A Human Development Index for the United States-Mexico Border

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Nearly everyone would agree that human welfare and human development are dependent on more than just material wealth or income. As economists and social scientists, we would like to affirm this point while, at the same time, we would like to have standards for measuring human development and welfare that are comparable across countries and through time. This is a tall order, since "The basic purpose of development is to enlarge people's choices" (ul Haq, 2003), and no simple numerical measurement can possibly portray the level of development in all of its dimensions and complexity. Nevertheless, simple, comparable measures are very useful to policy makers, as well as to academics who are trying to understand the effects of economic changes on the quality of life. The purpose of this paper is to present a human development index that attempts to compare changes in the quality of life over time and between border communities in both the U.S. and Mexico. Our Border Human Development Index covers all U.S. counties and Mexican municipios that touch the U.S.-Mexico border.

Economists and other social scientists have long used gross domestic product (GDP), usually in real per capita terms, as a crude indicator of the level of well-being in society and as a means to compare the same place at different points in time, and different places at the same time. This widely used indicator for economic development is simple to interpret and, since it is based on statistics that nearly every nation produces, is relatively easy to obtain. In addition, the connection between material well-being and human development is pervasive, since income and wealth can be used by both societies and individuals to obtain health care, education, cultural goods, and even a cleaner, healthier, environment. Citizens of Oslo, Norway, for example, have more opportunities and choices than citizens of Ciudad Juarez, in part because they have higher incomes and can afford more of the things that enrich their lives, such as travel, safe drinking water, education, and so on. Within its limitations, real GDP per capita provides a crude indicator of development. At the same time, however, every introductory economics texts point out how GDP omits and hides a number of important features of any economy, such as environmental conditions, political and civil liberties, inequality in income's distribution, nonmarket transactions, leisure, and the negative effects of many goods and services (tobacco, pornography, fast-food, and so forth).

This tension, between the desire to have a simple numerical indicator that can be easily obtained and interpreted, and the recognition that no single number can adequately capture and express all of the elements of human development, led to the search for alternatives to GDP per person. Development economists have discussed various quality of life measures for countries, such as life expectancy, infant mortality, physicians per capita, literacy, access to safe drinking water, caloric intake, quality of housing, radios per capita, kilometers of highway, and so forth. The problem with a long list of indicators, often not all varying in the same direction, is that it is hard to compare and rank development levels of various countries. For example, the Mexican national statistics office, INEGI, produces a composite index of 36 variables which it uses to rank all of the municipios and states in the country (INEGI, 2004). This is a useful series for within-Mexico comparisons, but it cannot be used to compare Mexico, or regions of Mexico, to areas outside the country since the same variables are not universally available.

In the search for a composite "quality of life" index that could combine many easily available variables into one number, one candidate eventually emerged, mainly because of its simplicity, the Physical Quality of Life Index (PQLI). This index was developed in 1979 by the Overseas Development Council, Washington, D.C. and is composed of measures of literacy, infant mortality and life expectancy after age one, all equally weighted one-third, and is constructed so that it ranges from 0 to 100. The composite of these three variables, not only broadens the measurement of development, but these components are all very sensitive to income distribution, amending one of the biggest shortcomings of using per capita GDP as the sole indicator of development. The most important omission from the PQLI is that it ignores income or consumption. Subsequently, in 1990, development economists at the United Nations Development Program replaced the PQLI with the Human Development Index which combines quality of life components with real GDP per person (Hogendorn, 1992).

The HDI provides a summary measure of the level of human development by combining measures of material living standards (per capita income), education (enrolment and attainment) and longevity/health (life expectancy). The developers of the index readily acknowledge that the concept of human development is much more complex and richer than this simple index, but given that it is an improvement on the use of either the PQLI or GDP per capita by themselves, it represents a step forward in the search for an internationally comparable measure that allows us to monitor progress in at least three key dimensions of human development (Sen, 1999). The index is scaled from 0 to 1.0 and is divided into high human development countries that score above 0.8, medium human development countries that score between 0.5 and 0.79, and low human development for countries below 0.5. One important aspect of this measure is that its ranking can differ substantially from rankings based exclusively on GDP per capita, especially where incomes are distributed unequally (UNDP, 2000, pp. 147-50).

Since 1992, the United Nations Development Program (UNDP) has produced an annual comparison of human development in most of the world's nations and recently has begun to back-cast its estimates to 1975. Known as the *Human Development*

Report, the comparison is widely disseminated and freely available over the Internet (http://hdr.undp.org). The *Human Development Report* contains a wide array of indicators, indices, and measures of the human condition, but its primary focus remains on the Human Development Index, which has become the standard for measuring levels of human development.

In light of the usefulness of the HDI, this paper presents a Border Human Development Index, which is a modified version of the UNDP's index, in order to compare the development levels of the U.S. counties and Mexican *municipios* that touch the U.S.-Mexico Border.[1] The modifications are necessary in order to have variables that are both comparable between the U.S. and Mexico and available at the local level. The contributions of this paper are several-fold. To our knowledge, it is the first attempt to create a comprehensive quantitative indicator of human well being on the border. Second, it uses methods that are widely accepted internationally. Third, it analyzes both sides of the border and treats U.S. and Mexican communities symmetrically. And fourth, the HDI that we construct enables us to make a number of comparisons between communities on opposite sides of the border, as well as between communities aligned along an east-west transect on the same side of the border.

The next section of the paper presents the methodology used for constructing this index and the third section gives results of the three sub-indices and the full Border HDI for 1990 and 2000. The final section presents some policy implications of the results.

Calculation Of The Border Human Development Index

[1] We are not aware of any previous attempts to construct a quantitative measure of well being or human development along the border. Previous work, for example, Clement (2002), has sought to analyze non-random survey data, or has focused on specific issues, such as water quality or housing. See the SCERP Monograph Series for examples of this type of useful work (www.scerp.org).

The methodology used for the construction of the Border HDI is as close to the methodology and concepts used in the United Nations Development Program's (UNDP) national HDIs as possible, given the data constraints. Both indices are composed of the three, equally weighted components of per capita income, education, and health. However, within the broad education and health categories, some specific data series differ from the UNDP's variables. This is necessary in order to have data series that are available at the local level and that are comparable between the U.S. counties and Mexican *municipios*. The general formula for calculating each sub-index is:

$$(1) \qquad \text{Index} = \frac{\text{Actual } x_i \text{ value} - \text{minimum } x_i \text{ value}}{\text{Maximum } x_i \text{ value} - \text{minimum } x_i \text{ value}}.$$

The numerator in each case represents the gap between the actual value and the minimum possible value, while the denominator is the difference between the maximum and the minimum. Consequently, the ratio is the share of difference between the minimum and maximum that has actually been traveled by the region. A detailed description of the estimation follows.

Estimating border incomes

Income is a proxy for a decent standard of living. As is true for the UNDP, the data used for income are gross regional product (GRP), at the county (U.S.) and municipio (Mexico) levels, converted to U.S. dollars using purchasing power parity exchange rates, and divided by population to put them into per capita terms.[2] The per capita GRP used in the Border HDI are in constant 1996 dollars. GRP estimates for U.S. counties are derived from the U.S. Department of Commerce's Regional Economic Information System (REIS) estimates of U.S. personal income at the county level (Department of Commerce, 2002). These estimates must be transformed from personal

[2] Gross regional product (GRP) is the conceptual regional equivalent of a nation's gross domestic product (GDP). All initial calculations are in totals, and per capita values are derived as a final step.

income to the more comprehensive aggregate measure of gross regional product.[3] Personal income at the county level is therefore adjusted upward by a factor that compensates for the difference between the personal income concept and the gross product concept. The assumption we make is that county personal income is the same proportion of county regional product as state personal income and state product:

(2) County PI/Total County Product = State PI/Total State Product

This is a widely used method in the regional science literature for converting local personal income estimates into a regional product equivalent (Gilmer, 1995a, 1995b).[4] After conversion to regional product, the U.S. CPI is used to obtain 1996 dollars and, as a final step, the data are converted to per capita terms.

The income or output of Mexican municipios are less straightforward to estimate for several reasons. First Mexico's national statistical agency, the Instituto Nacional de Estadística, Geografía, e Informática (INEGI), does not calculate income levels below the state level. Second, the state level data is only available for selected years (1970, 1980, 1985, and annually 1993-2000). And, third, all income measures are in pesos which must be converted to an equivalent dollar measure. The following is a description of the method used to obtain constant dollar, purchasing power parity estimates of product per capita for the municipios along the border.

Gross state product (GSP) for the six Mexican border states are disaggregated into municipio shares based on each economic sector's share of GSP and each municipio's share of state employment in each sector. Let Y_m equal municipio m's total

[3]In general, a nation's or a region's gross product is greater than its personal income primarily because the former includes output not received by individuals, such as capital depreciation and indirect business taxes. Gross product rather than personal income must be used in order to create consistency between the U.S. county and Mexican municipio estimates.

[4]This assumption may overstate regional product in counties where there are proportionately fewer businesses and indirect business taxes make up a smaller share of total economic activity. However, since income is but one of three components of the index, and all counties are aggregated when we construct the overall border index, the bias on the Border HDI is likely to be small.

income, Y_s equal state s's total income, e_{im} is sector i's employment in municipio m and e_{is} is total state employment in sector i and state s. Then

(3) $$Y_m = \lambda Y_s, \text{ where } 0 < \lambda < 1, \text{ and}$$

(4) $$\lambda = \Sigma_i(Y_{is}/Y_s)(e_{im}/e_{is}).$$

Equation (3) simply states that any municipio's total income is a fraction of the state's total income. Equation (4) shows how to estimate the fraction, λ, as an employment share. Specifically, it states that municipio m's share of state income is equal to the sum of the products of state-level sectoral income shares times municipio-level employment shares. There are nine sectors. Equation (4) assumes the same productivity within a given sector and across the municipios of a given state. For example, agriculture in each border municipio in the state of Chihuahua is assumed to have a share of total state agricultural output that is the same as its share of total state agricultural employment. This may bias upward rural incomes, and bias downward urban ones since productivity within a sector is likely to be greater in urban areas than in rural, particularly in manufacturing. However, given the concentration of manufacturing within the border municipios, this is not likely to create a significant bias. Furthermore, we feel that the use of sector and municipio specific employment data is the best way to divide state-level sectoral output into its municipio-level shares since this method covers 100 percent of municipio economic activity, and it relies only on the relatively mild assumption of equal labor productivity within a given sector and across the municipios of a given state.

Conversion from current pesos to constant 1996 dollars at purchasing power parity exchange rates is accomplished using the series RGDPCH (chained real international dollars) from the Penn World Table, version 6.1 (Heston, Summers, and Aten, 2002). The use of the RGDPCH is necessary for this exercise since we are not interested in the value of border incomes if spent "on the other side" (converted from pesos to dollars or vice versa at market exchange rates). Rather, we are estimating the value of production in real terms, taking into account the price differences between the U.S. and Mexico. In at least one test (Fullerton and Coronado, 2001), border prices for identical goods in Ciudad Juárez and El Paso have been shown to differ significantly if converted at market exchange rates. Hence, the use of purchasing power parity exchange rates is necessary in order to make the conversion from pesos into dollars of equivalent purchasing power.[5] State products given by INEGI are converted to purchasing power parity dollars using the RGDPCH series, and municipio incomes are then calculated as λ times the state income. As a final step, per capita estimates are obtained by dividing by population.

Once the GRP per capita is estimated, the income sub-index is formed following the UNDP methodology of using equation (1) and \$40,000 as the maximum value and \$100 as the minimum. These maximum and minimum values are somewhat arbitrary, but we simply use the same values as those used by the UNDP in their HDI calculations. Similarly, we use the UNDP's methodology and take the logarithms of GRP per capita. This follows from the fact that GRP per capita is a proxy for living standards and "achieving a respectable level of human development does not require an unlimited income," (UNDP, 2000, p. 269). Using logarithmic values discounts the importance of increases in GRP when it is already at relatively high levels. The UNDP uses this method under the assumption that greater levels of development are associated with higher levels of product, but at a decreasing rate. In support of this assumption, Cahill (2002) tested various possible functional forms for GDP in national indices and

[5] A more complex question relates to regional price variations within each country. That is, prices along the U.S. border are not adjusted for local price differences between U.S. regions. Similarly, prices along the Mexico border are not adjusted for differences between Mexican municipios. To our knowledge, there is no way to make such adjustements.

concluded that the natural logarithm of GDP is the most appropriate transformation.

The income index is calculated for each county and municipio as:

(5) $$\text{Income index} = \frac{\text{Log } y_i - \text{Log}(100)}{\text{Log}(40{,}000) - \text{Log}(100)}$$

where y_i is the per capita GRP for the i^{th} county or municipio.

Educational Attainment

The educational component of the Border HDI is composed of two data series: the proportion of school-aged population that are enrolled in school and the proportion of population 25 and older who have graduated from high school (i.e. completed 12 years of schooling). The enrolment component is the same as that used by the UNDP and is calculated by dividing the number of people enrolled in kindergarten through twelfth grade by the population between 5 and 19 years of age for the U.S. and 6 and 19 years of age for Mexico.[6] Since this number is a proportion, its maximum value is 100 and its minimum is 0.

(6) $$\text{Gross enrolment} = \frac{\text{Actual } x_i \text{ value} - 0}{100 - 0}$$

The educational attainment segment of the education index as calculated by the UNDP is the literacy rate. However, in the United States the Census Bureau ceased to gather data on literacy at state and local levels after 1970.[7] Furthermore, as the UNDP itself admits, there are problems with the definition of what constitutes literacy. They use a working definition of "the ability to read and write, with understanding, a simple statement related to one's daily life." (UNDP, 2000, p. 143) This definition lacks an

[6] The discrepancy in youngest age is due to the difference in the data as reported in the U.S. and Mexican censuses. Since the enrolment is divided by population over the same age range, it was felt that the year's difference in starting age would not cause a large bias. Basically the U.S. data starts with kindergarten and the Mexican data with first grade.

[7] The type of data gathered by a country's census is highly influenced by the level of its economic development. The differences in development levels between the U.S. and Mexico add to the difficulties in getting compatible data.

exact meaning and data are gathered in different ways, raising concerns over data reliability. Some countries equate never having attended school with illiteracy, some countries equate literacy with having attended and completed four years of primary school. In view of the lack of U.S. data on literacy, the Border HDI substitutes the completion of 12 years of school (high school) as the measure of educational attainment. This is a better measure for a developed country than for a developing country, but it has the advantage of comparable data for both the U.S. and Mexico. The number used for both countries is the proportion of population 25 years and older who have completed twelve years of education (not including kindergarten). This number also has a minimum value of zero and a maximum of 100. The equation for the educational attainment index is:

$$(7) \qquad \text{Educational Attainment Index} = \frac{\text{Actual } x_i \text{ value} - 0}{100 - 0}$$

The educational index is a combination of these two proportions and is weighted as one third for enrollment and two thirds for educational attainment, the same weightings assigned by the UNDP.

(8) Education index =

$$(2/3)*(\text{education attainment index}) + (1/3)*(\text{gross enrolment ratio})$$

Health Index

The UNDP uses life expectancy at birth, a measure of longevity, for the indicator of health. Life expectancy data is available at the national and state levels for both the U.S. and Mexico, but is not available at the county or *municipio* level for either country. Therefore, we have substituted the infant mortality rate in calculating the Border HDI. As indicated above, the infant mortality rate is one of the components of the Physical Quality of Life Index, the index that preceded the Human Development

Index. Development economists have long viewed infant mortality as a key indicator of quality of life because it not only is an indicator of the level of medical care available, but it is also closely correlated with conditions of housing, levels of sanitation and access to safe drinking water.[8] The infant mortality rate gives the number of infant deaths per 1000 live births, and a higher value indicates worse conditions in health care, housing, sanitation and water. Since the other indicators in the Human Development Index imply improvement with higher values, the infant mortality rate must be converted into an infant survivability rate, equal to 1000 minus the infant mortality rate. It is the number of infants who survive out of 1000 live births with a maximum of 1000 and minimum of zero. For example, in 2000 the Mexican border region had an infant mortality rate of 15.4 infant deaths per 1000 live births. This translates into 984.6 infants that survive per each 1000 live births. The indicator is calculated as:

$$(9) \qquad \text{Health Index} = \text{Infant survivability Index} = \frac{(1000 - \text{Infant Mortality Rate}) - 0}{1000 - 0}$$

Since Mexico did not start publishing numbers of births and infant deaths at the local level until the late 1980's, the calculation of the Border HDI is limited to the 1990 and 2000 census years.

Border Human Development Index

In order to compare levels of economic development among the communities in the border region, the Border Human Development Index is calculated as the simple average of these three sub indices:

(10) Border HDI =

1/3*(Income Index) + 1/3*(Education Index) +1/3*(Infant Survivability Index).

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[8] A description of the use of infant mortality as one proxy for quality of life is fairly standard in texts on economic development. For example, see Todaro and Smith (2003) Some of the early statistical estimations of the relationship between infant mortality and other quality of life variables was done by Chenery and Syrquin (1975).

As such, the Border HDI presents a much broader view of the level of economic development than a view based solely on income levels. In fact, by using the logarithm of GRP per capita rather than absolute values, increases in income contribute less and less to the level of economic development. Furthermore, income is not independent of the health and education indicators since higher education and better health lead to higher productivity which, in turn, leads to higher per capita income.

The Border Human Development Index: Empirical Results

U.S. and Mexican census data for 1990 and 2000 are used to calculate the Border Human Development Index. This section presents separate indices for income, education and health, and these components are then combined into the Border HDI.

The Income Index

Figure 1
Trend in Per Capita GRP

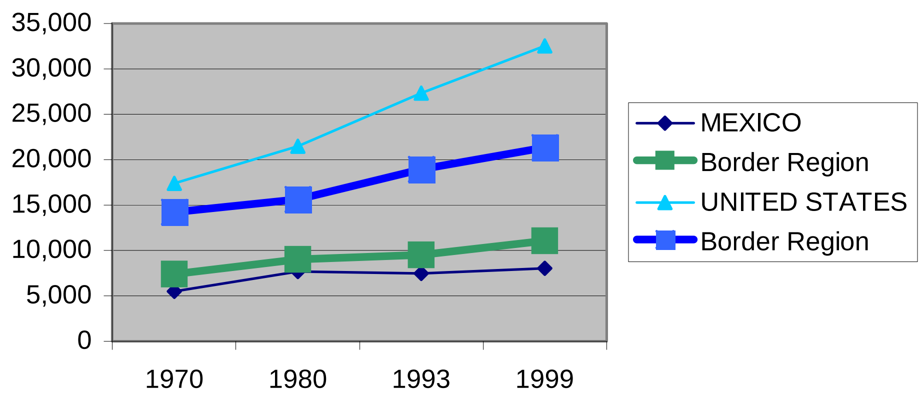
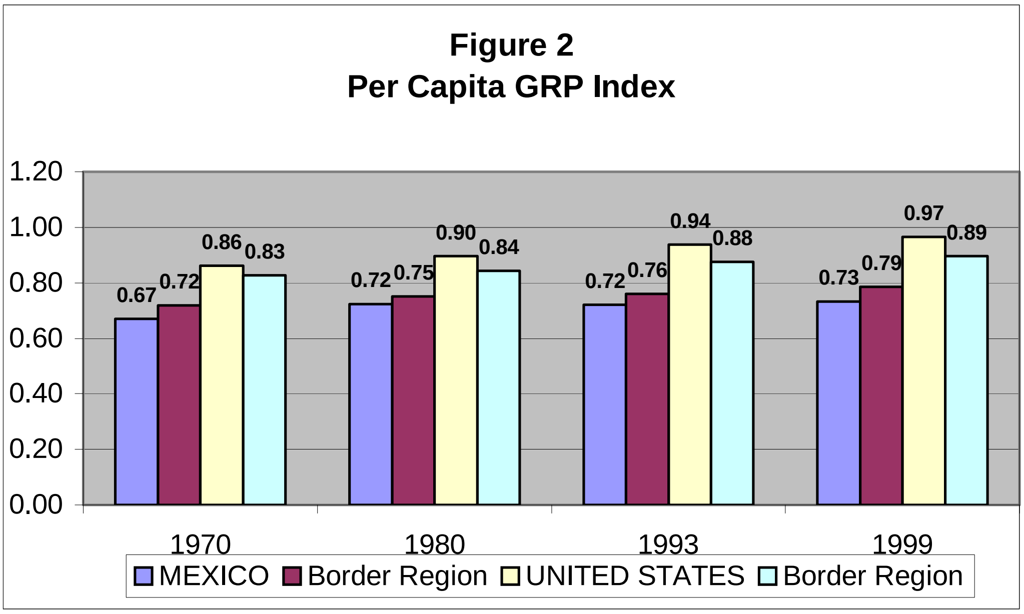


Figure 1 shows the trend in real per capita gross regional product, or GRP per capita, from 1970 to 1999.[9] Real per capita product increased for both border regions,

[9] Mexican income data at the state level (from which we derive income in the municipios) is available for 1970, 1980, 1985, 1993, and annually thereafter. In order to have comparable U.S. and Mexican data, we use 1993 income for both the U.S. and Mexico as our proxy for 1990.

as well as nationally.[10] In Mexico, border region per capita product has consistently been slightly higher than the national level while for the U.S. it has been lower with a growing gap. The absolute gap in per capita product between the U.S. and Mexico has also grown.

In order to turn the absolute values into an index, we follow the same methodology as the United Nations Development Program (UNDP), as given in Equation (5). In effect, the index is the actual amount by which a region exceeds the minimum logarithm of GRP, expressed as a percentage of the difference between the minimum and maximum possible values. The resulting index represents a one third weight of the border HDI. Figure 2 shows the summary border region and national values. This index ranged from 0.94 to 0.69 in 1990 and from 0.97 to 0.69 in 2000. The gap in product in the two border regions has decreased slightly from 0.11 index points in 1970 to 0.10 points in 1999.



[10] The data for individual counties/*municipios* are combined to give summary border region statistics. This was done by adding the raw numbers and then using the same formulas for the region as for the individual counties. For example, total income for each county touching the border was added and then divided by the sum of population in those counties to obtain per capita income. Then this region figure was transformed into the GRP index, using Equation 4. This same procedure was followed for all the border region statistics.

Looking at individual counties and municipios, (Table A.1 in the appendix) the three highest communities in both 1990 and 2000 are San Diego, California, Grant, New Mexico, and Terrell, Texas, in first, second, and third, respectively. Terrell is a sparsely populated rural county with only 1,081 people in 2000, mainly affluent ranchers (with much of the county's labor supplied by undercounted, undocumented workers.). The communities with the lowest per capita products were Janos, Chihuahua, in 1990, and Santa Cruz, Sonora, in 2000. By 2000, Janos had improved to 5th from the bottom, while per capita income in Santa Cruz fell during the 1990s.

In general and as expected, GRP levels in the U.S. counties are above the Mexican municipios, but there are a few exceptions. In 2000, Ciudad Acuña and Ciudad Juárez, the highest municipios, were both above the Texas counties of Maverick and Presidio. An additional 12 municipios, including all the Baja California municipios, were above Starr county, Texas, the poorest county in Texas and one of the poorest in the United States.

Table 1 shows per capita incomes in 1999 for the border counties and municipios, grouped by state and arranged from west to east and north to south. These aggregates are the population weighted averages for the municipios and countries within each state. One notable pattern on the U.S. side is that per capita product falls as you move from west to east. This pattern also holds somewhat on the Mexican side of the border, although less consistently primarily due to the higher per capita incomes in Chihuahua and Coahuila..

Table 1
Gross Regional Product per capita
for border counties and municipios

Border municipios and counties	*GRP per person, 1999*
US border counties	23, 628
California	29,618
Arizona	23,187

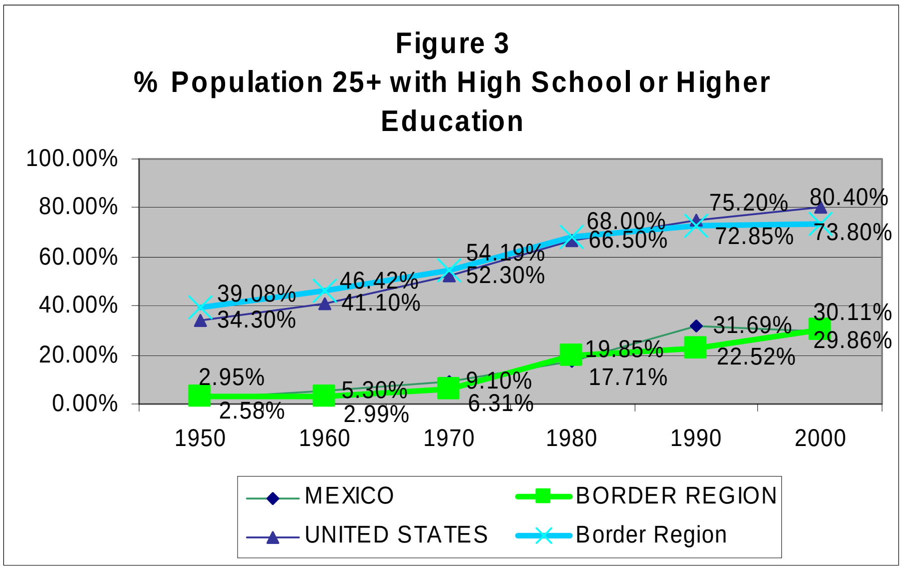
New Mexico	17,558
Texas	15,533
Mexico border municipios	11,029
Baja California	11,575
Sonora	10,047
Chihuahua	12,202
Coahuila	12,688
Nuevo Leon	10,306
Tamaulipas	9,357

Education

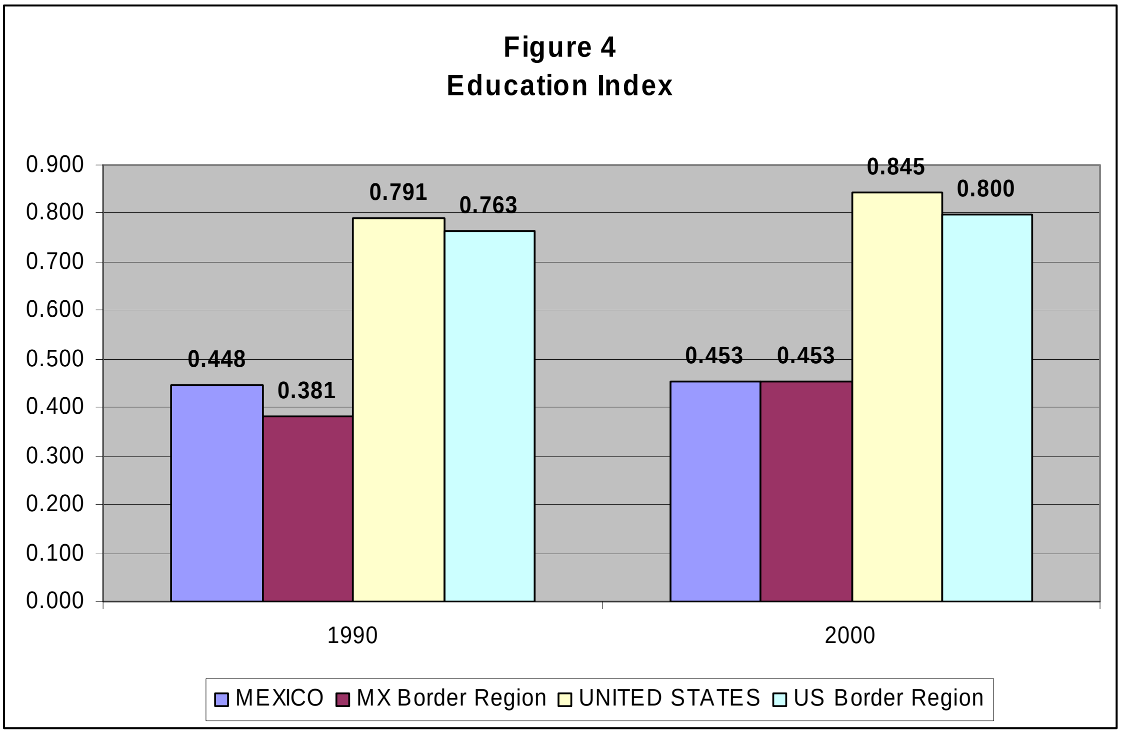
The education index has two components, the percentage of school-aged children enrolled in school and educational attainment. Enrolments are weighted one-third and educational attainment two-thirds. The latter is measured as the proportion of population 25 years and older who have at least a high school education (12 years or more of schooling.) Both countries have increased the percentage of population, ages 6 to 19 who are enrolled in school, but the increase is most dramatic on the Mexican side of the border. In 1950, the Mexican border region (the combined border municipios) had 39 percent of its 6 to 19 year old population in school, compared to 27 percent nationally. This increased to 69 percent in 1990 and 75 percent in 2000. Nationally the proportions in those census years are slightly higher at 71 percent and 76 percent, respectively. For the U.S., the border region proportions are also slightly lower than the national figures. For population 5 to 19, 83 percent were enrolled in school in the U.S. border region in 1990 and 90 percent in 2000. Nationally the corresponding proportions are 87 percent and 93 percent.

For educational attainment this study uses the proportion of adult population, 25 years and older who have completed 12 or more years of education. Figure 3 shows the trend in this proportion from 1950 through 2000. In 1950 only 34 percent of adults in the U.S. border region had 12 or more years of education, increasing to 74 percent in 2000, but always remaining below the national rate. In the Mexican border region in

1950, only 2.6 percent had 12 or more years of education, increasing to 30 percent by 2000, almost up to the1950 U.S. level. The Mexican border region, though higher in per capita income is lower in educational attainment than the national average.



To calculate the education index the percent of school-aged population enrolled and percent of adults 25 years and over with 12 or more years of education are each divided by 100 and then combined by adding one third times enrolment plus two thirds times attainment. The resulting indices show a substantial gap between the U.S. and Mexico, both nationally and in the border regions with U.S. index numbers almost twice as large as the Mexican index numbers.



In 1990, the range of the education index went from 0.81 in San Diego county to 0.16 in the municipio of Ascension, Sonora. In 2000, the range was from 0.86 in Pima, Arizona to 0.22 in Manuel Benavides, Chihuahua. In 1990 only three U.S. counties had education indices that were higher than the national index of 0.79: San Diego, Cochise and Pima (Tucson). No Mexican municipio had an index as high as the national. Mexicali's index of 0.42 was the highest on the Mexican side of the border. In 2000, only two U.S. counties were above the national index of 0.845: San Diego and Pima. On the Mexican side six municipios had indices above the national level with Mexicali now in second place, behind Cananea, Sonora.

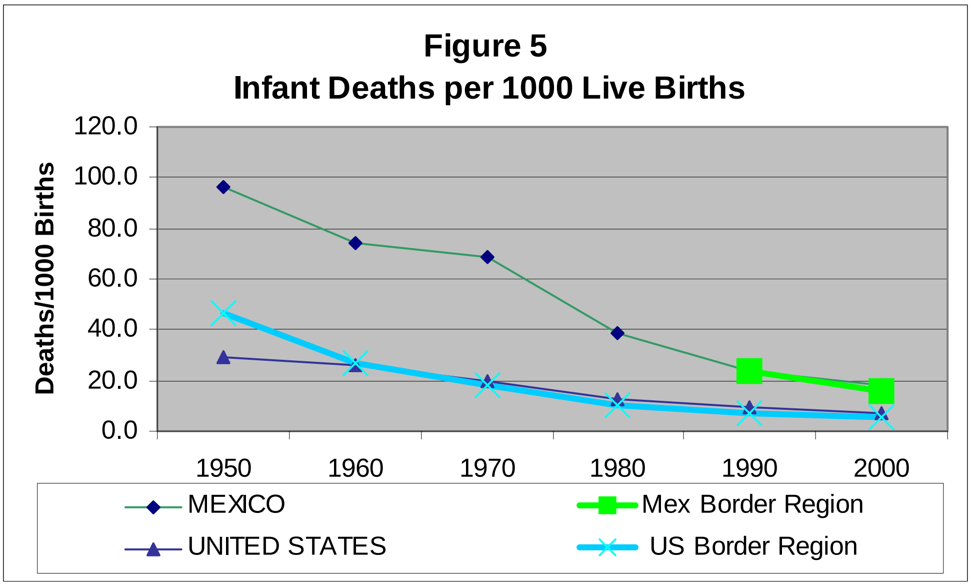
Table A.2 in the appendix lists all the border communities in descending order of the education index for 1990 and for 2000. There is no overlap between U.S. and Mexican border communities for this index, as Starr, Texas, the lowest U.S.-sample county in 1990 was still 10 index points above the highest Mexican municipio, Mexicali (0.52 to 0.42). By 2000, the gap between the lowest U.S. county (Starr, 0.54) and the highest Mexican municipio (Cananea, Sonora, 0.50) had shrunk to 4 index points.

Given the border location of these communities, Mexican enrolment data might be biased downward and U.S. data biased upward to the extent that some Mexican students cross the border and attend U.S. schools. These children would be counted in the Mexican census, their enrollment would be counted on the U.S. side. While this could lower the gap a little, it would not eliminate the substantial gap. The major source of the educational gap is from the gap in educational attainment which is two thirds of the weight of the education index.

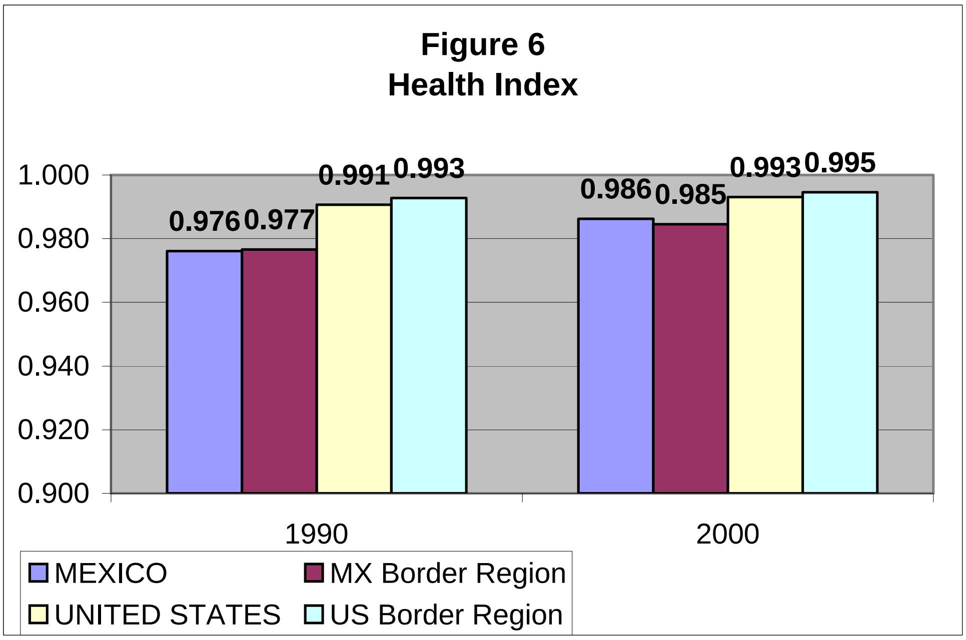
Health

The variable used to capture health is infant mortality. Development economists have often used this variable because it is highly correlated with the ratio of physicians per capita, medical technology and levels of sanitation and safe water, and, as noted above, it was one of the three components of the physical quality of life index.

Figure 5 shows the trends in infant mortality, measured in number of infant deaths per 1000 live births. In both countries the rate of infant mortality has shown a steady decrease, falling faster in Mexico than in the U.S. so that by 2000 the gap between infant mortality rates is very small. The rate on the border is very close to the national rate in both countries. For Mexico, this data is only available for the 1990 and 2000 censuses at the local level.



To use this data in the Human Development Index, which is arranged so that higher means better, the infant mortality rate is translated into the infant survivability rate. Figure 6 shows the index for the national and border regions for both countries. The U.S. and Mexican indices increased both nationally and in their respective border regions, but the Mexican indices increased more, narrowing the gap between the two countries. Except for the Mexican border region in 2000, all the border region indices are slightly higher than their corresponding national indices. At the county/municipio level some of them are 1, meaning that no infant death occurred in that year. These are all in relatively low population communities. In 2000, there were 10 communities with no infant deaths, 5 on the Mexican side and 5 in Texas. Comparisons of the index range in 1990 to its range in 2000, show that the range is the smallest of the three sub-indices. The Health index ranges from 1 to 0.931 in 1990 and from 1 to 0.968 in 2000. The gap between the U.S. and Mexican border regions decreased from .016 to .010.

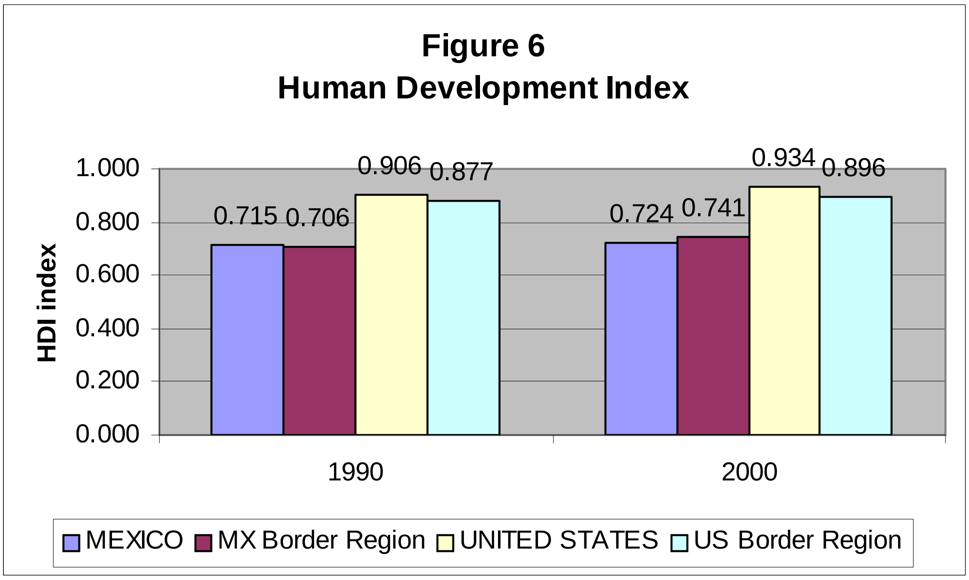


In this index more than for the others, there is a great deal of overlap between U.S. counties and Mexican municipios.. That is, unlike the education index, where the upper portion is all U.S. and the lower portion all Mexican, the health index has a significant amount of overlap between U.S. counties and Mexican municipios. Mexico has made major gains in health and has narrowed the gap with the U.S., at least in infant mortality. At the same time, health issues continue to be a serious problem on the U.S. border, as shown by the fact that the communities with the lowest infant survivability index are the two Texas counties, Kinney and Hudspeth, with 0.973 and 0.968, respectively.

Human Development Index

The income, education, and health indices are combined into the Human Development Index, with each component weighted equally. In the aggregate there is a significant gap between the U.S. and Mexico and their respective border regions. The U.S. border region's HDI is below that of the U.S. and slightly further below in 2000 than in 1990. The Mexican border region, while slightly below the national HDI in

1990 is above the Mexican national rate in 2000. It increased by .04 in the 10 years, while in the U.S. border region it only increased by .02.



The rankings of the border communities ranged from 0.915 to 0.623 in 1990 and from 0.941 to 0.647 in 2000 (Appendix Table A.4). San Diego has the highest HDI of all the border counties/municipios, followed by Grant County, New Mexico in both years. Pima County, Arizona (Tucson), drops from third in 1990 to fourth in 2000. With a big increase in HDI, Brewster County Texas moves from ninth place in 1990 to third place in 2000. At the bottom of the ranking are three Mexican municipios: Janos and Manuel Benavides and Hidalgo, Coahuila. These three changed rankings between 1990 and 2000, but in both years remained the bottom three with Hidalgo at the lowest HDI in 1990 and Manuel Benavides in 2000.

In the HDI rankings there is no U.S. county lower than the highest Mexican municipio. This is true even though there is a considerable amount of intermingling of counties and municipios in the infant survivability sub-index and some overlap in the per capita income sub-index. However, the gap between the lowest U.S. counties and highest Mexican municipios in educational attainment was large, the biggest factor in the HDI gap between the two sides of the border. Nevertheless, the differences between the lowest counties and the highest municipios in both the area of education and the overall HDI declined between 1990 and 2000. With respect to the overall HDI, both in 1990 and 2000 the lowest county was Starr, Texas and the highest municipio was Mexicali. In 1990 Starr's HDI was 0.754 and Mexicali's was 0.718, a difference of 0.036. In 2000 Starr's HDI was 0.766 and Mexicali's was 0.757, only 0.009 lower. These results suggest that closing the education gap may be the most important step in decreasing the quality of life gap between the U.S. and Mexican border regions.

Conclusions

Although the Border Human Development Index is a relatively simple index, its construction is a useful exercise. In his discussion of the UN's HDI, Nobel Laureate Amartya Sen recognizes the "inescapably crude" nature of the HDI, but also points out that it can "broaden substantially the empirical attention that the assessment of development processes receive," due in part to the fact that it is "not exclusively focused on economic opulence" (Sen, 1999). In this regard, we think that the border HDI serves as a useful but rough comparison of the counties and municipios along the U.S.-Mexico border.

The index shows modest convergence during the 1990s in the sense that the gap between Mexican municipios and U.S. counties is slightly smaller. Further, this modest convergence did not come about through a decline in U.S. values but was the result of faster improvement on the Mexican side. Nevertheless, the convergence is very slight, and at the rate of the 1990s, it would take about 12 more decades to completely close the gap.

Not surprising to development specialists is the fact that the sub-index of health (infant survivability) shows the smallest gap, both in 1990 and 2000. Sanitation improvements and modern medicines are, in some ways, much cheaper and easier to obtain than higher incomes or higher levels of educational attainment. In this respect, the border region is not an exception. By 1990, the gap in the health index was only 0.015, and by 2000 it had fallen to only 0.010. Further, there are a number of Mexican municipios among the top ten in health in both years and quite a few municipios rank higher than some U.S. counties.

In contrast to health, the differences in education are the largest of the three indices and are the main determinant of the broader difference in the overall border HDI. While there is a definite improvement between 1990 and 2000, no Mexican municipio is ranked above the lowest U.S. county. The importance of the education gap is a key finding of the paper because it has significant implications for an approach to closing the human development gap in the border region, and more generally between the United States and Mexico.

Since World War II, Mexico and the Mexican border region have made great strides in providing public education to a larger share of the population. In this regard, its experience is similar to many other Latin American countries, but at the same time, the pattern of educational expansion differs significantly from other developing areas such as Asia. In particular, the border shows the general educational trend in Mexico and Latin America in which illiteracy has been reduced significantly and higher education expanded, but far less progress has been made in raising the completion rates for secondary education (the equivalent of high school in the U.S. or preparatory school in Mexico). Morley (2001, p55) notes that:

> Asia put a lot of its education dollars into eliminating the bottom tail of its educational distribution and universalizing secondary education. Latin America

let most of its young cohorts leave school after the primary level, using the money instead to expand university coverage.

In 2000, Mexico and the Mexican border were considerably below where the U.S. was in 1950 with regard to educational attainment, as measured by high school completion rates. Between 1880 and 1930, the states of the U.S. increased the standard for school leaving from 8th grade to 12th grade. Some states were in the lead and others lagged behind, but slowly a national consensus emerged during a half century of educational expansion. In most of Latin America, including Mexico and its border region, the same expansion has yet to occur. It was only in 1992 that Mexico increased compulsory education from 6 years to 9 years of schooling.

This is an important observation for two reasons. First, education must be a key component in anyone's definition of human development and second, because education and income are not independent. Increased education leads to increased productivity which, in turn, leads to increased per capita income. At the same time, higher income provides the resources for an expansion of schooling. In the border region in particular, limits on the growth of high school education are negatively impacting income. The growth of border manufacturing and its potential to create higher wages and good paying jobs is dependent on the skills and ability of the labor force. Completion of high school or its equivalent signals that a worker can be easily trained for many of the jobs of modern manufacturing, while less-than-high school signals uncertainty and risk with regard to finding an adequate labor force for more skilled, better paid, manufacturing work.

In sum, it is hard to imagine a feasible public policy that would be more effective at removing some of the development gap between the United States and

Mexico in the border region, than a broad expansion of the equivalent of high school on the Mexican side.

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DATA APPENDIX

Table A.1
Index for Per Capita Real GRP, ranked Highest to Lowest

	1993		1999
MEXICO	0.720	**MEXICO**	**0.731**
Border Region	0.761	**Border Region**	**0.786**
UNITED STATES	0.936	**UNITED STATES**	**0.966**
Border Region	0.875	**Border Region**	0.895
SD	0.926	SD	0.953
Pima	0.896	Pima	0.920
Terrell	0.886	Terrell	0.907
Imperial	0.871	Brewster	0.893
Cochise	0.870	Cochise	0.879
Yuma	0.870	Yuma	0.876
Brewster	0.859	Grant	0.869
Grant	0.855	ElPaso	0.867
donaAna	0.852	Imperial	0.867
ElPaso	0.849	donaAna	0.865
Jeff Davis	0.844	Val Verde	0.854
Val Verde	0.836	Culberson	0.842
Luna	0.836	Jeff Davis	0.839
Kinney	0.824	Kinney	0.836
Cameron	0.822	Cameron	0.836
Webb	0.819	Luna	0.834
Hidlago, TX	0.806	Webb	0.834
Acuna	0.799	Hudspeth	0.830
Culberson	0.795	Hidlago, TX	0.824
Presidio	0.794	*Acuna*	0.824
Hudspeth	0.789	Zapata	0.813
Juarez	0.786	*Juarez*	0.805
Zapata	0.785	*Tijuana*	0.798
Nava	0.782	*Nava*	0.798
Nogales	0.777	*Nogales*	0.790
Piedras Negras	0.772	*Piedras Negras*	0.790
Tijuana	0.768	Maverick	0.789
Maverick	0.761	Presidio	0.788
Ascension	0.759	*Mexicali*	0.787
Cananea	0.757	*Cananea*	0.780
Mexicali	0.756	*Anahuac*	0.774
Nuevo Laredo	0.747	*Tecate*	0.771
Caborca	0.745	*Ojinaga*	0.770
Puerto Penasco	0.744	*Nuevo Laredo*	0.768
Tecate	0.743	*Reynosa*	0.765
Matamoros	0.743	*Agua Prieta*	0.765
Agua Prieta	0.741	*Jimenez*	0.761
SLR Colorado	0.739	*Puerto Penasco*	0.759
Anahuac	0.738	*SLR Colorado*	0.758
Reynosa	0.738	*Caborca*	0.757
Ojinaga	0.737	*Guadalupe*	0.757
Starr	0.736	*Matamoros*	0.756
Naco	0.730	Starr	0.751
Jimenez	0.729	*Miguel Aleman*	0.748
Miguel Aleman	0.725	*Guerrero*	0.744
Guadalupe	0.716	*Ascension*	0.743
Camargo	0.712	*Praxedis G. Guerre*	0.742
Santa Cruz, AZ	0.712	*Ocampo*	0.737
Santa Cruz, Son	0.712	*Naco*	0.734
Ocampo	0.712	*Camargo*	0.730
Praxedis G. Guerrer	0.711	*Mier*	0.728
Rio Bravo	0.710	*Hidalgo, Coa*	0.728
Gustavo Diaz Ordaz	0.709	Hidalgo, NM	0.728
Altar	0.708	*Rio Bravo*	0.728
Mier	0.700	*Gustavo Diaz Orda*	0.727
Valle Hermoso	0.699	*Valle Hermoso*	0.725
Hidalgo, Coa	0.695	*Manuel Benavides*	0.725
Hidalgo, NM	0.695	*Janos*	0.724
Guerrero	0.693	*Altar*	0.721
Manuel Benavides	0.693	*Guerrero, Tam*	0.720
Guerrero, Tam	0.690	*Saric*	0.695
Saric	0.690	Santa Cruz, AZ	0.695
Janos	0.689	*Santa Cruz, Son*	0.695

Table A.2

Index for Education Ranked Highest to Lowest

	1990		2000
MEXICO	0.448		0.453
MX Border Region	0.381		0.453
UNITED STATES	0.791		0.845
US Border Region	0.763		0.800
SD	0.812	Pima	0.860
Cochise	0.798	SD	0.858
Pima	0.796	Brewster	0.843
Jeff Davis	0.768	Grant	0.836
Grant	0.758	Cochise	0.835
Hidalgo, NM	0.752	Jeff Davis	0.816
Terrell	0.749	Terrell	0.814
donaAna	0.736	Hidalgo, NM	0.768
Brewster	0.728	Kinney	0.764
ElPaso	0.716	ElPaso	0.750
Yuma	0.711	Yuma	0.743
Luna	0.690	donaAna	0.733
Kinney	0.681	Santa Cruz, AZ	0.720
Santa Cruz, AZ	0.658	Imperial	0.705
Val Verde	0.657	Val Verde	0.698
Imperial	0.650	Culberson	0.680
Culberson	0.642	Cameron	0.680
Zapata	0.636	Webb	0.664
Cameron	0.632	Zapata	0.660
Webb	0.623	Hidlago, TX	0.644
Hudspeth	0.611	Luna	0.623
Hidlago, TX	0.609	Hudspeth	0.618
Presidio	0.586	Presidio	0.612
Maverick	0.528	Maverick	0.589
Starr	0.520	Starr	0.539
Mexicali	0.420	*Cananea*	0.504
Tijuana	0.403	*Mexicali*	0.502
Nogales	0.400	*Nogales*	0.492
Naco	0.397	*Reynosa*	0.483
Gustavo Diaz Ordaz	0.396	*Matamoros*	0.466
Nuevo Laredo	0.392	*Nuevo Laredo*	0.457
Reynosa	0.385	*Tijuana*	0.449
Matamoros	0.383	*Tecate*	0.445
Piedras Negras	0.382	*Caborca*	0.439
Juarez	0.377	*Juarez*	0.439
SLR Colorado	0.376	*SLR Colorado*	0.433
Agua Prieta	0.369	*Miguel Aleman*	0.422
Tecate	0.361	*Agua Prieta*	0.421
Caborca	0.347	*Valle Hermoso*	0.416
Miguel Aleman	0.347	*Mier*	0.416
Cananea	0.332	*Rio Bravo*	0.407
Rio Bravo	0.328	*Puerto Penasco*	0.402
Acuna	0.323	*Gustavo Diaz Ordaz*	0.402
Mier	0.320	*Piedras Negras*	0.401
Valle Hermoso	0.314	*Acuna*	0.390
Guerrero, Tam	0.312	*Ojinaga*	0.389
Nava	0.299	*Altar*	0.367
Altar	0.295	*Nava*	0.367
Ocampo	0.293	*Anahuac*	0.363
Camargo	0.287	*Camargo*	0.352
Anahuac	0.283	*Guerrero, Tam*	0.348
Puerto Penasco	0.250	*Ocampo*	0.336
Ojinaga	0.248	*Naco*	0.325
Santa Cruz, Son	0.247	*Ascension*	0.321
Hidalgo, Coa	0.243	*Santa Cruz, Son*	0.308
Saric	0.232	*Praxedis G. Guerrero*	0.288
Guerrero, Coa	0.223	*Guadalupe*	0.285
Guadalupe	0.221	*Saric*	0.283
Praxedis G. Guerrero	0.206	*Jimenez*	0.257
Janos	0.206	*Guerrero, Coa*	0.254
Manuel Benavides	0.199	*Janos*	0.246
Jimenez	0.195	*Hidalgo, Coa*	0.246
Ascension	0.159	*Manuel Benavides*	0.217

Table A.3

Index for Infant Survivability Ranked Highest to Lowest

	1990		2000
MEXICO	0.976		0.986
Border Region	0.977		0.985
UNITED STATES	0.991		0.993
Border Region	*0.993*		*0.995*
Santa Cruz, Son	1	*Saric*	1
Hudspeth	1	*Praxedis G. Guerrero*	1
Culberson	1	*Manuel Benavides*	1
Jeff Davis	1	*Hidalgo, Coa*	1
Terrell	1	*Guerrero, Tam*	1
Kinney	1	Culberson	1
Guadalupe	0.999195	Jeff Davis	1
Praxedis G. Guerrero	0.997899	Presidio	1
Starr	0.995641	Terrell	1
Hidlago, TX	0.994439	Zapata	1
Valle Hermoso	0.993837	Cameron	0.996392
Camargo	0.99375	Santa Cruz, AZ	0.996241
Imperial	0.993715	*Valle Hermoso*	0.996034
Luna	0.993651	ElPaso	0.99559
Val Verde	0.993562	Val Verde	0.995501
Maverick	0.993485	Imperial	0.995334
Cameron	0.99315	donaAna	0.995041
Grant	0.993007	Hidlago, TX	0.994987
ElPaso	0.992879	Yuma	0.994679
Webb	0.992572	SD	0.994059
SD	0.992552	Maverick	0.993976
Anahuac	0.992233	Webb	0.993941
Yuma	0.992147	Pima	0.993926
donaAna	0.992053	*Mier*	0.993865
Pima	0.991959	Starr	0.993831
Cochise	0.99176	Cochise	0.993667
Presidio	0.991525	*Miguel Aleman*	0.993432
Santa Cruz, AZ	0.990679	*Nava*	0.992982
Rio Bravo	0.990044	*Rio Bravo*	0.992751
Guerrero, Tam	0.989899	Brewster	0.991304
Zapata	0.989848	*Janos*	0.991124
Hidalgo, NM	0.989583	*Anahuac*	0.991091
Miguel Aleman	0.989432	Grant	0.990476
Gustavo Diaz Ordaz	0.987203	*Nuevo Laredo*	0.990176
Ascension	0.987013	*Gustavo Diaz Ordaz*	0.990123
Janos	0.985915	*Guadalupe*	0.989418
Naco	0.985612	*Matamoros*	0.988328
Matamoros	0.984986	*Ascension*	0.98797
Manuel Benavides	0.983051	*Ocampo*	0.987952
Nuevo Laredo	0.982843	*Piedras Negras*	0.987607
Brewster	0.981982	*Naco*	0.9875
Reynosa	0.981449	*Camargo*	0.987406
Nava	0.980723	*Acuna*	0.987165
Puerto Penasco	0.98041	Hidalgo, NM	0.987013
Piedras Negras	0.977754	*Caborca*	0.986577
Acuna	0.977586	*Reynosa*	0.986232
Mexicali	0.977376	*Tecate*	0.985159
Ojinaga	0.97686	*SLR Colorado*	0.984058
Caborca	0.975439	*Cananea*	0.983689
Guerrero, Coa	0.975	*Santa Cruz, Son*	0.983607
Ocampo	0.974684	*Altar*	0.983402
Tecate	0.974328	*Mexicali*	0.981839
Jimenez	0.972868	*Tijuana*	0.981574
SLR Colorado	0.97134	*Jimenez*	0.9801
Altar	0.970588	*Ojinaga*	0.979927
Nogales	0.970495	*Juarez*	0.979649
Tijuana	0.969573	*Puerto Penasco*	0.979144
Saric	0.96875	Luna	0.979003
Cananea	0.968254	*Nogales*	0.978592
Juarez	0.959424	*Guerrero, Coa*	0.977778
Agua Prieta	0.956853	*Agua Prieta*	0.973333
Mier	0.954545	Kinney	0.972973
Hidalgo, Coa	0.931034	Hudspeth	0.967742

Table A.4
Human Development Index, Ranked from Highest to Lowest

	1990		2000
MEXICO	0.715		0.724
Border Region	0.706		0.741
UNITED STATES	0.906		0.934
Border Region	0.877		0.896
SD	0.910	SD	0.935
Pima	0.895	Pima	0.924
Cochise	0.887	Brewster	0.909
Terrell	0.878	Terrell	0.907
Jeff Davis	0.871	Cochise	0.903
Grant	0.869	Grant	0.899
donaAna	0.860	Jeff Davis	0.885
Yuma	0.858	Yuma	0.871
Brewster	0.856	ElPaso	0.871
ElPaso	0.853	Kinney	0.858
Luna	0.840	Imperial	0.855
Imperial	0.838	Val Verde	0.849
Kinney	0.835	Culberson	0.840
Val Verde	0.829	Cameron	0.837
Cameron	0.816	Webb	0.830
Culberson	0.812	Hidalgo, NM	0.828
Hidalgo, NM	0.812	Zapata	0.825
Webb	0.812	Hidlago, TX	0.821
Zapata	0.804	Luna	0.812
Hidlago, TX	0.803	Hudspeth	0.805
Hudspeth	0.800	Santa Cruz, AZ	0.804
Presidio	0.790	Presidio	0.800
Santa Cruz, AZ	0.787	Maverick	0.791
Maverick	0.761	donaAna	0.789
Starr	0.751	Starr	0.761
Mexicali	0.718	*Mexicali*	0.757
Nogales	0.716	*Cananea*	0.756
Tijuana	0.714	*Nogales*	0.753
Piedras Negras	0.711	*Reynosa*	0.745
Juarez	0.707	*Tijuana*	0.743
Nuevo Laredo	0.707	*Juarez*	0.741
Naco	0.704	*Nuevo Laredo*	0.738
Matamoros	0.704	*Matamoros*	0.737
Reynosa	0.701	*Tecate*	0.734
Acuna	0.700	*Acuna*	0.734
Gustavo Diaz Ordaz	0.697	*Caborca*	0.728
SLR Colorado	0.695	*Piedras Negras*	0.726
Tecate	0.693	*SLR Colorado*	0.725
Caborca	0.689	*Miguel Aleman*	0.721
Agua Prieta	0.689	*Agua Prieta*	0.720
Miguel Aleman	0.687	*Nava*	0.719
Nava	0.687	*Puerto Penasco*	0.713
Cananea	0.686	*Ojinaga*	0.713
Rio Bravo	0.676	*Mier*	0.713
Anahuac	0.671	*Valle Hermoso*	0.713
Valle Hermoso	0.669	*Anahuac*	0.709
Camargo	0.664	*Rio Bravo*	0.709
Guerrero, Tam	0.664	*Gustavo Diaz Ordaz*	0.706
Ocampo	0.660	*Altar*	0.690
Mier	0.658	*Camargo*	0.690
Puerto Penasco	0.658	*Guerrero, Tam*	0.689
Altar	0.658	*Ocampo*	0.687
Ojinaga	0.654	*Ascension*	0.684
Santa Cruz, Son	0.653	*Naco*	0.682
Guadalupe	0.645	*Guadalupe*	0.677
Praxedis G. Guerrero	0.638	*Praxedis G. Guerrero*	0.677
Ascension	0.635	*Jimenez*	0.666
Jimenez	0.633	*Santa Cruz, Son*	0.662
Saric	0.630	*Saric*	0.659
Guerrero, Coa	0.630	*Guerrero, Coa*	0.658
Janos	0.627	*Hidalgo, Coa*	0.658
Manuel Benavides	0.625	*Janos*	0.654
Hidalgo, Coa	0.623	*Manuel Benavides*	0.647