: 21-44	22.6063	6.0524	8.1242	2.3686
Age: 44-64	74.8904	15.7308	49.1738	10.6960
Age: 65+	364.4717	75.3766	328.6394	69.9825
Due to deficient nutrition	0.9944	0.5799	0.9902	0.5976
Total	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

Source: Author's estimations. See text for data sources.

Table 2: First-stage regression coefficients

	(1)	(2)	(3)	(4)
	log(GDP)		log(GDP pc)	
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

Clustered standard errors at the state level in parentheses. The regressions included state and monthly dummies, and a linear time trend.

** p<0.01, * p<0.05

Table 3: Effect of GDP on mortality rates by groups of interest

	OLS		IV w/ share '85		IV w/ distance	
	Female (1)	Male (2)	Female (3)	Male (4)	Female (5)	Male (6)
Neonatal	-0.3365 (0.2010)	-0.5175* (0.2500)	-1.0708** (0.3186)	-1.5607** (0.3724)	-0.3135 (0.2240)	-0.4214 (0.3000)
Infant	-0.5918 (0.3589)	-0.7887 (0.4163)	-2.1064** (0.7001)	-2.7957** (0.7959)	-0.7192* (0.3584)	-0.9568* (0.4570)
Child due to nutritional deficiencies	0.0068 (0.0226)	0.0110 (0.0223)	-0.0414 (0.0292)	-0.0544 (0.0323)	-0.0703** (0.0266)	-0.0772** (0.0277)
Child	0.0190 (0.0681)	-0.0432 (0.0689)	-0.1440 (0.1079)	-0.2992* (0.1209)	-0.1397 (0.0805)	-0.2448** (0.0748)
Maternal	-0.0001 (0.0202)		-0.0540* (0.0259)		0.0147 (0.0252)	
Nutritional	0.2755 (0.3741)	0.0669 (0.3527)	-0.1288 (0.4889)	-0.3381 (0.4463)	-0.3135 (0.3259)	-0.4981 (0.3919)
Age: 13-20	0.4329 (0.7851)	0.9278 (1.2453)	-0.0068 (0.8147)	2.2665 (1.8421)	-1.0024 (1.0580)	-2.4744 (2.0220)
Age: 21-44	0.4876 (1.3687)	4.4751 (3.4309)	-0.4495 (1.8269)	-4.8485 (4.9843)	2.6716* (1.2917)	-4.2144 (3.0676)
Age: 45-64	-3.3610 (3.9905)	5.5515 (6.6256)	-0.3057 (5.6185)	-3.7752 (11.5144)	-2.5790 (5.1738)	10.4477 (8.0024)
Age: 65+	-93.4637** (21.6886)	-110.7826** (27.4220)	-102.0333** (22.6945)	-107.2582** (23.9805)	-169.5389** (24.4157)	-163.5062** (31.1500)
Total	-10.2743** (2.6576)	-11.6221** (3.3663)	-11.4901** (3.2324)	-14.9396** (4.6292)	-10.3175** (1.8624)	-12.0186** (3.6229)
Observations	5376	5376	5376	5376	5376	5376

Clustered standard errors at the state level in parentheses. The regressions included state and monthly dummies, and a linear time trend.

** p<0.01, * p<0.05

Table 4: Population at risk in 2006

Group	Females	Males
Births ('000s)	1144.7780	1193.524
Age: 13-20 (hundred '000s)	87.1926	86.2504
Age: 21-44 (hundred '000s)	215.1697	189.4476
Age: 44-64 (hundred '000s)	102.4348	91.6285
Age: 65+ (hundred '000s)	39.2998	33.8397
Population (hundred '000s)	571.4045	534.0058

Source: Author's estimations. See text for data sources.

Table 5: First-stage regression coefficients

	(1)	(2)	(3)	(4)
	log(GDP)		log(GDP pc)	
Precrisis x Share of manuf. '85	-0.1079		-0.0475	
	(0.1435)		(0.1522)	
1995 Crisis x Share of manuf. '85	-0.4064**		-0.4253**	
	(0.1272)		(0.1424)	
Intercrisis x Share of manuf. '85	-0.0980		-0.1738	
	(0.0905)		(0.1021)	
2000 Crisis x Share of manuf. '85	-0.0045		-0.0256	
	(0.0521)		(0.0587)	
Precrisis x Distance to US port		0.0098		0.0172**
		(0.0068)		(0.0048)
1995 Crisis x Distance to US port		-0.0048		-0.0003
		(0.0054)		(0.0052)
Intercrisis x Distance to US port		0.0022		0.0041
		(0.0039)		(0.0042)
2000 Crisis x Distance to US port		0.0022		0.0034*
		(0.0021)		(0.0014)
Additional controls:				
State educational composition	Y	Y	Y	Y
Public health expenditures	Y	Y	Y	Y
Emigration rates	Y	Y	Y	Y
R-squared	0.998	0.998	0.987	0.987
Significance of instruments: F-stat	32.93	23.13	32.99	30.62
Observations	448	448	448	448

Clustered standard errors at the state level in parentheses
** p<0.01, * p<0.05

Table 6: Effect of GDP on mortality rates by groups of interest

	OLS			IV w/ share '85			IV w/ distance		
	Female (1)	Male (2)		Female (3)	Male (4)		Female (5)	Male (6)	
Neonatal	-0.3489 (0.2491)	-0.5500 (0.3166)		-0.8149** (0.2608)	-1.2237** (0.3250)		-0.3648 (0.2290)	-0.5667* (0.2846)	
Infant	-0.7210 (0.4988)	-0.9718 (0.5585)		-1.9748** (0.5223)	-2.5765** (0.6097)		-1.1726** (0.4068)	-1.4375** (0.4806)	
Child due to nutritional deficiencies	-0.0369 (0.0192)	-0.0239 (0.0146)		-0.0957** (0.0221)	-0.1073** (0.0285)		-0.1165** (0.0290)	-0.1168** (0.0292)	
Child	-0.0687 (0.0648)	-0.1242 (0.0702)		-0.2463** (0.0941)	-0.4107** (0.1061)		-0.2329** (0.0698)	-0.3579** (0.0859)	
Maternal	-0.0103 (0.0232)			-0.0531 (0.0282)			-0.0185 (0.0281)		
Nutritional	-0.4395 (0.2824)	-0.5926 (0.3097)		-1.1386** (0.3877)	-1.2992** (0.4225)		-1.2484** (0.4014)	-1.2436** (0.4278)	
Age: 13-20	-0.5275 (0.6408)	0.2649 (1.4172)		-1.1685* (0.5949)	1.1575 (2.0567)		-2.3135** (0.8077)	-3.4844 (2.1709)	
Age: 21-44	-0.8557 (1.2307)	0.3144 (2.8113)		-3.0440* (1.4742)	-7.8821* (3.5105)		-1.0869 (1.3516)	-9.7285* (3.8705)	
Age: 45-64	4.2852 (3.8720)	13.9485 (7.7914)		0.2297 (4.5708)	0.2579 (8.4988)		-0.6903 (5.5039)	6.7268 (9.1326)	
Age: 65+	-69.1177* (25.4467)	-70.3216* (28.0011)		-120.9804** (26.8680)	-96.6703** (33.4629)		-142.4011** (34.1861)	-129.0441** (40.1436)	
Total	-11.0861** (2.4847)	-12.2270** (3.2530)		-17.5111** (2.4425)	-18.4205** (3.4818)		-16.7874** (1.9320)	-18.1448** (3.4333)	
Additional controls									
State fixed effects	Y	Y		Y	Y		Y	Y	
Month fixed effects	Y	Y		Y	Y		Y	Y	
Time trend	Y	Y		Y	Y		Y	Y	
State's educational composition	Y	Y		Y	Y		Y	Y	
Health expenditures per capita	Y	Y		Y	Y		Y	Y	
Interstate migration rate	Y	Y		Y	Y		Y	Y	
International migration rate	Y	Y		Y	Y		Y	Y	
Observations	5376	5376		5376	5376		5376	5376	

Clustered standard errors at the state level in parentheses

** p<0.01, * p<0.05

Table 7: Additional deaths for a one percent contraction of GDP

	(1)	(2)	(3)
Group	Females	Males	F+M
Neonatal	112	175	287
Infant	271	369	640
Child due to nutritional deficiencies	13	15	29
Child	34	59	93
Maternal	7		7
Nutritional	78	83	161
Age: 13-20	12	NS	12
Age: 21-44	79	111	190
Age: 65+	571	393	963
Total	1201	1180	2381

These estimates use the 2006 population at risk.

Table 8: Effect of GDP on mortality rates by groups of interest

	OLS		IV w/ share '85		IV w/ distance	
	Female (1)	Male (2)	Female (3)	Male (4)	Female (5)	Male (6)
Neonatal	-0.3386 (0.2515)	-0.5389 (0.3210)	-0.8136** (0.2689)	-1.2264** (0.3365)	-0.3920 (0.2336)	-0.6031* (0.2862)
Infant	-0.6707 (0.4958)	-0.9196 (0.5572)	-1.9172** (0.5279)	-2.5238** (0.6209)	-1.1596** (0.4121)	-1.4227** (0.4839)
Child due to nutritional deficiencies	-0.0346 (0.0190)	-0.0223 (0.0148)	-0.0937** (0.0218)	-0.1063** (0.0288)	-0.1168** (0.0296)	-0.1154** (0.0296)
Child	-0.0505 (0.0644)	-0.1098 (0.0688)	-0.2205* (0.0930)	-0.3902** (0.1048)	-0.2118** (0.0728)	-0.3378** (0.0857)
Maternal	-0.0097 (0.0229)		-0.0538 (0.0284)		-0.0216 (0.0279)	
Additional controls						
State fixed effects	Y	Y	Y	Y	Y	Y
Month fixed effects	Y	Y	Y	Y	Y	Y
Time trend	Y	Y	Y	Y	Y	Y
State's educational composition	Y	Y	Y	Y	Y	Y
State's mean female education	Y	Y	Y	Y	Y	Y
Health expenditures per capita	Y	Y	Y	Y	Y	Y
Interstate migration rate	Y	Y	Y	Y	Y	Y
International migration rate	Y	Y	Y	Y	Y	Y
Observations	5376	5376	5376	5376	5376	5376

Clustered standard errors at the state level in parentheses

** p<0.01, * p<0.05

Table 9: First-stage regression coefficients by crisis period

1995 crisis period				
	(1)	(2)	(3)	(4)
	log(GDP)		log(GDP pc)	
1995 Crisis x Share of manuf. '85	-0.2108**		-0.2386**	
	(0.0207)		(0.0204)	
1995 Crisis x Distance to US port		-0.0069**		-0.0080**
		(0.0012)		(0.0013)
R-squared	0.999	0.999	0.996	0.995
Observations	448	448	448	448
2000 crisis period				
	(1)	(2)	(3)	(4)
	log(GDP)		log(GDP pc)	
2000 Crisis x Share of manuf. '85	0.0100		0.0343	
	(0.0167)		(0.0197)	
2000 Crisis x Distance to US port		0.0005		0.0011
		(0.0006)		(0.0014)
R-squared	0.999	0.999	0.988	0.988
Observations	448	448	448	448
Clustered standard errors at the state level in parentheses				
** p<0.01, * p<0.05				

Table 10: Effect of GDP on mortality rates by groups of interest during the 1995 crisis

	OLS				IV w/ share '85		IV w/ distance	
	Female (1)	Male (2)	Female (3)	Male (4)	Female (5)	Male (6)		
Neonatal	-0.2279 (0.2427)	-0.3430 (0.2880)	-0.3659 (0.4318)	-0.6998 (0.5784)	-0.5740 (0.5822)	-1.1123 (0.7450)		
Infant	-0.5432 (0.4664)	-0.7463 (0.5182)	-1.1294 (0.6699)	-1.7587 (0.9051)	-1.5765 (0.8708)	-2.2444 (1.2155)		
Child due to nutritional deficiencies	-0.0393 (0.0224)	-0.0347 (0.0183)	-0.0796* (0.0327)	-0.1121** (0.0374)	-0.1083** (0.0346)	-0.1188* (0.0465)		
Child	-0.1019 (0.0835)	-0.0244 (0.0800)	-0.1863 (0.1082)	-0.2873* (0.1243)	-0.1296 (0.1476)	-0.3239* (0.1561)		
Maternal	-0.0670* (0.0277)		-0.1017* (0.0479)		-0.1085* (0.0532)			
Nutritional	-0.0485 (0.2680)	-0.4243 (0.2832)	-0.7385 (0.5600)	-0.6010 (0.5101)	-1.8959** (0.7012)	-1.1457 (0.7584)		
Age: 13-20	0.8058 (1.2934)	3.0921 (2.1081)	1.1172 (1.5834)	3.4566 (2.9121)	-1.3921 (2.1096)	-0.3911 (3.9132)		
Age: 21-44	-0.6529 (0.9491)	4.9095 (2.9942)	-1.0070 (1.9075)	-1.5013 (3.6226)	-0.5264 (2.3272)	-8.7727 (7.0455)		
Age: 45-64	-4.6046 (3.6343)	11.0868 (8.5744)	-3.5180 (9.3222)	17.3867 (10.2411)	3.2547 (10.5216)	10.7331 (17.4880)		
Age: 65+	-52.8018* (25.2146)	-35.5000 (22.4631)	-122.6396** (46.7944)	-87.1472** (31.1604)	-153.9564** (58.1113)	-99.1395* (48.2262)		
Total	-6.5796** (2.3899)	-3.2060 (2.8290)	-8.5688** (2.4642)	-6.0937 (3.2870)	-11.5219** (3.5468)	-13.1143* (6.6255)		
Additional controls								
State fixed effects	Y	Y	Y	Y	Y	Y		
Month fixed effects	Y	Y	Y	Y	Y	Y		
Time trend	Y	Y	Y	Y	Y	Y		
State's educational composition	Y	Y	Y	Y	Y	Y		
State's mean female education	Y	Y	Y	Y	Y	Y		
Health expenditures per capita	Y	Y	Y	Y	Y	Y		
Interstatal migration rate	Y	Y	Y	Y	Y	Y		
International migration rate	Y	Y	Y	Y	Y	Y		
Observations	2304	2304	2304	2304	2304	2304		

Clustered standard errors at the state level in parentheses

** p<0.01, * p<0.05

A Appendix of Tables and Figures

Figure A-1: Share of births registered by state

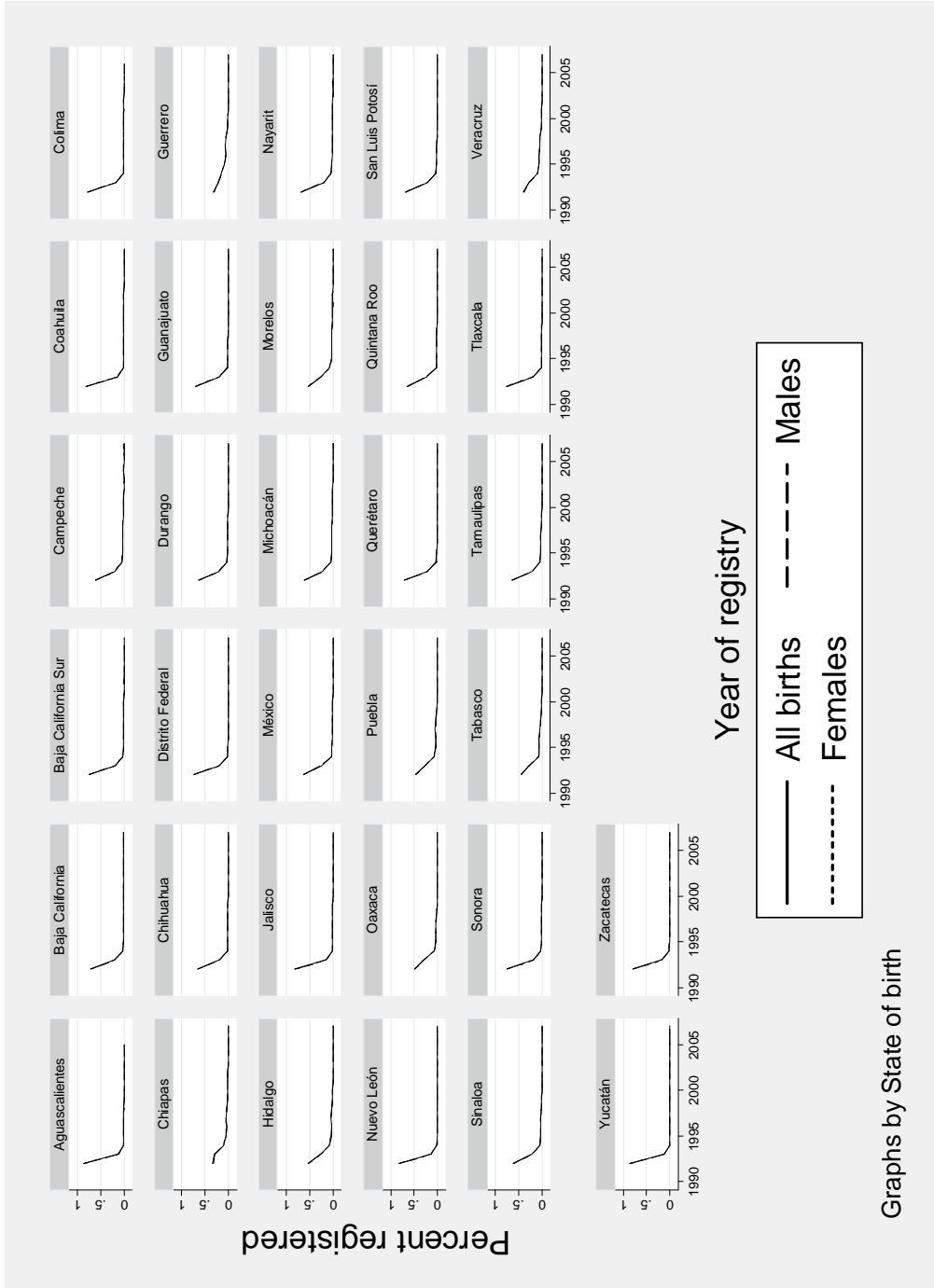


Figure A-2: Birth series by state

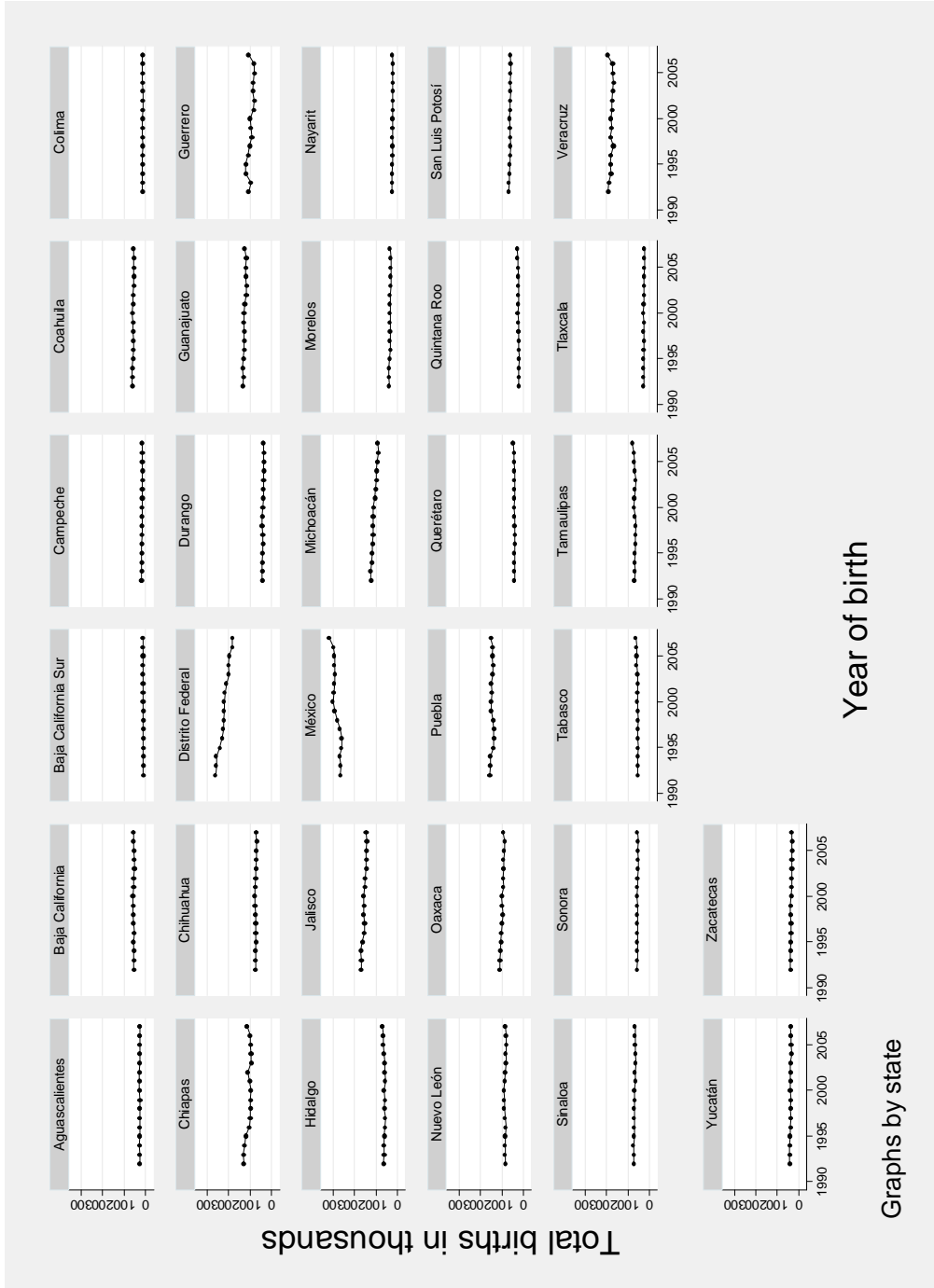


Table A-1: Effect of GDP on mortality rates by groups of interest

Coefficient on log(GDP per capita)	OLS		IV w/ share '85		IV w/ distance	
	Female (1)	Male (2)	Female (3)	Male (4)	Female (5)	Male (6)
Neonatal	-0.1922 (0.1233)	-0.2371 (0.1554)	-0.9012** (0.2795)	-1.2737** (0.3446)	-0.1966 (0.1745)	-0.2213 (0.2275)
Infant	-0.1553 (0.2196)	-0.2118 (0.2561)	-1.4153** (0.5230)	-1.9559** (0.6324)	-0.0121 (0.2561)	-0.0678 (0.3048)
Child due to nutritional deficiencies	0.0141 (0.0128)	0.0118 (0.0125)	-0.0447 (0.0241)	-0.0537* (0.0270)	-0.0354 (0.0189)	-0.0345 (0.0194)
Child	0.0596 (0.0392)	0.0207 (0.0417)	-0.0317 (0.0745)	-0.1851 (0.0955)	0.0463 (0.0570)	-0.0290 (0.0412)
Maternal	-0.0078 (0.0103)		-0.0563* (0.0231)		0.0070 (0.0193)	
Nutritional	0.0607 (0.2154)	0.0024 (0.1974)	-0.5502 (0.3745)	-0.4490 (0.3398)	-0.1943 (0.2572)	-0.1473 (0.2853)
Age: 13-20	0.3813 (0.5943)	1.4239 (0.8188)	0.0368 (0.7295)	2.4771 (1.3105)	-0.0096 (0.8849)	-0.1076 (1.5606)
Age: 21-44	0.4109 (0.8282)	2.3963 (1.9410)	0.6256 (1.2816)	-0.7528 (3.3879)	3.7847** (1.0140)	3.8811 (2.3699)
Age: 45-64	-14.6222** (2.4501)	-15.2982** (3.6444)	-11.3876* (4.8558)	-13.5364 (8.1070)	-19.8312** (4.6122)	-10.6357 (7.3458)
Age: 65+	-120.4067** (18.4705)	-125.3970** (20.6071)	-128.9232** (19.3756)	-116.5796** (17.3823)	-150.7160** (31.1804)	-140.2950** (32.2596)
Total	-6.9273** (2.2143)	-7.0770** (2.5436)	-8.1164** (2.5984)	-8.3569** (3.1852)	-3.6634 (2.1483)	-1.6135 (3.1851)
Observations	5376	5376	5376	5376	5376	5376

Clustered standard errors at the state level in parentheses. The regressions included state and monthly dummies, and a linear time trend.

** p<0.01, * p<0.05

Table A-2: Effect of GDP per capita on mortality rates by groups of interest

	OLS					
	IV w/ share '85		IV w/ distance			
	Female (1)	Male (2)	Female (3)	Male (4)	Female (5)	Male (6)
Neonatal	-0.2129 (0.1563)	-0.2430 (0.1953)	-0.7933** (0.2560)	-1.1229** (0.3222)	-0.3996 (0.2151)	-0.5348* (0.2668)
Infant	-0.3160 (0.3122)	-0.3719 (0.3467)	-1.7081** (0.5013)	-2.1893** (0.6016)	-0.9962** (0.3773)	-1.1456* (0.4460)
Child due to nutritional deficiencies	-0.0100 (0.0134)	-0.0088 (0.0102)	-0.0868** (0.0230)	-0.0997** (0.0283)	-0.0985** (0.0296)	-0.0970** (0.0294)
Child	0.0097 (0.0449)	-0.0161 (0.0501)	-0.1859** (0.0868)	-0.3350** (0.1076)	-0.1734* (0.0685)	-0.2635** (0.0851)
Maternal	-0.0072 (0.0104)	-0.0072 (0.0104)	-0.0537* (0.0255)	-0.0537* (0.0255)	-0.0124 (0.0248)	-0.0124 (0.0248)
Nutritional	-0.2617 (0.1741)	-0.3071 (0.1977)	-1.1875** (0.3599)	-1.1658** (0.3814)	-1.0004** (0.3650)	-0.9352* (0.3730)
Age: 13-20	-0.3223 (0.5642)	0.5876 (1.0519)	-1.0091 (0.5169)	0.7202 (1.7827)	-1.8761* (0.7789)	-3.4160 (2.1374)
Age: 21-44	-0.1631 (0.8148)	-0.3427 (2.0517)	-2.3126 (1.2287)	-6.6473* (3.0691)	-0.0072 (1.3723)	-7.8015* (3.9450)
Age: 45-64	-1.5077 (2.5051)	0.3582 (5.4900)	-4.5149 (4.2827)	-2.8878 (7.7054)	-5.9981 (6.0383)	2.4392 (9.0229)
Age: 65+	-66.5980** (17.4688)	-65.4001** (19.8701)	-126.2161** (20.1459)	-105.4089** (24.3067)	-133.4537** (36.9287)	-124.7529** (37.2103)
Total	-6.5094** (2.3683)	-7.1613* (2.9322)	-15.7966** (2.5222)	-15.8509** (3.2443)	-14.0641** (2.2836)	-14.8686** (3.7431)
Additional controls						
State fixed effects	Y	Y	Y	Y	Y	Y
Month fixed effects	Y	Y	Y	Y	Y	Y
Time trend	Y	Y	Y	Y	Y	Y
State's educational composition	Y	Y	Y	Y	Y	Y
Health expenditures per capita	Y	Y	Y	Y	Y	Y
Interstate migration rate	Y	Y	Y	Y	Y	Y
International migration rate	Y	Y	Y	Y	Y	Y
Observations	5376	5376	5376	5376	5376	5376

Clustered standard errors at the state level in parentheses

** p<0.01, * p<0.05

Table A-3: Effect of GDP per capita on mortality rates by groups of interest

	OLS		IV w/ share '85		IV w/ distance	
	Female (1)	Male (2)	Female (3)	Male (4)	Female (5)	Male (6)
Neonatal	-0.2078 (0.1550)	-0.2367 (0.1932)	-0.7919** (0.2568)	-1.1208** (0.3226)	-0.4275* (0.2165)	-0.5701* (0.2653)
Infant	-0.2926 (0.3068)	-0.3469 (0.3397)	-1.6810** (0.4951)	-2.1604** (0.5947)	-1.0207** (0.3848)	-1.1698** (0.4499)
Child due to nutritional deficiencies	-0.0089 (0.0132)	-0.0081 (0.0104)	-0.0861** (0.0226)	-0.0988** (0.0282)	-0.0995** (0.0303)	-0.0959** (0.0299)
Child	0.0176 (0.0456)	-0.0095 (0.0493)	-0.1777* (0.0854)	-0.3256** (0.1055)	-0.1703* (0.0749)	-0.2569** (0.0863)
Maternal	-0.0069 (0.0104)		-0.0541* (0.0255)		-0.0153 (0.0252)	
Additional controls						
State fixed effects	Y	Y	Y	Y	Y	Y
Month fixed effects	Y	Y	Y	Y	Y	Y
Time trend	Y	Y	Y	Y	Y	Y
State's educational composition	Y	Y	Y	Y	Y	Y
State's mean female education	Y	Y	Y	Y	Y	Y
Health expenditures per capita	Y	Y	Y	Y	Y	Y
Interstate migration rate	Y	Y	Y	Y	Y	Y
International migration rate	Y	Y	Y	Y	Y	Y
Observations	5376	5376	5376	5376	5376	5376

Clustered standard errors at the state level in parentheses

** p<0.01, * p<0.05

Table A-4: Effect of GDP per capita on mortality rates by groups of interest

	OLS		IV w/ share '85		IV w/ distance	
	Female (1)	Male (2)	Female (3)	Male (4)	Female (5)	Male (6)
Neonatal	-0.2220 (0.2332)	-0.3127 (0.2940)	-0.3233 (0.3794)	-0.6182 (0.4999)	-0.4924 (0.4895)	-0.9540 (0.6111)
Infant	-0.5051 (0.3977)	-0.7114 (0.4860)	-0.9977 (0.5826)	-1.5536* (0.7713)	-1.3522 (0.7204)	-1.9251 (0.9838)
Child due to nutritional deficiencies	-0.0562* (0.0226)	-0.0451* (0.0173)	-0.0703* (0.0281)	-0.0991** (0.0324)	-0.0929** (0.0282)	-0.1019** (0.0393)
Child	-0.0943 (0.0673)	-0.0062 (0.0735)	-0.1646 (0.0952)	-0.2538* (0.1099)	-0.1112 (0.1265)	-0.2778* (0.1307)
Maternal	-0.0521 (0.0266)		-0.0898* (0.0418)		-0.0931* (0.0452)	
Nutritional	-0.1791 (0.2793)	-0.6078 (0.3367)	-0.6524 (0.4874)	-0.5309 (0.4425)	-1.6262** (0.5698)	-0.9827 (0.6325)
Age: 13-20	0.1626 (1.1009)	2.6902 (1.8934)	0.9869 (1.4172)	3.0536 (2.5343)	-1.1941 (1.7994)	-0.3354 (3.3555)
Age: 21-44	-1.5002 (0.7731)	3.6873 (2.9889)	-0.8896 (1.6764)	-1.3263 (3.1851)	-0.4515 (1.9859)	-7.5247 (5.8263)
Age: 45-64	-2.7052 (3.7182)	4.2791 (6.6836)	-3.1079 (8.2267)	15.3596 (9.2962)	2.7917 (9.0508)	9.2062 (15.2561)
Age: 65+	-38.2040 (21.6267)	-30.5932 (21.5523)	-108.3408** (40.8761)	-76.9865** (27.4701)	-132.0546** (50.9890)	-85.0359* (40.6837)
Total	-5.2860** (1.8109)	-2.7379 (2.2368)	-7.5698** (2.0948)	-5.3832 (2.8121)	-9.8828** (2.9972)	-11.2487* (5.3614)
Additional controls						
State fixed effects	Y	Y	Y	Y	Y	Y
Month fixed effects	Y	Y	Y	Y	Y	Y
Time trend	Y	Y	Y	Y	Y	Y
State's educational composition	Y	Y	Y	Y	Y	Y
State's mean female education	Y	Y	Y	Y	Y	Y
Health expenditures per capita	Y	Y	Y	Y	Y	Y
Interstate migration rate	Y	Y	Y	Y	Y	Y
International migration rate	Y	Y	Y	Y	Y	Y
Observations	2304	2304	2304	2304	2304	2304

Clustered standard errors at the state level in parentheses

** p<0.01, * p<0.05