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Did Population Well-Being Improve During Porfirian Mexico? An Approximation using a Quasi-Index of Human Development

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Abstract

It is argued that economic growth during the Porfiriato did not improve the well-being of Mexican population. One explanation for such result is that economic growth pattern was skewed and benefited more the northern states and less the southern ones. Following the estimation method of the Human Development Index (HDI), we calculate a Human Development Quasi-Index for the Mexican states during the period 1895-1910. Results show that starting the period (1895) the northern states were already the most developed. During the next 15 year this pattern was maintained and the dispersion in human development increased marginally. Finally, it is shown that the true losers of Porfiriato were the states surrounding Mexico City and not the southern ones.

Keywords: Human Development, Well-Being, Mexico, Porfiriato

JEL Codes: I30, N36, O10

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The nineteenth century in Mexico was almost a "lost century" in economic terms. The per capita income in 1876 was 15 percent lower than in 1800 (Coatsworth, 1978). In contrast, during the ruling of Porfirio Diaz, a period known as "Porfiriato" (1876-1910), per capita income practically doubled.[1] Nevertheless, some critics mention that such growth did not spread homogenously among people and geographical regions. Gonzalez (2000), for example, argues that economic growth did not increase the well-being of the population: "the Mexican economic bonanza only benefited a few…" (p.686). Katz (1991) also mentions that growth pattern was skewed and benefited more the northern states.[2] Even a recent book by Moreno-Brid and Ros (2009) mentions that during the Porfiriato "Modernization did little to improve the living conditions of the poor." (p. 65).

One way to evaluate quantitatively these statements is by estimating the Human Development Index (HDI) for all Mexican states for that period of time. The HDI assesses the most important social conditions of a population: health, literacy and income.[3] Unfortunately, not all variables used to estimate the HDI are available for late nineteenth century Mexico. It is argued, however, that it is possible to rely on approximations of the original variables in order to construct a Human Development Quasi-Index (QHDI) for the period 1895-1910. As proxies for the unavailable variables on health and income conditions

[1] Porfirio Diaz ruled the country from 1876 to 1910. He left the Presidency in 1880-1884, however, such sub-period is still considered as part of the Porfiriato.
[2] There is not a clear definition of "North" and "South" states. We interpret that northern states are those in the border with the U.S., while southern states are those in the south of Mexico City and Puebla: Guerrero, Oaxaca and Chiapas. Campeche, Tabasco and Yucatan are not included in this group. See Map 1 in the Appendix.
[3] The HDI is published by the United Nations Development Program (UNDP) in the *Human Development Report* since 1990.

there are used the number of physicians per 10,000 people and urbanization rates, respectively.[4]

This paper makes two important contributions to previous research. First, it provides a methodological note on how to calculate and measure social conditions with an index similar to the HDI. Variables like number of physicians and urbanization rates are more easily observed than life expectancy and income for time periods before the twentieth century. Second, it provides detailed information on social conditions across states in Mexico with the goal of evaluating arguments by different academics.

QHDI estimations show that criticisms are true but also give us disaggregated information to better understand the pattern of development experienced in Mexico during the Porfiriato. Human development did improve on average but northern states were more benefited. Southern states, on the other hand, did increase their human development but not enough to catch up. Finally, states that did not benefit at all were the ones neighboring Mexico City.

These results are important because they show how economic growth is not a sufficient condition to improve homogenously general living conditions of the population. Moreover, the fact that states surrounding Mexico City were the least benefited suggests that the followed economic model was not able to spread benefits. This last result must be analyzed

[4] Both proxies are correlated with those included in the HDI. In the late nineteenth century Mexican context such correlation should be stronger, given the fact that transportation and health systems did not exist in the country.

in further research under a specific theoretical framework on patterns of geographic concentration (Mexico City).[5]

The work is divided in six sections. In section I we briefly discussed the Mexican socioeconomic historical context prior and during the period of study. Next section reviews the HDI literature and discusses the importance of analyzing development in a wider scope rather than only in terms of economic growth. Section III describes the HDI basic calculation, the selection of alternative variables due to the lack of data, and the construction of the QHDI. Section IV presents a simple test of QHDI's consistency. In section V results are presented. Finally, Section VI concludes.

I. The Historical Context

A. Pre-Diaz Period 1810-1876: Wars, Disorders and No Progress.

Before Porfirio Diaz became President, the rest of the nineteenth century in Mexico was characterized by wars, disorders and economic stagnation. It was a century epitomized by invasions from foreign countries, civil war and struggle for power.[6]

[5] A nice approach for this kind of analysis is the one proposed by Livas and Krugman (1991). They proposed a model for the effects of urban concentration around a few metropolitan areas of the third world under specific trade policies.

[6] Spain sent an army trying to recover the colony in 1829. The United States army invaded Mexico in 1847-1848 during the Mexican-American War. A Civil War occurred during the period 1857-1860. A French army invaded Mexico in 1862-1863 and backed Emperor Maximilian of Habsburg until he was defeated and executed in 1867. Mexico had 24 Presidents during the period 1824-1846.

Wars and social disorders came with high economic costs (see Figure 1). Coatsworth (1978), for example, shows a decrease of 15 percent in per capita income (in 1950 USD) from 1800 ($73 USD) to 1877 ($66 USD). Moreover, the government was bankrupt. If Mexico wanted to succeed, it was not only necessary to industrialize the country but, also to honor previously acquired debts to avoid foreign invasions.

[Figure 1 Here]

B. Diaz Period 1877-1910: Peace, Order and Progress.

Based on his military formation and utilitarian view of public affairs, President Diaz took several decisions to reestablish order in the country, as his own words show:

> "We began by making robbery punishable by death and compelling the execution of offenders within hours after they were caught and condemned….These were military orders, remember...We were harsh. Sometimes we were harsh to the point of cruelty. But it was all necessary then to the life and progress of the nation. If there was cruelty, results have justified it…It was better that a little blood should be shed that much blood should be saved. The blood that was shed was bad blood; the blood that was saved was good

> blood...Peace was necessary, even an enforced peace, that the nation might have time to think and work."[7]

In the political arena, Diaz was cautious with opposition parties. Contrary to his predecessors, he did not confront the Catholic Church. As a self declared "Liberal", Diaz did include in the Cabinet "Conservatives" and people who had supported previous regimes. The *Pax Porfirica* had arrived and was accompanied by the policies needed to industrialize the country. Diaz, however, faced a difficult scenario:

> "When Diaz seized power in 1877, nothing had been done to reform the colonial mining code since the 1820's… No legislation existed to encourage the formation of corporations with limited liability. No banking laws were passed… No mortgage-credit law existed to protect long-term investment… A modern patent law did not exist… Colonial fiscal measures like the internal customs still provided most of the revenue for the state and municipal governments. Economic activities of all kinds required special permits and licenses for which special taxes and fees were charged."[8]

According to Coatsworth (1978), the causes of economic Mexican backwardness in the nineteenth century were the inefficiency of the economic organization and an inadequate transportation system. As he explains: "Fiscal policy made transactions more costly,

[7] Interview made by the American journalist James Creelman (1908).
[8] Coatsworth (1978), p. 98.

discouraged use of markets as a means for exchanging products, and contributed to the geographical isolation of those regional and local markets which did develop" (p.93).

Diaz' regime tackled these problems. By 1885, all the external debt contracted in the past was consolidated (including the English one dating from 1820). As a consequence, cumulated interests were diminished by 85 percent and external credit was possible again.[9] Domestic taxes to commerce known as "alcabalas" were eliminated. By 1895, Mexico enjoyed its first budget surplus. Economic growth was vigorous as never in the country's independent era. After 30 years with Diaz in power, per capita income almost doubled.

Railroads were crucial to promote economic progress: they explain more than half of the increase in productivity prior to 1910 (Coatsworth, 1979, p.951). At the beginning of Porfiriato, the country had only 396 miles of railways, while at the end there were 11,980. Although reforms were crucial to increase the rate of economic growth, the process of industrialization was different:

> "In Mexico, forward linkages were concentrated in the export sector, backward linkages were few, foreign-exchange costs involved in financing and operation were high, positive institutional consequences were small, and retrograde social forces achieved a new mandate to rule the country. Mexico it did not develop; it 'underdeveloped'."[10]

[9] Carmagnani (1994), p. 281.
[10] Coatsworth (1979), p. 940.

Another negative aspect of the industrialization process was that people close to the circle of political authorities received "favors" with large economic value, as described in Haber (2002). This "crony capitalism" was used to create a credible commitment to property rights that otherwise would not have been possible to create. In this sense, "crony capitalism" could lead to an increase in economic growth benefiting certain groups of the population: the ones with close ties to the group in power.

Some authors argue that well-being of lower classes did not improve. For example, Gonzalez (2000) asserts that economic growth during Porfiriato did not benefit poor people. Katz (1991) also argues that economic development was concentrated among northern states: "Another deep-seated discrepancy that Porfirian development produced was an increasing regional disparity in Mexico between the center, the south and the north of the country" (Katz, 1991, p. 79). Also, Moreno-Brid and Ros (2009) mentions that during Porfiriato "modernization did little to improve the living conditions of the poor." (p. 65).

Moreno-Brid and Ros (2009) cite Rosenzweig (1989) and Paz Sanchez (2000) mentioning that life expectancy and infant mortality may have worsened during Porfiriato. These statistics are drawn from *Estadísticas Sociales del Porfiriato* (Secretaria de Economia, 1956). However, such data should be taken with caution. For example, life expectancy in the state of Chiapas shows a decline from 95.8 years in 1895 to 30.1 in 1910. Sonora shows a decline from 71.2 in 1895 to 44.7 in 1910. It is important to remind that the current life expectancy at birth for Mexico in 2000 was 75 years. On the same venue, the smallest

mortality rate reported in 1895 was for Chiapas, the historical poorest state in the country. Clearly, variables like life expectancy and mortality rates are not reliable for comparisons or strong conclusions such as those in Moreno-Brid and Ros (2009).

In sum, Porfirian Mexico shows a bipolar situation. On one hand, there was economic progress measured by income statistics and construction of railroad lines. On the other hand, according to some academics cited above, the general view of Porfirian Mexico is that economic progress was not transformed into a homogenous increase in well-being. In this paper, our main goal is to evaluate the validity of those criticisms.

II. Literature Review

Economic growth does not imply development. Economic growth is a necessary but not a sufficient condition to improve human well-being. As previously discussed, economic growth can be skewed to benefit only a share of the population or a specific geographical region. Arguments made by Gonzalez (2000), Katz (1991) and Moreno-Brid and Ros (2009), however, leave unclear the meaning of living standards. We argue, therefore, that it is necessary to build a consistent methodology in order to evaluate improvements of social conditions during the Porfiriato.

One alternative is to use the Human Development Index (HDI). As the UNDP claims, human well-being is multidimensional and it should be measured in such a way. As a result, the HDI is composed not only by income, but also by education and health conditions indicators. Human development is defined as the process of widening the choice

possibilities among individuals, so they can span their options with the adequate means to interact in their social environment. In this sense, underdevelopment is understood as the lack of certain basic *capabilities* such as literacy, life expectancy and health conditions.[11]

This view was made by Professor Amartya Sen (1985a, b) and consists in differentiating between the *functionings* and *capabilities* of human beings. The former refers to the "states of being and doings" like "being healthy", while the latter refers to the set of *functionings* "available" for one person. So, the goal of development should be to widen *capabilities* rather than focus on increasing the income per se. As Sen (2000) describes it: "Human development accounting involves a systematic examination of a wealth of information about how human beings in each society live" (p. 18).

In this sense, economic growth does not guarantee benefits for people without access to markets, *i.e.*, there is "ruthless growth" or "bad growth" (Ravallion, 1997). The *capabilities* concept is consistent with the notion of economic growth with development. For example, education and health are fundamental to promote economic growth. Good education and health have value *per se* for people. Moreover, they are correlated: education improves health condition and good health improves education returns. Also, economic growth cannot be sustained without improvements in education and health (UNDP Report 2003, Ch. 3).

The HDI is computed as a simple average of the three dimensions mentioned above.[12] However, because the way it is built, the HDI is subject to several critiques. Firstly,

[11] Of course this definition of the HDI by no means is saying that other aspects of life are not important.

Ravallion (1997) explains that a simple average makes possible perfect substitution among its three variables. He also mentions that valuations of such variables are not explicit and, hence, questionable. On a similar critique, Srinivasan (1994) mentions that the HDI is weak and "empirically unsound", involving comparability problems, measurement errors and biases. The critiques do not affect the main conclusions of the HDI for two reasons. First, the HDI was created originally as a simple, universal and pluralist measure.[13] Therefore, the HDI methodology is used in order to achieve comparability. Second, the index was not created to define the most valuable aspects for each society but to create a consistent methodology to measure the degree of development.

Secondly, Kelley (1991) argues that the HDI formula is not well justified. According to him, changing the "optimal limits or boundaries" of the formula can change results. This argument is valid. Changes of weights in the boundary can cause changes in the distribution of original results. For this reason, in Section V estimations are subject to sensitivity analysis in order to check for results robustness.

To sum up, the HDI is by no means perfect. Three fundamental aspects should be taken into account. The first one is the not inclusion of more variables that may capture more about the development process. The second aspect is about comparability along time. It is more difficult to increase the HDI at higher than at lowers levels of development. Also, it is not clear how to make inferences of results when equal absolute gains at different points in the distribution are obtained. In order to tackle this last point, different measures of ranking and

[12] For the HDI formula see Table I.
[13] Jahan (2002)

dispersion are taken. Finally, as a simple average the HDI is not sensitive to existent inequalities among and within its three dimensions.[14]

III. The Human Development Quasi-Index and Data Description

There are two studies with historical series for the HDI at state level in Mexico, but no one covers a period before 1950. Both of them do not include the exact variables needed to estimate the contemporary HDI (see Table I). Firstly, Jarque and Medina (1998) use data of different Census to obtain HDI's from 1960 to 1990. And secondly, *The Human Development Report for Mexico 2002* calculates national and state level HDI from 1950 to 2000.[15]

[Table I here]

We use data at the state level coming from the national census for years 1895, 1900 and 1910.[16] Not all variables to estimate the HDI are available; therefore, some proxies are chosen to estimate a quasi-index (QHDI):

[14] The Hicks Human Development Index (Hicks, 1997), for example, is sensitive to inequality, but it violates the sub-group consistency property. A more recent alternative is a measure proposed by Foster, López-Calva and Székely (2003). In their case, the adjusted Human Development Index is sensitive to inequality among and within dimensions, and more important, it is sub-group consistent.

[15] This historical HDI differs from standard HDI in two variables: (1) used school enrollment rate is for people between 6 and 14 years old, instead of 6-24 years; (2) the state level per capita GDP is adjusted by oil incomes. Other studies with HDI indexes for more recent periods are the ones by Conapo (2001) and García-Verdú (2002).

[16] The analysis is done for 30 states. Baja California Sur and Quintana Roo were declared states of the country until 1974.

- *Health*: number of physicians per 10,000 people. Physicians are taken from Secretaria de Economia (1956) and population is taken from INEGI (2000).
- *Education*: literacy rates taken from INEGI (2000), the number of students and age composition of total population are taken from Secretaria de Economia (1956), El Colegio de México (1964) and INEGI (2000).
- *Income*: urbanization rates and population density taken from INEGI (2000).

As well as in the case of the HDI, the QHDI is a simple average of standardized health, education and income measures (see Table I). Each sub-index is constructed as follows.

A. Health Index.

Birth and mortality rates are also available in data sources, but as previously explained they are measured with error and are not reliable. Therefore, the best available health proxy is the number of physicians per 10,000 people (NP). In Figure 2 it is shown the relationship between life expectancy at birth (the proxy used in the HDI) and NP at state level for year 2000.

[Figure 2 here]

There is a positive relationship between NP and life expectancy and we can expect a stronger one for late nineteenth century. States and communities were more isolated and less communicated. Therefore, it was more difficult for people to visit physicians settled in far places. Coatsworth (1979), for example, reports that from six million travelers counted

at different checkpoints in 1882, 68% were walking and 25% were mounted.[17] In sum, we can expect that the available doctors in each state during those days better explained the health conditions of settlers than today.

To transform this number into an Index, the simplest approach is taken. The rate for the Mexican states is divided by the "maximum" rate for contemporary world. World Bank Development Indicators show that in 2001 Italy and Greece are the countries with the highest NP per 10,000 people: 44. However, given the fact that NP shows decreasing marginal returns to life expectancy, (*i.e.*, there are other countries in Europe with less NP but higher life expectancy), the chosen NP is 35, that is the number for the country with the highest life expectancy in Europe: Switzerland.[18,19] Then, the Health Index is calculated as follows:

$$HI_t^i = \frac{NP_{i,t}}{35} \qquad (1)$$

Where *i* refers to each state of Mexico and *t* represents each year of the sample.

B. Education Index.

Education is the most accurate measure in our data source. Literacy rates for individuals older than 10 years old are available for 1895, 1900 and 1910. The number of students per state and the population structure by age, on the other hand, are only available for 1900 and

[17] Coatsworth (1979), p.944.
[18] The next countries with the highest rate after Italy are Lithuania with 40, and Belgium with 39, but with less expectancy of life than Switzerland.
[19] World Bank Development Indicators available at http://data.worldbank.org/indicator.

1910. As we can see from Table I, the education index for the HDI is a weighted index of school enrollment (6-24 years old) and literacy rates (15 years old and over).[20] For the period of study, the number of students under 6 years old is not specified for all states. Therefore, the enrollment rate can be overestimated for some cases.[21]

The enrollment rates for 1895 are interpolated.[22] Despite of probable measurement errors in the 1895 calculation, the correlation between literacy and enrollment rates is quite high, 0.82 and correlations in 1900 and 1910 show similar values (0.79, 0.86). Hence, we are confident that our interpolation procedure does a good job in estimating enrollment rates.

The Education Index (*EI*) is calculated as follows:

$$EI_t^i = \frac{\phi_1 LR_t^i + \phi_2 ER_t^i}{3} \qquad (2)$$

[20] Enrollment rates were calculated as follows: Populations per state were obtained from Estadisticas Historicas de Mexico, INEGI (2000). Students per state and share of population from 0-15 and 15-30 years old obtained from El Colegio de Mexico (1964), Number of people from 0-5, and 26-30 were found in Secretaria de Economia (1956). The calculation is number of students divided by the population from ages 6-25. Literacy rates were obtained from Estadisticas Historicas de Mexico, INEGI (2000).

[21] A second problem arises with statistics of Oaxaca. For 1900, this state shows an impressive number of enrolled students (144,858), almost twice as high as the number in Mexico City (it is important to remind that President Diaz was born in Oaxaca). Therefore, instead of using this number for Oaxaca, we take the number of students who passed the academic year (42,807).

[22] The following estimation was obtained by pooling OLS:

$$ER_{i,t}=9.793+0.023Dens_{i,t}+0.284NT_{i,t}-5.05Dummy_i,$$

s.e. (0.877) (0.006) (0.060) (0.819) $R^2=0.8205$

where *i* represents the state and *t* the years estimated 1900 and 1910, *ER* is the enrollment rate, *Dens* the density of population per square kilometer, *NT* the number of teachers per 10,000 people, and *Dummy* takes the value of 1 if the enrollment rate for the state *i* is less than 10% in any year *t* and 0 otherwise, this is made in order to not overestimate the *ER* in 1895 of those states that their *ER* is too small in other years. Then, once obtained the coefficients, the real values for the independent variables in 1895 are plugged-in such that the *ER* predicted for 1895 is obtained. The *ER* for the state of Tlaxcala in 1910 is also obtained from this interpolation, given that *ER* is not available for that state in that year.

Where *LR* is the literacy rate, *ER* is the enrollment rate and ϕ*'s* are the weights for each index such that $\phi_1 = 2, \phi_2 = 1$.[23]

C. Income Index.

For the present exercise, there is no available income data and it is necessary to rely on proxy variables. Acemoglu *et al*. (2002) argue that urbanization is a good proxy for income per capita. In Figures 3 and 4 is presented the relationship of GDP per capita with urbanization and population density, respectively, for 2000 in Mexico. In this case, urbanization is defined as the proportion of population living in places with more than 2,500 people. On the other hand, population density is measured by squared kilometer.

[Figure 3 here]

[Figure 4 here]

As it is shown, the relationship of GDP per capita with urbanization is stronger: 0.78 *versus* 0.63 for population density. Such relationship should be stronger during the Porfiriato. Access to markets was easier for people living in cities than for those settled in communities far from urban areas.

Urbanization data is not available for 1895. Therefore, such problem is tackled interpolating urbanization rates using the number of physicians and population density as

[23] We present an estimation variation with $\phi_1 = 3$, $\phi_2 = 0$ given that enrollment rates for 1895 are obtained from an interpolation (and, of course, contain measurement errors).

predictors.[24] The correlation between predicted urbanization and population density in 1895 is 0.81, while in 1900 using the true variables the correlation is 0.79. Nevertheless, in order to check for robustness in the results, one of the estimations of QHDI presented in section V does not include the urbanization rate.

D. Summing Up

Once obtained the values of each Index, the standard QHDI is estimated as follows:

$$QHDI_t^i = \frac{\alpha_1 HI_t^i + \alpha_2 EI_t^i + \alpha_3 II_t^i}{\alpha_1 + \alpha_2 + \alpha_3} \qquad (4)$$

Where *HI*, *EI*, and *II* are the Health, Education and Income (Urbanization) Indexes defined above. Besides this simple average, variations are calculated in order to check for robustness of results.

IV. QHDI Consistency

First of all, it is necessary to see how the QHDI behaves or compares with the HDI. For this purpose, the QHDI is computed for year 2000 and compared with the one estimated for the *Human Development Report Mexico 2002*. Figure 5 shows the comparison, where the HDI

[24] The following was obtained by pooling OLS:

$$Urb_{i,t}=31.77+0.094Dens_{i,t}+1.189NP_{i,t}-8.261Dummy_i,$$

s.e. (1.649) (0.011) (0.512) (0.879) $R^2=0.8839$

where *Urb* is the urbanization rate for state *i* in time *t*, where *t* takes the values of 1900 and 1910, *Dens* is the density of population per square kilometer, *NP* is the number of physicians per 10000 people in state *i*, *Dummy* is a variable created to give less weight to states that had a lower urbanization rate in 1900 or 1910. In the first interpolation model *Dummy* takes the value of 1 for states that has an *Urb* less than 25% in any of the years and zero otherwise, and in the second interpolation *Dummy* (-9.146) can take three values, 2 if Urb is less than 20% in any of the years, 1 if it is between 20-30%, and 0 otherwise. Once obtained the coefficients in each regression, the values for the independent variables in 1895 are plugged-in to obtain an estimate of the *Urb*. The first interpolation is the based model, the second interpolation is simulated just for the states with the lowest rates of urbanization in 1900: Guerrero, Hidalgo, Sinaloa, Sonora y Tabasco, given that the first model clearly overstates the rate of urbanization in 1895 for those states. *Urb* is constructed given data in El Colegio de Mexico (1964), *Dens* from Secretaria de Economia (1956), and *NP* was constructed using data of number of physicians and population per state given in Secretaria de Economia (1956).

is sorted in ascending order. The QHDI approximately ranks in the same way as the HDI in the first and last third of the distribution. States that are in the lower tail or in the upper tail of the distribution in the HDI are also in the lower or upper tail in the QHDI distribution. However, in the middle of the distribution the ranking is not that clear.

[Figure 5 here]

QHDI for 2000 ranks exactly the same as the HDI for the lower tail ranking: Chiapas (32), Oaxaca (31) and Guerrero (30). Comparing QHDI-HDI rankings, 7 states stay in the same place, 10 move up-down one or two places, 7 move up-down three or four places, and 8 move up-down five or more places. The biggest change in rankings is the one for Chihuahua: 11 places (from place 4 with the HDI to 15 with the QHDI). .

Although results show ranking differences between HDI and QHDI, we have to keep in mind that such comparison is not a perfect predictor of HDI-QHDI differences during the period of study. As previously explained, some variables included in the QHDI should be measuring better human development during the Porfiriato.

A second way of checking for consistency is by comparing ranking changes for QHDI's with different weights in formula (4). In particular, the QHDI is transformed such that, in each case, a different variable is eliminated: (1) $\alpha_1=\alpha_2$, and $\alpha_3=0$; (2) $\alpha_1=\alpha_3$, and $\alpha_2=0$; and (3) $\alpha_1=0$, and $\alpha_2=\alpha_3$ (see Table II). Ranked states are divided in three groups of 10: top group, middle group and bottom group. For each group, it is checked if state members remain in the group for each of the above estimation alternatives. Then, if one state remains in the group all the time, we say that it shows a 100 per cent repetition rate. If the state

remains in the group in 3 out of 4 cases, we say that it shows a 66.7 per cent repetition rate. If it remains in 2 out of 4 cases, we say that it shows a 33.4 per cent repetition rate. And finally, if the state is only a member of the group for a single estimation, the repetition rate is equal to 0. Once repetition rates are estimated for all members of the group, simple averages are calculated.

As we can see in Table #, the lowest repetition rate is 50 per cent. Staying in the top or bottom group depends less on the variables' selection. This result has two possible explanations. On the one hand, data suggest that correlations among human development dimensions are stronger for extreme cases. On the other, however, it is possible that lower repetition rates are reflecting the incapacity of single dimensions to identify uneven human development processes. Further research is needed to clarify these issues. In any case, almost all repetition rates are high enough to be confident on the consistency of the QHDI.

[Table # here]

V. Results

As data is available only for the second half of Porfiriato, it is valid to question if this restriction is going to affect the final results. As it is shown in Figure 1, the highest rate of economic growth was before 1895. Then, if higher improvements in social conditions during Porfiriato were made before 1895, it is possible to underestimate the total effects on

population's well-being. It is necessary to keep in mind these considerations when results are analyzed.

Table II shows calculations for the standard QHDI ($\alpha_1=\alpha_2=\alpha_3$). At national level, QHDI improved by 18 per cent (from 0.168 to 0.199). Other studies confirm such improvement. Lopez-Alonso (2007), for example, presents adult physical stature trends for period 1850-1950. Basically, adult height is a multidimensional variable that reflects the history of childhood welfare. [25] Raw data from Lopez-Alonso show that average height of federal soldiers (arranged by birth cohort) increased during 1890-1910 by around one centimeter (it decreased by around the same value during the Mexican Revolution).[26]

An alternative way of evaluating the size of national improvements during Porfiriato is by projecting QHDI for 2000. For the calculation, QHDI for 1910 is used as the initial value and the projection is estimated assuming the same annual growth rate for 1895-1910.[27] "Real" QHDI for 2000 is equal to 0.657 (estimated for consistency analysis in the previous section). On the other hand, projected QHDI is equal to 0.537, *i.e.*, at Porfirian growth rate,

[25] Besides genetics, the quality of diet, work effort and disease environment mostly during early childhood are the main determinants of adult height. For a discussion on the main determinants of heights and to understand their importance to analyze living standards in history see Steckel (1995, 1998) and Komlos and Baten (2004),

[26] Because of minimum height requirements in the Army, once the sample is restricted only to those over 159-160 centimeters, average height does not show any increase. Lopez-Alonso explains, however, that "Height and health were the least enforced requirements" (p.93). Therefore, using the whole sample should not bias trends.

[27] Annual growth rate is estimated by:

$$r = \left(\frac{V_{final}}{V_{initial}} \right)^{\frac{1}{n-1}} - 1$$

where *r* is the annual growth rate, *V final* is the QHDI value for 1910, *V initial* is the QHDI value for 1895 and *n-1* es equal to 15 year. Once r is obtained, the same equation is used to estimate *V final*, where final year is 2000 and initial year is 1910 (therefore, *n-1* is equal to 105 years)

another 18 years are needed to catch up the "real" level. It has to be said, however, that during 1895-1910 per capita income increased by 27 per cent, while for the whole Porfiriato such increase was of 96 per cent. Therefore, it is possible that higher achievements in human development took place before 1895.

To sum up, QHDI improved during 1895-1910. Population well-being did increase on average during Porfiriato. In order to analyze the magnitude of the improvement, we project QHDI for 2000 using Porfirian growth rates. We find that projected QHDI is lower than the "real" value. However, given the fact that per capita income increased more during the first than the second half of Porfiriato, we can expect that absolute and relative human development improvements were bigger for the whole 30 years period. Hence, it is difficult to assess the full benefits of the improvement during Porfiriato by using data from 1895-1910.

Once estimates at national level were analyzed, inter-regional comparisons are made in order to identify possible concentration of human development improvements in northern states. Results presented in Table II show, firstly, that Mexico City is the state, by far, with both highest level and growth rate in QHDI during the whole period. Secondly, since the beginning of the period of study there is a significant difference between the northern and southern states. Thirdly, in terms of dispersion, last row of Table II shows a slight increase in the coefficient of variation (standard deviation divided by the average national level) of QHDI among Mexican states.

In order to analyze inter-state dispersion more carefully, states are divided in six regions: Northeast, Northwest, West-Center, Center, South-Southeast and Mexico City. All regions, but the Center, show improvements in human development (see Table #). Stepping Mexico City aside, the Northeast region starts and finishes with the highest QHDI. Moreover, during the period the Northwest is the region that gains more in absolute terms (0.037). On the other hand, the Center region shows no improvements (QHDI decreases by 0.001). At the end of the period, the three closest regions to the U.S. border are the ones with highest QHDI. Results also show that Southern states were the least developed in all periods. Since the beginning of the available data, there is a contrast between the northeast and southern states. Nonetheless, the absolute increase in QHDI between Northeast and South is the same. We conclude from these results that inter-state inequality is driven by the Center region not the South. In fact, according to our results the Center lagged behind during Porfiriato. This is an important result in the Porfirian literature that needs further exploration.

Table # analyzes the possible polarization effects of the human development pattern during Porfiriato. We group states by relative position with respect to the average QHDI national level: (1) over 125 per cent; (2) between 100 and 125 per cent; (3) between 75 and 100 per cent; (4) and 75 per cent or below. As it is shown, the number of states in the extreme groups increases during the period. Moreover, in 1910, no state in group (1) is coming from the Center and South-Southeast regions. This is consistent with the increase of the coefficient of variation and standard deviation in Table II.

To sum up, Mexico City concentrates benefits of human development during Porfiriato. Secondly, states closer to the U.S. border are better off on average than those of the Center and South-Southeast. Thirdly, results show clearly that states neighboring Mexico City are the true losers of Porfiriato. And finally, the regional human development pattern during the period suggests a polarization process.

VI. Conclusions

Main criticisms of Porfiriato point out that economic growth during the period did not benefit poor people. Also, it is argued that dispersion of development benefited the northern states at the expense of the south. In the present study, these statements are evaluated by estimating a Human Development Quasi-Index (QHDI) for the period 1895-1910. We argue that in absence of the variables in the HDI, proxy variables can be used instead. In particular, urbanization rate is a good proxy for the income dimension and number of physicians captures differences in health conditions among regions.

This paper makes two important contributions. First, it provides a methodological framework on how to measure population well-being with an index similar to the HDI. Second, it provides disaggregated information on social conditions at the regional level. Of course, state level data does not allow us to disaggregate the analysis within states and we are not able to identify whether benefits of Porfiriato were concentrated in high income groups.

Our results are threefold. Firstly, results show that contrary to general wisdom living standards at the national level did improve during the period of study. In comparison with national results for more recent periods of Mexican history, Porfirian performance on human development was less successful. However, to be fair comparisons should be done with other empirical studies on Porfirian Mexico or with other countries' experiences during the same period.

Secondly, state level analysis confirms that human development improvements were skewed more in favor of northern regions. Southern states did increase their human development, but not enough to catch up with both the Northeast and Northwest regions. Available data since 1895 show that northwestern states, stepping aside Mexico City, were already the most developed. Also, results show that during the last fifteen years of Porfiriato this pattern was maintained.

Thirdly, states surrounding Mexico City were the true losers of the Porfiriato. Once they are grouped as a single region, results show that QHDI did not grow for those states. Finally, it is shown that more states were in the upper and lower tail in 1910 than they were in 1895, suggesting that a polarization process took place in the country. These two last results suggest that economic concentration (Mexico City) put limits and avoid geographical spread of social benefits.

Why were northern states more developed than the southern ones at the beginning of Porfiriato? A true and complete answer for that question is out of the scope of this paper, but a possible answer is an adaptation to the story given by Acemoglu et al. (2002) and

Engerman and Sokoloff (2002): when Spaniards arrived in Mexico extractive institutions in the south were settled.[28] In contrast, as population density was lower in the north than in the south, it was more profitable to annihilate or transfer population to other regions. As a result, in the northern region was easier to establish more efficient institutions, and that is why inter-regional disparities arose. Future research should address more specifically why and when the northern region developed.

[28] More research in this topic is needed. It is possible that Spaniards did not settle at all in the south, so that the problem is not of extractive institutions but of no institutions at all in that region.

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Table I. Formulas for the HDI

Index	Variables	Formula
HDI		$\frac{Health\ Index + Literacy\ Index + Income\ Index}{3}$
Health Index	*e=expectancy of Life*	$\frac{e-25}{85-25}$
Education Index	*LR= Adult population (over 15) literacy rate* *ER=Enrollment rate population (6-24)*	$\frac{2LR+ER}{3}$
Income Index	*y= per capita income*	$\frac{\log y - \log y_{\min}}{\log y_{\max} - \log y_{\min}}$

Note: The UNDP defines $y_{\min}$ and $y_{\max}$ as 100USD and 40,000USD respectively.

Table II. Human Development Quasi-Index, Mexico, 1895-1910												
	QHDI 1895				*QHDI 1900*				*QHDI 1910*			
	a	b	c	d	a	b	c	d	**a**	b	c	d
Aguascalientes	**0.180**	0.110	0.191	0.241	**0.233**	0.138	0.255	0.307	**0.284**	0.184	0.283	0.384
Baja California	**0.203**	0.190	0.159	0.260	**0.222**	0.209	0.162	0.294	**0.263**	0.285	0.163	0.340
Campeche	**0.206**	0.144	0.215	0.259	**0.224**	0.165	0.232	0.276	**0.233**	0.181	0.218	0.302
Coahuila	**0.206**	0.144	0.215	0.259	**0.236**	0.180	0.222	0.308	**0.295**	0.228	0.271	0.385
Colima	**0.212**	0.163	0.180	0.292	**0.228**	0.164	0.200	0.321	**0.259**	0.209	0.194	0.374
Chiapas	**0.106**	0.059	0.117	0.142	**0.133**	0.055	0.151	0.192	**0.106**	0.066	0.107	0.145
Chihuahua	**0.192**	0.133	0.189	0.253	**0.195**	0.154	0.169	0.260	**0.212**	0.189	0.164	0.284
Distrito Federal	**0.448**	0.318	0.475	0.553	**0.510**	0.358	0.546	0.627	**0.569**	0.417	0.578	0.713
Durango	**0.131**	0.096	0.122	0.177	**0.146**	0.111	0.133	0.193	**0.146**	0.119	0.117	0.201
Guanajuato	**0.159**	0.076	0.184	0.217	**0.176**	0.088	0.195	0.245	**0.167**	0.098	0.169	0.235
Guerrero	**0.087**	0.047	0.095	0.119	**0.081**	0.052	0.081	0.110	**0.092**	0.061	0.087	0.128
Hidalgo	**0.114**	0.077	0.107	0.159	**0.127**	0.109	0.096	0.177	**0.109**	0.109	0.065	0.152
Jalisco	**0.193**	0.129	0.191	0.257	**0.197**	0.149	0.180	0.263	**0.206**	0.167	0.171	0.281
Estado de Mexico	**0.166**	0.091	0.170	0.238	**0.149**	0.095	0.141	0.210	**0.165**	0.113	0.149	0.234
Michoacan	**0.122**	0.076	0.127	0.163	**0.141**	0.095	0.136	0.191	**0.154**	0.104	0.151	0.206
Morelos	**0.179**	0.107	0.185	0.246	**0.212**	0.149	0.197	0.289	**0.228**	0.161	0.202	0.320
Nayarit	**0.132**	0.098	0.115	0.182	**0.154**	0.118	0.131	0.214	**0.176**	0.145	0.142	0.242
Nuevo Leon	**0.245**	0.190	0.244	0.300	**0.248**	0.208	0.233	0.301	**0.249**	0.204	0.192	0.351
Oaxaca	**0.099**	0.053	0.101	0.142	**0.119**	0.060	0.124	0.172	**0.128**	0.066	0.135	0.184
Puebla	**0.171**	0.095	0.184	0.233	**0.181**	0.111	0.181	0.250	**0.166**	0.112	0.160	0.226
Queretaro	**0.123**	0.081	0.115	0.174	**0.196**	0.087	0.222	0.278	**0.140**	0.105	0.117	0.199
San Luis Potosi	**0.159**	0.088	0.170	0.218	**0.156**	0.107	0.152	0.208	**0.168**	0.110	0.162	0.234
Sinaloa	**0.131**	0.113	0.096	0.184	**0.127**	0.121	0.087	0.174	**0.144**	0.137	0.097	0.197
Sonora	**0.155**	0.142	0.127	0.197	**0.169**	0.162	0.121	0.223	**0.218**	0.214	0.163	0.277
Tabasco	**0.140**	0.116	0.131	0.173	**0.113**	0.121	0.083	0.136	**0.134**	0.131	0.100	0.171
Tamaulipas	**0.176**	0.156	0.138	0.234	**0.208**	0.168	0.182	0.276	**0.206**	0.190	0.157	0.270
Tlaxcala	**0.174**	0.145	0.130	0.247	**0.138**	0.090	0.127	0.199	**0.158**	0.140	0.109	0.226
Veracruz	**0.124**	0.081	0.121	0.168	**0.135**	0.105	0.118	0.183	**0.173**	0.118	0.166	0.236
Yucatan	**0.192**	0.124	0.206	0.245	**0.190**	0.149	0.191	0.231	**0.242**	0.206	0.238	0.282
Zacatecas	**0.136**	0.103	0.118	0.186	**0.165**	0.116	0.155	0.225	**0.168**	0.134	0.135	0.235
National	**0.168**	0.118	0.164	0.224	**0.184**	0.134	0.174	0.245	**0.199**	0.157	0.172	0.267
MAX	**0.448**	0.318	0.475	0.553	**0.510**	0.358	0.546	0.627	**0.569**	0.417	0.578	0.713
MIN	**0.087**	0.047	0.095	0.119	**0.081**	0.052	0.081	0.110	**0.092**	0.061	0.065	0.128
S.D.	***0.065***	0.053	0.072	0.078	***0.075***	0.059	0.085	0.090	***0.088***	0.072	0.092	0.109
C.V.	***38.6***	44.8	43.8	34.6	***40.7***	44.0	48.6	36.8	***44.3***	45.9	53.2	40.9

Notes: Weighted averages are estimated to get four different QHDIs: α1 is the chosen weight for health index (HI), α2 is the chosen weight for education index (EI) and α3 is the chosen weight for income index (II). Column (a) is the standard QHDI, where all three indexes are included to estimate a simple average. a) α1=α2=α3; b) α1=α2, α3=0; c) α1=α3, α2=0; d) and α1=0, and α2=α3

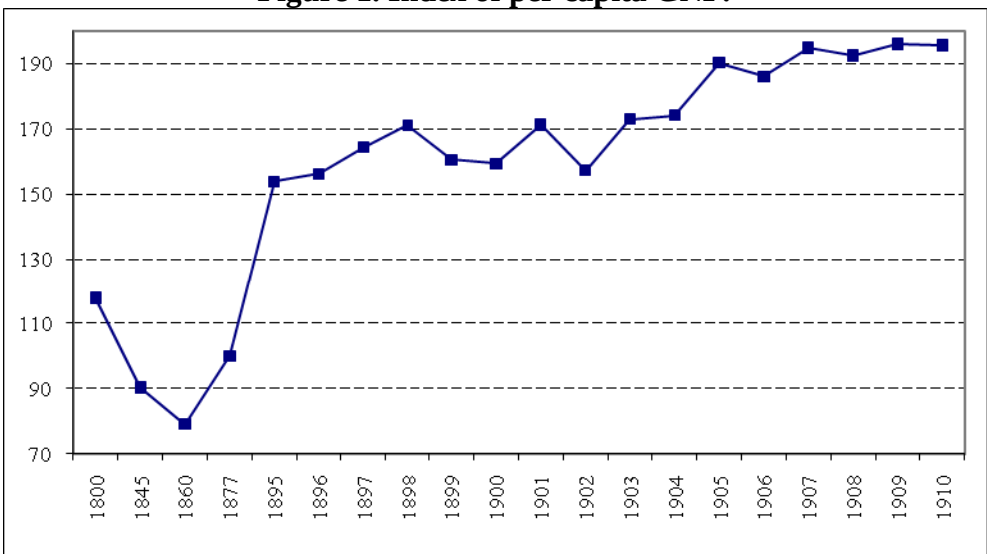
Table III. Average of absolute gains during Porfiriato by geographical region.

	1895-1910	1900-1910
Definition 1		
North	0.0443	0.0275
Center	0.0044	0.0039
South	0.0115	-0.0026

Definition 2		
Northeast	0.0316	0.0153
Northwest	0.0448	0.0352
Occident	0.0342	0.0086
Center	0.0044	0.0039
South	0.0220	0.0159
Total	0.0271	0.0141

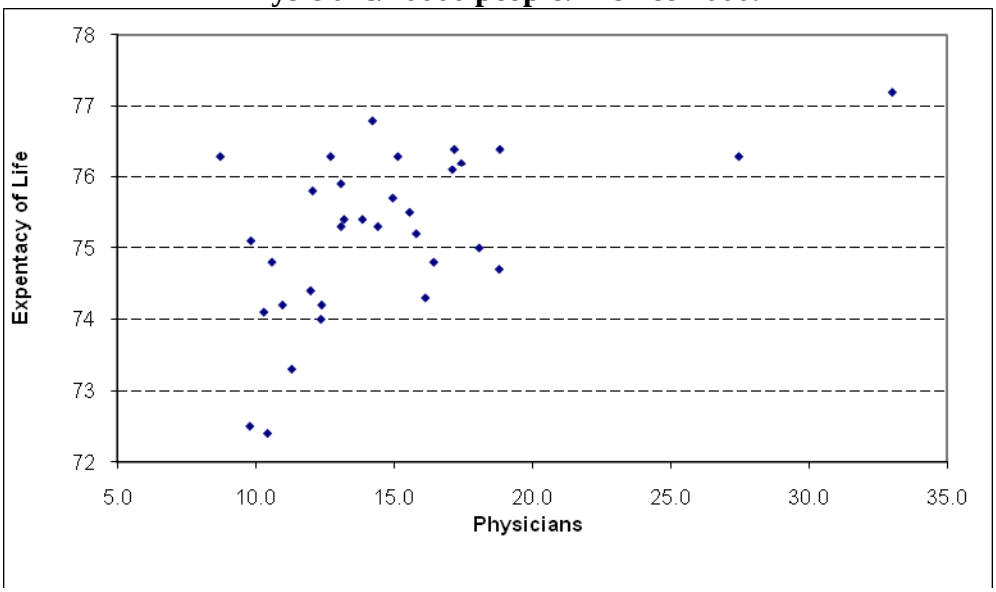
Note: Def. 1: North: States that share a border with the U.S.; Center: Hidalgo, Morelos, State of Mexico, Tlaxcala, Puebla; South: Guerrero, Oaxaca, Chiapas. Def. 2: Northwest: Baja California, Sonora and Sinaloa; Northeast: Coahuila, Chihuahua, Durango, Nvo Leon and Tamps; Occident: Aguasc., Colima, Guanajuato, Jalisco, Michoacan, Nayarit, Queretaro and San Luis Potosí; Center: same as before; South: Campeche, Chiapas, Guerrero, Oaxaca, Tabasco, Veracruz and Yucatán.

Figure 1. Index of per capita GNP.



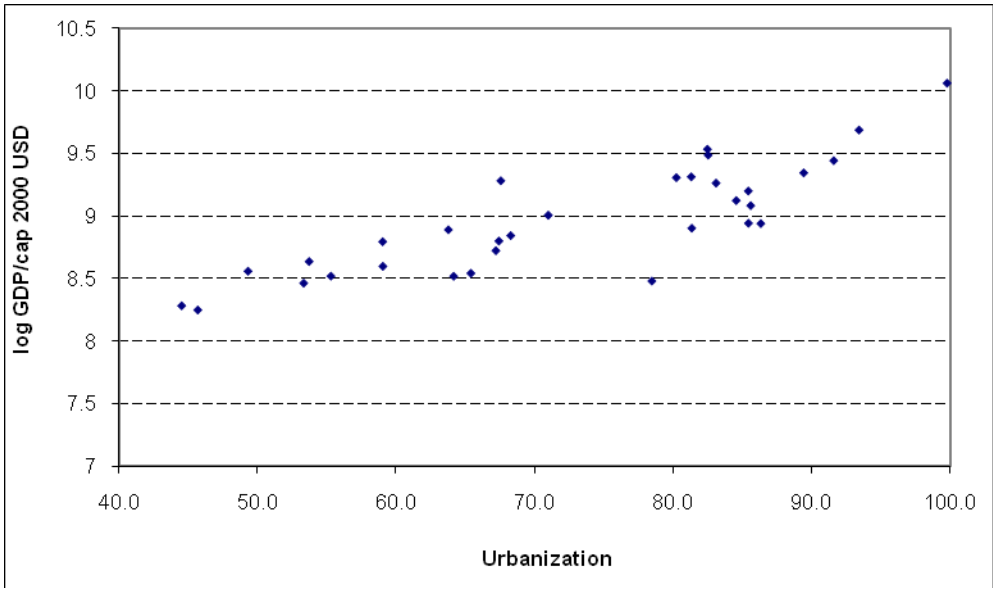
Notes: Data from Estadisticas Historicas de Mexico, INEGI, 1998. 1877=100.

Figure 2. Expectancy of Life and Number of Physicians/10000 people. Mexico 2000.



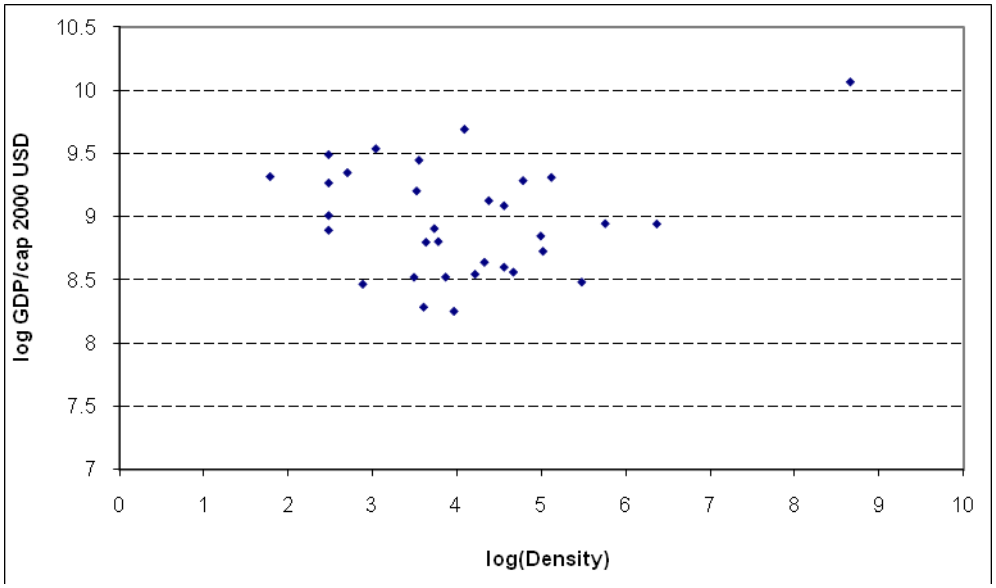
Note: Number of Physicians was obtained from Atlas de Salud Pública (2003), and Expectancy of Life from Human Development Report for Mexico 2002.

Figure 3. Urbanization and per capita Income. 2000.



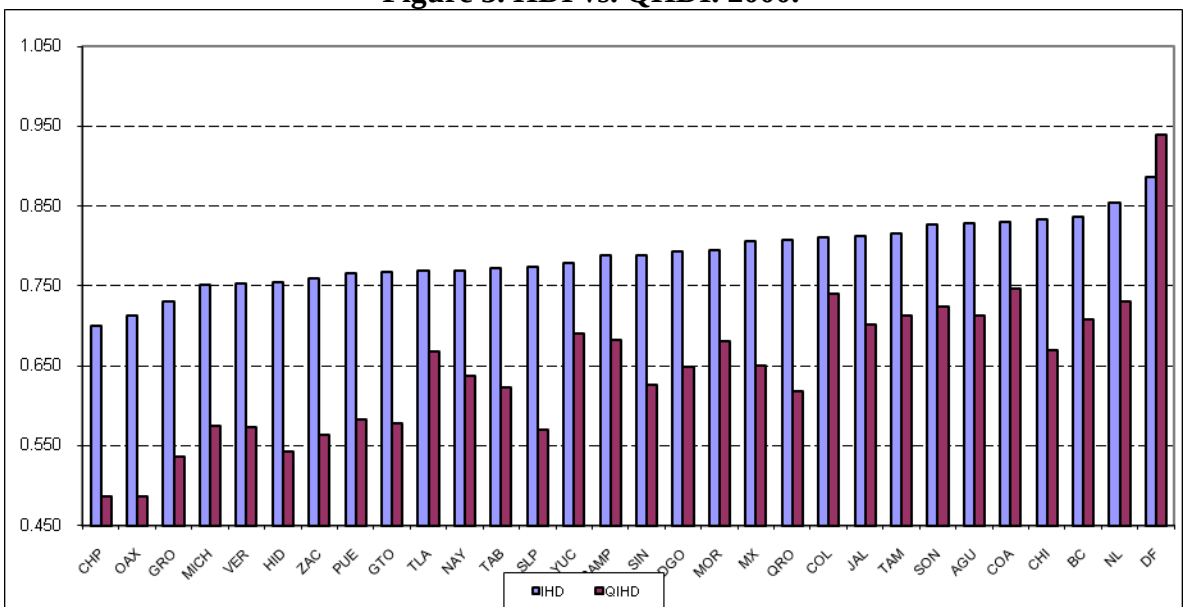
Note: GDP/cap is obtained from the Human Development Report for Mexico 2002. Urbanization is obtained from INEGI.

Figure 4. Density of Population and per capita Income. 2000.



Note: GDP/cap is obtained from the Human Development Inform for Mexico 2002. Density of population per kilometer square is obtained from INEGI.

Figure 5. HDI vs. QHDI. 2000.



Note: The HDI is obtained from the Human Development Report for Mexico 2002, where the HDI is the Refined HDI, given that an adjustment for oil revenues is necessary. The QHDI is computed with data obtained from: Atlas de Salud Pública (2003) for the number of physicians, INEGI for urbanization rates, and education variables were obtained from the Human Development Report for Mexico 2002.

Table #. Repetition Rates for Different Weights' Selection, Mexico, 1895-1910

	1895	1900	1910
Top Group (10)	0.767	0.800	0.833
Middle Group (10)	0.600	0.500	0.667
Bottom Group (10)	0.833	0.800	0.833

APPENDIX
Map 1.
Location of Each State.

Table IV. Data for the calculation of QIHD.

	1895					1900					1910				
	Health	*Education*			*Income*	*Health*	*Education*			*Income*	*Health*	*Education*			*Income*
	NP	LR	ER	NT	Urb	NP	LR	ER	NT	Urb	NP	LR	ER	NT	Urb
Aguasc.	2.1	17.4	13.2	10.4	32.1	3.0	21.4	14.2	12.8	42.4	2.9	35.2	15.0	17.2	48.3
Baja Calif.	3.1	37.3	12.6	9.7	23.0	2.7	41.2	19.9	16.6	24.7	3.8	56.9	24.5	29.1	21.8
Campeche	3.5	22.0	12.4	9.1	33.0	4.2	24.8	13.3	11.8	34.3	3.4	33.5	12.2	14.2	33.9
Coahuila	3.5	21.6	13.1	11.4	33.0	3.3	34.2	11.4	16.5	34.9	4.0	42.5	17.5	25.4	42.8
Colima	1.8	33.4	15.8	20.5	30.8	1.5	32.5	20.6	16.3	35.7	1.0	51.8	13.1	22.8	35.9
Chiapas	1.2	9.1	6.9	7.3	20.0	0.5	13.1	2.7	2.2	28.8	1.0	13.4	4.5	5.5	18.6
Chihuahua	2.4	23.4	12.3	8.9	30.9	2.2	31.4	10.9	6.7	27.5	2.4	39.3	14.1	11.6	25.9
Dist. Fed.	8.4	44.8	28.9	41.4	71.0	9.7	49.5	32.8	47.0	81.5	9.9	64.6	36.4	57.2	87.3
Durango	1.4	19.3	6.8	7.0	20.3	1.8	21.5	8.1	8.6	21.5	1.2	25.4	10.3	9.8	19.9
Guanajuato	1.5	12.6	7.3	6.0	32.6	1.3	16.3	9.0	8.0	35.2	1.1	20.1	9.1	9.6	30.6
Guerrero	0.8	7.7	6.0	3.8	16.7	0.8	8.9	6.7	3.4	13.9	0.7	12.2	6.2	2.6	15.4
Hidalgo	0.9	13.3	12.1	6.0	18.8	1.0	21.7	13.6	13.6	16.3	0.8	23.5	11.8	7.3	10.7
Jalisco	2.2	22.5	13.7	12.7	31.9	2.3	28.2	13.1	13.1	29.4	2.0	34.1	15.0	16.6	28.5
México	0.8	17.5	12.6	6.8	31.7	0.9	19.0	11.4	10.0	25.6	1.0	23.6	12.3	12.1	26.9
Michoacán	1.4	13.2	7.1	7.2	21.4	1.4	17.7	9.6	6.6	23.2	1.7	19.7	8.3	9.4	25.3
Morelos	1.6	18.2	13.9	11.8	32.4	2.0	26.1	20.2	11.7	33.7	1.5	32.2	19.5	10.8	36.1
Nayarit	1.1	18.7	12.0	7.3	19.9	1.2	22.9	14.5	8.7	22.7	1.6	29.8	13.7	16.8	23.9
Nvo León	4.7	29.8	14.2	15.0	35.4	4.9	33.3	16.4	18.0	32.6	1.6	46.1	16.6	23.8	33.9
Oaxaca	0.4	8.7	11.0	3.4	19.0	0.4	11.1	10.3	5.1	23.6	0.6	13.5	7.3	6.3	25.3
Puebla	1.6	14.9	13.5	10.6	32.2	1.5	20.9	11.9	13.7	32.0	1.6	21.0	11.3	11.7	27.5
Querétaro	0.8	14.7	12.3	7.3	20.8	1.1	16.4	10.2	9.4	41.3	0.8	22.3	11.6	10.6	21.1
SL Potosi	1.4	14.4	12.2	7.7	30.0	1.8	17.4	13.9	7.9	25.3	1.3	22.9	8.9	8.9	28.6
Sinaloa	0.9	23.8	12.7	10.0	16.7	1.2	24.7	13.2	21.4	13.9	1.3	29.5	12.1	9.8	15.7
Sonora	2.5	27.6	8.3	12.6	18.3	2.1	36.7	6.0	14.7	18.1	3.5	45.9	6.4	18.0	22.6
Tabasco	2.6	17.3	12.6	9.5	18.8	2.4	20.9	10.1	7.7	9.8	2.1	24.1	12.2	8.5	14.0
Tamps.	2.1	31.0	13.6	13.1	21.5	2.6	32.3	13.7	12.7	29.0	2.7	38.2	14.7	17.6	23.7
Tlaxcala	1.0	33.9	10.8	17.7	23.2	0.6	20.1	8.4	14.9	23.6	0.8	31.1	14.7	13.6	19.6
Veracruz	1.2	14.9	8.7	13.0	20.8	1.4	20.7	9.5	6.5	19.6	1.7	23.9	8.7	9.3	28.3
Yucatán	3.0	17.2	14.4	15.5	32.7	3.8	22.8	11.1	14.7	27.3	5.7	30.0	14.8	26.3	31.4
Zacatecas	1.2	19.8	11.9	7.0	20.1	1.6	21.0	13.6	8.5	26.5	1.2	27.3	15.8	13.2	23.6
Total	2.0	20.7	12.1	11.0	27.0	2.2	24.3	12.7	12.3	28.5	2.2	31.1	13.3	15.2	28.2

Note: NP: Number of Physicians per 10000 people, constructed with data from Secretaria de Economia (1956) and El Colegio de México (1964). LR: Literacy rate obtained from INEGI (2000), Estadísticas Históricas de México; ER: enrolment rate. Shares of population obtained from El Colegio de México (1964) and Secretaria de Economia (1956), and number of students per state obtained from El Colegio de Mexico (1964), interpolation used for 1895. NT: number of teachers per 10000 people, obtained from El Colegio de Mexico (1964). Urb: urbanization rate, obtained from Secretaria de Economia (1964), interpolation used in 1895. Baja California Sur and Quintana Roo do not have available data for the years of 1895 and 1900, so these states are not taken into account in any year , weights are adjusted just to take into account 30 states.