Differences in Intelligence and Socio-Economic Outcomes across the Twenty Seven States of Brazil

Article *in* Mankind Quarterly · June 2017

6 authors, including:

Richard Lynn
University of Ulster
528 PUBLICATIONS **13,928** CITATIONS
SEE PROFILE

Mayra Antonelli-Ponti
Laboratório de Estudos e Pesquisas em Economia Social (LEPES)
49 PUBLICATIONS **185** CITATIONS
SEE PROFILE

Rodrigo Focosi Mazzei
University of São Paulo
6 PUBLICATIONS **21** CITATIONS
SEE PROFILE

José Aparecido Da Silva
University of São Paulo
196 PUBLICATIONS **3,305** CITATIONS
SEE PROFILE

MANKIND QUARTERLY 2017 57:4 519-541

Differences in Intelligence and Socio-Economic Outcomes across the Twenty Seven States of Brazil

Richard Lynn
University of Ulster, UK

Mayra Antonelli-Ponti,* Rodrigo Focosi Mazzei,
José Aparecido Da Silva
Psychobiology Unit, University of São Paulo at Ribeirão Preto, Brazil

Gerhard Meisenberg
Ross University School of Medicine, Dominica

*Corresponding author: antonelli.may@gmail.com

In a number of countries, earlier studies have reported significant associations between regional differences in intelligence within countries and economic and social phenomena. Using scores on the Program of International Student Assessment (PISA) tests as indicator of intelligence, we find statistically significant correlations for the 27 states of Brazil between intelligence and nine indicators of socio-economic development. Spatial analysis indicates that relationships are present both at the level of differences between adjacent states and over long-distance clines. Most of the relationships observed after initial analysis persisted after controlling for spatial autocorrelation. Among the socio-economic variables, those that describe the standard of living of the less affluent sections of the population tend to correlate most with PISA scores.

Key words: Intelligence; PISA; Brazil; Income; Health; Fertility; Spatial analysis

The importance of intelligence for people's lives has been shown in numerous studies that found high correlations of intelligence, measured by IQ tests, with many important outcomes. Measured intelligence is considered the best predictor of school performance (Deary et al., 2007; Laidra, Pullmann & Allik, 2007; Rindermann & Neubauer, 2004), being more potent than other plausible predictors (Poropat, 2009). Importantly, cognitive abilities measured early in life are great predictors of future events such as health and longevity (Gottfredson & Deary, 2004), level of schooling, job placement, and income (Sorjonen et al., 2015). The implication of this is that cognitive ability is not only an outcome of circumstances in a person's life, but to some extent also a cause.

This conclusion is plausible theoretically, in addition to being compatible with the observed relationships. Problem solving ability is part of intelligence (Carroll, 1993; Snyderman & Rothman, 1988), and it impacts all aspects of life: accident prevention, study strategies, struggling with information technology, navigating the job market, and managing one's personal life. Problem solving ability is an essential part of competence in virtually every occupation. In this way, people tend to cluster intellectually and create their personal environments according to their intellectual level and personal preferences (Da Silva, Ribeiro-Filho & Santos, 2012).

The importance of intelligence, as well as other personal qualities not examined in our research, is not confined to the personal lives of individuals. These traits also shape the communities that people form and the worldviews, lifeways and forms of governance they adopt. Intelligence is postulated to be a major driving force of economic and cultural development (Meisenberg, 2014; Rindermann, Sailer & Thompson, 2009). In support of this hypothesis, many studies found that regional differences in intelligence within countries are robustly associated with economic and social phenomena (Table 1, see also Lynn & Vanhanen, 2012). Davenport and Remmers (1950) were the first to report relationships of state IQ with per capita income, lynchings, and several other outcomes in the United States. The positive association with income was confirmed and followed up by Kanazawa (2006) and McDaniel (2006) more than half a century later.

Further studies reporting associations of intelligence with per capita income and related economic measures at the level of sub-national administrative units have been conducted in other countries (Table 1). They include 13 regions of the British Isles (Lynn, 1979), 90 regions of France (Lynn, 1980; Montmollin, 1958), 12 regions of Italy (Lynn, 2010), 19 regions of Italy (Piffer & Lynn, 2014; Templer, 2012), 18 regions of Spain (Lynn, 2012), 16 regions of Germany (Roivainen, 2012), 47 prefectures of Japan (Kura, 2013), 12 regions of Turkey (Lynn, Sakar & Cheng, 2015), 31 regions of the People's Republic of China (Lynn & Cheng, 2013), and 12 regions of the United Kingdom (Carl, 2016). Many of these studies also reported significant correlations between regional differences in intelligence and a variety of social phenomena including health, fertility and crime.

Table 1.*Summary of earlier studies reporting correlations between intelligence of regions and socioeconomic indicators. Correlations are for measures of per capita GDP, average income, or related measures.*

Country	Outcomes reported	Author, date	*r* with GDP/income
USA	12 economic and social variables	Davenport & Remmers,1950	0.32
USA	Gross domestic product (GDP)/capita	Kanazawa, 2006	0.57
USA	GDP, health, crime, govt. effectiveness	McDaniel, 2006	0.59
Britain	GDP, unemployment, infant mortality, crime	Lynn, 1979	0.73
France	Earnings, unemployment, infant mortality, migration	Lynn, 1980	0.61
Italy	Income, education, infant mortality	Lynn, 2010	0.94
Italy	GDP, murder, anthropometry	Templer, 2012	0.98
Spain	Income, employment, literacy, life expectancy	Lynn, 2012	0.42
Germany	Education, church membership	Roivainen, 2012	0.79 (1992) 0.27 (1998)
China	GDP, ethnicity, education	Lynn & Cheng, 2013	0.42
Japan	Income, homicide, divorce, fertility, suicide	Kura, 2013	0.51
Turkey	Income, education, fertility, infant mortality	Lynn, Sakar & Cheng, 2015	0.81
Britain	Unemployment, poverty, patent applications	Carl, 2016	0.42

In our study we use the scores of PISA tests as measures of intelligence, forming the average of the Reading, Mathematics and Science sections. PISA scores are adequate measures of intelligence. Scientific competence, language skills and mathematics, along with reasoning and problem solving, are components of general intelligence in Carroll's (1993, p. 524) taxonomy. Carroll identifies math ability as "quantitative reasoning". Among other components (1993, pp. 598-599) he lists reading comprehension, defined in the PISA studies as the capacity to understand, use and reflect on written texts, and science understanding identified as "general science information". Furthermore, it has been inferred that the same genetic polymorphisms determine cognitive ability measured by educational tests and intelligence tests (Bartels et al., 2002; Plomin, Kovas & Haworth, 2007).

Furthermore, the data deal with populations, not individuals. Therefore, we will always work with averages. The aim is to relate the average intelligence of state populations to indicators that represent important real-life phenomena. The aim is to chart the relationships between the cognitive traits of local populations and the environments created by them (Jones, 2016). The average, therefore, does not represent any individual, and the observed relationships are population-level phenomena that may or may not hold true at the individual level. Our hypothesis is that intelligence has a positive impact on desirable conditions, and a negative impact on undesirable conditions. More specifically, intelligence of Brazilian states is predicted to have a moderate or strong positive correlation with higher education, income, life expectancy and water availability, and a moderate or strong negative correlation with infant mortality, fertility, poverty and violence.

In Brazil, the economists Curi and Menezes (2014) investigated the association of income with mathematical abilities measured in an educational testing program (SAEB - Assessment of the Basic Education System) at the level of Brazilian states. Fuerst and Kirkegaard (2016) investigated ancestry factors of Latin American countries, including Brazil; Kirkegaard (2015) also investigated PISA scores and their associations, but focusing on socioeconomic development. Our study adds another piece to the puzzle of intelligence and its correlates in the provinces of a large country. It is a study with a view of the real-world implications of the psychological construct of intelligence. Considering the geographic scale of Brazil, where each state can have the size of a European country, the subject of the study is of more than purely local interest. Its results can point to the social importance of developing people’s cognitive abilities, and perhaps provide indications of how this aim can be achieved.

Method

The measures of intelligence for the 27 states (26 federal states and the federal district) of Brazil (Fig. 1) were calculated from the PISA (Programme for International Student Assessment) scores of 15-year-old school students in Math, Science and Reading for the years 2009, 2012 and 2015 with results for 61,862 Brazilian school students (OECD, 2016). The values were obtained as follows:

- The plausible values (five in 2009 and 2012 and ten in 2015) of each area (mathematics, reading and science) were obtained by state and for each of the three years.
- The average of plausible values was calculated for each state and year.

- The average of the total scores was calculated by state and year.
- The average of the three years was calculated for each state with weighting by sample size, which was different in different years.

The PISA data have been used as measures of intelligence in a number of studies, e.g. for the regions of Italy (Lynn, 2010; Templer, 2012) and of Turkey (Lynn, Sakar & Cheng, 2015). These tests are regarded as valid measure of intelligence with which they are highly correlated (Kaufman et al., 2012). It has been shown that PISA tests and intelligence tests are very highly correlated across countries, e.g. at *r*=.89 for 63 countries reported by Rindermann (2007) and at *r*=.91 for 82 countries reported by Meisenberg and Lynn (2011).

The economic and social data for 2010 were collected from a Brazilian national database (Atlas of Human Development in Brazil, 2013). The violence data were obtained for 2014 and 2015 from State Departments of Public Safety and/or Social Defense; National Statistical System for Public Security (SINESP); Brazilian Institute of Geography and Statistics (IBGE); and Brazilian Forum on Public Security (Folha de São Paulo, 2015; O Estado de São Paulo, 2016).

1. *Higher education*: Percentage with a university degree.
2. *Income*: Per capita household income in Brazilian currency reais.
3. *Infant mortality*: Deaths of infants below 1 year per 1,000 live births.
4. *Water availability*: Percentage of the population living in houses with piped water.
5. *Life expectancy*: Average number of years that individuals born in the same year can expect to live, for men and women.
6. *Fertility*: Total Fertility Rate (TFR) defined as the average number of children a woman would have in her life at current age-specific fertility rates.
7. *Poverty*: Percentage of individuals with an income of 70 reais or less per month.
8. *Violence 2014*: Intentional lethal violent crimes, including homicide, robbery, bodily injury followed by death and victims of police actions in 2014 (Folha de São Paulo, 2015).
9. *Violence 2015*: Intentional lethal violent crimes, including homicide, robbery, bodily injury followed by death and victims of police actions in 2015 (O Estado de São Paulo, 2016).

Descriptive statistics for PISA scores and the economic and social variables are given in Appendix 1.

For the analysis of the data, we chose correlation, spatial analysis and principal components analysis. Statistical data analysis was done with SPSS-23 statistics software.

Figure 1. *Map of the 26 Brazilian states and the Federal District of Brasilia.*

Results

Correlations

The Pearson product moment correlations between the variables were examined first. The results are given in Table 2. The correlations above the diagonal were calculated without weighting, and those below the diagonal are weighted for the square root of population size, converted to a weight factor with average value of 1 in order to preserve degrees of freedom for statistical analysis. Weighting was done because small states are more likely than larger ones to be affected by idiosyncratic conditions and to have atypical relationships between the variables. For example, the small Federal District might be atypical on some measures because of its high concentration of well-paid government officials. Table 2 shows that correlations tend to be somewhat higher with weighting than without, as is expected if the observed relationships are true and if the signal-to-noise ratio is higher in the bigger states.

Table 2. *Correlation matrix for PISA scores and economic and social variables. Unweighted correlations are above the diagonal, and correlations weighted by square root of population size are below the diagonal. N = 27 states;* *, *p<.05;* **, *p<.01;* ***, *p<.001, two-tailed t tests.*

	PISA score	Higher educ.	Income	Infant mort.	Water available	Life exp.	Fertility	Poverty	Violence 2014	Violence 2015
PISA score	1	.721***	.791***	-.815***	.765***	.869***	-.678***	-.854***	-.475*	-.499**
Higher education	.739***	1	.964 ***	-.658***	.613***	.760***	-.480*	-.724***	-.426*	-.497**
Income	.786***	.972***	1	-.720***	.698***	.803***	-.579***	-.811***	-.414*	-.488**
Infant mortality	-.875***	-.720***	-.782***	1	-.693***	-.873***	.522**	.838***	.506**	.454*
Water available	.813***	.712***	.765***	-.789***	1	.734***	-.887***	-.891***	-.172	-.259
Life expectancy	.878***	.764***	.793***	-.877***	.774***	1	-.564***	-.845***	-.493**	-.514**
Fertility	-.715***	-.620***	-.674***	.652***	-.901***	-.614***	1	.706***	.075	.165
Poverty	-.874***	-.793***	-.856***	.897***	-.932***	-.855***	.770***	1	.313	.370
Violence 2014	-.614***	-.540**	-.550**	.576**	-.387*	.576**	.332	.499**	1	.930***
Violence 2015	-.636***	-.621***	-.624***	.560**	-.472*	.604***	.426*	.559**	.947***	1

Most of the correlations of PISA scores with indicators of economic prosperity (income, poverty, water availability) and health (infant mortality, life expectancy) are near .80 or above .80, and correlations with higher education and fertility are not much lower. Also the socio-economic variables are highly correlated among each other as expected, to an extent similar to their correlations with PISA scores. Correlations of the two measures of violence are lower both with PISA scores and with the other socio-economic indicators.

Spatial patterning

The statistical significance values in Table 2 must not be taken at face value because of spatial patterning of the variables. The usual observation in geographic data is that neighboring units are similar on many dimensions. The greater the distance, the greater are the differences. The implication for data analysis is that the data points are not independent of each other and that traditional significance testing, which assumes independence of data points, is not applicable (Eff, 2004; Hassall & Sherratt, 2011). This is especially the case when features such as average PISA score, income or life expectancy form a geographic gradient, or cline, over an extended territory. In Brazil, the southern states in general tend to have higher levels of socio-economic development than the northern states. For example, the correlation with latitude is -.787 for PISA score, -.656 for income, and -.709 for life expectancy. Any variable that shows clinal variation will produce high correlations with any other variable that forms a cline in a similar direction. Indeed, two perfect clines, lying at a 45° angle, will produce a correlation of r=.71. In other words, two random clines have a 50% probability of being correlated at r>.71.

To explore the extent to which the results are due to spatial gradients, we calculated for each variable the differences between each of the 351 pairs of states, and related them to the distance between the states (proxied by their capital cities). The positive signs in the first data column of Table 3 show that as expected, for each of the variables, states that are more distant are more different from each other. This clinal distribution is most evident for fertility, availability of piped water and poverty, but minimal for percentage with higher education degrees. The distance effect is intermediate for PISA scores.

A more commonly used measure of spatial patterning is Moran's I, which is defined by the following formula:

$$\text{Moran's } I = (N / \textstyle\sum_{i,j} wij) \times (\sum_{ij}(wij \times zXi \times zXj) \,/\, \sum_{i} zXi^{2})$$

N is the number of state pairs (351), and w_{ij} is the spatial weight. Distances ranged from 104 km (Paraiba – Pernambuco) to 3788 km (Roraima – Rio Grande do Sul), and we calculated the spatial weight as inverse distance between the state capitals: distance subtracted from 3892. zXi and zXj are the standardized values of the variable in state i and state j. Numerically, Moran's I can vary between -1 and +1. The values of Moran's I for each of the 10 variables are listed in the third data column of Table 3. Across the 10 variables, the correlation of Moran's I with the simple distance-difference correlation in column 1 is .926 (p<.001). Thus these two measures of spatial dependence are nearly equivalent.

Another question, and one that is more relevant for statistical analysis, is whether the relationship between two focal variables is consistent across locations. To this end we performed simple regressions across the 27 provinces with PISA score as independent variable predicting each of the other 9 variables in Table 3. The differences between the residuals were then tabulated for the 351 pairs of states and correlated with distance. Column 2 in Table 3 shows that results are quite different for different variables, with income and higher education showing significant negative correlations. Across the 9 variables, the distance-dependence of residuals correlated .706 (p = .034) with the distance-dependence of the scores and .697 (p = .037) with Moran's *I*. The result suggests that in Brazil, some of those socio-economic indicators that show more pronounced long-distance clines (fertility, water availability) also tend to have greater distance-dependent differences in their non-cognitive determinants.

Table 3. *Spatial patterning of variables in the Brazilian states. N = 27 states;* **, p<.05;* ***, p<.01;* ****, p<.001, two-tailed t tests.*

Measure	**Correlation of distance with**		**Moran's *I***	
	score difference	residual difference	Scores	diff. scores
PISA score	0.260^{***}		0.129	-0.049
Higher education	0.024	-0.152^{**}	0.041	-0.060
Income	0.151^{**}	-0.184^{***}	0.080	-0.057
Infant mortality	0.245^{***}	0.105	0.098	-.044
Water available	0.496^{***}	0.187^{***}	0.158	-0.025
Life expectancy	0.262^{***}	0.032	0.116	-0.057
Fertility	0.503^{***}	0.410^{***}	0.156	-0.006
Poverty	0.426^{***}	-0.012	0.160	-0.024
Violence 2014	0.145^{**}	0.113^{*}	0.114	0.032
Violence 2015	0.150^{**}	0.063	0.095	-0.018

The positive values for Moran's *I* emphasize the need to control for the non-independence of data points in order to obtain valid statistical significance estimates. The procedure followed was to form, for each variable, the difference score between the state's value and the average of the values of those states with which the state shares a boundary (Appendix 2). For example, the difference score for the fertility rate in Espirito Santo is the difference between fertility in Espirito Santo and the average of the fertility rates in Bahia, Minas Gerais and Rio de Janeiro (see Fig. 1). Because only neighboring states are compared, spatial proximity is no longer an important determinant of similarity between the states, and the correlations are no longer confounded – and inflated – by variations in spatial proximity. This method is similar to the K nearest neighbor method (Fortin, Dale & VerHoef, 2002), but avoids the need to somewhat arbitrarily decide about the number of nearest neighbors with which each state is compared. It determines whether, for example, states in which the average PISA score is higher than in the surrounding states also have higher life expectancy than the surrounding states.The last column in Table 3 shows that when Moran's *I* is calculated based on the difference scores, the values are closer to zero for all variables except higher education. The average Moran's *I* across the 10 variables is .115 for the calculation based on actual scores, and -.031 for the difference scores.

Table 4 shows that, as expected, the correlations between the difference scores are lower than the raw correlations in Table 2. However, most of the relationships remain moderately strong and many remain statistically significant. We see, for example, that states in which the PISA score is higher than in the surrounding states tend to have more piped water, higher life expectancy, lower fertility, lower infant mortality and lower poverty rates than the surrounding states, and that these relationships are unlikely to be chance observations. Income and higher education still are highly correlated, as are, obviously, rates of violent crime in 2014 and 2015. Now, income, higher education and violent crime are only weakly related to PISA scores and socio-economic indicators, but high correlations are preserved between members of a "poverty cluster" that includes poverty, water availability, infant mortality and fertility. This time we do not observe conspicuously higher correlations with weighted than unweighted data, presumably because greater "typicality" of larger states is offset by greater distances from the population centers of neighboring states. In general, the results presented in Table 4 support the existence of true relationships among many of the variables.

Principal components analysis was performed with the unweighted difference scores of the socioeconomic variables in Table 4, but excluding PISA scores. It produced three principal components with eigenvectors above 1. Figure 2 shows the scree plot. Table 5 shows the loadings of the variables on these three varimax-rotated principal components. The first of these can be described as a "poverty factor", with highest loadings on water availability, poverty, fertility and infant mortality. The second is a "prosperity factor" defined by income and proportion with a university education; and the third is a "crime factor". Also shown in Table 4 are the correlations of PISA scores with these three principal components. PISA scores are inversely associated with poverty. Correlations with the other principal components are of smaller magnitude and do not reach statistical significance with our sample size of 27 states, but are in the hypothesized direction.

Table 4. *Correlation between the difference scores. Unweighted correlations are above the diagonal, and correlations weighted by square root of population size are below the diagonal. N = 27 states; *, p<.05; **, p<.01; ***, p<.001, two-tailed t tests.*

	PISA score	Higher educ.	Income	Infant mort.	Water available	Life exp.	Fertility	Poverty	Violence 2014	Violence 2015
PISA score	1	.281	.280	.516**	.319	.509**	-.424*	-.436**	-.273	-.059
Higher education	.224	1	.933***	-.300	.288	.448*	-.184	-.357	-.330	-.362
Income	.177	. 946***	1	-.330	.336	.436*	-.363	-.419*	-.162	-.188
Infant mortality	-.526**	-.306	-.338	1	-.703***	-.659***	.674***	.753***	.198	-.089
Water available	.369	.331	.353	-.688***	1	.474*	-.766***	-.844***	-.171	-.096
Life expectancy	.502**	.302	.244	-.571**	.410*	1	-.380	-.493**	-.047	.112
Fertility	-.375	-.301	-.434*	.683***	-.732***	-.236	1	.702***	.157	.014
Poverty	-.443*	-.405*	-.454*	.760***	-.876***	-.411*	.740***	1	.074	-.058
Violence 2014	-.326	-.316	-.196	.149	-.166	.036	.271	.116	1	.844***
Violence 2015	-.176	-.373	-.244	-.072	-.121	.156	.182	.027	.876***	1

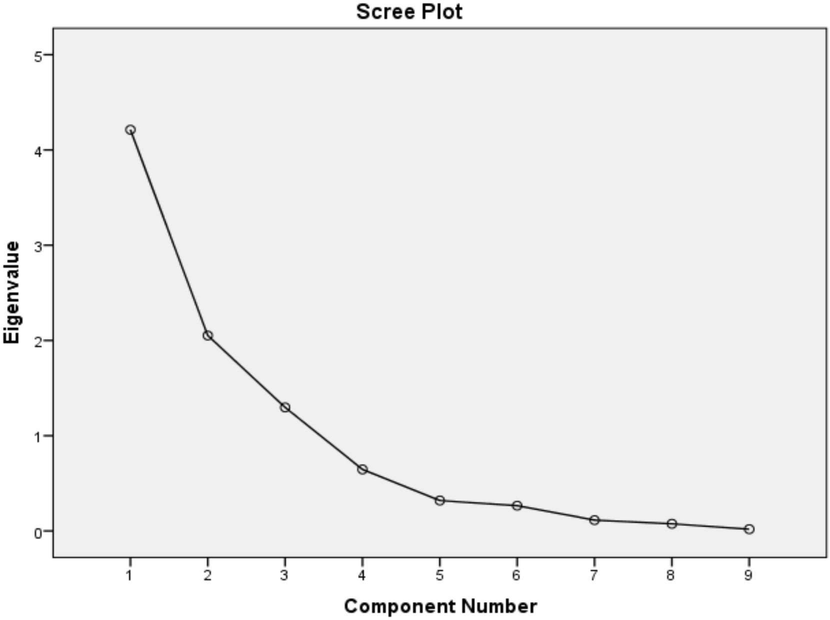

Figure 2. *Principal components analysis of unweighted difference scores, scree plot.*

Table 5. *Loadings of the difference scores on the first three principal components, **, p<.01.*

	Principal Component			Communalities
	1 "Poverty"	2 "Prosperity"	3 "Crime"	
Higher education	-.132	.944	-.259	.976
Income	-.222	.928	-.092	.919
Infant mortality	.868	-.204	-.015	.795
Water availability	-.905	.121	-.119	.847
Life expectancy	-.550	.510	.176	.594
Fertility	.863	-.064	.082	.756
Poverty	.879	-.235	-.034	.828
Violence 2014	.132	-.089	.938	.905
Violence 2015	-.076	-.137	.957	.941
Factor correlation with PISA score	-.528**	.291	-.231	

The causal paths between cognitive ability and the different outcomes are uncertain. One plausible hypothesis is that higher cognitive ability produces prosperity, indexed by income, and that all other outcomes are a direct consequence of higher income. In this case, income would beat PISA scores as the principal predictor of the other outcomes in multiple regression models. The test of this hypothesis is shown in Table 6. The β coefficients in the first two data columns show that most outcomes are independently predicted by both PISA scores and income, and that in most cases the coefficients are larger for PISA scores than for income. This indicates that either cognitive resources are more important than material resources for outcomes such as infant mortality and life expectancy, or that PISA scores are more accurate than income for measuring their respective constructs. The last two columns in Table 6 show the results when difference scores are used. Now the effect sizes and significance levels are generally reduced, but many of the PISA effects retain at least marginal statistical significance.

Table 6. *Results of regression models predicting diverse outcomes with PISA scores and income. Standardized β coefficients are shown. The first two data columns use actual scores, and the last two columns use difference scores for both the independent and dependent variables. Cases are weighted by square root of population size. N = 27 states; $^{+}$, p<.10; *, p<.05; **, p<.01; ***, p<.001, two-tailed t tests.*

	Scores predicted by		Δ scores predicted by	
	PISA	**Income**	**Δ PISA**	**Δ Income**
Higher education	-.066	1.024***	.059	.936***
Infant mortality	-.681***	-.247	-.481**	-.253
Water availability	.552**	.331^{+}	.316^{+}	.297
Life expectancy	.668***	.268^{+}	.474*	.161
Fertility	-.485*	-.293	-.308^{+}	-.379*
Poverty	-.528**	-.441**	-.375*	-.389*
Violence 2014	-.476^{+}	-.176	-.301	-.143
Violence 2015	-.380	-.325	-.137	-.220

Discussion

The main result of the present study is that cognitive ability, proxied by PISA scores of 15-year-olds, is related to a variety of socio-economic outcomes at the level of Brazilian states. Geographic distance is important, as is seen when the correlations in Table 2 are compared with those in Table 4. In general, we observe a pattern of attenuated but still substantial correlations for most relationships in Table 4. Correlations of PISA scores with infant mortality, life expectancy, poverty and fertility still are statistically significant, and the others are still in the same directions as in the original analysis. The results show that variation exists both between adjacent states and along long-distance clines, and that a control for spatial autocorrelation is therefore meaningful.

The results do not show that those correlations that became statistically non-significant in the spatial autocorrelation control should be dismissed. The spatial autocorrelation control that we used removes distance as a confounding factor by limiting the analysis to variance among neighboring states. The raw correlations reported in Table 2 are still relevant because they include the entire variance, including the long-distance component. Turning to specific results, we note six findings of interest:

1. The raw data show a high positive correlation between the intelligence of states and household income, with Pearson's *r* close to .79. Flores-Mendoza et al. (2012) analyzed the cognitive performance of Brazilian adults in four states: Amazônia, Bahia, Minas Gerais and São Paulo. They concluded that intelligence is not a good indicator for economic factors. Although our initial results reported in Table 2 seem to contradict this conclusion, the analysis of difference scores reported in Table 4 casts doubt on a key role of cognitive ability for income differences, at least between neighboring states. In Brazil, both cognitive ability and average income appear to vary mainly along correlated long-distance clines, rather than between neighboring states.

Associations between intelligence and income have been reported at the level of sub-national units for the United States, the British Isles, France, Italy, Spain, Germany, the People's Republic of China, and Turkey. However, none of these studies subjected its results to spatial analysis to clarify at what geographic scale these correlations arise. In the case of Brazil, the high correlation between PISA scores and income is easily explained considering that Brazil is an extremely unequal country. If we double the per capita GDP of the lowest-income state in 2010 (Maranhão - R$360.34), we do not even come close to the value of the state with the second highest income (São Paulo - R$1,084.46) in the same year. This does not take into account the Federal District with the capital Brasilia, which has the highest income (R$1715.11). Also average PISA scores vary substantially, from 351 in Alagoas to 426 in the Federal District. This spread of 75 points corresponds to 75% of the individual-level standard deviation in the OECD countries, or about 11 IQ points.

2. Tables 2 and 4 show that in Brazil, the closest correlate of average family income is the percentage of university graduates. Although we would expect a high correlation between PISA scores and higher education, the initially moderately high correlations between these variables tend to fade into insignificance when only neighboring states are compared. High correlations of cognitive measures with higher education have been reported at the subnational level from other countries, for example the association in Turkey between regional IQ and higher education graduation rate (r=.63) (Lynn, Sakar & Cheng, 2015). A likely reason for the lack of robusticity in the relationship between PISA scores and higher education in Brazil is that PISA scores reflect mainly the intellectual prowess of the average school child, whereas the proportion of university graduates depends on the size of the intellectual elite. The high correlation between higher education and income may also indicate that universities are more likely to be established in prosperous states rather than poor states.

3. There is a negative correlation of cognitive ability with infant mortality that clearly persisted even in comparisons between neighboring states, suggesting a rather direct relationship between the two variables. Similar associations had been reported before for a number of countries including the regions of the British Isles (r=-.78), France (r=-.30), Italy (r=-.80), the American states (r=-.54), Finland (r=-.79), India (r=-.39), European Russia in the late nineteenth century (r=-.28), Finland and the contemporary Russian Federation (r=-.43) (Dutton & Lynn, 2014; Grigoriev, Lapteva & Lynn, 2016; Grigoriev, Ushakov

et al., 2016; Lynn, 1979, 1980, 2010; Lynn & Yadav, 2015; Reeve & Basalik, 2011). These results at the aggregate level are consistent with the negative association of infant mortality with IQ of mothers reported by Savage (1946). It is proposed that the explanation for these correlations is that people with higher intelligence are more competent in looking after their babies. They are better able to avoid accidents, and are more likely to be knowledgeable about infant nutrition and hygiene, with the result that their infants are healthier and less likely to succumb to diseases. The association can also be explained by scarcity of resources, since the negative correlation of infant mortality with income and especially its positive correlation with poverty are high (Table 2). The relationship with poverty is still highly significant in the correlation among difference scores (Table 4).

4. The negative correlation of intelligence with fertility is still evident after the spatial autocorrelation control. It confirms the negative correlations of intelligence with fertility rates across the American states (r=-.37), the regions of Turkey (r=-.89) and India (r=-.25), European Russia in the late nineteenth century (r=-.28), and the contemporary Russian Federation (r=-.39) (Grigoriev, Lapteva & Lynn, 2016; Grigoriev, Ushakov et al., 2016; Lynn, Sakar & Cheng, 2015; Lynn &Yadav, 2015; Shatz, 2009).These results are consistent with studies in many countries showing that dysgenic fertility for intelligence has been near-universal during the twentieth and twenty-first centuries (Lynn, 2011; Woodley & Figueredo, 2013). In Latin America, this has been confirmed through path analysis by León & Avilés (2016), who reported cognitive ability → fertility path coefficients ranging between -.25 and -.40 for a set of more than 1000 districts in Peru.

5. The positive correlation of intelligence with life expectancy was found to be robust even with control for spatial autocorrelation. This result is consistent with a number of studies reporting an association at the individual level between intelligence and longevity, e.g. Deary, Whalley and Starr (2009, p. 50); Gottfredson and Deary (2004).

6. The negative correlations of intelligence with violent crime confirm the negative association in the United States between state IQs and violent crime (r=-.58) reported by Bartels et al. (2010) and in Japan between regional IQs and homicide rates (r=-.60) reported by Kura (2013). These results are consistent with numerous reports of an association between crime and low intelligence summarized in more than a hundred studies in a number of countries by Ellis and Walsh (2003). However, the state-level correlations we observe between violent crime and PISA scores are rather low and do not survive the spatial

autocorrelation control. Factors other than cognitive ability appear to be the more important determinants of violent crime in Brazil. Violence among human beings can be due to the lack of essential resources (Allen et.al, 2016). However, the weakness of the relationship between income and violent crime (Tables 2, 4, 6) suggests that this may not be of great importance in Brazil—or, perhaps, that mean income is not a good indicator for the condition of poorer people in Brazil, as it is disproportionately determined by the numbers and income of the rich. Median rather than mean income would be a better indicator for the standard of living of average people.

Principal components analysis was performed to obtain conceptual clarity about the socio-economic factors that are most closely related to intellectual ability. This analysis produced three interpretable factors. The first is represented by infant mortality, water availability, poverty, and fertility. It describes the living conditions of the poorer sections of the population. This factor is strongly related to PISA scores as shown in Table 5, perhaps because most of the students taking the PISA tests are the children of relatively poor parents. In addition to their numerical strength, the lower socio-economic groups have higher fertility than wealthier and more educated people, and therefore make a greater contribution to the next generation. For example, in the Brazilian sample of the World Values Survey the correlation between education and fertility is -.229 for females (N = 763) and -.192 for males (N = 495) with completed fertility. As a result, a disproportionate fraction of the school children taking the PISA tests are from lower socio-economic origins.

The second principal component includes income and higher education. The high correlation between these two variables suggests a strong bidirectional relationship, with higher education leading to high income and high income being an important prerequisite for obtaining a university education in Brazil. This relationship is observed on the background of a high level of income inequality, with a Gini index above 50 according to United Nations data (http://www.wider.unu.edu/research/Database/). In consequence, the *average* income most closely reflects the proportion of high earners in a community or state, which in turn is proxied by the proportion of people with a university degree.Thus the income-education factor describes the abundance of wealthy and educated people in the state. This “prosperity factor” is related less closely to PISA scores than is the “poverty factor.” The third principal component is a “crime” factor that has relatively weak connections with both PISA scores and with other socio-economic indicators.

Does the relationship of PISA score with the “poverty factor” mean that higher average intelligence and/or education of the general population is required in order to achieve better living conditions for common people and the poor? Or does it mean that the development of higher intelligence, at least when measured as school achievement, depends on decent living conditions? These questions cannot be answered with the present data, which are cross-sectional rather than longitudinal. The first hypothesis predicts that PISA scores today have a direct effect on standards of living 20 or 30 years later, when the children who are tested today are economically active. The second hypothesis predicts that standards of living affect PISA scores (measured at age 15) up to 15 years later. Future studies with longitudinal data will have to address these questions.

Even without a definitive answer to the question of whether intelligence produces wealth or wealth produces intelligence, we can approach the more general question of whether cognitive resources or material resources are more important for various outcomes that people care about. One possibility is that the material resources available to a society, measured as mean income or per capita GDP, are the direct cause for multiple outcomes related to health, standard of living, crime rates and the like. A second possibility is that cognitive resources have direct effects on these outcomes that are not mediated by material wealth alone. The results presented in Table 6 show that in Brazil, cognitive resources do matter for many outcomes at the state level independent of the available material resources, in addition to effects that cognitive development may have on the generation of material resources. One implication is that successful efforts at raising the average cognitive level of the population can produce multiple benefits, even independent of their effects on economic growth. Surprisingly, PISA scores appear to even have a poverty-reducing effect that is independent of *average* income. This may indicate that brighter people are either more able or more inclined than less intelligent ones to redistribute resources in order to restrain poverty when material resources are in limited supply.

It is also evident that the correlations among most of the variables are quite high at the level of Brazilian states, compared to similar correlations for subnational administrative units in other countries. One explanation for the strength of the correlations is the inequality of the income distribution: in Brazil there are states with a level of development similar to poor countries in Asia and Africa, and there are states with a near-European level of development. Another explanation is investment in education. Although primary education is compulsory and free in Brazil, states like Paraná and São Paulo have high levels of school enrolment, while states like Maranhão and Alagoas do not. These inequalities between states invariably lead to high correlations. There are at least two explanations for poor cognitive development in some of the states: (1) the financial distress of the poor leads people to work rather than study, which leads to educational and cognitive deficits; and (2) financial needs restrict access to foods and especially to healthy foods, which leads to poor brain development and cognitive deficits. These possibilities will be investigated in future studies.

References

Allen, M.W., Bettinger, R.L., Codding, B.F., Jones, T.L. & Schwitalla, A.W. (2016). Resource scarcity drives lethal aggression among prehistoric hunter-gatherers in central California. *Proceedings of the National Academy of Sciences* 113: 12120-12125.

Atlas of Human Development in Brazil (2013). Available at: http://www.atlasbrasil.org.br.

Bartels, M., Rietveld, M.J.H., van Baal, G.C.M. & Boomsma, D.I. (2002). Heritability of educational achievement in 12 year olds and the overlap with cognitive abilities. *Twin Research* 5: 544-553.

Bartels, J.M., Ryan, J.J., Urban, L.S. & Glass, L.A. (2010). Correlations between state IQ and FBI crime statistics. *Personality and Individual Differences* 48: 579-583.

Carl, N. (2016). IQ and socioeconomic development across regions of the UK. *Journal of Biosocial Science* 48: 406-417.

Carroll, J.B. (1993). *Human Cognitive Abilities: A Survey of Factor-Analytic Studies*. Cambridge University Press.

Curi, A.Z. & Menezes-Filho, N. (2014).The relationship between school performance and future wages in Brazil. *Economia* 15(3): 261-274.

Da Silva, J.A., Ribeiro-Filho, N.P. & Santos, R.C.D. (2012). Inteligência humana e suas implicações. *Temas em Psicologia* 20(1): 155-188.

Davenport, K.S. & Remmers, H.H. (1950). Factors in state characteristics related to average A-12/V-12 scores. *Journal of Educational Psychology* 41: 110-115.

Deary, I.J., Strand, S., Smith, P. & Fernandes, C. (2007). Intelligence and educational achievement. *Intelligence* 35: 13-21.

Deary, I.J., Whalley, L.J. & Starr, J.M. (2009). *A Lifetime of Intelligence*. Washington DC: American Psychological Association.

Dutton, E. & Lynn, R. (2014). Regional differences in intelligence and their social and economic correlates in Finland. *Mankind Quarterly* 54: 447-456.

Eff, E.A. (2004). Spatial and cultural autocorrelation in international datasets. *Department of Economics and Finance Working Paper Series*, available at http://www.mtsu.edu/~berc/working/spatial%20autocorrelation%20z.pdf

Ellis, L. & Walsh, A. (2003). Crime, delinquency and intelligence. In: H. Nyborg (ed.), *The Scientific Study of General Intelligence*. Amsterdam: Elsevier.

Flores-Mendoza, C., Widaman, K.F., Mansur-Alves, M., da Silva Filho, J.H., Pasian, S.R. & Schlottfeldt, C.G.M.F. (2012). Considerations about IQ and human capital in Brazil. *Temas em Psicologia* 20(1): 133-154.

Folha de São Paulo (2015). Available at: http://www1.folha.uol.com.br/cotidiano/2015/10/1691547-casos-de-morte-violenta-intencional-aumentam-em-18-estados.shtml. Access: 23/07/2016.

Fortin, M.J., Dale, M.R. & VerHoef, J.M. (2002). Spatial analysis in ecology. In: A.H. El Shaarawi & W.W. Piegorsch (eds.), *Encyclopedia of Environmetrics*. Wiley Stats Ref: Statistics Reference Online.

Fuerst, J. & Kirkegaard, E.O. (2016). Admixture in the Americas: Regional and national differences. *Mankind Quarterly* 56: 255-373.

Gottfredson, L.S. & Deary, I.J. (2004). Intelligence predicts health and longevity, but why? *Current Directions in Psychological Science* 13: 1-4.

Grigoriev, A., Lapteva, E. & Lynn, R. (2016). Regional differences in intelligence, infant mortality, stature and fertility in European Russia in the late nineteenth century. *Intelligence* 55: 34-37.

Grigoriev, A., Ushakov, D., Valueva, E., Zirenko, M. & Lynn, R. (2016). Differences in educational attainment, socio-economic variables and geographical location across 79 provinces of the Russian Federation. *Intelligence* 58: 14-17.

Hassall, C. & Sherratt, T.N. (2011). Statistical inference and spatial patterns in correlates of IQ. *Intelligence* 39: 303-310.

Jones, G. (2016). *Hive Mind: How Your Nation's IQ Matters so Much More than Your Own*. Stanford: Stanford University Press.

Kanazawa, S. (2006). IQ and the wealth of states. *Intelligence* 34: 593-600.

Kaufman, S.B., Reynolds, M.R., Liu, X., Kaufman, A.S. & McGrew, K.S. (2012). Are cognitive *g* and academic achievement g one and the same? An exploration of the Woodcock-Johnson and Kaufman tests. *Intelligence* 40: 123-138.

Kirkegaard, E.O. (2015). The S factor in Brazilian states. *The Winnower*.

Kura, K. (2013). Japanese north–south gradient in IQ predicts differences in stature, skin color, income, and homicide rate. *Intelligence* 41: 512-516.

Laidra, K., Pullmann, H. & Allik, J. (2007). Personality and intelligence as predictors of academic achievement: A cross-sectional study from elementary to secondary school. *Personality and Individual Differences* 42: 441-451.

Léon, F.R. & Avilés, E. (2016). How altitude above sea levels affects intelligence. *Intelligence* 58: 33-41.

Lynn, R. (1979). The social ecology of intelligence in the British Isles. *British Journal of Social and Clinical Psychology* 18: 1-12.

Lynn, R. (1980). The social ecology of intelligence in France. *British Journal of Social and Clinical Psychology* 19: 325-331.

Lynn, R. (2010). In Italy, north-south differences in IQ predict differences in income, education and infant mortality. *Intelligence* 38: 93-100.

Lynn, R. (2011). *Dysgenics: Genetic Deterioration in Modern Populations*, 2nd revised edition. London: Ulster Institute for Social Research.

Lynn, R. (2012). North-south differences in Spain in IQ, educational attainment, per capita income, literacy, life expectancy and employment. Mankind Quarterly *52: 265-291.*

Lynn, R. & Cheng, H. (2013). Differences in intelligence across thirty-one regions of China and their economic and demographic correlates. *Intelligence* 41: 553-559.

Lynn, R., Sakar, C. & Cheng, H. (2015). Regional differences in intelligence, income and other socio-economic variables in Turkey. *Intelligence* 50: 144-150.

Lynn, R. & Vanhanen, T. (2012). *Intelligence: A Unifying Construct for the Social Sciences*. Ulster Institute for Social Research.

Lynn, R. & Yadav, P. (2015). Differences in cognitive ability, per capita income, infant mortality, fertility and latitude across the states of India. *Intelligence* 49: 179-185.

McDaniel, M.A. (2006). Estimating state IQ: Measurement challenges and preliminary correlates. *Intelligence* 34: 607-619.

G. Meisenberg (2014). Cognitive human capital and economic growth in the 21st century. In: T. Abrahams (ed.), *Economic Growth in the 21st Century: New Research*, pp. 49-106. New York: Nova Publishers.

Meisenberg, G. & Lynn, R. (2011). Intelligence: A measure of human capital in nations. *Journal of Social, Political and Economic Studies* 36: 421-454.

Montmollin, M. (1958). Le niveau des recrues du contingent. *Population* 13: 259-268.

O Estado de São Paulo (2016). Available at: http://www.em.com.br/app/noticia/nacional/2016/10/28/interna_nacional,818765/mortes-caem-1-2-no-paislatrocinio-cresce-7-8.shtml. Access: 08/11/2016.

Organization for Economic Cooperation and Development – OECD (2016). Available at: https://www.oecd.org/pisa/pisaproducts/.

Piffer, D. & Lynn, R. (2014). New evidence for differences in fluid intelligence between north and south Italy and against school resources as an explanation for the north-south IQ differential. *Intelligence* 46: 246-249.

Plomin, R., Kovas, Y. & Haworth, C. (2007). Generalist genes: Genetic links between brain, mind, and education. *Mind, Brain and Education* 1(1): 11-19.

Poropat, A.E. (2009). A meta-analysis of the five-factor model of personality and academic performance. *Psychological Bulletin* 135: 322-338.

Reeve, C.L. & Basalik, D. (2011). A state level investigation of the associations among intellectual capital, religiosity and reproductive health. *Intelligence* 39: 64-73.

Rindermann, H. (2007). The *g*-factor of international cognitive ability comparisons: The homogeneity of results in PISA, TIMSS, PIRLS and IQ tests across nations. *European Journal of Personality* 21: 667-706.

Rindermann, H. & Neubauer, A.C. (2004). Processing speed, intelligence, creativity, and school performance: Testing of causal hypotheses using structural equation models. *Intelligence* 32: 573-589.

Rindermann, H., Sailer, M. & Thompson, J. (2009). The impact of smart fractions, cognitive ability of politicians, and average competence of peoples on social development. *Talent Development and Excellence* 1(1): 3-25.

Roivainen, E. (2012). Economic, educational and IQ gains in eastern Germany 1990-2006. *Intelligence* 40: 571-575.

Savage, S.W. (1946). Intelligence and infant mortality in problem families. *British Medical Journal* 19 (Jan): 86-87.

Shatz, S.M. (2009). State IQ and fertility in the United States. *Mankind Quarterly* 49: 38-49.

Snyderman, M. & Rothman, S. (1988). *The IQ Controversy, the Media and Public Policy*. Transaction Publishers.

Sorjonen, K., Hemmingsson, T., Deary, I.J. & Melin, B. (2015). Mediation of the gravitational influence of intelligence on socio-economic outcomes. *Intelligence* 53: 8-15.

Templer, D.I. (2012). Biological correlates of northern–southern Italy differences in IQ. *Intelligence* 40: 511-517.

Woodley, M.A. & Figueredo, A.J. (2013). *Historical Variability in Heritable General Intelligence. Its Evolutionary Origins and Socio-Cultural Consequences*. Buckingham, UK: University of Buckingham Press.

Appendix 1. *PISA total scores and economic and social data for the 27 federative units of Brazil.*

Federative unit	PISA score	Higher educ.	Income	Infant mortality	Water available	Life expect.	Fertility	Poverty	Violence 2014	Violence 2015
Acre	378.1	8.98	522.2	23.0	47.24	71.63	2.95	15.59	26.83	25.3
Alagoas	351.4	6.90	432.6	28.4	75.64	70.32	2.22	16.66	66.48	50.8
Amapá	374.9	10.84	599.0	15.1	66.38	73.80	2.48	9.93	35.56	40.6
Amazonas	379.8	8.23	539.8	17.0	62.16	73.30	2.59	16.43	26.49	37.1
Bahia	370.6	6.40	496.7	21.7	77.60	71.97	2.05	13.79	41.42	41.7
Ceará	385.5	7.60	460.6	19.3	76.28	72.60	1.99	14.69	50.77	46.1
Distrito Federal	425.8	23.95	1715.1	14.0	96.01	77.35	1.75	1.19	25.84	23.4
Espírito Santo	421.4	11.06	815.4	14.2	96.01	75.10	1.80	2.67	42.21	37.4
Goiás	397.8	10.27	810.6	14.0	93.66	74.60	1.87	2.32	42.86	44.3
Maranhão	356.8	5.43	360.3	28.0	51.79	70.40	2.56	22.47	32.17	33.8
Mato Grosso	385.3	10.47	762.5	16.8	90.37	74.25	2.08	4.41	42.64	41.3
Mato Grosso do Sul	405.1	11.99	799.3	18.1	93.76	74.96	2.04	3.55	24.39	22.6
Minas Gerais	417.9	10.57	749.7	15.1	94.91	75.30	1.79	3.49	19.72	20.8
Pará	377.6	6.21	446.8	20.3	57.50	72.36	2.50	15.90	44.81	45.8
Paraiba	386.1	8.02	474.9	21.7	78.91	72.00	1.95	13.39	38.36	37.8
Paraná	416.6	12.75	890.9	13.1	96.69	79.80	1.86	1.96	25.35	25.2
Pernambuco	376.3	8.01	525.6	20.4	78.22	72.32	1.92	12.32	37.02	41.6
Piauí	378.7	7.29	416.9	23.1	67.12	71.62	1.99	18.71	22.92	20.8
Rio de Janeiro	396.1	14.41	1039.3	14.2	94.37	75.10	1.68	1.98	34.74	30.3
Rio Grande do Norte	375.5	8.32	545.4	19.7	85.06	72.52	1.98	10.33	49.99	48.6
Rio Grande do Sul	414.2	11.28	959.2	12.4	96.46	75.38	1.76	1.98	22.16	24.7
Rondônia	387.6	8.04	670.8	18.0	79.62	72.97	2.16	6.39	30.88	31.0
Roraima	376.6	10.16	605.6	16.1	74.04	73.51	2.41	15.66	14.69	18.2
Santa Catarina	418.8	12.53	983.9	11.5	97.00	76.61	1.71	1.01	13.77	14.3
Sao Paulo	409.0	15.10	1084.5	13.9	97.12	75.69	1.66	1.16	12.74	11.7
Sergipe	388.9	8.53	523.5	22.2	82.24	71.84	1.95	11.70	48.93	57.3
Tocantins	374.3	10.30	586.6	19.6	80.41	72.56	2.41	10.21	24.12	25.7

Appendix 2. *Difference scores between each state and its neighbors for PISA and economic and social variables.*

Federative unit	Neighbors	PISA score	Higher educ.	Income	Infant mortality	Water available	Life expect.	Fertility	Poverty	Violence 2014	Violence 2015
Acre	Amazonas, Rondônia	-5.6	0.85	-83.2	5.50	-23.65	-1.51	0.58	4.18	-1.86	-8.75
Alagoas	Bahia, Pernambuco, Sergipe	-27.2	-0.75	-82.7	6.97	-3.71	-1.72	0.25	4.06	24.02	3.90
Amapá	Pará	-2.7	4.63	152.2	-5.20	8.88	1.44	-0.02	-5.97	-9.25	-5.20
Amazonas	Acre, Mato Grosso, Pará, Roraima, Rondônia	-1.2	-0.54	-61.8	-1.84	-7.59	0.36	0.17	4.84	-5.48	4.78
Bahia	Alagoas, Espirito Santo, Goiás, Maranhão, Minas Gerais, Pernambuco, Piaui, Sergipe, Tocantins	-14.2	-2.30	-83.4	1.14	-2.40	-0.70	-0.01	2.62	4.04	4.76
Ceará	Paraiba, Pernambuco, Piaui, Rio Grande do Norte	6.3	-0.31	-30.1	-1.93	-1.05	0.49	0.03	1.00	13.70	8.90
Distrito Federal	Goiás, Minas Gerais	17.9	13.530.	935.0	-0.55	1.73	2.40	-0.08	-1.72	-5.45	-9.15
Espirito Santo	Bahia, Mato Grosso, Rio de Janeiro	26.5	0.600.	53.5	-2.80	7.05	0.98	-0.04	-3.75	10.25	6.47
Goiás	Bahia, Distrito Federal, Mato Grosso, Mato Grosso do Sul, Minas Gerais,Tocantins	1.3	-3.79	0.2	4.82	-3.55	-2.00	-2.00	-2.00	-2.00	-2,002
Maranhão	Bahia, Pará, Piaui, Tocantins	-18.5	-2.11	-126.4	6.83	-18.87	-1.73	0.32	7.82	-1.15	.30
Mato Grosso	Amazonas, Goiás, Mato Grosso do Sul, Pará, Roraima, Tocantins	-1.7	1.31	120.2	-1.03	12.52	0.79	-0.18	-4.72	10.38	6.88
Mato Grosso do Sul	Goiás, Mato Grosso, Paraná, São Paulo	2.9	-0.16	-87.8	3.65	-0.70	-1.13	0.17	1.09	-6.51	-8.03
Minas Gerais	Bahia, Distrito Federal, Espirito Santo Goiás, Mato Grosso do Sul, Rio de Janeiro	14.5	-0.36	-0.4	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0,362
Pará	Amapá, Amazonas, Maranhão, Mato Grosso, Roraima, Tocantins	3.00	-3.02	-128.9	1.53	-13.36	-0.61	0.08	2.72	15.53	13.02
Paraiba	Ceará, Pernambuco Rio Grande do Norte	7.0	0.04	-35.6	1.90	-0.94	-0.48	-0.01	0.94	-7.57	-7.63
Paraná	Mato Grosso do Sul, Santa Catarina, São Paulo	5.6	-0.46	-65.0	-1.40	0.73	4.05	0.06	0.05	8.38	9.00
Pernambuco	Alagoas, Bahia, Ceará, Paraiba, Piaui	1.9	0.77	69.3	-2.44	3.11	0.62	-0.12	-3.13	-6.97	2.16
Piaui	Bahia, Ceará, Maranhão, Pernambuco	6.4	0.43	-43.9	0.75	-3.85	-0.20	-0.14	2.89	-17.43	-20.00
Rio de Janeiro	Espirito Santo, Minas Gerais, São Paulo	-20.0	2.17	156.1	-0.20	-1.64	-0.26	-0.07	-0.46	9.85	7.00
Rio Grande do Norte	Ceará, Paraiba	-10.3	0.51	77.6	-0.80	7.47	0.22	0.01	-3.71	5.43	6.65
Rio Grande do Sul	Santa Catarina	-4.6	-1.25	-24.7	0.90	-0.54	-1.23	0.05	0.97	8.39	10.40
Rondônia	Acre, Amazonas, Mato Grosso	6.5	-1.19	62.7	-0.93	13.03	-0.09	-0.38	-5.75	-1.11	-3.57
Roraima	Amazonas, Pará	-2.2	2.94	112.3	-2.55	14.21	0.68	-0.14	-0.51	-20.96	-23.25
Santa Catarina	Paraná, Rio Grande do Sul	3.4	0.52	58.8	-1.25	0.43	-0.98	-0.10	-0.96	-9.99	-10.65
Sao Paulo	Goiás, Mato Grosso do Sul, Minas Gerais, Paraná, Rio de Janeiro	0.1	2.67	214.7	-1.23	2.19	-0.60	-0.18	-1.59	-13.31	-13.03
Sergipe	Alagoas, Bahia	27.9	1.88	58.9	-2.85	5.62	0.70	-0.19	-3.53	-5.02	11.05
Tocantins	Bahia, Goiás, Maranhão, Mato Grosso, Pará,	-3.4	2.49	11.2	-0.56	6.23	-0.16	0.20	-1.57	-16.66	-15.68